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THE IMPERIAL AGRICULTURAL RESEARCH CONFERENCE.

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THE Imperial Agricultural Research Conference, which met in October, had two unusual features. It was the first conference of the kind to be held within the Empire, and it was probably the most nearly world-wide gathering of agricultural experts ever summoned in history. Secondly, unlike other Imperial Conferences, it did not " stay put " in London. Instead, delegates travelled as far north as Aberdeen, as far west as Aberystwith, and visited Belfast. In this way all the more important centres of research in Great Britain and Northern Ireland were inspected by some, at least, of the oversea visitors. The full report of the Conference shows in detail how it came to be called, what decisions it reached and who attended it. No one concerned with the efficient management of agriculture either in this country or elsewhere in the Empire can afford to overlook this report. In the following pages I can only summarise what will be found in that document, adding a few comments of a more informal kind.

There have, for several years, existed at least some bones of a skeleton framework of co-operation in agricultural research within the Empire. The Royal Botanical Gardens, Kew, and the Imperial Bureaux of Entomology and Mycology have Empire-wide functions, and there has, further, been some interchange of individual workers in the various branches of agricultural science. But it was felt that a more complete system of co-operation within the Empire should be developed. Accordingly a proposal for holding an Imperial Agricultural Research Conference was considered by the Research Special Sub-Committee, which was appointed, under the chairmanship of Lord Balfour, by the Imperial Conference in 1926. This proposal was approved by the Sub-Committee and subsequently a favourable resolution was adopted by the full Conference.

The delegates, who were welcomed by the Minister of Agriculture in Westminster Hall on October 4th, 1927, were, therefore, meeting with the formal approval of all the Dominion Governments. The Colonial Governors' Conference, which had sat earlier in the summer, had similarly expressed itself favourable from the point of view of the Crown Colonies and Mandated Territories. In short, the Agricultural Conference, which had been suggested by the Home Government, had willingly been taken up by all oversea Empire Governments without exception.

The agenda was very roughly divided under three headings :—

(1) Recruitment, training and interchange of workers.
(2) Chain of research stations.
(3) Imperial bureau and interchange of information.

The Conference appointed an Administrative Commission under the chairmanship of Lord Bledisloe, which in turn appointed a separate committee for each of these three questions, with Mr. Engledow, Major Elliot and Sir Robert Greig as Chairmen.

As there were about 170 delegates present, the full sessions of the Conference naturally required efficient handling if they were to pass off satisfactorily. In the event, all interested parties, representatives of the smaller Colonies no less than those from the Dominions, were given ample opportunities of stating their views, and the general feeling was, I think, that proceedings passed off most satisfactorily.

Before turning to a brief consideration of the formal results achieved by the Conference, I should refer to its no less valuable, though officially unrecorded, effects. The delegates were thrown together for a month. They met officially in Westminster Hall and in the numerous specialist committees. They visited together the great research stations of Cambridge, Edinburgh, Aberdeen and Belfast. They were also given an opportunity of inspecting the remarkable results achieved in a very brief space of time by Imperial Chemicals, Ltd., at Billingham in Durham. The delegates were there the guests of Sir Alfred Mond and his fellow directors, who are engaged on the mass production of synthetic nitrates—an enterprise that concerns agriculturists in most parts of the Empire, including, of course, the home country.

In the course of all these goings and comings, in the extremely comfortable special train in which they spent many hours, and over lunch and dinner tables, the delegates were able, in the space of a few weeks, to do what they could never have done by years of official correspondence. The work of facilitating the interchange of knowledge from one corner of our scattered Empire to the opposite has, on the evidence of the delegates themselves, been vastly speeded up as a result of what happened outside the formal Conference.

It was unanimously agreed that this line of approach towards efficiency in the business of managing the Empire's economic affairs is too good not to be repeated. An invitation was received from the Australian Government to hold the next conference of this kind in Australia five years hence, in 1932, and the invitation was warmly accepted.

Turning to the formal results of the Conference, that concerned with the chain of tropical and sub-tropical research stations may be taken first. One such station already exists, while the framework of another is already in process of being prepared. The Imperial College of Tropical Agriculture in Trinidad has now been at work for several years and has trained men for service all over the tropical Empire. The Amani Institute (which the Germans founded in Tanganyika), after having been allowed almost to disappear, is now being restored by joint contributions from the East African Governments and from the Empire Marketing Board Fund, and has been put under the direction of that distinguished and experienced scientist, Dr. Nowell. But these two stations, even if they were both in full working order, would be very far from adequate to meeting the needs of our swiftly extending interests in the tropics. One quarter of the whole Empire lies in the tropics, and we, and indeed the whole world, are becoming more and more dependent upon them, both for foodstuffs and for raw material. As their economic fertility is matched by the appalling losses they suffer through our at present imperfect control of the forces of nature, the need for better organised and more intensive research is urgent.

A Committee, under Lord Lovat, is working out the details of a scheme for setting up a chain of tropical research stations, and for satisfying the local interests of the colonies concerned as well as those of the tropical area as a whole. The Research Conference approved the project in principle and laid down several considerations which should govern the setting up of any particular station. The Report states that the establishment of such stations should be governed primarily by the ascertained needs of Empire research in particular fields of agriculture, rather than by considerations of geographical distribution. A central research station to deal with irrigation was further suggested, and it was recommended that this need should be brought to the notice of the Lord President of the Council with a view to the appointment of a sub-committee of the Committee of Civil Research to investigate and report upon it, including its engineering, medical, agricultural, chemical and physical aspects.

The setting up of bureaux for the interchange of information of value to workers in soil science, animal nutrition and animal health was approved. Rothamsted and the Rowett Institute were recommended for the two first, respectively, and London for the third. Clearing-houses on a smaller scale to be called "correspondence centres" were recommended for Animal Genetics and Animal Breeding at Edinburgh; Agricultural parisitology, Institute of Agricultural Parasitology and London School of Hygiene and Tropical Medicine; Plant Genetics, the Plant Breeding Institute, Cambridge, and the Aberystwyth station (for herbage plants), and finally Fruit Production, East Malling. £13,000 for a bureau and £7,000 for a correspondence centre were considered a reasonable annual cost.

Recruitment and training were dealt with in a report which emphasised the urgent need in an Empire so overwhelmingly agricultural as is the British for the very best type of men as agricultural research workers. A flourishing agriculture throughout the Empire was described as the best guarantee of a market for Empire manufactures. It was, therefore, suggested that the founding of scholarship schemes to promote agriculture deserved the attention of all industries. So far as official action was concerned, the present Colonial Office scheme, strengthened and extended to include veterinary subjects, was described as adequate for the present. Finally, the inadequacy of existing facilities for the interchange of workers was stressed.

This in brief is the account of the results foreshadowed by the Conference and of the stimulating atmosphere in which it worked. Time will inevitably be needed before all its recommendations are put into practice, but already the necessary preliminary steps are being taken.

THE CROFTING PROBLEM, 1790-1883.

MARGARET M. LEIGH, M.A.

I.—THE STATE OF AGRICULTURE IN THE WESTERN HIGHLANDS AND ISLANDS AT THE END OF THE EIGHTEENTH CENTURY.

THE western Highlands and Islands, where the social and political system of the middle ages lingered among a people cut off as much by language and traditions as by seas and mountains from the march of civilisation in the south, formed the last stronghold of the unimproved agricultural practices once general in Scotland as a whole. The victory of Culloden not only destroyed the feudal power of the Highland chieftains, but opened up large tracts of country to the trader, the capitalist sheep-farmer, and the curious traveller, whose accounts of the barbarous and horrid customs of the natives directed public attention to the agricultural problems of a remote and unknown part of the kingdom. At the end of the eighteenth century the condition of the Highland crofters aroused as much interest and controversy as it did a hundred years later. Between 1790 and 1820 a stream of books, reports and pamphlets appeared, many of them official, describing the existing state of affairs and proposing improvements. The pacification of the Highlands was not to be effected merely by the building of roads and forts, but by the encouragement of local industries and the introduction of the improved husbandry of the lowland districts. By these means it was hoped that the increased value of the land would enable landlords and principal tacksmen to live in the style of their southern counterparts, and small tenants and sub-tenants to form a class of industrious and contented agricultural labourers. But natural difficulties, and the unprecedented increase of population in the first half of the nineteenth century, doomed these hopes to disappointment. The independence of the clans was broken, and became no more than a romantic tradition; but the Report of the Commission of 1883 reveals a world in which St. Columba would not have felt himself a stranger. It will be worth while to describe in some detail the primitive condition of agriculture which prevailed at the end of the eighteenth century, since in many ways it depended on factors which have not ceased to operate, and must be taken into account in making any schemes for future improvement.

The break-up of the clan system left the Highland proprietor in no very different position from the English landlord, except that his revenues were more precarious and the temptations to non-residence greater. The management of estates was too often left to factors, but apart from this, the landowning class as a whole requires no special comment. As in other places, the character and policy of the individual was all-important.[1]

I.—TENURES.

(1) *Tacksmen.*—Land was held in three different ways: (1) on lease by tacksmen, or gentlemen farmers; (2) without lease by tenants at will; (3) without lease by sub-tenants. Tacksmen were often relations of the proprietor, and, in however rude a way, lived as gentlemen, maintaining a large and wasteful retinue of servants. They held directly from the proprietor; their rents in most cases fell between £20 and £55, and their leases were for 19 years' duration. Farms were often let by auction to the highest bidder, a practice which the landlords defended on the ground that they could not otherwise discover the value of their land. This system discouraged improvements,[2] and in any case it was complained that the highest bidder was often not the substantial tenant, but an adventurer who had nothing to lose and was willing to gamble.[3] Larger tenants were often non-resident. Successful men with capital added farm to farm, a practice which suited the landlords, as it reduced the expenses of upkeep and management to a minimum.[4] The terms of leases were vague, and contained no restrictions on sub-letting. This vagueness was the source of much evil, and Dr. Walker,[5] whose book contains many reasonable if not always feasible suggestions for improvement, proposed that landlords

[1] See James Macdonald, Agricultural Survey of Hebrides (1811), p. 70.

[2] Pennant, who visited the Hebrides in 1774, remarks that in Arran it was customary to let the farm down at the end of the lease, lest a better price should be offered by an outsider (Voyage to Hebrides, p. 176) In the last decade of the 18th century, leases of 25 years were given in Lochcarron, which led to much improvement. (Sinclair, Statistical Account, xiii, p. 553.)

[3] John Smith, Agricultural Survey of Argyllshire (1798), p. 39.

[4] The system of "led farms" is still very common in Scotland, and is encouraged by the high cost of building and repairs. Lowland arable farmers who sell fat stock often have a West Coast grazing farm to supply their own stores.

[5] Economical History of the Hebrides, 1812. embodying the results of six journeys made from the Clyde to Cape Wrath between 1760 and 1786. He held a commission from the Royal Commissions on the Annexed Estates to enquire into the natural history, agriculture, manufactures and fisheries of this district.

should undertake to supply timber for building, enclose kitchen gardens, take rent in money instead of kind, commute all services and casualties, give premiums for reclaimed waste, and ask no rent for fallowed land. They were also to forbid sub-letting except by special permission, restrain continuous cropping, insist on the raising of green crops, confine the cultivation of potatoes to waste land, and abolish wasteful practices like the use of straw for thatching and the making of graddan bread.[1]

On the whole, if we remember that farming was undertaken not as a commercial enterprise but purely for maintenance, the tacksmen were not in an unenviable position. They were independent, and having a small idea of comfort as judged by southern standards, could satisfy their ordinary needs. It was said that a Highland farmer was contented if at the end of the year he could make his income balance his expenditure,[2] a state of things possible only when everything in daily use is produced at home. As Loch[3] puts it :—" Every man was his own mason, carpenter, tanner, shoemaker, &c., and Mr. Falconer, the factor, told us that work could not be done in the country for love or money. Every man wore his own cloth, ate his own corn and potatoes, sold a lean Kyloe to pay his rent, had no ambition for any comfort or luxury beyond the sloth he then possessed." The income of tacksmen must have been further diminished by the maintenance of an excessive number of servants. This was commented upon by all observers. A farm rented at £20 would employ 12 of 14 servants of both sexes, twice the number that would be found on a corresponding farm in the Lowlands.[4] The reasons are not far to seek. The gentleman farmer, his head still full of feudal notions, liked to surround himself with a crowd of dependants. Inefficient husbandry made excessive demands upon labour, while the lack of day labourers made it necessary to maintain through the year a staff large enough to meet the needs of seasonal work.[5] Wages, though they were rising throughout the last years of the eighteenth century, were still very low,[6] and maintenance exceedingly cheap. Unmarried

[1] A method of roasting the grain before grinding in the quern, which involved setting fire to the whole of the straw.

[2] Smith, Agricultural Survey, p. 57.

[3] James Loch, Improvements on the Sutherland Estate, 1820.

[4] Walker. i, p. 82.

[5] All agricultural reformers were anxious to create a class of day-labourers by turning sub-tenants into part-time crofters, free from services, who could hire themselves out for seasonal work.

[6] Some idea of wages in different districts, 1790-1800, can be obtained from the following:—

1791.	Applecross (Ross) ...	Men, £2, 8s. Women, £1, 10s.	(Statistical Acc., iii, p. 375.)
1793.	Craignish (Argyll) ...	Men, £4, 10s.–£6. Women £2, 10s.–£3.	(„ vii, p. 443.)
1797.	Stornoway	Men, £2–£5. Women, £1, 10s.	(„ xix, p, 252.)
1797.	Uig (Lewis)	Men, £2. Women, 10s.–5s.	
1799.	Argyllshire	Men, £8. Women, £3.	—(Smith, Agr. Survey, p. 57.)

N.B. Argyll is in every respect a more advanced district.

servants were lodged in the farm-house, those with families often had a cottage with grazing. In many cases the wages included two pairs of shoes.

(2) *Tenants at will.*—The smaller farms, usually producing less than £20 of rent, were occupied by tenants at will. Technically, these men could be evicted at the landlord's good pleasure, but in earlier times, when numerous small tenants were an asset for defence, they had little to fear from the absence of legal security.[1] But when the hope of increased rents from capitalist sheep-farmers made Highland proprietors forget their traditional obligations, the evils of the system became apparent. The relation between landlord and tenant was completely changed. "The patrimonial notions," says a contemporary,[2] "are mostly exploded, and the whole transaction between landlord and tenant is purely a matter of paction, into which not a particle of affection enters on the part of the former, nor of gratitude on the part of the latter. He no longer considers himself as the father and protector of his people, nor do they feel or cherish the dutiful regards of children; all these sweet endearments are dissipated and endure no longer." An occasional landlord preferred to sacrifice his profits and keep on the old tenantry,[3] but as time went on such men became rarer. Without security of tenure, no small tenant found it worth while to improve his holding. The duty of erecting and repairing farm buildings, being as much a domestic concern as the making of gates and fences, lay with the tenant alone, and this acted as a further check upon improvement. The majority of small tenants occupied their farms under the ruinous system of runrig, which had long been abandoned in other parts of Scotland, and was incompatible with any progress in agriculture. Each farm was occupied by a group of tenants known as a township, and the land was let to the whole body, who bound themselves conjointly and severally for the payment of the whole rent. The total amount was settled by the factors, and this, together with the lands, was apportioned by a committee of elders among the different occupiers. In case of default the whole body was responsible. The pasture was held in common, and each man put his own stock upon it. Theoretically there was a definite quota or "souming" of live stock, in proportion to the rent paid, but in practice the number was often unlimited.[4] The arable was

[1] The Statistical Account, vi, p. 239 (parish of Eddrachylis), shows that in Sutherland the small tenants were not unprosperous. "For upon a farm of 20*s.* or sometimes only 10*s.* rental, many families want none of the necessaries of life, having bread and potatoes, fish and some flesh, wool and clothing, milk, butter and cheese, all the fruits of their own industry and produce of their farms." This was in 1793. The Sutherland Clearances were not in full swing till 1807.

[2] Agricultural Survey of Inverness-shire, p. 85.

[3] In 1786, a threefold increase of rent was offered to the owner of a vacant farm in Glenshiel, but it was refused, and the land relet to the old occupiers at a small increase. (Statistical Account, vi, p. 128.)

[4] In many places, land had three valuations, penny, half penny, and farthing land. The souming for penny land was 25 cattle, with a proportionate number of horses and sheep. The grazing unit was generally reckoned as a cow and her "followers," i.e., one calf, one yearling, one 2-year-old, one three year-old. One cow was equal to 5 or sometimes 6 sheep.

divided into individual lots, which were redistributed every year, so that the shares might be equalised. There were no enclosures, and after harvest the arable was thrown open to grazing. It will be seen that this system put a premium on poor cultivation, and dragged everyone down to the level of the lowest. The runrig holding was not a club farm, held and managed by the representatives of the community on behalf of the whole, but a group of individuals, each having his private stock and exclusive share of arable. The principle of occupation was pure individualism, only under such conditions that none of its benefits could arise. The good husbandman could not improve, because he lacked two essential conditions, the right of continuous occupation and the right of enclosure. He could not bring under the plough a fertile stretch of pasture, because by so doing he would encroach upon the rest. He could not depart from the customary cropping, as next year his strip would belong to someone else. He could not introduce a better breed, because of the impossibility of segregation, nor if the pasture were overstocked was it any use to limit his own souming, as his neighbours would take advantage of this to increase theirs. The system was condemned by everyone interested in the progress of agriculture, and its abolition was the first step towards improvement.[1] Yet in the more remote islands it lingered until a comparatively recent date.

(3) *Sub-tenants.*—The practice of sub-letting small parcels of land was the most serious abuse in the rural economy of the Highlands. In course of time it led to reckless increase of population and exhaustion of the soil to the point where it would no longer support a fraction of those who sought to live upon it. These sub-tenants, holding from tacksmen or larger tenants, with no direct connection with the landlord, were already numerous, and continued to increase till they formed the wretched class of cottars and squatters on whom the Royal Commission of 1883 issued a separate report. A farm of £30 rental might support ten sub-tenants with their families, who, together with the tacksman's family and a dozen servants, might make 70 persons in all.[2] In Arran a farm rented at £40 had 18 occupiers.[3] In Skye some farms were sub-let in Steel-bow, together with the whole stock and equipment, which the sub-tenant must produce in the same condition or pay the difference. The rents, though low in actual amount,[4] were excessive in proportion to the land occupied, for the profits of sub-letting rather than of farming enabled the superior tenants to pay their own rent. In Canna,

[1] Runrig was abolished on the Duke of Argyll's estates in 1776 and on the Sutherland estates in 1816.

[2] Walker, i, p. 54. He proposed that one-quarter of cultivable land should be allotted to large farms rented at £20–£100, the remainder to small farms at £1–£20, and that sub-letting be abolished.

[3] Pennant, p. 176.

[4] As a rule, between 15*s.* and 40*s.* According to the Statistical Account, sub-tenants in Stornoway parish were able to make a living in non-agricultural pursuits. They paid 30*s.* to 60*s* in rent, together with 12 days' service. They were employed in fishing ling, which they sold to their tacksmen at 5*d.* each, engaged on herring boats at £1 monthly, made kelp at 30*s.* per ton, and roads at 8*d.* a day. (Statistical Account, 1797, xix, p. 243.)

when Pennant visited it in 1776, the proprietor's factor occupied most of the island, paying 2 guineas to the landlord for each penny land, and sub-letting the same for 4½ guineas plus three days' labour in the quarter. The position of a sub-tenant was not improved by the vexatious system of casualties or payment in kind and services or forced labour, which were justly described by a contemporary writer as " a gothic medley, which created much perplexity to all parties." Forced service was a remnant of feudalism which was kept alive by the shortage of day labourers, and receipt of payments in kind was a means of stocking the landlord's larder and granary in districts where provisions could not be bought. The system of services was ruinous to the small holder, as his labour was wanted at the very moment when his own holding required most attention. How the system worked in detail may be seen from a table given in Appendix I to Loch's Account of the improvements on the Sutherland Estates (1820).

The farm of Kintradwell in Sutherland was in 1819 let to a single tenant, Mr Houston, " an active and intelligent gentleman of this county." Before that it had been granted in wadset (mortgage) and the wadsetter had let it to a tenant, who in turn let it to a numerous class of inferior tenants, some of whom again sub-let to others. The rental of 1811, payable to the sub-tenant for that part of the lands relet by him, is given as follows :—

	Conversion of Servitudes.	*Conversion of Casualties.*
Money Rent	...	£145 19 7
Victual, 17¼ bolls at 25*s.* per boll ...	...	21 11 3
Casualties.		
78 Hens at 1*s.* each	...	3 18 0
55 doz. eggs at 6d. per doz.	..	1 7 6
Servitudes.		
Harvest work, 138 days at 2*s.* per day ...	£13 16 0	...
Threshing 144 stooks at 2*d.* per stook .	1 4 0	...
Casting and spreading peats, 38 days at 1*s.* per day	1 18 0	...
Repairing peat road, 20 days at 1*s.* 3*d.* per day	1 5 0	...
Leading ware. 250 horses at 1*s.* 6*d.* per head	18 15 0	...
Clearing hay land, 28 sub-tenants, say 1 day each of man and horse	2 16 0	...
Covers for kiln-drying, 9 at 4*s.* each ...	1 16 0	...
Thatching houses	1 0 0	...
Besides the above 40 sub-tenants, there were 28 whose services may be estimated at 10*s.* each	14 0 0	...
		56 10 0
Total payments		£229 6 4

Rents.—The last half of the eighteenth century brought a great rise in rents. After the '45, the chiefs ceased to be petty monarchs and no longer required the services of a numerous tenantry. They were reduced to the position of other proprietors, and as they mixed more in English and Lowland society, they saw that their rents were far below those received for land of equal quality elsewhere. By degrees they exacted increases, and were fortunate enough to find the southern sheep-farmers, who had begun to invade the Highlands, able and willing to pay almost any price for a stretch of rough hillside. As Loch puts it :—"The demand for raw material for wool by the English manufacturers enabled the Highland proprietor to let his lands for quadruple the amount they ever produced to him."[1] They were further able to justify themselves by the reflection that the increased prices of store cattle[2] made it easier for native tenants, whose income depended upon stock-raising, to pay higher rents. James Macdonald[3] attributes the rise in rents to the increase of population and the Highlander's partiality for land, which made him demand it at any price. A few examples will show the rapid and startling increase. Pennant remarks that in 1750 the total rental of Skye, which then had 13,000 inhabitants, was £3,500, while in 1774 this figure was doubled or trebled. A farm, formerly rented at £16, then fetched £50. In North Uist, the Statistical Account[4] shows the same tendency. In 1763 the total rental, including the kelp shores, was £1,200. By 1771 it had risen to £1,800 and in 1794 reached 2,100, besides the profit from the sale of 800 tons of kelp, which on account of the fluctuations of price could not be accurately estimated. On the Torridon estates (Western Ross) the increase was still more striking.[5]

1777	£80
1781	£130
1792	£240
1798	£300
1805	£800

II.—CULTIVATION.

Most Highland farms were divided into infield and outfield, according to the system that once prevailed all over Scotland. The infield, which lay round the steading, consisted generally of a light loam of deep black colour, continuously cropped with oats and barley. Having been in tillage from time immemorial, it was said to be remarkably free from weeds.[6] It received all the dung produced on the farm. Divided into three plots or kevels, it was manured once in three years, and produced a crop of barley and two of oats. Dr. Walker thought it worth from 20*s*. to 30*s*. an acre.

The outfield usually consisted of light gravelly soil on the skirt of the hill, and was never manured except by the folding of

[1] Improvements on Sutherland Estates, p. xvii.

[2] In consequence of the extension of green crops and the impetus this gave to the trade in fat cattle, Pennant estimated that 4,000 cattle were exported annually from Skye at £2–£3 a head, and 1,700 from Islay at 50*s*. a head

[3] Agricultural Survey of Hebrides p. 188. According to this account, the usual rent in the islands was 25*s*. for each cow with followers, and 5*s*. for each ewe with followers (i.e. one 2 year-old, one yearling, one or two lambs) Ib., p. 146.

[4] Statistical Account, xiii. p. 309.

[5] Stewart Mackenzie, Agricultural Survey of Ross and Cromarty, p. 236.

[6] This is a little hard to believe when land was never cleaned by a root crop, and in a cool, moist sunless climate which specially favours the growth of weeds.

cattle in summer. It was left ley from four to seven years and then yielded three successive crops of oats.[1] It was valued at 2s. to 3s. an acre. This system Dr. Walker proposed to alter as follows.[2] The infield was to be devoted to sown grasses, roots and beans without manure, while all the dung was to be used for the improvement of the outfield, in which crops were to be raised in a seven-year rotation, thus :—(1) fallow, with lime, marl or shell-sand; (2) oats; (3) roots; (4) barley with seeds; (5) clover hay; (6) pasture; (7) pasture. Where the land was in good heart, oats were to take the place of fallow in the first year.

The chief obstacles to good cultivation, apart from conditions of soil, climate, and tenure were (1) inadequate tillage operations; (2) late sowing; (3) bad seeds; (4) continuous cropping; (5) scarcity of manure; (6) absence of enclosure; (7) general ignorance.

Inadequate Tillage.—No ploughing was done before Candlemas, and little if any before March. It was said that the autumn and winter rainfall was too heavy; manure would be wasted, and the effects of tillage obliterated; low-lying fields would get puddled, and the light gravelly soils of hillsides be washed away. There is of course much sense in this, but a good deal depended on local conditions and variations of climate. There must have been many seasons in which autumn tillage would have been beneficial, and the work could have been done at a time when men were otherwise unemployed and horses in good condition. As it was, all operations were crowded into the late and congested spring season, when the privations of winter made many horses unfit for work. Nor were the implements generally employed very helpful. The modern two-horse plough had found its way on to few gentlemen's farms, but smaller men used the native plough, "a singular and feeble instrument." It had but one stilt, and a wooden mould-board attached by leather straps; it was drawn by four horses abreast, led by a man who walked backwards in front of them and urged them forward by striking them on the face. Another man was required to guide the plough, and a third to follow with a spade and rectify the furrow. On rough land it was often preceded by the reestle, a kind of grubber with a single sickle-shaped coulter, which was drawn through the soil at a depth of about 8 ins. to clear tough roots and other obstacles from the track of the plough. This implement was worked by one man and two horses, so that the whole operation of ploughing might require five horses and four men.

On the smaller crofts, especially in rough and stony places, the plough gave way to the caschrom or crooked spade, an instrument about 6 feet long having a thick wooden head shod with iron. This spade cultivation, wasteful as it was in time and labour,[3] was much more efficient than the scratching of the

[1] In Lewis, the yield of meal from 1 boll of oats was reckoned as 12–14 pecks from infield land, and 20–25 pecks from outfield.

[2] I., p. 178.

[3] Walker reckoned that one man, working from Christmas till the end of April, could dig enough land to sow 5 bolls of oats.

unimproved plough, and in its proper place won the praise of most observers. According to Walker, poor ley land, which yielded only threefold to the plough, would give a fivefold return to the caschrom, and Osgood Mackenzie,[1] writing in 1920, compares its results very favourably with those given by careless ploughing with borrowed teams.

The harrows commonly employed were like large hay rakes with wooden teeth. They were often dragged by hand[2] or tied to the tail of a horse.[3] Such implements were of little avail to pulverise the soil; their chief use was in covering seeds.

Horse-hoeing was scracely practised anywhere. All improvers were anxious to introduce green crops not merely to supply winter feed for stock, but for the sake of cleaning the land, for as the grain crops were broadcast and no fallowing practised, the destruction of weeds was a matter of great difficulty. The Duke of Argyll[4] comments on the choked state of his crofters' arable in Tiree.

Late Sowing.—The evils of late sowing are mentioned by all observers. It is true that after a wet winter, when the land has lain untouched, the soil is often too water-logged for the making of a proper seed-bed and the germination of seed. But most Highland soil is light and forward, and after a mild and not excessively rainy winter much land could be sown earlier, provided that ploughing had begun in good time. But oats were rarely sown before the end of April and barley not often before the end of May,[5] with the result that the crops were not harvested until the equinoctial storms made their condition most precarious. In the case of barley, a quickly maturing crop, the unnecessary delay was specially unfortunate, as if sown a month earlier it could normally be harvested in good condition. Walker remarks that at Gairloch in 1762 oats sown on April 10 were reaped on September 8, while in Tiree barley sown on April 28 was reaped on July 22. This must be exceptional. The summer of 1762 may have been like those of 1925 and 1926, and in any case the rainfall in Tiree (35–40 ins.) is comparatively low, sunshine records good, while Gairloch, with no very high mountains in the immediate neighbourhood, has a rainfall not exceeding 50 ins. In Snizort (Skye) the crop was rarely got in before the beginning of November, often much later.[6]

The low yield of crops was partly caused by the use of poor and degenerated seeds. No seed from other districts was introduced, while the best grain and finest potatoes were always used

[1] Osgood Mackenzie. A Hundred Years in the Highlands.

[2] Pennant noticed that in Skye this was a woman's job. As Loch puts it: "The burthen of work was cast upon the females." The men deemed such an occupation unworthy of them, continued labour of any sort being most adverse to their habits." (Sutherland Improvements, p. 63.) This attitude has not altogether ceased.

[3] Young colts were often broken in by this barbarous method.

[4] Crofts and Farms in the Hebrides (1884), p. 32.

[5] The Statistical Account, iv, pp. 70–91, gives the dates of seed-time and harvest at Gairloch as follows:—Oats, mid-March to late April; Barley, early May to mid-June; Harvest, late August to mid-October. These dates are on the early side, but Gairloch is a forward district.

[6] Statistical Account, xvii, p 182, cf. Stornoway, xix, p. 250.

for food and the worst reserved for seed. "White Oats," says the Statistical Account,[1] "yield a better return (i.e. than grey), but, if new seed be not procured, in the course of a very few years degenerate to the quality of small oats."

Continuous Cropping.—Continuous corn-cropping was one of the worst features of Highland agriculture. The natural fertility of the soil in many places, especially in parts of the outer isles, is commented on by all observers from the sixteenth century onwards, otherwise the production of crops would have been impossible, so continuously was the land "scourged" with cereals. The ordinary practice was to raise successive crops of oats and barley on the infield, while potatoes, which in the absence of any other cleaning crop might have been alternated with them, were cultivated in lazy beds. The rotation system, with its insistence on root cultivation, was unknown, except possibly on a few gentlemen's farms. And the fact that cereals, on account of transport difficulties, were chiefly used for human food, made fallowing seem the waste of a season.[2] This was specially true in the first half of the nineteenth century, when the population rose to its highest level and crofts were so far subdivided that neither rotation nor fallowing was possible. In Tiree, a fertile and densely populated island, the poorer tenants tried to increase their arable plots by ploughing up sandy downs which in grass formed excellent pasture, but when broken up became a mere waste of blown sand, useless for any purpose whatever.[3]

Lack of Manure.—Before the introduction of artificial fertilisers farmers were confined to the use of dung, seaweed, lime, marle, shell-sand, &c. Of these, the two first alone were extensively used in the Highlands. Improvers were keenly interested in lime, since much Highland soil is very acid, while limestone, which could be burnt in peat kilns, can be found in many places. Along the coast were banks of shell-sand, but the absence of roads made inland transport impossible, and in any case there was no capital to finance ambitious schemes of land improvement. Farmyard manure was small in quantity, and, as the animals received no concentrated food, not very rich in quality. As most cattle were unhoused in winter, a large proportion was lost altogether, though a certain amount was retained on the land by the practice of folding. Bracken was largely used for litter, thus making good the deficiency of straw. Seaweed, a useful manure, especially for potatoes, which require potash, was available on the coast, and a great majority of Highland crofts were, and are still, situated near the sea-shore. Much of it, however, was wasted by being left to dry in thin layers on the surface instead of being ploughed in at once or stacked; and it was complained that the best material was taken for manu-

1 Ib., x, p. 265 (Morven, Argyllshire).

2 Walker suggested that fallowing should be encouraged by the remission of rent for fallowed land.

3 Argyll, Farms and Crofts, p. 7. The practice was checked by special estate regulations.

facture of kelp. Inland crofters used rotted bracken, especially for the cultivation of potatoes in lazy beds.

Defective Enclosures.—Before the introduction of wire fences fields were enclosed with drystone dikes, which were generally made when the land was first cleaned of stones. They were laborious and expensive to build, but it was the system of agriculture above all that made adequate fencing a difficult business. Where land was held in runrig no one found it worth while to enclose a temporary plot, and in any case no one would have been suffered to do so, as it was the custom to throw open all the arable after harvest for common grazing. Animals grazing near arable land had to be constantly herded, though in some cases they were allowed to eat down the young corn.[1] On farms held in severalty, lack of enclosure made it impossible to reserve the lower and richer pastures for later winter and spring grazing; the stock roamed freely, picking and choosing the grasses they liked best. Their active, muscular build made them hard to restrain. After speaking of the careless disregard of property shown by the natives, Macdonald continues :—" Nor is this strange tendency to hurtful activity confined to what we call (perhaps Hibernically) the rational animals of this country. The horses, sheep and cows are universally of a similar disposition. The same enclosure that suffices for protecting the rich meadows of Suffolk and Essex would be no more heeded by a Hebridean beast, not even by the smallest cow, than if it consisted of the mist of the mountain."[2] Of gates he remarks :—" The gates must be so contrived that they shall close of themselves, for no Hebridean ever takes the trouble of shutting a gate after he has passed through it. It must also be very easy to open, otherwise the improvident and impatient native will not hesitate to break it. Nor will he dismount from his horse without much reluctance, although he may risk his own and his horse's bones by his laziness." There is no doubt that indolence played its part, but in many leases the duty of fencing as well as of erecting buildings was laid on the tenant.[3] A proper system of fencing was essential, and the business should have been undertaken by landlord and tenant in common, the former providing the material and the latter the labour.

Lack of Education.—It is not surprising that to conservatism of temperament was added a profound ignorance of the possibilities of improvement. The natural barriers which kept the Highlander, and especially the Hebridean, remote and secluded had scarcely been affected by the work of man. At the end of the eighteenth century a Government packet plied fortnightly between Stornoway and the Clyde,[4] otherwise there was no regular communication with the islands. Before 1746 there was

[1] In Tiree, cattle were allowed to graze the young corn until the middle of June. (Statistical Account, p. 396.)

[2] Macdonald, Agricultural Survey of Hebrides, p. 172.

[3] The leases on the Argyll estates contained such conditions, but the rent was reduced in respect of them. (Farms and Crofts, p. 9.)

[4] Statistical Account, xix, 244. Walker, ii, p. 337. In 1797 this service became weekly.

no post office in the western Highlands, nor were there any markets or fairs where people could meet to exchange ideas and learn something new, and with the exception of Oban, Stornoway and Fort William, there were no regular villages. In the middle of the nineteenth century, when intercourse with the outer world was easier, the Duke of Argyll[1] complained that the remoteness of Tiree prevented the introduction of a more enlightened system of agriculture, and defended the letting of farms to outsiders on the ground that they set a higher standard for the imitation of their neighbours. Further, the lack of markets and means of communication forced the Highlander to adopt subsistence farming,[2] since in no other way could he obtain the necessaries of life. Thus in a stock-raising country with a soil and climate unfavourable to arable farming, corn-growing held a disproportionate place, and cereal crops for human food occupied land that should have produced fodder for cattle.

Crops.—*Corn.*—The staple corn crops were oats and four-rowed barley, called in the north bear or bigg. Wheat was tried by some landowners, and appears to have succeeded occasionally,[3] but the climate is quite unsuitable. The commonest variety of oats was the wretched grey kind (*Avena strigosa*), which in early days prevailed in other parts of Scotland; no other kind was known in Galloway till 1720.[4] It often gave no higher return than threefold, and its yield of meal was equally poor; 1 boll (16 pecks) of grain would produce as little as 4 pecks of meal.[5] White oats were first sown in Skye in 1763 and in Lochbroom in 1760. Rye gave a slightly higher yield than grey oats, but was less frequently sown, as it was believed to be injurious to the soil.

Bear seems to have been the best crop. It was said to be well suited to very poor soil, matured early, and when thinly sown would tiller well. Its yield was higher than that of oats or rye, being five to eightfold, while in Uist and other less mountainous and drier districts yields of 10, 15 or 20 fold were known. Much bear was used for the distillation of whisky, and thus withdrawn from the food supply.[6]

The Statistical Account throws some light on the yield in various parishes. At Gairloch home-grown supplies would last for six or seven months in a good season, and the deficiency was

[1] Farms and Crofts, p. 31.

[2] Yet, according to Pennant, in Islay, one of the most fertile of the Isles, £1,000 worth of meal had to be imported annually to supply the 7,500 inhabitants, whose poverty prevented them from taking advantage of the excellence of the soil. (Voyage to Hebrides, p 228.)

[3] Pennant says that the proprietor of Islay raised wheat successfully on enclosed land. (Voyage to Hebrides, p. 228.) But Islay is one of the drier and more genial of the Isles.

[4] Walker, i, p. 215

[5] The grey oat will, however, grow on land where white oats fail completely. This is not only the case on sandy land rendered alkaline by excessive manuring with seaweed. See Agriculture in the Hebrides, *Scottish Journal of Agriculture.*

[6] The demand for bear to make whisky is even greater than that for bread to eat, and the distillers have a brisker trade and more ready cash than the bakers. (John Smith, Agricultural Survey of Argyll, p. 100.)

made good by importing meal by sea in summer at 16*s* or 18*s*. a boll.[1] In Kilmuir, a fertile parish in the north of Skye, surplus corn was sold in good seasons at 13*s*. 4*d*. a boll.[2] In Kilbride (Arran) the best tilled land yielded scarcely two returns; potatoes formed the principal food for nine months of the year, and £500 was spent annually on the purchase of seed corn and meal.[3] At Inverchaolain (Argyll) land under the old methods yielded 3–4 bolls of oats per acre and 4–5 bolls of barley, while a gentleman's farm, which was heavily manured and limed and cultivated in rotation, gave 6–8 bolls of oats and 8–10 bolls of barley.

Potatoes.—This crop had an importance out of all proportion to its intrinsic value as food. The spread of potato-growing was, with the introduction of the kelp industry and the success of vaccination, the chief cause of the extraordinary increase of population in the first half of the nineteenth century, and thus proved as much of a curse as a blessing. Potatoes first came to the isles in 1743, when Clanranald, the proprietor of South Uist, introduced them from Antrim.[4]

In 1752 they were first planted in Barra and the following year they reached Lewis; eleven years later they provided a substitute for bread during more than half the year. On the whole the crop gave good returns. Though it is most successfully cultivated in the drier wheat-raising areas, the potato is very tolerant of lime deficiency, and it responds well to seaweed. Scientific potato-growing requires much labour, but tolerable results were got from the lazy-bed method of tillage, which had the advantage of being an easy means of bringing wild land into cultivation.[5] Potatoes could be followed by a corn crop without further manuring. The quality was, however, lowered by the use of the worst tubers for seed, and growth checked in autumn by the practice of cutting the haulms for fodder at the end of August. Nor was the crop very reliable. According to Loch,[6] disease was prevalent in Sutherland, and bad harvests occurred every three or four years. And as the potato became more and

[1] Statistical Account, iii, p. 90.

[2] Ib., ii, p. 553.

[3] Ib., viii, p. 578.

[4] On his (Clanranald's) arrival the tenants were convened and directed how to plant them, but they all refused. On this they were all committed to prison. After a little confinement they agreed at last to plant these unknown roots, of which they had a very unfavourable opinion. When they were raised in autumn they were laid down at the Chieftain's gate by some of the tenants, who said that the Laird might indeed order them to plant these foolish roots, but they would not be forced to eat them. In a very little time, however, the inhabitants of South Uist came to know better, when every man of them would have gone to prison rather than not plant potatoes. (Walker, i, p. 251.)

[5] Lazy beds were made as follows:—A grassy spot was selected and trenches were dug at intervals of a few yards which served as drains. The space between the trenches was covered with a layer of seaweed, rotted bracken, weeds, cut grass, &c. On this the seed potatoes were placed, and the whole covered in by earth taken from the trenches. See also Dr. Walker's Essay on Peat in the Transactions of the Highland and Agricultural Society, Vol. ii (1808). The Statistical Account (x, p. 265, Parish of Morven) compares the yield of lazy-bed cultivation with that of drilled potatoes:—Lazy bed, 10 fold; drills, 15-20 fold. The drilled potatoes were no doubt on a gentleman's farm where the seed and general treatment would be better.

[6] Sutherland Improvements, p. 54.

more the staple food, a complete failure of the crop, like that of 1846, meant universal famine and disaster.

Hay.—There was a great deficiency of hay. The growing of artificial grasses was not generally understood, so that natural hay alone was used, and that in very small quantities. No hay was cut in the Long Island until Clanranald, the enterprising patron of the potato, introduced the practice in 1756.[1] Eighteen years later, when Pennant visited Rum, there was still no hay, and the inhabitants killed their cattle in the autumn and salted them down.[2] Before 1812, Sutherlandshire farmers imported hay from the south side of the Moray Firth.[3] As the people commonly spent the summer in their sheilings on the mountain pastures, where they occupied themselves in the making of butter and cheese and only returned to the steading when the corn was ripe, hay making and corn cutting must be carried on simultaneously, with the result that both operations were protracted far into the autumn. In the Highland climate an August or September hay crop is always precarious. The large farmer had the advantage of spacious barns with wattled sides in which hay could be rapidly dried under cover, but the small man had not even the modern wire fence or wooden frame in which to keep his mouldy swathes from rotting on the ground. Walker suggested that hay should be made at the shielings in June and July, but the difficulty of transporting it on horseback or sledges for several miles across moor and bog made this a not very practical proposition.

Pasture.—In many parts of the West Highlands, especially in less mountainous island districts like Tiree or North Uist,[4] there is much fine natural pasture with a good growth of clover. But the grazings, though extensive, were badly managed. Except for occasional heather-burning, there was no attempt to improve the quality of the grass. On such wide areas liming or manuring was impossible, and the droppings of animals of little value. Bracken mowing was heavy labour, and as few cattle were housed there was little inducement to cut it in large quantities for litter. Much could have been done by careful herding: in summer stock should have been kept on the more perishable grasses at higher altitudes, thus sparing the lower levels for winter use. But this was rarely done, so that most pastures were understocked in summer and overstocked in winter.

III.—LIVE STOCK.

Horses.—There are few better tests of the efficiency of farm organisation than the economical management of horses. Judged by this standard, Highland methods are seen at their worst. Everywhere an excessive number were kept. According to Pennant,[5] each of the 18 occupiers of a farm in Arran rented at £40

[1] Transactions of Highland and Agricultural Society, ii (1803).
[2] Voyage to Hebrides, p. 308.
[3] Sutherland Improvements, p. 151.
[4] See Statistical Account, xiii, p. 301; Argyll, Farms and Crofts, *passim*.
[5] Voyage to Hebrides.

kept a horse, and the total horse population of the island was 1,050, or rather more than one horse to every three cows. In all parts many small farmers would keep six, eight or ten horses, without breeding any for sale, though each of these might plough perhaps two acres annually, and otherwise, except for occasional carrying of loads, run idle.

"In Glenmoriston alone," says John Robertson,[1] "a district of no great extent, a gentleman of veracity told me that there had been 900 horses till very lately. There is no species of bestial more useless or more expensive than an idle horse." A few figures from the Statistical Account showing the proportion of horses to cattle and sheep in various districts will illustrate the point :—

Parish.	Horses.	Cattle.	Sheep.	Reference.
(1) Uig (Lewis) (pop. 1898)	682	2,921	...	xix, p 301
(2) *Barvas* (Lewis) (pop. 2006)	1,050	2,670	3,392	xix, p. 266
(3) *Tiree*	1,400	1,800	...	x, p. 410
(4) Snizort (Skye) (pop 1808)	597	2,537	...	xviii, p. 184
(5) Barra	557	1,170	2,216	xiii, p. 342
(6) Kildonan (Sutherland)	812	2,479	...	iii, p. 408
(7) Morven (Argyll)	250	2,500	14,000	x, p. 266

From this table it becomes clear that the population of horses is highest where crofts are smallest and kelp is most extensively made. Tiree, Barra and Barvas have the highest figures, all island and kelp-making districts, where crofts were notoriously subdivided. The lowest figure is for Morven, which supported one horse to every ten cattle and every 56 sheep. The land in this parish was at the time of the survey held by 17 gentlemen tacksmen with large flocks of sheep; five farms were leased to shepherds, and ten only were occupied by small tenants. The contrast is striking. Where kelp was made large numbers of horses were required for three or four months to cart the seaweed to the kilns; as a rule every kelper kept his own horse, which, in the case of landless squatters, was otherwise unemployed. And when it is remembered that the smallest plough required a team of four, and that most loads were carried on horseback, it is not surprising that the number of horses was so large. Further, the keep of a horse was generally reckoned as nothing, although the grass consumed would have supported a cow. In winter many died of starvation, or became so enfeebled that in spring they remained long unfit for work. Macdonald[2] gives a miserable picture of the condition of Hebridean horses. He states that the

[1] Agricultural Survey of Inverness-shire, p. 79.
[2] Agricultural Survey of Hebrides, p. 479.

cost of maintaining a horse in the isles was one-ninth of the cost in Berwickshire.

Cattle.—The real wealth of the Highlands had always consisted in cattle. The native black[1] breed was very hardy, produced excellent beef and a small quantity of rich milk. Cattle were exported as stores to be driven south for fattening; dairy produce, though good in quality, was not produced in sufficiently large quantities to be sold away from home. Owing to bad winter feeding the rate of fertility was low. Heifers were rarely mated earlier than four years. Some cows were too ill-nourished to bear calves every year, and often a calf born in winter received insufficient milk for the first five or six weeks of its life. When two calves were born about the same time it was a common practice to kill one of them, so that the survivor might have the combined supply of both cows.[2] An extreme case is mentioned in the Statistical Account of Tiree.[3] One crofter had a cow of ten years which had only calved once; another had three or four cows, but no calf for the last six years. The mortality in spring was very high. In Kildonan alone 200 cows and 500 young cattle died in the spring of 1807.[4] Pennant describes the stocking of one of the larger farms in Skye as follows:—20 cows, 20 heifers ready for the bull, 30 three-year-olds, 35 two-year-olds, 40 yearlings. The farmer sold about 20 animals annually, made butter and cheese to supply the family, but none for sale. The Highland stock-raiser suffered seriously from the lack of competition among buyers. He had no opportunity of meeting dealers, and had to take whatever price a chance drover happened to offer.[5] Below are given a list of cattle prices in various districts. The sale of one or two beasts was often the sole source of income.

Date.	Place.	Price.	No. sold annually.	Reference.
1776	Islay	£2, 10*s*.	1,700	Pennant.
1776	Skye	£2–£3.	4,000	Do.
1794	Applecross (Ross)	£2, 15*s*.	200	Stat. Account, iii, p. 375.
1794	Lochcarron ...	£5–£6.	...	Do. xiii, p. 553.
1793	Kintail (Ross) ...	£4–£5 (milch cows).	...	Do. vi, p. 247.

Dairying.—Although the raising of store cattle was the main business, there seem to have been plenty of milch cows. According to Pennant, there were 1,383 milch cows in Arran in 1774. This is surely an error, but even if we suppose him to have taken the total number of cattle of all sorts, it would give about 1,000 milk cows—a good figure. Dairying of a primitive

[1] It is open to doubt whether the cattle were uniformly black.
[2] Statistical Account, iii, p. 375 (Parish of Applecross (Ross)).
[3] Ib., x, p. 412.
[4] Loch, Sutherland Improvements, p. 65.
[5] Statistical Account, xix, p. 272 (Parish of Barvas).

kind, almost exclusively for home consumption,[1] was carried on in the summer season. In all probability far more dairy produce was eaten at this period than at the present day, when white bread and strong tea, with margarine or butter from English and Danish factories, takes the place of home-grown food.[2] In summer, when Highland cows grazed freely on the sweet and succulent pastures that a rainy climate brings forth, the milk was rich if small in quantity, and Hebridean cheese and butter were reckoned among the best. According to Walker, the best milkers would give one Scots quart (about equal to one imperial gallon) daily,[3] while the inferior yielded no more than one Scots pint. According to Pennant, the average yield of the best milkers in Skye was three quarts (presumably English) at a meal. James Macdonald[4] says that the Hebridean cow yielded one Scots pint, which is one-fifth of the yield of an Ayrshire cow, though the proportion of carcases was one and three-quarters to one. Healthy calves, not milk, was the object of breeders, and dams were selected for strength and appearance rather than for milking qualities. Butter and cheese were made from the milk of cows whose calves were not considered good enough to rear, or were killed to prevent overstocking. Walker gives the average season's yield of butter as 48 lbs. and of cheese as 96 lbs., and Macdonald as 44 lbs. and 88 lbs. The prices in 1808–1809 were 1*s*. 2*d*. to 1*s*. 6*d*. for butter and 4*d*. to 6*d*. for cheese.[5] Ten or twelve years earlier prices were lower. At Kilmuir butter fetched 10*s*. a stone (generally 22 lbs.) and cheese 4*s*. a stone.[6] At Kildonan butter was sold for 12*s*. a stone and cheese for 4*s*. 6*d*.[7]

Sheep.—The native breed of sheep was very small; the carcase weighed about 20 lbs., sometimes less, and the fleece rarely more than 1 lb.[8] The price for carcase with hide was 10*s*. to 14*s*. In colour they were not unlike the present St. Kilda breed, but had often four and sometimes even six horns. As late as 1793 there was no other kind of sheep in Harris; they were said to number 11,000, but as they roamed unherded they were not easy to count. Ten to eleven carcases went to a barrel, and 16 fleeces produced a stone of wool.[9] The price of a ewe and lamb at Whitsun was 3*s*. 4*d*., while 10*s*. would buy a stone of wool ready washed. Sheep were kept almost exclusively for domestic use, and their numbers were small. They were not considered rent-paying animals, so that landlords often restricted them to the proportion of one sheep to one cow, or even less. Thus Arran, which was said to raise over 3,000 cattle, produced only

[1] Yet, according to the Statistical Account, much butter and cheese of the best quality was exported from Lochalsh, where by 1793 farmers were beginning to enclose and to raise natural and artificial hay (xi, p 424).

[2] At the present day only a portion of the Stornoway milk supply is local. Some comes by rail and steamer from Elgin, a journey of nearly twelve hours. Recently the farm of Gress, near Stornoway, was let on condition that it was run as a dairy farm.

[3] II, p. 62.

[4] Agricultural Survey of Hebrides, p. 440.

[5] Ib.

[6] Statistical Account, ii, p. 553.

[7] Ib., ii, p. 408.

[8] Agricultural Survey of Hebrides, p. 447

[9] Statistical Account, x, p. 358.

1,600 sheep. In Sutherland the proportion was higher—5,041 sheep to 2,479 cows.[1] Sheep were barbarously managed. They were folded in summer and harvest time, housed in winter and spring. No attention was paid to the selection of rams, and breeding left to the discretion of the flocks, so that lambs often came too early in the season. From the middle of May onwards lambs were deprived of half their milk ration by separating them at night from their dams, which were milked in the morning. At the end of June they were weaned altogether, after which the ewes were milked night and morning till September. "Nothing but their remarkable hardiness," says John Smith, "could save them from utter perdition under such wretched management."[2] In some places sheep were not clipped, but their wool was pulled off by hand, a practice often fatal in cold weather.[3]

THE SCOTTISH BANKS AND FARMERS.

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IN the present acutely depressed state of agriculture it is often asked what the Scottish banks are doing for the benefit of farmers. The answer is short and emphatic. The Scottish banks are giving no exceptional unsecured financial assistance to farmers to meet current expenses, which they do not give to other traders similarly situated. The reason is not far to seek. The banks are private corporations managed for the benefit of the shareholders, and the directors and officials of such banks are not under existing circumstances justified in giving advances to any customer without reasonable security for its repayment. The banks have no incentive to take any undue risks in the giving of advances. They are not tied down to any specific class of investment of their funds. At present banks can get as profitable returns on the sums invested in good class securities with a possible appreciation in the capital value of the sum invested as they can get from ordinary unsecured overdrafts. In considering all the charges levelled to-day at the methods of our Scottish banks, justified or otherwise, we must never forget that Scotland's material prosperity in the past was due in part to our old Scottish banks. If authority is needed for this it is abundantly supplied. When, in 1826, the Government proposed extending to Scotland the English Bill prohibiting the issue of notes under £5, Sir Walter Scott, in these three powerful letters of his over the signature of Malachi Malagrowther to his friend James Ballantine, editor of *The Edinburgh Weekly Journal*, in which periodical they appeared, thus wrote :—

> "It is not less questionable that the consequence of this banking system as conducted in Scotland has been attended

[1] Ib., ii, p. 408. [2] Agricultural Survey of Argyllshire, p. 240.
[3] Statistical Account, xix, p. 267 (Parish of Barvas).

with the greatest advantage to the country. The facility which it has afforded to the industrious and enterprising agriculturist or manufacturer, as well as to the trustees of the public in executing national works, has converted Scotland from a poor, miserable and barren country into one where, if nature has done less, art and industry have done more, than in perhaps any country in Europe, England herself not excepted. Through means of the credit which this system has afforded, roads have been made, bridges built and canals dug, opening up to reciprocal communication the most sequestered districts of the country; manufactures have been established unequalled in extent or success, wastes have been converted into productive farms, the productions of the earth for human use have been multiplied twenty-fold, while the wealth of the rich and the comforts of the poor have been extended in the same proportion—and all this in a country where the rigour of the climate and sterility of the soil seem united to set improvement at defiance. Let those who remember Scotland forty years since bear witness if I speak truth or falsehood."

The modern trend of banking is not the fostering of local industries by local unsecured loans to develop personally owned and controlled industries which yield but a moderate return, but the more lucrative, although questionable, expedient of investing a not inconsiderable portion of their available assets in foreign securities and in joint stock enterprises. The temptation to earn huge profits must often be irresistible to the bank manager whose ambition in life may be annually to appear at a meeting of his shareholders and notify an increase to a dividend already liberal. It has only been when bankers have forsaken the traditions of their profession that disasters have occurred. If precedent is required we have but to reflect on what Scotland has suffered in the past by the misguided use of her funds through over-trading and reckless speculation in lands beyond the seas—the Darien scheme, with its multiplied disasters and tragic end, the ruinous effects of the failure of the Western Bank, and the still harder retribution which followed in the wake of the liquidation of the City of Glasgow Bank, all tell their own tale.

The people of Scotland are in a large measure responsible for the present position. While they have every reason to be satisfied with the care and prudence with which the affairs of our great banking institutions are in these days managed, still, as the miseries which follow a great financial crisis are apt to be forgotten in the times of prosperity, the words of Lord Goschen—at the time Mr. Goschen—should be fresh in our minds :—

"In the most friendly spirit I would indicate to the banks of this country that the public have an enormous interest in the proportion of the reserves which they hold to deposits. They all hold together, and you have this remarkable fact that the soundest and strongest banks may be making the smallest dividends, whilst the more imprudent banks, who invest the depositors' money, leaving a small reserve, are able to show much larger dividends to their shareholders. Why are the latter able to take this course? Because they have the conviction that the failure of any of these big banks would be such a disaster to the whole community that the other banks would be compelled to come to their assistance and to rescue the offending bank from the consequences of its offences by themselves undertaking a part of their liabilities. The more imprudent banks will say there is no imprudence. We shall never be allowed to fail : our fellow-bankers must come to our assistance; and if not our fellow-bankers then the Bank of England; and if not the Bank of England, then the Government. I say that gives us a *locus standi*, and in the same way as the Government has had a *locus standi* with regard to shipping, and has said that excessive cargoes shall not be carried because they are dangerous to the safety of the public, the question may arise whether the public might have the right to say that no excessive cargo shall be carried by the banks receiving the public money—that business shall be conducted in a manner which shall be considered safe by the community at large."

The control of certain of our leading banking institutions has now been transferred to London, and, while the old name of the bank is retained, that is only done for the privilege of securing the existing note issue of the banks. Again two of our oldest banking institutions have in comparatively recent years been granted increased powers by Act of Parliament. The Acts were passed as private Bills and did not receive the public discussion in Parliament which their importance demanded. If they had been publicly discussed we doubt if they would have been passed in their present form. We may here refer briefly to the latest Act on the subject, that of the Royal Bank of Scotland, passed on 16th August 1920. Among the additional powers may be noted the following :—(1) " to procure the bank to be registered, licensed, or otherwise legally recognised in the British colonies or dependencies or any of them or in any foreign country " ; (2) " to enter into partnership or into any arrangement for sharing profits, union of interest, co-operation, joint adventure, reciprocal concession or otherwise with any person or company carrying on or engaged in, or about to carry on or engage in any business or transaction which the bank is authorised to carry on or engage in, or any business or transaction capable of being conducted so as directly or indirectly to benefit the bank, and to lend money, to guarantee the contracts and obligations of, or otherwise assist, any such person or company, and to acquire shares and securities of any such company, and to sell, hold, re-issue with or without guarantee or otherwise deal with the same " ; (3) " to guarantee or otherwise become responsible for the performance of obligations or contracts of every kind by any government, colony, corporation, board, council, association, society, local or other public authority, company, firm, managing committee, institution, philanthropic, charitable, religious, or secular body or person whatsoever "; (4) " to grant indemnities against loss and risks of all kinds "; (5) " to guarantee or underwrite or acquire and re-issue or become liable to secure the subscription or placing of or to agree unconditionally or subject to any conditions to subscribe for or procure the subscription of any money or of the whole or any part of any issue of stock, shares, loans, funds, debentures, debenture stocks, mortgage debentures or mortgage debenture stock "; (6) " to act as and to undertake the duties of executor and trustee of wills or settlements, to act as trustee of deeds or documents securing debentures, debenture stock or other issues of joint stock or other companies."

The conducting of such businesses is perfectly legitimate and profitable, but by whatever name the businesses may be called, they are not banking, and are not such businesses as were originally contemplated when Parliament granted powers to our banks, and not such businesses as those in which the old shareholders in Scottish banks invested their money.

The Government have no say in the control of the banks notwithstanding the valuable Government monopoly they possess. No new bank can now start business in Scotland with power to issue notes. The banks retain this monopoly. The Bank of France has the monopoly of the issue of bank notes in that country, and the monopoly is no greater than that possessed by the Scottish banks. In 1897, on the renewal of the Bank's Charter, the renewal was granted only on condition that the bank gave a perpetual loan of 40,000,000 francs free of interest for aiding agriculture.

There is no doubt that the present Government has afforded considerable financial assistance to agriculture is such ways, for example, as relief of rates, grants for drainage, encouragement of sugar-beet growing, &c.; but nothing has been done to provide advances to farmers to meet working expenses. Nor can it reasonably be expected that the Government should provide money for farmers to meet current expenses until the produce of agriculture is realised. If the Government did so, it is difficult to see how they could refuse assistance to other industries. We may here suggest two methods by which the necessary money might be placed at the disposal of farmers. In the first place, a change in the law would enable a security to be created in favour of a lender over the produce of agriculture. According to our existing law no security by whatever name it is called can be constituted over moveable property so long as the debtor remains in possession. Hence there are no means at present by which a farmer can give an effectual security to a lender over his growing crops, the hay or straw in his stackyard, or the grain in his barns. It is here that a change in the law might be beneficial. In certain of the British colonies such securities can be created, and the constitution of them has met with marked success. One outstanding example might be cited. Under the Canadian Bank

Act, which came into force on the 30th June 1923, amending a previously existing Bank Act of 1913, powers in the direction just stated have been conferred upon banks. In Canada, banks may now lend on the security of (1) growing timber; (2) the produce of agriculture; (3) the threshed grain grown upon his farm. In virtue of such security the bank obtains the same security as if it had acquired the security by virtue of a warehouse receipt. The only charges preferable to the bank are the wages or other remuneration of the workmen employed by the farmer. In event of non-payment at maturity of the advances made the bank may sell the produce or so much thereof as will suffice to pay their debt interest and expenses. It is unlikely that without some added security, personal or otherwise, loans to farmers on the security proposed would be popular with Scottish banks unless at considerably enhanced rates of interest. The second mode suggested for obtaining the necessary loan is that of making available for advances a portion at least of the huge deposits at present lodged in the Post Office Savings Banks. As is well known these deposits are all invested with the Government, and the rate of interest paid to depositors is 2½ per cent. The Post Office Savings Bank far outstrips other forms of working class savings. The total funds at present deposited in Post Office Savings Banks amount to the huge sum of 285 million pounds. The most of that money has no doubt been saved by the working classes, and it is not inequitable that a considerable portion thereof should be returned to foster and develop home industrial enterprises. The depositors have no security provided for them other than Government securities and the credit of the British Empire. Repayment to them of their deposits is always assured. It is not without the range of practicability that the Government at comparatively small cost could add a lending department to the Post Office banks, and advance money to farmers against like security to that just referred to as competent to the Canadian Banks.

THE BIOLOGICAL CONTROL OF INSECT PESTS.

R. STEWART MACDOUGALL, M.A., D.Sc.

THE farmer has to expect and should not be surprised at attack on his crops by insect and other enemies. Constant watchfulness is a price he has to pay for interference with what is called the "balance of nature." Where great stretches of land have lain for long periods of time uninhabited or not interfered with by man, harmonic relations and a kind of equilibrium have come to be established between plant and plant, and animal and animal, and animal and plant. Now and again, owing to some temporary exceptional change in the environment, one species may so increase as to be a plague, unsettling the balance, but nature, by her own methods, adjusts the balance.

Think, however, how man has altered the face of Scotland, since say before the coming of the Romans, with all the changes in fauna and flora; or again how to-day Australia bulks in fruit-farming, in dairying, and in sheep farming, and yet before Britain colonised Australia our sheep and cattle and apple orchards did not exist there. Man the pioneer, the hunter and sportsman, the farmer, the gardener, the forester, is continually interfering with nature, making clearings, cultivating "waste" ground, encouraging one animal at the expense of another, artificially inducing new chains of circumstance which render adjustment of the balance of nature difficult or impossible. Apart from more subtle changes, fascinating in their interest, let us take example, one easy to follow. The hardy so-called weed-plants are replaced by, or come to be alongside, thousands of a crop plant more succulent and more abundant in reserve. The insect leaves the wild plant and attacks the related crop plant, finding breeding places and food material much more easily and abundantly. The result is that protective and remedial measures against such insect enemies have to become a part of the regular farm operations and practice. Such measures may be roughly divided into artificial or chemical, cultural and natural. By artificial treatment is meant the use of insecticidal washes or sprays and fumigants. By cultural methods one aims at the best seed, the best plants, the most suitable soil, suitable manuring, change of rotation, and it may be earlier or later sowing to dodge some specific insect pest. One of the methods of control under the wide name of nature's methods is biological control, in the sense of introducing and breeding and setting free and encouraging insect enemies which will prey upon the insect pests of the crop. There are many examples of insects, sometimes pests in their native country, sometimes neutral, being conveyed to other countries in commerce; in the new country such insects may become acclimatised and develop into major pests, and as their natural enemies have been left behind, biological control means that attempts must be made to introduce these enemies to prey on the crop pests.

BIOLOGICAL CONTROL.

It has to be admitted at the outset that in this work there have been failures, and disappointing failures. But the work is difficult, and the inter-relationships of insect with insect and plant with plant are often so complex that failures must be expected. At the same time there have been triumphs, as will appear below. Much pioneer work has been done in which American entomologists, under the leadership of Dr. L. O. Howard, have played an honourable part. Officers of the United States Bureau of Entomology are engaged in different countries collecting parasites of destructive foreign insects that have through commerce gained entry into the United States, and in addition some foreign field stations have been opened for the study of parasites. With scientific justification and approval the practice of such biological control of insects has been taken up internationally. Britain is concerned chiefly with its dominions and colonies, for the annual loss due to destruction of crop plants by insects runs into millions of pounds annually. At home the Imperial Bureau of Entomology has for some years been doing what it could to meet requests from various dominions and colonies for consignments of insect parasites. Now, recognising the Empire importance of the control of insects, the Empire Marketing Board has made a grant of £30,000 to the Imperial Bureau of Entomology for the establishment, staffing and equipment of a Parasite Laboratory. Already under Dr. Guy Marshall, and with Dr. Neave as superintendent, this new laboratory at Farnham House, Farnham Royal, Bucks, is actively engaged on a programme of work which gives hope of fruitful results.

Beneficial Insects.

Apart from insects which produce something of direct use,—e.g. the hive bee, the cochineal insect, the lac insect, the silkworm,—there are certain insects which war upon other insects. In Britain workers are more or less familiar with some of these, such as ladybirds, hover flies, lacewings, tachinid flies and ichneumon flies; and there are others,—solitary wasps, robber flies, dexid flies, tiger beetles, ground beetles. One divides these for convenience into predaceous and parasitic insects.

Predaceous Insects.—The term predaceous in biological control is applied to an insect which is carnivorous in habit, preserves its freedom of movement, and moves about or hunts for the injurious insect which it may have been introduced to devour and destroy. Two examples may be quoted in illustration. From Australia a special ladybird beetle (*Novius cardinalis*), black with red markings, was introduced to the orange groves of California. The orange groves were being ruined by the Cottony Cushion or Fluted Scale insect—a cousin of our own aphides or greenflies—against which all artificial methods of control had failed. The ladybirds, collected in different stages of development, were shipped to California. In tents reared in the orange groves the ladybirds were bred—the food offered to them was the Cottony Cushion Scale—and colonies of them were set free among the orange plants. In time the ladybirds so increased in numbers and did their work of destruction so effectively that the orange growers were able to hold up their heads again; the Scale had ceased to be a pest. The great success in this Californian experiment was due to several favouring circumstances. The Cottony Cushion Scale was an introduced Australian insect, and the Australian ladybird found a natural food; the climate of that part of California was genial, so that the ladybirds and their greedy grubs were able to breed and to feed all the year round; further, the ladybird's own enemies were left behind. In Australia and New Zealand the Cottony Cushion Scale is, at the present time, effectively controlled by *Novius cardinalis*.

both successful; but, when both are present in the same fruit-fly maggot, *O. humilis* is destroyed by *D. tryoni*. The opinion has been expressed that perhaps the introduction of one parasite only might have been better than the introduction of four useful, but competing forms. All this shows how complex and how difficult the work in biological control may be, and how patient must be the work of following out the biology of the parasite and the inter-relationship of one parasite with another.

An excellent example of the successful introduction of a parasite for the control of a pest is the case of *Aphelinus mali* and the Woolly Aphis or Blight of the apple, a universal and troublesome enemy of the fruit grower. The masses of " wool "—really wax secreted by special glands—covering apple trees in old neglected orchards and to a less degree on apple trees that receive attention are very familiar. Under cover of the " wool " the Aphids live, piercing the bark of stem and branch (they also infest the roots) by their mouth-bristles and drawing away the sap. The result is seen in large swellings and canker-like areas (Fig. 2). There are artificial methods of fighting the Woolly Aphis, but on a wide scale these are expensive and difficult and sometimes impossible to apply. Hence the search for a parasite.

It is probable that, though the Woolly Aphis of the apple is now cosmopolitan, its native home is America; and in the United States the parasite *Aphelinus mali* was found and its life-history worked out.[1] The parasite, a Chalcid of the Order Hymenoptera, is a very minute insect about $\frac{1}{20}$ inch long. The female, after pairing, searches for and pierces with her fine ovipositor the skin of a Woolly Aphis, introducing an egg. The Aphis so treated may show wriggling movements that mean discomfort. The rule is only one egg for each Aphid. In a day or two the egg hatches, giving a legless slightly elongated grub, which nourishes itself upon the juices and tissues of the Aphis. In a fortnight or less the parasite grub is full grown and prepares to pupate. The pupa lies under cover of the hollowed out body of the Aphis, whose skin has become hard and black and has lost all trace of the white " wool" (Fig. 3). When the fully developed Aphelinus is ready it escapes from the hard case by an opening made in the upper surface of the hard Aphis skin, towards the hind end. In Lundie's experiments the larva fed for almost a fortnight; the whole life-cycle from egg to adult, in favourable conditions, was completed in from 19 to 29 days. The adult Aphelinus has a life of only a few days.

From parasitised material received from the United States, Dr. Tillyard in New Zealand raised colonies of Aphelinus, and in the course of two or three years has distributed very many thousands of the parasite for introduction in different parts of New Zealand, where the Woolly Aphis is one of the worst pests.

[1] A Biological Study of *Aphelinus mali*, Hald, a Parasite of the Woolly Apple Aphid (*Eriosoma lanigera*, Hanson), by Arnold E. Lundie, Cornell University Agricultural Experiment Station. Memoir 79, August 1924.

Dr. Tillyard writes,[1] about four years after its reception from the United States :—" In New Zealand the Aphelinus has been an unparalleled success; for the first time in the history of the apple industry in Nelson and Auckland Provinces the trees have been quite free from the blight during the ripening and picking seasons, the new growth on the trees has markedly improved, picking has been carried on without mess and discomfort, and packing without the expense entailed in securing fruit clear of the Aphis. It is hoped to get this valuable parasite thoroughly settled into every corner of New Zealand. The parasite has already been recorded as attacking other Aphis, Scales and young Mealy Bugs. The parasite promises to be the most valuable beneficial insect ever introduced into New Zealand, exclusive of the honey bee."

Aphelinus mali has been successfully established in France, where I had the pleasure of seeing it at work in the open garden. Further, from a flourishing colony at the Ministry of Agriculture's Pathological Experimental ground Mr. J. C. F. Fryer has distributed the parasite to a number of English centres.

A Tachinid Parasite.—Tachinidæ is a family of two-winged flies that, on the average, look to the ordinary observer like very bristly house-flies. Many species are parasitic on other insects. Among the numerous parasites introduced from Europe to the United States in the war against the unfortunately introduced Gipsy Moth and Brown Tail Moth was a Tachinid Fly named *Compsilura concinnata*. The eggs of this fly hatch in the body of the mother, and the young maggots are introduced into the body of the host caterpillar by means of a special structure, horny at the tip. The whole larval or maggot life is passed in the body of the parasitised caterpillar. This introduced Tachinid Fly has proved in the United States to be one of the most important parasites. It has spread and multiplied, and now does not confine its parasitism to Brown Tail and Gipsy Moth caterpillars, but has turned its attention to native American species.[2]

Egg Parasites.—The biological control experiments against the Gipsy and Brown Tail Moths were extremely thorough, parasites being introduced to attack all stages of the pests. Among the introduced parasites were certain egg-destroying species. Two of these, *Anastatus bifasciatus* and *Schedius kuvanæ*, both Chalcids, have been colonised, and millions of them have been distributed in the areas where the moths are at work leading to the parasitism of a high percentage of the pests' eggs.

THE PARASITE WORK OF THE IMPERIAL BUREAU OF ENTOMOLOGY.

The purpose of the new Parasite Laboratory at Farnham, Bucks, is to find, to breed and to despatch to various centres of

[1] Insects in relation to the New Zealand Food Supply, by Dr. J. Tillyard, Entomologist and Chief of the Biological Department, Cawthron Institute, Nelson, New Zealand. A Paper prepared for the Pan-Pacific Food Conservation Conference, 1924.

[2] A Study of *Compsilura concinnata*, by Julian J. Culver, United States Department of Agriculture. Bulletin No. 766, July 1919.

the Empire parasites which have a possible or proved value as destructive to insect enemies of cultivated plants. A certain proportion of the insects carried in commerce and accidentally introduced to the more temperate parts of the Empire are European insects. In their new country a number have become acclimatised and have developed into pests, doing much greater damage than in their original home. This is partly due to the fact that their parasites—insects that acted as a check on them at home—have been left behind. One of the aims at Burnham will be to breed and send consignments of effective parasites so that the balance be readjusted.

Before the establishment of the new Parasite Laboratory at Farnham, the Imperial Bureau with the assistance of Rothamsted had already been trying to advance the method of biological control. Some of the tsetse flies of tropical Africa are harmful as the carriers of minute protozoa, the trypanosomes, which are the cause of sleeping sickness in human beings and nagana of our domesticated animals. A Chalcid parasite lays her eggs in the pupa-case of a tsetse fly in East Africa. Consignments of these parasites were bred in England and sent in cold storage to West Africa.

The European earwig, carried to New Zealand, has spread and become a major pest in some of the fruit-growing districts. In response to requests from New Zealand two Tachinid parasites were sent. One of these flies lays her eggs near groups of earwigs and in places frequented by them; the fly maggot on hatching moves to an earwig and proceeds to bore into its body. The second Tachinid lays her eggs on food favoured by the earwig; the earwig in eating swallows the eggs, which hatch in the alimentary canal, and the maggot having thus gained entry to the host proceeds to destroy it. The experimental infection by these Tachinid maggots reads easily, but in practice is very difficult, calling for much skilled and patient work. In this country the farmer knows how troublesome blow-flies can be, and they are great pests in Australia and New Zealand. In 1909 I recorded in the Transactions of the Highland and Agricultural Society the breeding out of a parasite named *Alysia menducator* from maggots of one of our blue bottles (*Calliphora erythrocephala*) taken from a dead mole, starling and crow. This parasite has also been found in the green-bottle (*Lucilia*) and other related flies. Large consignments of this parasite have been sent by the Bureau to Australia and New Zealand.

Space does not allow of mention of the great success of biological control as practised in Hawaii against several injurious insects, nor of the recent work in the United States, where parasites have been introduced to fight the imported Japanese Beetle, nor of work in Canada, where, for example, two European parasites—2,500,000 of the one and 120,000 of the other—have been distributed in Ontario in the campaign against the European Corn Borer,[1] but enough has been said to prove

[1] International Entomology—Retrospective and Prospective, by Arthur Gibson Dominion Entomologist, *Journal of Economic Entomology*, vol. xx, No. 1, Feb. 1927.

Fig. 1.

Mass of Cocoons and Egg Clusters of the Vapourer Moth (*Orgyia antiqua*).
(Nat. Size.)

Here and there may be seen the white cocoons of *Apanteles solitarius*.

From nature.

Fig. 2.
Portion of Branch of Apple attacked by Woolly Aphis.
From nature.

Fig. 3
Branch of Apple badly infected with Woolly Aphis.
A number of the Aphids have been parasitised by Aphelinus.

Figs. 2 and 3 are the Author's figures, by courtesy of the Highland and Agricultural Society.

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how, more than ever before, the importance of economic entomology has come to be recognised internationally, and how there is room for hope in the more widespread practice of biological control as a means of checking injurious insects.

AGRICULTURAL SURVEY OF FOUR PARISHES in the SOUTH of SCOTLAND.

In the issue of the Journal for July 1926 an account was given of an agricultural survey of four parishes in Kincardineshire, which was carried out by officials of the Board during the winter of 1925–6. The object of the survey was primarily to describe the state of agriculture in the district surveyed. The report brought out many interesting features, but in particular it emphasised the importance of proper farm management in all its varied aspects. So far as the information available made it possible, the profit or loss for the year for each holding was worked out, with the result that striking contrasts were revealed even as between farms of similar size and character. Generally speaking, it could be said that the agriculture of the parishes was of a high standard; yet, notwithstanding this, the profit and loss account frequently showed a balance on the wrong side. While allowance required to be made for certain factors over which the farmer had little or no control, such as low prices for his produce and high working expenses, the general conclusions arrived at by the reporters were that in too many cases methods that were suitable neither to the particular farm nor to the times were being blindly followed, and that in other cases lack of skill of management accounted for losses. The reporters indicated various directions in which improvement seemed to be possible.

The report aroused a considerable amount of interest, and it was decided to carry out further sample surveys, this time in the south of Scotland. In this case, two independent agricultural experts, Sir James I. Davidson and Mr. J. H. Milne Home, were associated with the Board's officials in the enquiry. The methods adopted in carrying out these surveys were somewhat similar to those followed in Kincardineshire. Every holding was visited, and as much information as possible was obtained from the occupiers in regard both to the methods of management and to the financial aspects. The districts were visited in the spring of 1927. An account is given below of the survey of two Berwickshire parishes; the reports on the south-west parishes will be discussed in the next number of the Journal.

Parish A.

This parish was selected as being typical of the extensive tract of fertile country lying between the foothills of the Lammermoors and the River Tweed known as the Merse of Berwick. It comprises an area of about 5,600 acres, almost wholly devoted to productive agricultural purposes, there being some 3,700 acres of arable land and 1,500 acres of pasture land. Generally speaking, the agriculture might be said to be partly cereal growing, partly cattle feeding, and partly sheep breeding and feeding.

The holdings, above one acre, numbered twenty in all, and these varied considerably in size from a few acres to 700 acres, there being six under 50 acres, five between 50 and 300 acres, and nine above 300 acres. As a result of observation the reporters classified the holdings as follows :—

	Holdings under 50 acres.	Holdings between 50 and 300 acres.	Holdings over 300 acres.	Total.
Class A	1	2	4	7
Class B	4	...	4	8
Class C	1	3	1	5
	6	5	9	20

A. Farms where cultivation was well done and timeously carried out, the land clean and in good heart, pastures well cared for, stock well managed, fences, hedges and ditches in good order, and stackyards clean and tidily kept, and where there was a general air of prosperity and good management.

B. Farms which, while not of the same high standard as the *A* farms, were efficiently cultivated, with the land in good heart and pastures well cared for, but where the fences, hedges and ditches had not been attended to so well, and the premises and stackyards were in a less orderly state.

C. Farms which had got somewhat out of hand, or were not being cultivated to the same advantage or with the same degree of efficiency.

As in the case of the Kincardineshire survey, there appeared to be striking differences in the financial results. The fact that a farm was being worked by a skilled farmer and could be classed as an *A* farm did not necessarily ensure a profit, allowance being made for interest on capital, though there was of course a much greater chance of this being the case than with a *C* farm. The reporters made an attempt to arrive at the profit or loss in the year 1926–7 for most of the holdings, but in view of the many varying factors which required to be taken into account, and as in only three cases were detailed statements of income and expenditure made available, and these were for the previous year, the results arrived at could only be regarded as a basis of comparison, of a general kind, as between farms and farming methods. It may be observed, however, that after due allowance was made for personal services and interest on capital the balance varied from a small margin of profit to one of considerable loss.

There were several owner-occupiers who had recently bought their farms, either because they had to buy or leave, or because they could not under recent competition lease a farm at a rent which they were prepared to pay. The opinion among them was all in favour of tenancy. Not only had the occupier now to bear the owner's burdens in connection with rates, the upkeep and renewal of buildings, fences, drains, &c., but in addition the assessment values of the holdings had been increased.

The following general observations are of interest :—

Crops.—The general rotation was a 4 or 5 course, or partly both, and in one or two cases a 6 course, as follows :—

4 course.	*5 course.*	*6 course.*
Hay	Grass or Hay	Hay
Oats	Grass	Oats
Green Crop	Oats	Beans
Barley with seeds	Green Crop	Wheat
	Barley with seeds	Green Crop
		Barley with seeds

On farms where a large area was under grass the 4 course rotation was practised on a smaller area under crop. A few farmers indicated their intention to lengthen the rotation by laying the land down to grass for a longer period, with a view to reducing labour costs. Though several tractors were in use, the horse is the principal motive power on all farms and for all operations.

Cereals.—The season of 1926 was one of the worst experienced in the Merse of Berwick so far as the yield of grain and difficulty of harvesting was concerned. Crops were badly laid and twisted by wind and rain, so that harvesting costs were much increased. The area under wheat has been considerably reduced during the years of high prices for barley, which generally gives a bigger yield per acre. Barley has been a profitable crop for many years, although in 1926 the yield was only about half the normal, the quantity given varying from 2½ to 4½ quarters per acre as compared with the normal average of 6 quarters per acre. The varieties of oats grown were Castleton Potato, Victory, Record and Yielder. The first named gives a lower yield per acre but commands a higher price, being in demand as seed for other districts and popular with millers.

Potatoes.—The general character of the soil militates against the extensive cultivation of this crop, the area in 1926 being only 90 acres. At the same time, in view of the proximity of the district to the English market, there would seem to be room for more attention being given to the growing of seed potatoes.

Turnips and Swedes.—The soil is particularly suited to the growth of this crop, which is the cleaning crop of the rotation, and a comparatively large area is generally sown, in some cases as much as one quarter of the entire arable area. This involves heavy labour costs, and there is very good reason to believe that farmers could, under present agricultural conditions, profitably reduce the area under roots and still carry the same head of stock. Finger-and-toe disease was found on a few of the smaller farms worked on the 4 course rotation.

Sugar Beet was grown on three farms in 1926. The yields were 6, 10½ and 13½ tons per acre of washed roots, with a sugar content of 17 per cent. to 18 per cent. The heavier yields were obtained on free working land. If farmers were assured that withdrawal of the subsidy would not reduce the price to them to an unprofitable level, it was believed that the area would be greatly increased.

Hay and Pasture Land.—The compounding of grass seed mixtures is often left to the seed merchants. Savings could be effected if this were done by the farmers themselves.

Manuring of Crops.—The root crops are the only ones to be systematically manured. The dung is generally applied to the lea oat stubble in autumn, or sometimes in the drill in spring. In addition, a dressing of artificials is applied before the roots are sown or the potatoes planted. Usually a compound turnip or potato manure is used. As with grass mixtures, economies could be effected by the home compounding of manures.

Live Stock.—*Cattle.*—On every farm cattle are fed in courts during winter. The object is to consume the turnip crop and to break down straw into manure. If the cattle show a profit, so much the better, but profit or no profit, the straw must be broken down. The most common system of laying in cattle is to buy Irish or English—but principally Irish—stirks or six quarter cattle in spring. These are put into the courts vacated by fat cattle, and are carried on with turnips, hay and about 3 lbs. per head daily of Bombay cotton cake until the grass is sufficiently well advanced. During March and part of April they may be out during the day and in at night. They are grazed for the summer, forward cattle being sold fat off the grass, and the others fed off in courts during autumn and winter in lots of from four to ten.

In discussing the possibility of better returns if the cattle fed were home bred, the farmers admitted that they could be assured of a better class of cattle, but generally expressed the opinion that while on cheaper higher land with plenty of rough grazings this would be desirable and profitable, on land rented at over 20*s*. per acre it was unlikely to pay. The possibility of rearing two calves on every cow was ruled out—(1) on account of the impossibility of getting suitable calves at the right time; and (2) on account of the difficulty of getting people to undertake the additional work involved in this system of management.

Large quantities of roots, varying according to the crop yield, are given to cattle in courts. It is questionable if the large quantities given, up to 1 cwt. per head per day, are advisable or profitable. Few farmers could state the actual daily quantity of cakes and meals given. This was left largely to the discretion of the cattleman, and there is reason to believe that in some instances the allowances were very considerably in excess of the farmers' estimates.

Sheep were kept on all but the very smallest holdings, and on nearly every farm there were flocks of breeding ewes. The ewes were mostly Half-Bred, but there were some ewes by Suffolk and Oxford rams out of Half-Bred ewes. For many years Suffolk and Oxford rams have been used for crossing purposes, but the tendency now is for the Half-Bred to displace the Down Cross ewe.

Three systems of management of ewe flocks were noted :—

(1) The most common practice is to keep up the ewe flock by purchase of ewe lambs at the autumn sales, and to sell the ewes as draft ewes when four-crop. The lambs are sold fat off the ewe in summer or autumn, or fed off on the turnip break. Occasionally they are sold as stores in autumn.

(2) Draft Half-Bred or Down Cross three-crop ewes are bought in autumn. The ewes and lambs are sold fat during the following summer and autumn, the lambs being sold so far as possible in May.

(3) In one case the ewe flock is kept up by gimmers bought in autumn.

It would be of value if an accurate system of costing could be carried out with a view to comparing the different systems followed.

The only sheep disease which causes concern is scrapie.

Pigs and *Poultry* get very little consideration.

Labour.—It is estimated that on holdings above 100 acres the labour bill varied from 29*s*. to 60*s*. per acre of the total area, or from 36*s*. to over 100*s*. per acre of arable land, the variation being mainly due to differences in the nature of the respective holdings. The farm servants were reported to be generally efficient, but it was becoming increasingly difficult to get really good men . Where cottages were good, the farmers said that men of a better class were attracted, and the frequency of changes at term time was reduced. During the years of good prices for produce farms were fully staffed. Under present conditions there is a definite move to reduce the number of workers rather than to reduce wages. Casual workers are scarce, the supply for turnip-hoeing, hay and harvest coming chiefly from Ireland.

Drainage.—While the bulk of the land did not appear to be ill-drained, further field drainage would be of advantage. The whole question of arterial drainage requires serious consideration. A general desire was expressed that where an arterial system affects a number of farms or estates, statutory powers should be vested in some central authority to ensure that those responsible for the maintenance of that system would duly and satisfactorily discharge their obligations.

Liming.—While there was no marked indications of a deficiency of lime, it does seem to be the case that a certain amount of fresh lime is required from time to time to maintain arable land in the best condition. The application of a moderate dressing of lime in some form once in the rotation would have a beneficial effect. The reporters made use of an American preparation " Soiltex " in testing the soil, but it is desirable that more exact chemical tests should be carried out.

Business Methods.—Fat cattle and sheep are generally sold through the local auction market. Store sheep are bought at one of the Border sheep sales or from dealers privately. Store cattle are usually bought privately from Irish dealers at Berwick-on-Tweed. Grain is sold privately in Berwick corn exchange. As regards co-operation, it was the general opinion that, under such conditions as those of the parish, the formation of small local co-operative societies led nowhere, and that such societies could not buy or sell to the same advantage as the private trader. They were not in the possession of sufficient capital to give the extended credit demanded by many farmers. Farmers were not enthusiastic over the present method of marketing. It is believed that a better regulation of supplies would make for stability in prices, and that there are too many middlemen. It is thought, however, that an organisation of farmers amongst themselves would not succeed on account of conflicting local views.

Education.—The attitude towards agricultural education was in general apathetic. The general belief was apparently that the education required was years of work on the farm. Lectures on agriculture were considered to be of little value.

General Conclusions.—The farmers as a whole were found to be capable, energetic and industrious. With some exceptions, the farms were fairly well equipped with buildings, machinery and implements, and the majority of farmers appeared to be in possession of ample capital. The change of system required to meet changing conditions, while slow to operate, is gradually taking place either by lengthening the rotation or by reducing the area under the usual rotation. Much could be done to develop pigs and poultry. Economies could be effected by the home compounding of manures and grass seed mixtures and by the farmer exercising closer supervision on the feeding of his stock. The home breeding and rearing of cattle cannot progress satisfactorily until a better supply of suitable calves at the right time can be assured. The elimination of cross-bred sires and of scrub bulls would be a distinct advance. There is need for much new drainage work, and measures are required to ensure the maintenance and efficiency of ditches and streams. Finally there is considerable room for development of the work of the Agricultural College. The present area worked by the College Organiser is too wide to enable him to get into touch with some of those who most require assistance. There is need for extensive experiment and demonstration on manuring and seeding, on the feeding of stock, on dairying, and on the management of pigs and poultry.

Parish B.

This parish, which has an elevation of from 590 to 1,470 feet, with a southern aspect, is fairly typical of the upland districts of the Border counties. It has an area of over 14,000 acres, 5,000 acres being arable and 8,000 acres pasture, the pasture land including 3,000 acres of hill grazings. Apart from a small quantity of potatoes and wheat, very little produce other than stock is sold. The agriculture is mainly directed towards the breeding or feeding of live stock—chiefly sheep.

The holdings above one acre numbered 25, there being five under 50 acres, five between 50 and 300 acres, five between 300 and 500 acres, and ten, including four consisting in part of open moor, of over 500 acres. The reporters classified the holdings thus :—

	Holdings under 50 acres.	Holdings between 50–300 acres.	Holdings between 300–500 acres.	Holdings over 500 acres.	Total.
Class A ...	1	1	2	7	11
Class B ...	...	4	2	2	8
Class C ...	2	...	1	1	4
	3	5	5	10	23

Two very small holdings consisting only of grass parks were not classified.

With one or two exceptions the farmers seemed to have ample capital at their disposal owing to the profitable nature of sheep farming during recent years. A number of farmers who had previously been tenants had bought their holdings, but the obligation to purchase had not apparently proved a serious handicap. The assessment values of the farms purchased by tenants had not, generally speaking, been altered, as they had been in Parish A.

Crops.—No uniform system of rotation is followed, but it is never closer than 5 course, while 7 or 8 course, or even longer, is common.

Grain.—Except for a few acres of wheat, grown to provide straw for covering potatoes, oats is the only grain crop. In 1926 there were about 1,200 acres under this crop. The yield varied in 1926 from 6 quarters per acre on good land to 3 quarters on poor land. The favourite varieties were Golden Rain and Castleton Potato, but Longhoughton, Yielder, Victory and Abundance also found a place. Damage by grub is common. Practically all oats grown are consumed at home by stock.

Potatoes.—Only 42 acres were grown in 1926. The soil and district appears well suited to the successful growth of the crop, and the reporters consider that there is scope for high-class seed production.

Turnips and Swedes.—This crop always follows lea oats. Dung is sometimes applied on the stubble in the autumn, and occasionally in the drill at the time the turnips are put in. There is not sufficient dung, however, to go over the whole fallow break, and artificials, blood and bone manure being favoured, are applied at the rate of 5 to 6 cwts. per acre in supplement to dung, or at the rate of 7 to 10 cwts. per acre where no other manure is used. There were few complaints of finger-and-toe and failure of the crop is unknown. The average crop was stated to be from 18 to 20 tons per acre. Wintering cattle receive few, and in some cases no turnips, the bulk of the crop being consumed by sheep.

Hay and Pasture.—It is usual to top dress the rotation hay, but not the meadow hay. Sulphate of ammonia is preferred to nitrate of soda. Three-quarters to 1 cwt. per acre is applied alone. On almost every farm good mixtures of grass and clover seeds are sown, usually at the rate of 40 to 45 lbs. per acre. A large area of the grass land has in the past been under cultivation, but has not been ploughed for at least a generation. In its present state much of this grass land is practically worthless. In view of the results obtained elsewhere in the improvement of pasture, there appears to be plenty of room for development.

Manuring of Crops.—Only the root crops, and, to a small extent, the temporary grass to be cut for hay, receive artificial manures as part of the general farming system.

Live Stock.—*Cattle.*—Few farmers had made any attempt at cattle rearing, and with one or two exceptions the class of cattle bred was poor. Cattle—chiefly English—are bought in and fed as in the lower districts of the county, but more commonly are wintered and sold off the grass either fat or as stores. In view of the opinion expressed in the lower district with regard to the rearing of cattle, to which reference was made above, it was expected that with plenty of hill grazing and with an average rental of considerably under 20*s.* per acre (9*s.* 6*d.* per acre over the whole parish as compared with about 27*s.* in Parish A), cattle rearing would form an important part of the farming system of the parish. This was not found to be the case, but it seems clear that if farmers went in more for cattle rearing it would not only be to their own advantage, but it would be of indirect benefit to neighbouring districts where feeding only could be carried out. The district is one which appears suitable for dairy farming, combined with the rearing of store cattle and some sheep; such a system would lead to increased production all round and would increase the farming population. With the exception of abortion, cattle are said to be quite free from disease.

Sheep.—The agricultural returns show that there were 20,000 sheep in the parish at 4th June 1926, an increase of 22 per cent. over the number returned at 4th June 1919, this increase being confined to the flocks of breeding ewes and their produce. The increase in the sheep stocks is an indication of the profitable nature of sheep rearing. The following yields and prices of wool were given :—

Blackface : 4½ to 5½ lbs. ewe and hogg. Average price per lb. 9¾*d.*

Cheviot : 4½ lbs. washed. Price per lb. 1*s.* 4*d.*

Half-Bred : 6 to 7 lbs. washed. Price per lb., ewe 1*s.* 2½*d.*, hogg 1*s.* 4*d.*

The question of disease gives cause for serious consideration. Cases of scrapie have occurred at one time or another on most farms. There were also losses from lamb dysentery in 1926. In wet seasons occasional losses occur from liver rot or fluke. Even on hill grazings footrot was prevalent, the wet condition of the land favouring the spread of the disease.

Pigs and *Poultry*.—At the time of inspection there was not a breeding sow or a boar in the parish. A few pigs are kept either by farmers, to consume household scraps and dairy by-products, or by farm servants. The few breeding sows that had been kept were disposed of when the price of bacon slumped. There were two small holdings devoted entirely to poultry-keeping, with about 300 and 500 birds respectively. The general belief is that poultry-keeping is unprofitable, only a few being kept on each farm for household purposes. The number of foxes in the district is against the development of this branch.

Labour.—Farm servants were stated to be efficient, and changes were infrequent. When the houses were good, it was said that the men never left. It was estimated that the wages bill for holdings above 100 acres varied from 6*s.* to 34*s.* per acre of the total area, or from 22*s.* to 48*s.* per acre of arable land. Some casual workers could be obtained locally, but the chief source of supply is Ireland. The same Irishmen come year after year to some farms.

Drainage.—Except for the hill pasture, nearly all the land has been tile drained in the past, but in many cases these old drains no longer work satisfactorily. On two farms a great deal of drainage had been carried out in recent years with the aid of Government grants. As in Parish A, it was found that the arterial drainage was far from satisfactory. Several hundred acres had become either unfit for cultivation or were being adversely affected through neglect to keep ditches clean. When the parish was in the hands of a few large proprietors it was comparatively easy to obtain concerted action, but with the increase in the number of proprietors this has become increasingly difficult.

Liming.—The "Soiltex" test indicated a general lack of lime. There was little finger-and-toe in turnips and no failure of wild white clover in the land in rotation, but, especially in the older pastures, plants usually associated with lime deficiency were in evidence. The opinion was expressed that great advantage would be derived if further Government assistance were given towards draining and also towards liming.

Business Methods.—Sheep and cattle are bought and sold privately or in the Border sale rings. Manures and feeding stuffs are generally bought from one of the larger firms engaged in this business, and are generally conveyed by road at a cost approximately equal to that of transport by rail to the nearest station. Several of the largest farmers were definitely opposed to co-operation, some were strongly in favour, while others had no decided opinion.

Education.—In most cases little or nothing was known of the work of the Agricultural College.

General Conclusions.—In this parish the farmers were found to be expert flockmasters and capable cultivators, but they were lacking in up-to-date knowledge on manuring, and, as a rule, had little interest in any stock other than sheep. Labour was efficient, but the housing provided was often poor and usually lacking the conveniences which are desirable if the best class of labour is to be retained. There was a general move towards laying a grêater area down to grass. There was room for the development of cattle-rearing, pig-rearing and poultry-keeping. The elimination of scrub bulls and a declaration as to the sire of calves exposed for sale would lead to a great improvement in the cattle reared. The wholesale removal of the woodlands without any provision being made for replanting is of serious consequence to the district. There is need for much drainage work and for measures to control the arterial drainage. The application of lime would greatly benefit the agriculture of the parish. As in the case of Parish A, there is a big field for agricultural education and for advice on up-to-date methods of agriculture. The instruction would be most effective by means of farm to farm visits, which would open up the way to large scale demonstrations.

THE CULTIVATION OF LUCERNE.

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LUCERNE or alfalfa is a native of Central Asia and appears to have been introduced into Europe about 490 B.C., when it was brought from Persia to Greece. From Greece it spread to Italy, and at a later period to Spain, France and Germany. In Britain the cultivation of lucerne is first referred to by Barnaby Googe in his "Whole Art of Husbandry," published in 1578, but until recently it has received comparatively little attention in this country.

Lucerne is one of the most valuable of forage crops. Like other leguminous plants its nutritive value is high, due largely to a high percentage of protein, but in feeding value it surpasses the majority of leguminous crop plants. In Table I the nutritive values of lucerne and red clover hay are compared on the basis of figures given by Henry and Morrison.

TABLE I.

Nutritive value of lucerne and red clover hay.

	Lucerne Hay.	Red Clover Hay.
Digestible Nutrients in 100 lbs. :—		
Crude Protein	10·6 lbs	7·6 lbs.
Carbohydrates	39 0 ,,	39·3 ,,
Fat	0·9 ,,	1·8 ,,
Nutritive Ratio	1 : 3·9	1 : 5·7
Minerals in 1000 lbs. :—		
Potash	22·3 lbs.	16·3 ,,
Phosphoric Acid	5·4 ,,	3·9 ,,
Lime	19·5 ,,	16·0 ,,

The high percentage of digestible protein and mineral matter, particularly lime and phosphoric acid, along with the narrow nutritive ratio renders lucerne particularly valuable for breeding stock, young animals and milk cows.

The beneficial effects produced upon subsequent crops by the growth of lucerne are very pronounced, and are due to the high nitrogen content of the root residues and to the fact that the root system is a very extensive one. The growth of the crop and its subsequent decay tend to open up and aerate the subsoil and to enrich the surface soil in valuable manurial constituents at the expense of the deeper layers. The effect of lucerne on a subsequent crop of oats is illustrated by the results of an experiment carried out at Rothamsted in 1912, in which oats were sown on land which had previously grown lucerne and red and alsike clovers since 1909. The yields of oats obtained are shown in Table II.

TABLE II.

Effect of lucerne and clovers upon a subsequent oat crop.

	Grain.	Straw.
	Bushels.	Cwt.
After lucerne	50·9	29·5
,, red clover	37·2	23·5
,, alsike clover	29·1	19·2

In suitable soils the roots of lucerne have been observed to penetrate to depths of 10 to 20 feet. Its extensive root system renders the crop very resistant to drought, and its perennial character further enhances its value.

Since the beginning of the present century the recognition of its value as a forage crop has been followed by a remarkable increase in the acreage under lucerne in the United States, Canada, and most other countries with the exception of Great

Britain. Thus the United States grew about 2 million acres of lucerne in 1899: in 1924 the acreage had increased to 10½ millions. The Argentine had in 1896 about 2 million acres under lucerne; in 1918 about 19 million acres were grown. In Canada the lucerne acreage increased from about 50,000 in 1909 to almost 400,000 in 1923. In Britain, however, since the beginning of the century the acreage has only increased from 48,000 to 65,000 in 1924. Of this area the greater part is grown in the south-eastern counties of England; Scotland has a few acres only. Numerous attempts have been made to introduce the crop into this country, but the majority of these have ended in failure. Some of the difficulties encountered in the growing of lucerne in the south-eastern counties of Scotland have been investigated and the results of these investigations are described in this paper.

Selection of Soil.—A frequent cause of the failure of lucerne in this country is the unsuitability of the soil. Of the cultivated crops lucerne is one of the most sensitive to acidity, and many Scottish soils show a decidedly high lime requirement. In the course of this investigation the data given in Table III on the pH value of the soil in relation to the growth of the crop have been collected. (Degrees of acidity and alkalinity are now frequently expressed by means of a scale, the numbers on which are termed "pH values." Seven denotes neutrality, while numbers below 7 indicate increasingly acid reactions and those above 7 increasingly alkaline reactions.)

TABLE III.

pH value of the soil in relation to growth of lucerne.

pH of Soil.	Number of Experiments.	Successes.	Failures.	Doubtful.*
5·00–5·49 ...	4	0	4	0
5·50–5·99 ...	7	2	4	1
6·00–6 49 ...	7	6	0	1
6·50–6 99 ...	7	6	0	1
Over 7·00 ...	9	8	0	1

* Failures, where the result was doubtful owing to the prevalence of perennial weeds.

In considering these results it should be borne in mind that the pH is only one of the factors involved in the lime requirement of a soil. It can, however, be taken as a rough guide, especially when comparing soils of the same region.

In all of the experiments reported upon in the above table the lucerne made a certain amount of growth, but where the pH was much below 6 development was so slow that it was found to be impossible to establish a crop worth cultivating. As a rule the liming of these soils, while it increased the yield, did not permit of satisfactory growth of the crop. In two cases with very heavy liming a fair crop was obtained during the first season, but in the subsequent year the lucerne died out, due, it is believed, to the roots penetrating to the acid subsoil which had not been reached by the lime. The two successes in the range 5·50 to 5·99 were on soils the pH of which was close to 6, and which were exceptionally well cultivated. It is considered, therefore, that where the pH of the soil is decidedly below 6, the cultivation of this crop should not be attempted.

On the other hand, where the pH of the soil is above 6·50 it has been found that the crop can be grown with a reasonable degree of certainty, provided the other conditions are suitable. In the range 6·00 to 6·49, while only one of the seven crops was a complete failure, four of the six recorded as successes could only be described as fair. When the pH lies between 6·00 and 6·50 an attempt may be made to grow lucerne, but only after the soil has been well limed, preferably in the autumn preceding sowing. If the liming is delayed till spring ground limestone should be used in preference to ground or shell lime as the latter is liable to destroy some of the bacteria introduced in the inoculation of the seed.

Two interesting cases, recently observed, may be quoted in support of the views here expressed on the relationship of the pH of the soil to the growth of lucerne. In a plot carrying a good crop there was a poor spot where the lucerne made only moderate growth. The soil from the poor area showed a pH of 6·35, while the value for the remainder of the plot was 6·99. In the second case the crop died out after the first season with the exception of a small area near a recently-built stone and lime wall. This spot produced a small crop, and the soil from it showed a pH value of 6·22 against 5·24 where the crop failed.

Lucerne succeeds best on a medium to heavy loam, which should be deep and well drained. It will not tolerate standing water at or near the surface of the soil, and in a poorly drained soil which is otherwise suitable it is liable to die out altogether even during a mild winter. Subsoiling is advantageous, especially where the subsoil is rather compact. A southern exposure and shelter from the prevailing wind are of considerable importance. The sheltering effect of even a hedge is sometimes noticeable, while the crop is liable to suffer severely from the effects of frost in winter when grown in hollows into which the sun does not penetrate.

Variety.—Apart from its ability to produce a satisfactory yield, the value of a lucerne strain or variety depends upon the length of its growing period and its ability to resist frost. The numerous varieties in existence show great variations in these characteristics. The varieties most frequently employed in our experiments have been Provence and Grimm. The former is extensively grown in France, and is also very valuable in the southern counties of England. Grimm appears to have originated in Baden, Germany, and to have been introduced into the United States of America about the middle of last century. It is extensively grown in the northern States and in Canada, where, owing to its frost-resisting properties, it is highly valued. Its hardiness is generally ascribed to the fact that the crown of the plant is low set, a characteristic which also renders it particularly suitable for grazing.

The observations made upon the Provence and Grimm varieties indicate that the latter is superior to the former under the conditions prevailing in the east of Scotland. It is decidedly more resistant to frost, and also appears to reach the flowering stage earlier than Provence. Where it has been tested against Provence it has yielded a larger crop even during the first season, and in subsequent seasons its superiority has been still more marked owing to the fact that Provence tends to become thinned out by frost in winter. The more procumbent habit of growth of the Grimm variety is also an advantage in the suppression of weeds. A few observations have been made on the Marlborough, Hunter River, Hungarian and Cossack varieties, while English-grown and South American seed has also been tried. Of these the most promising so far is the Hunter River variety. There is, however, great room for the selection and breeding of strains of lucerne adapted to the local conditions, particularly with regard to the length of the growing period. A hardy strain which would start growth two or three weeks earlier than Grimm would go far towards the solution of many of the outstanding difficulties in the cultivation of this crop.

Inoculation.—When growing under normal conditions, lucerne, like all other leguminous crops, possesses upon its roots nodules which contain bacteria. These organisms are present in soils which have previously grown a normal crop, and from the soil they penetrate the young root of the plant at an early stage. The invasion of its tissues causes the plant to develop nodules at the points where the bacteria have penetrated. In the case of lucerne the nodules are generally irregularly branched, and may occur in groups on the main root just below the surface of the soil or on the lateral roots (see Fig. 1). The bacteria live in the nodules in association with the plant, supplying it with nitrogen and receiving from it in return certain other nutrients.

Several types of nodule bacteria can be distinguished, each of which is associated with the plants of a particular genus or genera. Thus the organism found in lucerne nodules will only cause the formation of nodules on the roots of plants belonging to the genera *Medicago* and *Melilotus*, and as few of the species of these genera are cultivated in this country it appeared probable that one of the reasons for the failure of lucerne in Britain might be that the bacteria of this group are absent from the soil. Field experiments were therefore carried out to determine the effect of the addition of lucerne nodule bacteria to the soil in the form of a seed inoculation. In these experiments inoculation has produced the following percentage increases in yield of crop :—20, 25, 46, 84, 97, 103, 136, 138, 139 and 162, indicating that the organism is absent from many soils. The beneficial effects of inoculation have been observed on soils the pH values of which range from 5·93 to 7·50.

Not only did inoculation increase the yield, but in most cases it profoundly altered the appearance of the crop. The uninoculated plots were as a rule short and spindly, pale green or yellowish in colour, and showed all the symptoms of nitrogen starvation, while those which had been inoculated were taller and more vigorous, and were dark green in colour (see Fig. 2). Inoculation also markedly increased the percentage of nitrogen in the dry matter of the crop. Table IV gives the percentages of nitrogen in the oven-dried material of a number of inoculated and uninoculated crops.

TABLE IV

Effect of inoculation on percentage of nitrogen in dry matter.

Season.	Crop.	Uninoculated.	Inoculated.
		Per cent.	Per cent.
1st	1st	2·28	3·31
1st	1st	1·63	3·05
1st	1st	1·82	2·76
1st	1st	1·84	3·47
2nd	1st	1·47	2·34
2nd	1st	1·22	2·73
2nd	1st	1·12	2·47
2nd	2nd	3·43	4·53
2nd	2nd	2·35	4·27

It is clear, therefore, that inoculation is of decided value in increasing the yield obtainable as well as the percentage of nitrogen, and therefore the feeding value of the crop. The response to inoculation has been so general and so pronounced in these experiments that it is considered to be inadvisable to attempt to grow the crop without it.

Two strains of the lucerne organism have been employed in this work. The first (A) was obtained from the United States Department of Agriculture, the second (B) from Mr Thornton of the Rothamsted Experimental Station, who obtained it originally from Denmark. There is a marked difference between the two strains in the rapidity with which they produce their effects. Both strains have produced increases in yield of over 100 per cent., but whereas B has uniformly produced its effects during the first year, A has frequently failed to increase the yield till the second year. A series of pot experiments was carried out to test the two strains under comparable conditions. Four pots were sown with uninoculated seed, while eight were sown with seed inoculated with strain A and eight with seed inoculated with strain B. Fifteen plants were allowed to grow in each pot. The seed was sown on May 20th in garden soil which had been well limed and mixed before potting, and the crops were cut on August 24th, when they were beginning to flower. The average results are given in Table V.

TABLE V.

Effect of inoculation with different strains of lucerne nodule bacteria.

	Average weight of air-dried crop per pot.	Average percentage of nitrogen in oven-dried material.
Uninoculated	13·97 grams.	3·56
Inoculated with strain A ...	16·29 ,,	3·57
,, ,, B ...	25·37 ,,	3·83

Strain B is decidedly superior to A in inoculating power, and also grows more vigorously on laboratory media than strain A. This is in agreement with a previous observation made by Stevens at Wisconsin. Rapid inoculation is of the utmost importance in securing a satisfactory crop. If the crop grows slowly during the first year (as it does when weakly inoculated), it is very difficult to establish and keep free from weeds. The use of strain B as compared with A is of material assistance in establishing the crop.

For inoculation purposes the lucerne organism is grown on agar, on the surface of which it appears as a greyish white slime. The slime is scraped off and thoroughly mixed with fresh skim milk. The seed is then uniformly moistened with the milk and allowed to dry before sowing. Thornton recommends the addition of calcium phosphate to the milk, which he claims hastens inoculation.

After the seed has been inoculated it should be sown as soon as possible, as the bacteria tend to die if the seed is kept for some time. Experiments by Lochhead, from whose paper Table VI is taken, emphasise the importance of early sowing after inoculation.

TABLE VI.

Nodule formation and storage of seed after inoculation.

Time of storage of seed after inoculation.	Nodules per plant.
Sown immediately	10·0
Stored 1 day	6·7
,, 2 days	5·7
,, 3 ,, ...	3·0
,, 4 ,, ...	2·5
,, 5 ,, ...	2·2

The seed should be sown as soon as it is dry enough, and during drying it should be protected from sunlight, which is injurious to the bacteria.

Soil may also be inoculated by sowing on it several hundred-weights per acre of earth from a plot which has grown a

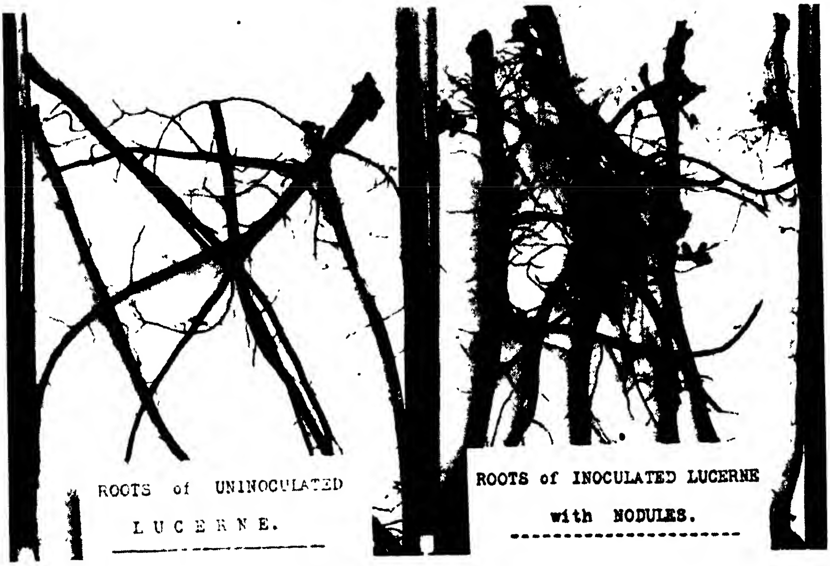

FIG. 1.—Effect of Inoculation on Roots of Lucerne.

FIG. 2. Showing effect of Inoculation on Yield of Lucerne.

successful well-inoculated crop, and immediately harrowing it. This method, however, involves considerable labour and transport, and has the disadvantage that it is liable to introduce plant pests, weed seeds, &c., quite apart from the fact that at the present time there is comparatively little well-inoculated soil available in the country. When the nodule bacteria have been introduced into a suitable soil they spread with considerable rapidity, so that it is frequently impossible to prevent uninoculated control plots from becoming inoculated from those into which the bacteria have been introduced. It is believed that movements of the soil water play a considerable part in spreading the organisms in the soil. In one case where alternate inoculated and uninoculated plots were sown across a slope, the only plot which did not ultimately become inoculated was that situated on the highest ground.

Sowing, Cultivation and Harvesting.—For lucerne the seed bed must be very carefully prepared. A fine tilth is necessary and the land must be free from weeds and weed seeds. This crop is exceedingly sensitive to the competition of weeds, particularly during the first season, and in order to allow it to become properly established it is absolutely essential that the land should be kept clean. Weeds are a very frequent cause of failure. Lucerne may follow potatoes or a root crop.

The seed should be sown about the middle of June to allow ample time for the cleaning of the land and to ensure that the crop will grow rapidly. Lucerne sown before this date is difficult to keep clean, tends to become blanky, and does not yield as well as a crop sown in June. Sowing later than June, e.g in early August, does not allow the crop to become sufficiently well established before winter. As soon as the land is dry enough to work it should be harrowed at intervals of two to three weeks till the time of sowing in order to encourage annual weeds to germinate and destroy them. A short time before sowing it should receive a thorough cleaning, such as is usually carried out in preparation for a root crop. The chief danger which must be guarded against when lucerne is sown in June is that a period of drought is liable to be encountered during which it is impossible to secure a satisfactory braird.

The seed should be sown in rows on the flat, 18 to 21 inches between the rows, covered if necessary with light harrows and rolled with a heavy roller. Rolling before sowing is also frequently an advantage. Broadcasting is not recommended as it does not allow of the crop being cleaned. On three occasions lucerne has been sown in a cover crop of barley in April to early May, but on all three occasions the crop has failed.

The quantities of seed sown per acre in these experiments have varied from 7 to 30 lbs., but as a rule from 10 to 15 lbs. has proved to be the most satisfactory seeding. In the case where 7 lbs. were sown the conditions were very favourable and a very good crop resulted. Generally, however, 10 to 15 lbs. is the quantity recommended. A dressing of phosphatic and potash fertilisers may be applied at seeding, and may consist of 4 cwt. superphosphate and 1 to 2 cwt. sulphate of potash per acre.

The after-cultivation consists in keeping the land free from weeds, for which purpose hand hoeing must generally be relied upon, as it is unsafe to harrow or cultivate till the plants are six to eight weeks old. After about two months from sowing the crop may, if necessary, be cultivated between the rows provided care is taken that the implement used is not set too wide.

Lucerne is generally ready to cut about the middle of September when it should be just coming into flower, and if cutting is delayed beyond this stage the crops obtained in subsequent years usually suffer. At this season it is as a rule best to feed the crop green to animals. It may, however, be made into hay provided the weather is suitable, but in this case it must be allowed to dry very slowly to avoid the loss of the leaves, which contain a large proportion of the protein (three to four times as much as the stems). In the second and subsequent seasons two crops are obtained, one in July and the other in September. So far not more than two cuts per annum have been obtained under field conditions.

After the last cut for the year has been removed the land should receive a small dressing of ground limestone if the pH is below 7, and should be harrowed with heavy harrows. In October the rows should be lightly ridged up with an ordinary plough to protect the crop from frost during winter. In spring the land should be levelled by cross-harrowing, which assists in destroying weeds, and kept clean till the crop begins to grow. The dressing of phosphatic and potash manures already recommended may be repeated at this time.

General Conclusion.—It has proved to be extremely difficult to obtain complete records of the weight of lucerne hay obtainable from the experimental plots owing to the fact that hay-making in September is rather uncertain, and that many of those who have grown the crop have preferred to feed it green to animals. The records are therefore incomplete. Under the most favourable conditions it has been possible to obtain a yield of about one ton of hay in the first season and a total of about 3½ tons from the two cuttings in the second season. These results have, however, been obtained only in early districts and with very careful management. The essentials appear to be :—

(1) Suitability of the soil;
(2) Use of the Grimm variety;
(3) Inoculation of the seed;
(4) Thorough cleaning of the land;
(5) Sowing not earlier than June.

In conclusion I wish to express my thanks to all those farmers and others who have placed land at my disposal, to members of the County Staff of this College for assistance in laying down experiments, and to Dr. W. G. Ogg for the determinations of pH of the soils.

THE BIOLOGIST on the FARM.—No. XXVIII.

Prof. J. Arthur Thomson, M.A., LL.D., (Edin. *et* MacGill).

X-Rays and Breeding.—It is well known that X-rays in certain doses bring about in mammals a sterility which commences soon after treatment and may be subsequently recovered from, in part at least. But while rats and mice are very useful subjects for experiment, being relatively near domesticated animals, the use of X- or radium rays is apt to cause *permanent* sterility. This fatal disadvantage can be readily avoided by working with such humble creatures as the fruit-fly. Moreover, the fruit-fly experiments are inexpensive and rapid, and the experimenters, who have worked for many years on this particular type, know what to expect in the way of change apart from that induced by the special factor experimented with. Thus Prof. H. J. Muller of the University of Texas has spent eight years in the study of the " mutation rate " of one of the fruit-flies, *Drosophila melanogaster*, and is therefore in a very favourable position for studying the effects of X-ray treatment, which may be regulated so as to avoid fatal effects. " It has been found quite conclusively that treatment of the sperm with relatively heavy doses of X-rays induces the occurrence of true ' gene mutations ' in a high proportion of the treated germ-cells. Several hundred mutants have been obtained in this way in a short time, and considerably more than a hundred of the mutant genes have been followed through three, four, or more generations." We may recall that " gene " means a hereditary " factor," the germinal representative or initiative of a particular character. They are believed to lie in linear order, like beads on a string, in the nuclear bodies or chromosomes of the germ-cells. Most biologists believe that the novelties that crop up in the course of generations in plants and animals are due to changes in the " genes " or hereditary factors, and Muller may be said to have proved this at least, that X-rays may artificially provoke heritable variations usually breeding true and mostly behaving in Mendelian fashion. More than this has been proved, but let us keep to the broad result. " The transmuting action of X-rays on the genes is not confined to the sperm-cells, for treatment of the unfertilised females causes mutations about as readily as treatment of the males." The young stages of the eggs in the ovaries are definitely affected. It may be noted that the raying of the sperm-cells may be effected in the males or after they have been transferred to the female receptacles. This success in artificially inducing mutations is sure to throw light on the nature and behaviour of the genes, and it also frees the investigator from the necessity of having to wait for mutations to turn up. " For the practical breeder it is hoped that the method will ultimately prove useful." But he had better practise first on a *corpus vile* like a white rat. The evolutionist should not hurriedly toss aside these and similar experiments as being far away from what may have occurred or may still occur in wild nature. For just as there are ultra-violet rays in sunlight, so there is a small amount of gamma radiation present in nature. Whether there is enough to pull the trigger of a mutation will soon be determined experimentally.

Blood Worms.—In stagnant and dirty pools in the summer time, even in rain-water barrels, we sometimes see "blood worms," which are the aquatic larvæ of certain gnats or midges, best called Harlequin Flies (*Chironomus*). Some species have the same red blood pigment, hæmoglobin, as we have; and this, as Dr. Isabella Leitch and others have shown, is well suited for utilising the scarce oxygen in the foul water. It may be noted that insects rarely have any pigment in their blood, and that the insect's blood has not much importance as a gas-carrier, being in the main a distributor of the digested food. Although insects have a contractile blood-vessel or heart, which gives off some arteries anteriorly, there is no closed blood system. The fluid circulates in ill-defined spaces, and here we get an illustration of the use of technical terms, for the nutritive fluid is so different from our blood that it is better to call it "hæmolymph." The reason why the "blood" system remains poorly developed in insects is doubtless to be found in the very strong development of the system of air-tubes or tracheæ, which carry air to every hole and corner of the body. The larvæ of some species of harlequin fly have no hæmoglobin, and these have to live near the surface of the water, where oxygen is more abundant. In these forms the system of air-tubes is better developed than in the red larvæ which burrow in the mud or live in little tubes at the foot of the pool. This is the first remarkable thing about blood-worms, that they have somehow produced hæmoglobin and are therefore able to live in water with little oxygen. Their air-tubes are closed, but there are delicate branchial filaments growing out from near the posterior end of the body. Into these the air in the water diffuses.

Another peculiarity has been pointed out recently by Toyowo Matsuki, who has been able to count the heart-beat of these little larvæ. Just after the hatching there is an astonishing rate of 300 beats per minute. Matsuki found that the shorter the body the greater the pulse-rate. As the body length increased from 5 millimetres to 25 mm. (i.e. one inch), the pulse-rate gradually decreased from about 133 to 61. In the smaller larvæ there is a quickening of the quick pulse as the temperature of the water increases. Here then is another peculiarity—a very high pulse-rate.

In the summer time it rewards one to put a living blood-worm in a watchglass with water and study it with a good lens or the low power of a microscope. It is a fine instance of intense life, and no one who did not know would suspect that the blood-worm is going to turn into a dancing midge! There is a species called *Chironomus plumosus* that is peculiar in sometimes showing "phosphorescence" or "luminescence." This is remarkable, for there is almost no other case of the occurrence of this phenomenon in animals that have anything to do with fresh water. Everyone will recall the luminescence of glow-worms and fire-flies, but these are terrestrial. The vast majority of luminescent animals are in the sea. It would therefore be interesting to hear more about the luminescence of this Plumose Harlequin Fly. It is exhibited by some adults throughout the body and legs, but not in the wings. Perhaps it is a disease associated with the presence of luminous bacteria such as we see at night on drying fish.

How do Butterflies survive the Winter?—This is a very simple question, but it requires a long answer. (1) In the first place there are a number of hardy European butterflies which normally fly about during winter. In autumn they are chrysalids or pupæ, but they hatch out after the first keen frost. The females usually have imperfect or degenerate wings, and they are therefore less likely to be blown away from the woods and copses in which they shelter and find suitable food-plants for their offspring. (2) In the second place, many well-known butterflies like Tortoise-shells seek out a comfortable place in autumn and remain there as butterflies through the cold months. They are in a state of suspended animation, and it has often been noticed that a spell of winter sunshine may rouse some Tortoise-shells or Painted Ladies prematurely from their state of quiescence. It is not surprising to find that the Red Admiral, occasionally aroused during a British winter, normally flies about at this season in Sicily. Similarly, in a warm country, where the seasons are not well marked, there are butterflies all the year round. (3) In the third place, some of our butterflies spend the winter as quiescent pupæ or chrysalids, often well-protected from frost, damp, and enemies. (4) In the fourth place, though some will doubt this, the majority of North Temperate butterflies spend the winter as caterpillars. They have the advantage of having accumulated internal stores of reserve food, of being suited to creep into crevices and holes, of being relatively resistant to injurious influences, and of being able to shift their winter quarters should these become very inhospitable. There can be little doubt that the larval chapter was interpolated into the old-fashioned insect's life-cycle because it favoured the success of the winged adult phase. That is to say, variations in the direction of lengthening out a hungry youthful stage, still only half-finished, were rewarded or justified by giving additional vigour and length of life to the adults. Therefore it was automatically accentuated. An interesting fact is that among butterflies living under similar conditions the more old-fashioned types have the caterpillar-period long in proportion to the pupa-period. In other words, the interpolation of a caterpillar stage is historically older than the interpolation of a pupa stage. (5) In the fifth place, there are a few butterflies which die in late summer after laying their last group of eggs, leaving these to survive the winter. Wintering in the egg stage is most riskful of all, and one is not surprised to find that the eggs in these cases are well protected by hard chitinous shells and well hidden away.

Of importance on the farm, when fruit or forest trees are grown, are the winter moths which emerge from chrysalids in cold weather. The females have rudimentary wings and crawl up the stems of trees. They lay their eggs on the surface or in chinks, and the caterpillars which emerge in spring do much damage to the buds. Common kinds belong to the genera *Cheimatobia*, *Hibernia* and *Anisopteryx*. It is useful to put sticky bands of cart grease or the like round the tree-stems to entrap the crawling females, and to dig or hoe in lime or gas-lime round about the trees, so as to kill the pupæ, which spend the summer in the soil.

Intersecting Circles.—Among the half dozen biggest ideas that the biologist can impart to those who are willing to listen is the idea of inter-relations between life-circles or life-cycles. Let us take another instance of this biological idea to which we have often referred. At the present time there is much Bilharziasis in some parts of South Africa, such as Durban. It is a painful and enfeebling disease, due to the presence of some species of Bilharzia or Schistosomum in the region of man's bowel or the bladder. The hard-shelled microscopic eggs of this peculiar fluke or Trematode bear a sharp spine which cuts the walls of the fine branches of the blood-vessels, with painful and serious results. In South Africa the only known host of the adult Bilharzia is man, which simplifies matters. For in the case of the Chinese and Japanese species, *Schistosomum japonicum*, the adult parasite is also found in dogs and cattle, and will therefore be much more difficult to eradicate. In several recent papers Dr. F. G. Cawston in Durban discusses with skill the question of checking Bilharziasis in South Africa. If we ask how the water is infected, we are told that ignorance or indifference allows contamination with eggs passed from man. To a considerable extent this is preventable; yet people must wash dirty clothes somewhere! If we ask what happens to the eggs in the water, we are told that ciliated larvæ emerge from the eggs and enter a common water-snail, *Isidora africana*, where they pass through various stages. They leave the snail as minute forked threads, called cercaria larvæ, which find their way into man. If we ask how the water snails may be checked, we are told that they feed chiefly on the leaves of a rush and a water-lily, and that they congregate in large numbers when the water is fouled with rubbish and organic matter, even with the dung of cattle that stand in the shallows. It is important to check the accumulation of decayed leaves of rush and lotus, and to clear out pools where the snails are legion and give rise to legions. Another circle cuts in here, for there are various water-birds that play an important part in destroying the water-snails, so that bird protection is to the good. Unfortunately, the check effected by the birds is usually counterbalanced by careless fouling of the pools. And if we ask how children become infected, we are told that infection is usually cutaneous. The cercariæ bore their way through the skin of children who paddle or bathe in the pools. Here again is a possible check, and it is interesting to notice that the incidence of Bilharziasis is small among the Moslem children, who are not allowed to bathe in the open. Even religion has its finger in the pie!

But infection may occur in people who do not go near the pools, and Dr. Cawston indicates one of the ways. The hawkers of vegetables, who go round in the morning, carry such produce as lettuces. These were gathered the previous afternoon, but they have been steeped overnight in pool water swarming with cercariæ. Thus unbeknownst the vegetables are contaminated and man's infection by means of the food-canal follows. But our point is simply the number of intersecting circles :—man, bilharzia, water-snail, water-plant, water-bird, children at play, vegetables!

The Seventeen Year Cicada.—This is an American insect of unusual longevity, for, as its name, *Cicada septendecim*, implies, it may take seventeen years to complete its life-cycle. The story is not yet perfectly clear, but it seems that in a given locality there may be in a particular summer a huge number of these bugs, which live on trees and shrubs and do considerable damage. The males are vociferous, "happy," the ungallant Greek poet said, "in having voiceless wives." The female cuts slits in the twigs and deposits in these her fertilised eggs. It is said that some exudation from the mother insect weakens the twig, which dies and falls to the ground. A colourless larva emerges from the egg and buries itself in the soil. Year after year the underground larvæ feed and grow; and of course there are moults, perhaps six in all. The food is obtained from the roots of trees, and the larvæ dig several feet into the ground. They have a pair of specialised digging legs. The larval life usually lasts seventeen years in the northern States, thirteen in the south; but both periods sometimes occur in one locality. When its time comes the second stage or nymph, which lasts only for a few days, emerges on the surface, hooks itself on to a stem, and undergoes its last moult, a winged Cicada emerging. In some cases the brown nymph constructs a curious chimney which may project for several inches above the ground. In a short time, in a place where few Cicadas have been seen for years, there are immense swarms crowding the trees. They are often called "seventeen year locusts" or "harvest flies," both names as unfortunate as possible.

An anonymous writer in the *Turtox News*, published by the well-known Chicago Biological Supply House, from which we have received excellent specimens and preparations, describes at first hand an emergence of Cicada "nymphs" as the pre-adult forms are termed. "On quiet evenings the nymphs, as they emerged and crawled up the bushes and trees, produced by the movements of the thousands of insect feet a soft rustling that could be heard throughout the White Oak woods, where most of the nymphs seemed to be congregating." They climbed up the shrubs, their brown cuticle splitting along the back even as they crawled.

"Soon from the clinging nymph a milk white adult with wrinkled wings emerged, to leave the abandoned nymphal skin clinging with dead claws to leaf or twig, an empty husk." Of course, in speaking of moults one should never use the word "skin," for no animal could survive being skinned. What is moulted in young insects is the non-living renewable *cuticle* of chitin,—a product of the underlying living skin.

In our often maligned Scottish climate we are free from Cicadas and Bilharzias, but we have our green-flies (in the same sub-order as Cicadas), and we have our liver-flukes (in the same order as Bilharzias). We have nothing, however, to compare with the chorus of male Cicadas, whose effect a distinguished entomologist has compared to a combination of the noises of a distant threshing-machine and a distant frog-pond. Perhaps it is a masculine letting off steam; there is no convincing evidence that the females hear it at all! But there are other vibrational thrills than those that can be called auditory. Our serious intention as "Biologist on the Farm" was to suggest the deep-going idea of the plasticity of organisms—including ourselves. There are great possibilities in lengthening out one arc in the life-curve and shortening another.

Flights of Wild Geese.—In the last week of November we saw an impressive skein of wild geese passing *northwards* along the Aberdeenshire coast. There were about two hundred of them. At least two other big flocks were seen that week, one estimated at several hundreds, and all passing in the same direction—northwards. Of the five kinds of "grey geese" in Britain, the Grey Lag is the only one that nests with us, and that but sparsely in the Hebrides and North West Highlands. Thus the wild geese we see in the early part of the winter are winter visitors that have come, except some of the Grey Lags, from far north in Europe and Asia, where they breed. A thoughtful correspondent has asked us the reasonable question why these flocks were flying *northwards*. One would have expected them to be flying southwards, for many winter in the Mediterranean area and the like, and some feed in the fields in the Solway district. We suppose they do some damage to autumn-sown wheat and to clover. Their migratory flight to the north is a familiar sight towards the end of winter, but why should they be flying northwards at the end of November? We should think that the answer is that these flocks started from breeding-grounds far to the north-east of Britain, but struck our shores far to the south of Aberdeen. Perhaps they were disturbed after they had settled down in tentative pasture-grounds, say in Dumfriesshire, and took to wing again in the spring direction. More probably some of them had a memory of quiet and comfortable winter quarters beside some of the northern lochs, notably the Loch of Strathbeg, where large numbers congregate in winter.

When a creature is big-brained like a goose, and when its adult life extends over several years and when its habits are gregarious, there is no reason to hesitate in supposing that a kind of tradition is sustained from generation to generation. No goose could forget the Loch of Strathbeg, and some of the younger members of the flock may have been there several winters before they have to undertake the responsibility of leading the skein. As we watched the flying phalanx making its way north swiftly and confidently, we thought of the many different expressions that social life may take among animals—the beaver village, the troup of baboons, the rookery, the bee-hive, and so forth. Migration is in many cases a distinctly social phenomenon, and the V-shaped formation which the geese illustrate so well is a detail in the social arrangements. The flock flies as a corporate body, as a unit larger than the individual. A certain degree of self-subordination is implied. Flying in a V, with one side usually longer than the other, lessens the labour of flight for each individual bird, except the leader, who is frequently relieved. There are physical reasons for the economy effected, and the habit is instinctive not traditional. It is hinted at in the way young geese swim in a slanting line behind their parents. The V formation is exhibited by ducks, swans, cranes, flamingoes, and various other birds, but there are many quite different ways of flock-flying. Our particular point is that the arrow-head method is one of the many detailed expressions of social life.

THE SCOTTISH SEED POTATO TRADE.

W. J. Campbell, Edinburgh.

The Importance of the Potato.—The importance of the potato has long been recognised, and it is one of the most essential crops grown by the British farmer at the present time. From a food production point of view potatoes produce per acre twice as much as wheat, three times as much as oats and eight times as much as pasture. In value it exceeds wheat, barley or oats. Dr. Salaman, whose great and disinterested work on behalf of potatoes is widely appreciated, has stated that the potato industry of Great Britain in 1924 was worth £30,000,000. These figures indicate the value of the crop, but it is equally important to remember that the root crop is the pivotal crop, as it is the crop that cleans and prepares the land for subsequent crops; and if the area of the root crop is reduced, it will also mean a reduction in the grain area, and thus the country will have to buy from abroad what might very well be produced at home. From an employment point of view no other farm crop requires so much labour, and surely it is of national importance to keep as many workers on the land as possible. The potato crop is the only one which British agriculture can grow in sufficient quantity to feed our whole population and have a surplus for seed purposes for other countries. In view of the vital importance of the potato crop nothing should be permitted that would tend to make us dependent on outside sources for our requirements. Such a policy would ensure that growers would plant a more regular and constant acreage, and that consumers would be safeguarded by getting a full supply at an equable price. In the spring of 1923 (crop 1922) there was a large surplus of potatoes and thousands of tons were allowed to rot, yet between January and June 1923 potatoes to the value of over £2,250,000 were imported. In the following year the potato acreage in this country was reduced by over 100,000 acres, and potatoes to the value of over £5,000,000 were imported.

The Origin of the Scottish Seed Potato Trade.—Apart from the economic and social aspect the potato is of absorbing interest. In the early days it was so because of the ease with which new varieties could be raised, as each berry contains about one hundred seeds. In Lawson's *Agriculturist's Manual* published in 1836 there is a list of 136 varieties, with very complete details of habit of growth, &c. In more recent days, in addition to the raising of new varieties, a tremendous amount of interest has been aroused all over Europe and America in diseases affecting the potato, and the work of scientists has been of great benefit to the breeder, the grower and the merchant.

It was not until about 1860 that seed potatoes were taken in any quantity from Scotland to England, the seed being taken mainly by farmers who had left Scotland to settle in England. The main variety grown at that time was Regent, and it held the field for a considerable time, but gradually degenerated. It was followed by that excellent quality potato the Champion—a variety still grown with success in the north of Scotland, Ireland and Malta, but owing to its deep eye and coarse habit of growth it was soon discarded. Magnum Bonum and the Bruce followed, but these speedily gave way to Up-to-Date, a variety introduced in 1893. The success of Up-to-Date stimulated great interest and enthusiasm, and led to the speculation in new varieties which culminated at the beginning of this century in the Eldorado boom. The public entered into the gamble wholeheartedly and paid for the tubers more than their weight in gold, £100 being paid for a single tuber. The Eldorado proved an utter failure. While it brought financial ruin to many, it was not without good results. The public had suffered severely and became both critical and cautious, and the attention of scientists was directed to the potato. The introduction of Up-to-Date practically marked a new era, and thereafter arose a large demand for Scottish seed and with it the advent of the seed merchant.

Influence of Wart Disease on Development of Seed Trade.—In 1898 we have the first recorded presence of wart disease. It apparently came to this country with Hungarian potatoes imported through Birkenhead. The extensive growing of non-immune varieties like Up-to-Date favoured the spread of the disease, but in 1908 Mr. G. C. Gough of the Ministry of Agriculture found that certain varieties were immune to wart disease. This again added fresh interest, and created a demand for new immune varieties and for purity in existing stocks. Purity is an important point because impure stocks are a source of annoyance to the grower, the trader and the consumer, and affect the marketable value of stocks and the yield of the crop, especially in early varieties.

The discovery that certain varieties were immune from wart disease and the regulations framed to combat the spread of the disease in England were the factors responsible for the present very high standard of purity enjoyed by stocks in Scotland.

Inspection of Crops in Scotland.—To meet the changed circumstances the Board of Agriculture for Scotland introduced a scheme of crop inspection for purity. In 1918 the crop inspection was confined to immune varieties, and the Board had the assistance of a number of potato merchants. In 1919 the Board had ten inspectors employed, and most of the potato merchants who had assisted in the previous year did so again. It was then felt that the work of inspection should be in the hands of inspectors not directly connected with the trade, and the Board trained men specially for the purpose. The beneficial results of inspection soon became apparent, and growers and traders requested that non-immune varieties should also be inspected and reported on. The following statement shows the acreages of growing crops of potatoes inspected for purity from 1918 to 1927, and the number of temporary inspectors required to assist the Board's Officers in the inspection of the growing crops :—

Year.	Immune Varieties.	Non-immune Varieties.	Total Acreage.	Temporary Inspectors.
1918	10,009	...	10,009	...
1919	19,389	...	19,389	10
1920	36,930	...	36,930	22
1921	28,150	...	28,150	22
1922	22,405	17,546	39,951	41
1923	18,990	21,640	40,630	45
1924	19,274	22,474	41,758	50
1925	25,304	24,067	49,371	62
1926	25,799	27,059	52,856	76
1927	33,214	29,689	62,903	91

The crop inspection reveals a very high standard of purity. In 1927, out of 33,214 acres of immune varieties inspected 27,756 acres are certified with a purity of not less than 99·5 per cent., and in non-immune varieties out of 29,689 acres inspected 24,367 are reported to have a similar high standard of purity.

Crops of immune varieties found on inspection while growing to attain a standard of purity of not less than 99·5 per cent. are designated " T.S." (True Stock), while for a non-immune variety of similar purity the designation is " Grade A " ; in respect of both varieties with a purity of less than 99·5 but not less than 97 per cent. the designation is " Grade B," while crops less than 97 per cent. pure are designated " Mixed." There is a probability that in respect of the 1928 crop inspection the above designations may be slightly altered. Seed potatoes are included in the Seeds Act of 1920, and the regulations thereunder make it obligatory that where a variety is specified the stock must be 97 per cent. pure. Such a standard of excellence, however, has now been attained that first class seed merchants mainly sell seed of not less than 99·5 per cent. purity.

Stock Seed.—Having secured a very high standard of purity in Scottish potato crops, the Board of Agriculture is now encouraging the production of healthy stock and issue a " Stock Seed Report " to growers of crops of exceptional purity and freedom from disease. Progressive farmers are alive to the value of these healthy stocks, and in some varieties are prepared to pay pounds per ton more for such seed. The resultant crop justifies the outlay and the grower of the seed is worthy of his recompense.

Potato Varieties and the Evolution of New Types.—Dr. Salaman states that :—" A potato may be defined as a group of identical plants, sharing the distinctive characters of an original individual from whom they are derived by vegetative reproduction. A potato variety is considered distinct when it differs from all other known varieties by one or more recognisable characters, whether they be of a morphological or of a physiological nature." Growers should realise that there is no such thing as breeding back ; once a variety always a variety, and that variety only. In the few cases of known bud mutation the produce has not been superior to the parent. The only variations in potatoes that growers need trouble about are wildings and bolters. These should be rogued from stocks intended for seed, because the bolter and wilding condition is perpetuated by vegetative propagation. A wilding may be recognised by the large number of thin stems. The presence of wildings in a stock seriously diminishes the yield of ware tubers, and in consequence of the small size of tubers produced wildings tend to increase rapidly in stocks. Bolters are usually more easily recognised when the crop has attained full growth, the haulm is higher, maturity later and the tubers coarser. New varieties are got from the true seed in the berry. Potato breeding is somewhat of a mystery. In true line breeding it is difficult to get something better than the parent, and in cross fertilisation one never knows what may be got. It is said that Up-to-Date (a late variety with red-purple coloured flowers) and British Queen (a mid-season variety with white flowers) came from the same berry. From the tens of thousands of new varieties raised annually only once in a while is a variety got that is sufficiently good to be put on the market. The difficulty at present is increased because no matter how good a variety may be, unless it proves immune to wart disease, it is not put on the market.

Breeders, however, are greatly helped by a practical method of testing the reaction of the potato to wart disease without having recourse to field tests. This test, which is carried out at the Seed Testing Station of the Board of Agriculture for Scotland, is simple in application and is made during the winter and spring period, the time required for the disease to develop being about thirty days. During that period the test can be applied to a variety several times, and should prove a more trustworthy index of susceptibility than that provided by field tests, which are unreliable in dry seasons. During the past season the test was applied to about 4,000 seedlings and named varieties.

Having passed the wart disease test the variety is then taken in hand at the Plant Registration Station. It is tested against varieties of a similar period of growth, and if it shows no marked improvement over standard varieties in cropping, disease resistance and cover, it is discarded. A variety showing promise is grown for several years not only at East Craigs but also at other Experimental and College Stations. The records of all the trials are carefully noted, and if there is a distinct prospect of success the variety is registered under a name.

Synonym Committee. — The foundations for obtaining true stocks having been laid, it next became desirable that a variety should not be catalogued or put on the market under a hundred different names (in fact Up-to-Date had over two hundred aliases), and for this purpose a Synonym Committee was appointed. This Committee, although it may have caused some heartburning, has done an enormous amount of good work, and merits the sincere and grateful appreciation of every good worker. When a variety is said to be a " Synonym " it does not imply that it is merely a selection from an existing variety, but simply that a certain name has been applied to a variety which is indistinguishable from one bearing another name, and it matters not how the variety has arisen; for instance, if a breeder should raise a seedling which has all the characteristics of Majestic, the seedling should not be given a new name. If, under a new name, it is sold at an enhanced price, then the old stock would speedily pass under the new name. Such a seedling might be a " regenerated " stock, but this is the only sense in which the term " regenerated " can be used. No amount of selection or roguing can constitute " regeneration."

Virus Diseases and their Importance.—To-day the control of wart disease is well in hand; in fact, with the passing of the King Edward variety and the advent of new immune varieties the country may in course of time be declared comparatively free of a troublesome disease. That, however, does not mean the end of trouble. The attention of scientists in Europe, in the Northern Continent of America and in this country is now directed to the virus diseases, and much useful information has been gained. There are several virus diseases, but the most important are leaf roll and those of the mosaic group. Leaf roll has long been known, but as far as we are concerned it chiefly came into prominence with the introduction of "President" from the Continent of Europe in 1903. The result of that introduction has been disastrous to our stocks. Most of us saw the results, but at first did not know the cause. It was not till 1905, when the disease led to disastrous results in West Germany, that the attention of scientists was attracted and the disease identified. Dr. Murphy states that the first signs of this disease appear about one month after the plants have come above ground. Any farmer who suspects that the disease is present on his crop should take steps to acquaint himself with the symptoms, so that he may ensure the correctness of his diagnosis.

Mosaic was isolated by Dr. Quanjer in Holland and described by him in 1913. It is generally recognised by a mottling of the leaves with an indistinct pattern or mosaic of faint light green or yellowish spots, and the leaves are usually crinkled. The yellow variegation seen in Ninetyfold has no relationship to mosaic. The disease is said by some to be spread principally through the agency of green fly, which carry the infection from diseased to healthy plants. Infected tubers used for seed transmit the disease to next season's crop. Most varieties are subject to the virus diseases and no district is clear of it, but in every district there are good healthy stocks, and it is the selection of these stocks that now forms an important part of the business of the seed merchant. In Scotland the varieties which appear to be most resistant to the effects of the infection of mosaic are Great Scot, Epicure, Sharpe's Express, Up-to-Date and King Edward, while among the relatively susceptible may be mentioned Golden Wonder, Arran Chief, Tinwald Perfection, Majestic and Arran Consul.

The National Institute of Agricultural Botany, Colleges, Farm Institutes and various other bodies all over England have tested the relative merits of English saved and Scottish seed. These tests have shown that it is the greater freedom from virus diseases that establishes the superiority of Scottish seed. In English tests low yields have been traced to virus diseases, which predominate to a greater extent in English seed and cause "degeneration" or "running out" of the potato. Thus the value of seed almost entirely depends on the presence or absence of virus diseases, coupled with the presence or absence of wildings and bolters. These tests also show that the district from which the seed is obtained does not affect the yield or maturity directly, but only in so far as the district may be favourable or otherwise to infection of the seed with virus disease. The climatic conditions of Scotland do not favour the development of the aphis and are to a certain extent a safeguard against the spread of the disease. This superiority of Scottish seed is recognised not only in England, which is the principal outlet for Scottish seed, but also in South Africa, which now mainly draws its requirements from Scotland, and in the last two years a considerable quantity has been specially grown in Scotland for Spanish requirements. To retain and increase these foreign outlets it is necessary that the trade should be in the hands of seedsmen who think of their reputation as well as their profit.

Legislation.—Virus disease in potato growing is all important. It is estimated that it costs the country over five millions annually, and yet in this country practically nothing has been done through research or otherwise to combat it. It is understood, however, that comprehensive schemes of investigation are now being considered. It might be possible also to take legislative measures against the disease and to require certification of all stocks in respect of serious diseases. This has been done in Canada, Holland and elsewhere for several years with beneficial results. In Canada during 1923 the field inspection standard was blackleg 3 per cent., leaf roll 2 per cent., mosaic 2 per cent., wilts 3 per cent., providing that in no case shall a total of more than 6 per cent. be allowed. In tuber inspection the standard was bacterial rot or wilt 2 per cent., late blight and dry rot 3 per cent., common scab and rhizoctonia severe 5 per cent., powdery scab 1 per cent., with a total of not more than 10 per cent. These certified stocks are finding their way into the United States. With our present progressive achievements and with the passing away of non-immune varieties, and consequently wart disease infection, there is no reason why Scotland should not occupy a foremost place in the seed potato trade of the world, similar to that enjoyed by our live stock. A trip in America left the impression that there is better organisation there in marketing and a more direct touch between supply and consumpt. Britain has the finest potatoes in the world, grows the biggest crops of potatoes in the world, but does not make the most of the potato either in respect of marketing or of consumption. The speculator and the commission agent bring in potatoes for their own gain, regardless of the nation's requirements and best interests.

Some Cultural Considerations.—One is sometimes asked which is the best variety of potato to grow and what is the proper size of seed, but to such questions no direct answer can be given. The grower should know best, but he can be helped by the intelligent seedsman. "Chats" do very well where the water level is high, but small sets do not give the plants such a good start as the larger sets, and in a period of drought the larger sets have a distinct advantage in that they provide a source of water. The tuber absorbs water and increases in size after being planted. Some districts prefer very large seed, larger than 2 inches, but that seed is usually cut and the resultant crop is much larger tubers. It is somewhat risky to cut some varieties, especially Majestic and King Edward. Cut seed is better kept in a warm moist place than in a bright sun and a drying wind before planting. Probably the best results are obtained from planting large medium-sized tubers. In growing for the early market large tubers are desirable, as growth comes away better and maturity is earlier. In Scotland the crop is now largely grown for seed purposes and large sets planted whole give best results, because there is a greater proportion of seed-sized tubers owing to more eyes sprouting. In fact some growers break off the main sprout in order to encourage side sprouts, and thus produce a greater number of tubers. The question as to which is the best size of set has been tested for the past century and is still being tested. The sprouting of potatoes is important when the crop is wanted for the early market, but it is also important in respect of first early varieties, so susceptible to blight, in order to have a full crop before blight usually appears.

How the Trade is carried on.—The trade is mainly conducted by merchants.

(*a*) The larger merchant sells to the English merchant or direct to the English grower, and also has agents in England selling to growers at a fixed rate of commission.

(*b*) The smaller merchant usually sells to the larger Scottish merchant and also to the English merchant, but does not as a rule care to take the risk of selling to the grower.

(*c*) Growers in Scotland to a small extent sell to their friends in England and sometimes to English merchants, but rarely do growers comply with the requirements of the Seeds Act.

The value of the services rendered by the various firms is not equal. Some merchants examine growing crops and know exactly what they are handling. Other merchants do not and are hardly entitled to be called seed merchants. A seed merchant should know what the peculiarities of any variety are; whether it is resistant or susceptible to disease, whether it keeps well or badly, what conditions of soil and climate are favourable to its growth, and be able to identify the different varieties and select healthy stocks.

The trade is on a high level and is mainly conducted under the Conditions of Sale adopted by the Scottish Seed Potato Trade Association, an Association of about 60 members. That these conditions are fair as between buyer and seller may be inferred from the fact that, so far as is known, no buyer has ever made objections to them, and that several English merchants have adopted the Conditions for their business. Seed potatoes are as liable to faults and blemishes as anything in the world, and in order to settle disputes expeditiously and cheaply the Association has an arbitration tribunal, consisting of three of its members, to deal with such matters. The usefulness and impartiality of this tribunal may be inferred from the fact that not only Scottish merchants but some English merchants also submit their cases for settlement.

Fig. 1.—Typical Diseased Beds.

Fig. 2.—Healthy Strawberry Beds.

LANARKSHIRE STRAWBERRY DISEASE.

Further Observations on its Biology.

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In previous papers in this Journal [1] and elsewhere the author's observations on the cause of the Lanarkshire strawberry disease have been set forth. The nature of the disease was described, and it was pointed out that in the author's opinion the solution of the problem was more in the hands of the practical grower than in those of the mycologist. Continued observation has justified this conclusion. A short history of the research, which is still in progress, will help to give a fuller understanding of the problem, and will show that it is neither a small nor a special one, but rather is one both of very considerable agricultural importance and of biological significance.

The author's attention was first directed to the disease in May 1926; at this time the disease had almost reached its seasonal climax, and some of the fields were in a very deplorable plight indeed. The blighted condition of the beds was observed, and the small squat plants, with their blackened and almost obliterated root systems, were examined in detail. At this time a careful botanical and pathological study of the plants was made and certain conclusions were reached. These results were stated tentatively, because it was felt that a much fuller investigation, especially under different seasonal conditions, was required. It was clear to the observer that it was necessary to study the cycle of events continuously during the course of a whole year. This time has now elapsed, and the observations and experiments which have been conducted have made it possible to give a much wider and fuller account of the disease. It may be stated here that the general result has been to shift the position from that of a narrow special problem to one with a wide significance from the agricultural point of view.

In arriving at a general understanding of the position consideration has been taken of the following aspects :—

1. Weather conditions.
2. The seasonal growth activities of the strawberry plant.
3. Seasonal occurrence of the diseased state.
4. The general result.

These several aspects, however, cannot be studied as isolated from one another. They are all inter-related, and the various results observed are due to their inter-action. It is to such a state of affairs that a biological problem of this kind owes its complexity.

Rainfall and Weather Conditions.—Records of the rainfall for the past eleven years at Carluke show that, in that district, on the average August is the wettest month with 3·76 inches,

[1] Vol. x, No. 1, p. 8; Vol. x, No. 2, p. 156.

and June the driest with 1·65 inches. As in most rainfall tables, extending over a number of years, in certain months striking variations from the average are found. This is to be expected, but when the seasonal growth of the strawberry plant is considered, and further when the difficulties of working certain of the Lanarkshire soils are taken into account, some of these exceptional rainfalls have an added significance. Thus abnormal weather conditions during the winter and spring months are of the greatest importance in the actual working of the soil, making for either a good or a bad tilth, whilst variable weather conditions in the summer and autumn seasons have very important effects on the flowering, fruiting and vegetative activities of the plants.

Seasonal Growth of the Strawberry and Occurrence of the Disease.—For the disease to be visualised in its entirety, its seasonal occurrence must be understood in the relation it bears to the seasonal growth activities of the strawberry. Continued observation extending over the course of a whole year has now made this possible, and the author wishes to make it clear that the life-history to be recorded below is compiled directly from the observations made on the conditions of strawberry cultivation obtaining in Lanarkshire.

In Lanarkshire, as a rule, the flowering period begins about the middle of May, while the first pulling of fruit generally takes place in the last week in June or the first week in July. At the time when the berries are ripening, stout plants begin to throw the first of the season's runners, and this marks the state of transition from the reproductive to the vegetative phase in the life-cycle of the plant. The runners grow out along the soil surface, and according to the friability or hardness of the soil surface a more or less successful rooting is achieved. Given sufficient moisture the first runners may begin to be rooted towards the end of July or the beginning of August. By this time the fruiting period in the life-cycle of the plant is on the decline, and thereafter follows a period of very active vegetative growth, during which time the parent plant may throw many runners. The latter may grow out to one or two feet in length, rooting at two or more nodal points. The autumn season, therefore, is that in which the plants are at their most vigorous vegetative period, and at this time their virility and resistance probably reach their maximum points. As noted elsewhere the difficulties with which the plants are encountered at this time are consequent on the state of the soil surface. In the wetter spells the soil surface and top three or four inches of soil are softened and fairly easily penetrated by the roots. In the dry spells, however, owing to the mechanical texture and bad state of tilth of the soil in the beds, the surface becomes very hard, dried out, and impenetrable. This makes for a very faulty rooting, owing to the destruction wrought on the root-tips of the stout primary roots. The autumnal period is further characterised by the active development of the root system, and following what is a common rule in perennials, the growth below ground at this period is more important in the general economy of the plant than that above ground. During this period, apart from injury to root-tips and drying out due to drought, the roots do not show the disease to a marked extent, unless the season, like that of 1927, is an exceptionally wet one. In this instance the disease was clearly seen in October. This freedom from disease in autumn is probably partly due to the fact that the plants are in their most vigorous vegetative state, and therefore more highly resistant than at other periods. As winter approaches there is a decline in this vegetative vigour, and the plants enter on a period of comparative quiescence. The main growth activities consist in augmenting the root system by the formation of lateral rootlets where soil conditions permit. It is during this period that the diseased state of the roots begins to be apparent. The fact that many conditions work together in the causation of the disease has already been pointed out. In the first place the constant rainfall has caused the soil to settle down compactly in the beds, resulting in a loss of the free texture which makes for adequate drainage. There are two results. Firstly, the plants tend to grow fewer rootlets, and the whole root system is thus more meagre and scanty than it ought to be. Secondly, the soil ventilation is considerably reduced, and this militates against the free respiration, and consequently against the health of the roots. Then again there is a tendency for the water to remain in the soil; the soil is constantly wet and often soaked and water-logged. As strawberries will not stand "wet feet" the results are clear. If plants are dug up at this time the roots are found to be in a diseased condition. This is to be expected when due consideration is given to the attendant circumstances. The plants are in a state of quiescence or declining vegetative vigour, therefore probably less resistant, the soil has settled down into a badly drained, water-logged condition, with poor ventilation. The roots are thus reduced to a state of ill-health at a time of lowered vitality, and they may readily be attacked by parasitic soil organisms. During the winter months a number of strawberry fields were kept under close observation. At this time, in some cases, the general appearance of the fields was unhealthy. A patchy appearance was common, with rows blotted out, and the individual plants in other areas were squat, unhealthy, and with a tendency to yellowness or redness. The roots were then examined in detail. According to the state of the soil and the circumstances under which the original rooting had taken place, the root system varied from a poor lax development to a fairly moderate development. In the feebly developed patches, as a rule, the roots were found to be in a poor condition and the disease in its early state, causing watery blemishes; thinning and killing of the roots were clearly observed. Plants were taken into the laboratory and from the diseased regions fungi were extracted, including *Pythium debaryanum*, which was observed and isolated on a considerable number of occasions. Thus the conditions leading to the disease and the actual appearance of the diseased state of the roots are to be recognised during the winter months. During this period shallow rooted plants are liable to suffer from frost. Some experimental observations were made on this point, and the rapidity with which the strawberry roots blackened and succumbed was noted. This, however, did not prove of much importance in the field during the winter of 1926. It is mentioned here because it indicates the ready susceptibility to injury and destruction of the roots.

During the months of January and February there is a period of quiescence. When growth begins again in March, however, several new possibilities regarding the disease remain to be examined. According to rainfall and climatic conditions generally, there is the possibility of the disease becoming more accentuated or less so. Under favourable conditions there is the possibility that the plants may outgrow the disease, or they may hold it in check, and make up for diseased roots by the growth of new ones. The average monthly rainfall for February, March and April is not very great. What is more important is the way in which it is precipitated, i.e. in spells or daily. In the former case there will be periods when the ground becomes partially dry, and the plants will have the opportunity of more vigorous growth. Where there is daily precipitation the weather as a whole will be duller, and plant growth accordingly will be retarded, while the soil will remain constantly wet.

Several important points must now be considered in order that the diseased state *en masse* seen in May and June may be understood. In the first place, the spring period is characterised by a greater growth above ground than below ground. The plant throws out many new leaves; and after some time the flower trusses begin to appear. The root system, on the other hand, is only slightly augmented by the formation of lateral rootlets. In this connection it has been mentioned that the soil conditions in many fields tend to inhibit this development. Thus we have two factors working together to produce the important external symptoms of the disease. The aerial parts of the plant —crown, leaves, flower-buds—are developing rapidly and making great demands on the root system. The latter, however, owing to its poor development, weakly or diseased state, due to bad soil conditions and attack by soil organisms, does not prove equal to the demands, and the result is that sooner or later the plant goes down. A very dry spell during which the badly worked, heavy soil dries out also tells most on these plants which have failed to root deeply or well, or which have been attacked by soil organisms.

Thus the diseased appearance of fields seen mostly in the wet hollows or clay shoulders of hillocks is due, not to one cause alone, but to several causes working together, and it is in close relation to the life-cycle of the plant as a whole. It is clear, therefore, that what is seen strikingly in April, May and June is not so much an immediate product, but rather the cumulative result of what has gone before. The disease cannot be studied satisfactorily at the time when it is most apparent; it must be under close observation during the whole cycle of events.

To complete the cycle. It is commonly said that "the disease goes away after the Lanimers," i.e. from about the middle of June onwards. This is due to one or two things, partly that in the bad patches the disease has reached its climax leaving the plants dead or very much reduced in size and vigour, partly to the fact that the soil is becoming more hospitable, and most of all to the fact that the plants are beginning again to enter on the period of great vegetative vigour, with the corresponding virility and resistance.

Figures 1 and 2 are photographs of diseased and healthy beds respectively, and they give some idea of the amount of growth under favourable circumstances as compared with plants in the diseased state.

State of the Soil in Strawberry Fields.—A word or two on the state of the soil in strawberry fields during the different seasons may not be out of place. It is understood of course that, as the strawberry growing area is a wide one many soil types are encountered. Two types, however, are more or less conspicuous, namely, the silty or sandy loam of the characteristic Clyde Valley holms, and the stiffer clays of the hillocks, hillsides and knowes. Most of the soils are such as to require careful handling, and a continuously wet year such as the last one makes cultivation particularly difficult in Lanarkshire. In autumn and winter the general tendency is for the holm soil to lie fairly wet. Hillsides, which ought to have good natural drainage, are often in the same state. This constant state of wetness has the effect of settling the soil very firmly, and in the case of fields set out in strawberry beds, which receive little more than a shallow surface cultivation (chiselling), the results from the point of view of friability and good free tilth are necessarily far from favourable. The tendency of the soil to run together is a well marked feature which occurs frequently in different ways.

Other features of importance are seen when the soil, either in beds or in ploughed fields, is subjected to a dry spell in spring or early summer. The soil tends to dry out very quickly, while the stiff soil in the strawberry beds is often observed to be cracked to a very considerable extent. Under the same circumstances some of the plough sods dry to a stone-like hardness.

Another observation of interest is the readiness with which the soil becomes mossy. During the present year, after the continuous wetness of early July, fields which had been maintained in a good state of cultivation developed a conspicuous green surface. Further. in some of the badly tended or older strawberry fields mosses formed quite an important constituent of the weed flora of the strawberry beds. Such observations on the soil are brought forward because of their significance in relation to the improving of the soil condition and the cultivation and upkeep of the strawberry beds.

As to the actual occurrence of the disease, it is usually observed either in hollows which are apt to lie wet, or it breaks out on the shoulders of hillocks, or on the stiff clay spurs on the hill-sides. These characteristic hillocks, which arise out of the holms as rounded mound-like masses, are sometimes left conspicuously bare as a result of the disease. The fact that these knowes have persisted when the surrounding country was denuded and left flat by natural forces is an indication of the firm and resistant nature of the stiff soil of which such knowes are composed. It is not to be expected that fields on such hillocks will prove the most congenial for strawberries, unless the greatest care is exercised in cultivation.

In the fruit growing districts there is still of course a considerable conflict of opinion as to the nature and cause of the disease. This is to be expected, since many types of soil are involved, and a diversity of circumstances is a necessary result.

Agricultural Aspect.—It is now fairly well known that the strawberry, while it will thrive on a variety of soils and takes a considerable amount of killing, yet requires a kindly soil before it will really flourish. I find the following quotation in a recent practical manual[1] :—

> "There are very few ideal sites obtainable, and mostly the best use must be made of land of which it is possible for the grower to obtain possession. The land in the best position for the purpose should naturally be devoted to strawberry cultivation, but it should not be forgotten that continual care and attention must be devoted to this fruit if successful results are to be obtained.
>
> "Land which is to be devoted to strawberries should be well drained. It may often be noted in some plantations that there is a patch of land, mostly low-lying, on which the plants fail to grow, or if they grow they are unhealthy and cannot yield a crop of fruit. Such places are mostly found on a part of the plantation which does not get the water away properly.
>
> "Often such spots of land are saturated with moisture during a big part of the winter, and strawberries will not flourish under such conditions.
>
> "The plants may appear to flourish for a time, perhaps it may be for a year, perhaps for two, but they will gradually die off.
>
> "Drainage should receive attention before strawberries are put on the land at all."

The fruit grower in Lanarkshire, who has already suffered considerable economic loss, is undoubtedly faced with a difficult problem with regard to the continuance of his efforts in the matter of strawberry cultivation. Weather conditions make the soil difficult to handle well, and from the outset some fields labour

[1] Page 9, Commercial Strawberry Culture. J. W. Morton. Ernest Benn, Ltd. 2s. 6d.

under a severe handicap. The maximum fertility cannot possibly be reached under such circumstances. The writer has also been told of fields which have been under grass, then ploughed in and planted with strawberries, and still the disease was found to appear. It does not follow that, because a field has been under grass for some years, the soil condition is necessarily good, as in some cases the fields during that period never receive any treatment or manure. In quite old lea holms, where the grass should be good, with an underlying fibrous soil, it has been observed that on the contrary the grass is thin and mossy, both of which tell a tale. Grasslands in the Clyde Valley, on the other hand, adequately manured have yielded remarkably good crops of hay. The merit of breaking lea, therefore, is the merit of breaking good lea.

Diseased fields which have been allowed to go uncultivated for a year throw further light on the problem. Such fields are found to be covered here and there with large russet patches of sorrel, which has become the dominant vegetation. The need for lime in such cases is clear. This would also be advantageous in the improvement of soil texture. The presence of quantities of horse-tail and the weed flora generally, in some of the fields, point to the necessity of improving the supply of available food materials.

To ensure deep and successful rooting, as well as to improve the general tilth and drainage, the advisability of gradually breaking the hard plough pan is clear.

Further Work.—Experimental work and observations are still being carried on in several directions. A chemical analysis which is in progress has already shown in certain fields the very considerable deficiency of lime and general poverty of the essential food stuffs. Mechanical analyses of soils show that the ascendancy of the clay, silt and fine sand fragments makes for the lack of friability and openness, both of which would be assisted by liming and the addition of humus. Field plots have also been started. These are intended to give a thorough trial to certain simple agricultural methods of improving the texture and available food supply of the soil.

BREEDING OF SWEDES AND TURNIPS.

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As with many other agricultural crops, the cultivated Swedish and common turnips of to-day are very different from the wild species most nearly related to them; and, as far as feeding value is concerned, very much superior to them. Starting with small fibrous wild plants, in the course of ages man has selected accidentally and purposely until he is now in possession of varieties having large nutritious " roots."

It is known that turnips were used in certain countries during

Roman times both for cattle feeding and as human food. In Britain they were used only as a garden vegetable for many centuries. It was not until the beginning of the eighteenth century that their value in crop rotation was at last appreciated. Before that there had been little differentiation into varieties; but during the eighteenth century turnips were sorted out under different skin colour and flesh colour varieties, and swedes, white and yellow, were introduced. Since then selection has become intensive and variety names have been applied in profusion. Great improvements have been made in shape, size and quality, and more recently in composition, as indicated by the various tests, e.g. dry matter content.

There are a great number of named varieties in cultivation, but the groups to which the term " Varieties " is applied have not, of themselves, the same fixity as varieties of oats or barley. A different set of relationships exists within a variety of swede from that within, for example, one of the older oat varieties. It may be of interest to examine some of these differences.

In an oat variety, we know that, so long as no " rogue " seed is introduced, during threshing, &c., there will be no great differences between crop and parent crop, except such as are due to the different soil and weather conditions—the environment. The oat is normally self-fertilised, having only one parent. It, therefore, inherits from that parent alone, and the characters due to heredity will be similar throughout the line of descent after the variety has become established. There may be many different lines in an oat variety, or there may be only one line or type, where all are descended from one true-breeding seed, as in certain of the newer varieties.

The swede, on the other hand, is not necessarily self-fertilised. Bees and other insects carry pollen from flower to flower and plant to plant. Consequently a swede plant is quite likely to have arisen from a " natural cross " and to have had two parents. The pollen-parent will contribute its share of heritable factors, equal in importance to that of the seed parent. This pollen-parent may have been any swede in the neighbourhood or perhaps a common turnip or other *Brassica.* Strict isolation at flowering time is therefore necessary in the first place to prevent contamination by foreign pollen. Again, if inferior, misshapen or wrongly coloured bulbs are retained in the second year—the flowering period—not only may the seed borne on them produce similar faults, but also seed on many other plants which their pollen happened to fertilise. Faults such as these may show immediately in the progeny, or be masked for a generation and then reappear. Further, it is probably not an exaggeration to suggest that the standard of excellence of a variety may rise or fall depending upon the choice of seed parents. An oat variety suffers none of these vicissitudes.

The effect of cross-fertilisation is that characters, or rather factors in the constitution responsible for characters, are shuffled and reshuffled from generation to generation. The plants get different combinations of factors and consequently look different. When large populations are grown, there is a greater possibility for freaks to appear. Just as it is possible, though of very infrequent occurrence, to have a hand of cards dealt that contained only red cards or no honours, so it is possible for unexpected combinations to occur in individuals, and these "rank outsiders" might be "bulbless," "necky," or otherwise very undesirable.

Now it may be asked whether this variability could be reduced or eliminated, so that each seed- and pollen-parent held the same set of factors, and crossing gave the same result as self-fertilisation. The heritable factors, that are in some way responsible for characters, are generally assumed to be in pairs. One member of a certain pair possessed by the seed-parent is present in the ovum, and one member of the corresponding pair in the pollen-parent is in the pollen grain. These two members come together at fertilisation and form in the new plant a pair of factors alike or different as the case may be. With self-fertilisation, as occurs naturally in the oat, the pair of factors tend to become alike in a few generations; because once like members come together in a pair, only that one type of factor can be distributed to pollen and ova. So more and more pairs chance to be made up of like members, and to remain so in succeeding generations. Then the same characters appear in each generation, always modified to some extent by environment.

Plants are influenced by many outside agencies which may greatly modify the characters of the inherited factors. These are weather, soil, manures, drainage, animal and plant activities, &c., grouped as the "environment." Such modifications are not inherited and must not be confused with heritable variations.

Three questions present themselves in connection with the breeding of swedes and common turnips. If a swede were self-fertilised, the seed sown, a single selection made from the progeny, this selection selfed, its seed sown, and so on for a number of generations, and then the strain so produced were multiplied up by seeding the whole of a generation in natural isolation (away from other *Brassica* plants)—(1) Would the strain so produced breed true? (2) Would the strain lose vigour as the result of inbreeding? This should be determined by experiment in the first few generations. (3) Could good combinations of factors be maintained and improved varieties be obtained?

The possibility of loss of vigour is a very serious consideration when inbreeding is proposed. In some plants and animals there is no loss of vigour, in others, such as maize, an immediate drop in vigour ensues.

Answers to these three questions and many others need to be obtained by careful experiment; and it is with a view to this and to the ultimate production of improved varieties if possible, that the Scottish Society for Research in Plant Breeding have been carrying on experiments for the last six years at the Plant Breeding Station at Corstorphine.

Six years of breeding with biennial plants means only three or four generations, and several more are necessary to fix the more important characters in the plant. However, some interesting indications have already been observed :—

(1) There is no reason, so far, to believe that any lack of vigour occurs as a result of self-fertilisation. No reduction in size of bulb or shaw has been observed. The swede is easily self-fertilised by enclosing the inflorescences in a pollen-proof bag before the buds open. Under these conditions abundant seed is obtained, and, with one doubtful exception, there does not appear to be any decrease in fertility. This is difficult to determine, however, because only a limited number of plants can be dealt with in the second year.

(2) In the first generation after self-fertilisation a distinct change may be seen when comparing the plants with a plot of the parent stock grown alongside. A character tends to appear either in every plant of the " selfed " population or else in a large portion, the remainder of the plants exhibiting some contrasting character,—e.g. one quarter of the population might be bronze-top, the rest purple, where the parent plant was a purple-top and the parent variety, from which it was selected, purple with 1 or 2 per cent. of bronze-tops. Thus the population becomes uniform as regards a number of characters, and variable in certain other respects as indicated above.

(3) The second and third generations have populations that appear progressively to be uniform for more characters. There are many features of comparative unimportance that exhibit several forms in the ordinary crop, such as small differences in shape, size, texture of the leaves, &c. Self-fertilisation tends to eliminate alternatives and leave one set of these characters, which gives the plot a remarkably uniform appearance. This uniformity may again be noted in the succeeding generations.

(4) Once characters become " fixed " there is no fear of losing them, if the bagging and other operations are carried out carefully. But, unfortunately, it is also easy for very undesirable characters to become " fixed " and present in every individual. Perhaps a plant is chosen that has an inferior root system or splits on the sides. These defects may have been masked by counter effects of soil or weather. The progeny of that plant may every one of them possess " fanged " roots or bad splits. It would be useless to proceed further with such lines, and they would have to be discarded. Therefore numerous selections have to be made to cover these risks.

Besides selection for appearance and yield, the single bulb method permits the use of analytical tests such as dry matter content, &c., and also the selection for resistance to disease, as in the case where a healthy " root " is selected from an area badly infected with finger and toe disease, and having been self-fertilised, the progeny is sown in plots specially infected with the disease organism.

The above-mentioned breeding work was commenced by Prof. M. Drummond, former Director of Research, and Dr. Sansome, both of Glasgow University, and is now under the control of Mr. W. Robb, Director of Research, and the writer.

Reviews.

A Farmer's Fifty Years in Lauderdale. Dr. Robert Shirra Gibb. Messrs. Oliver & Boyd, Edinburgh.—Few men can have enjoyed life in many phases more fully than the late Dr. Shirra Gibb. He farmed extensively, experimented continuously, attended to his duties as a Medical Officer of Health and of the Volunteer Force, carried out numerous public and social services as County Councillor, Justice of the Peace, member of the School Board, director of the Highland and Agricultural Society, Governor of the College of Agriculture, travelled widely, and exercised a generous hospitality—all with a zest and heartiness and obvious enjoyment that made it a pleasure to be in his company.

This is the story of his life and work, and many friends at home and abroad will welcome it as a fitting memorial of a noted farmer and agricultural authority, a well deserving public servant, and a warm-hearted, kindly Scot.

But the book makes a wider appeal. As a record of farming and social history in a high-lying district of Berwickshire during the long period of years from Dr. Gibb's entry on the tenancy of Boon in May 1872 to his retiral at Whitsunday 1922, it is a valuable contribution to the literature of agriculture. The tenancy included the long years of depression in the late '70's and the '80's, the gradual recovery of the '90's and later seasons, and the prosperous times of the post-war boom, and Dr. Gibb's notes and commentaries upon the events and conditions of those times form a record which is interesting even now, and which will become increasingly valuable in future years.

Beginning with an account of his Border forebears, his Aberdeen connection and schooling, his medical studies and qualification, the story goes on to tell of his leaving medicine for agriculture on account of a slight defect in hearing, of his first grand tour through Austria, Germany and Holland, of his entry to the extensive upland farm of Boon, and of his experiences there during fifty years.

Apart from a family connection with farming, he had, when he began his tenure, no experience of practical farm management, and the undertaking was a big adventure. He was wise enough to seek guidance in his early years; he speaks indeed of one of his mentors—a knowledgeable neighbour— as " the Authority "; and the venture was in the main remarkably successful, a result which he attributes in no small measure to the faithful servants whom he was fortunate enough to gather about him. Of his personal relations with his employees, Dr. Gibb writes in a way that indicates the kindly old-time spirit that existed between them, and his sketches of ploughman or grieve or shepherd must have been noted with a shrewd, observant eye, and are drawn with humour and with affectionate appreciation of fine types of Scottish character.

The accounts given of hiring fairs, of labour conditions as they were and as they have been modified, of the "gains" system of payments in kind additional to or in lieu of money wages, are interesting and informative. His descriptions of the layout of farm buildings, of his schemes of cropping and of his management of sheep and cattle, his records of prices, and his notes on farm book-keeping are marked with his ripe experience.

Dr. Gibb was no ordinary farmer; his scientific training and his inquiring bent of mind made him an inveterate experimenter, and while his experiments did not always turn out economic successes, it is obvious from the relish with which he describes them that they added enormously to the interest and zest with which he pursued his vocation. Several appendices to the book give details of the noteworthy experimental work on the improvement of hill pasture which he carried on at Boon for many years by arrangement with the Highland and Agricultural Society.

But the Doctor's sympathies were not confined to agriculture even in its wider application: they were catholic, and not the least interesting parts of his memoirs are the references to local antiquarian and historical topics, his descriptions of sport and of social conditions in Lauderdale a generation or two ago, and the accounts of his travels as a member of the Scottish Agricultural Commission to Denmark, Ireland, Canada and Australia.

The book is like the man himself as one knew him, breezy, humorous, well-informed, vigorous and uncompromising in expression of opinion, and yet full of warm-hearted kindliness of feeling.

Sir Robert Greig, to whose suggestions the writing down of the reminiscences was largely due, contributes an appreciative and laudatory introduction.

The Potato. Its History, Varieties, Culture and Diseases. By T. P. M'Intosh, B.Sc. 264 pp. and 38 illustrations. Oliver & Boyd, Edinburgh, 1927. 12*s.* 6*d.* net.—The potato as a plant or as a crop has attracted many an author, and the number of papers on it published in the last two hundred years must run to thousands. Now and again an author has attempted a complete book, but so quickly are old varieties replaced by new and so rapid has been the increase of knowledge on such things as diseases and degeneration, that any book soon became antiquated. The time was ripe for another attempt to gather knowledge together. An important food plant like the potato has received attention in many countries, and the outlook in each tends to differ. This book by Mr. M'Intosh, while it is a monograph on the potato in general, is influenced by the Scottish point of view. The climate of Scotland is favourable for root crops, and the industrial districts have made a good market for the crop. Incidentally it was discovered that seed potatoes from Scotland were specially suitable for cropping in England, where home-grown seed potatoes soon deteriorate. The importance of the seed trade was early recognised by the Board of Agriculture for Scotland, and a special staff has built up a department at East Craigs farm, near Edinburgh, which can be safely said to be one of the best in the world. Each summer for about eight years thousands of plants of several hundred varieties have been grown, and careful records kept of botanical characters, cropping and other points. It is appropriate that a member of that staff has written this book, backed by the experience gained either on this station or during field inspections in all parts of Scotland.

The first part of the book is historical, and the introduction into Britain is discussed. As with so many old cultivated plants there is considerable difficulty, but the evidence points to the potato having been imported between 1580 and 1600, although not by Sir Walter Raleigh. Nearly a hundred years later the potato was still a little known garden plant, till about the middle of the eighteenth century, when accounts of its culivation began to be included in books. Lawson's catalogue of 1836 names 146 varieties, few of them known now, and since then the popular varieties may be said to have changed every twenty-five years. This book gives a useful summary of the newer varieties, from the time of Paterson and his Victoria strains on to the latest "Arran" races. The account of the varieties raised by Archibald Findlay from " Up-to-Date " and " British Queen " on to " Majestic " is more complete than any we have seen.

The part of the book where the author's own observations form the basis of the work are the three chapters on Intervarietal Differences. The identification of the numerous kinds of potatoes depends on differences, often minute, of tuber, foliage and flower, and these are so numerous that it is easy for an expert to pour out information that soon reduces the ordinary person to a state of muddle. Mr. M'Intosh, however, has succeeded in presenting the matter fairly simply. The characters of tuber, foliage and flower are illustrated by good original figures, and there are several useful tables of classification which, with practice in the field, will indicate what points must be considered in identification. It should be remembered, however, that no illustration or description can cover all the possible variations due to climate, soil and abnormal growth. It is especially the case with the potato that identification depends mainly on energetic practice on the growing plant, and that there never can be a book from which the whole subject can be learned. Pure varieties are obtained by removing " rogues " during the period when the haulms and flowers are mature or by careful selection of the tubers, and for each of these the reader will obtain many useful hints. The parts dealing with the raising of new varieties, with variation, and with quality are summarised cautiously, as is necessary with a part of potato knowledge of which not too much is assured. The chapters on cultivation, manuring and utilisation of the crop are short but to the point. A chapter on degeneration diseases is a good summary of a mass of recent work on a subject which is by no means cleared up yet. The early literature of the potato has many references to "curl," and there has been many a theory to account for the falling off or degeneration of the crop. Recent investigations have made it clear that there are several distinct forms, of which Leaf-roll and Mosaic are best known. The cause is not any recognisable fungus, bacteria or insect, hence the term "virus disease" used at present. Most of these diseases are transmitted by the seed tubers and bring about a reduced crop, hence the value of an up-to-date statement. Other diseases of the potato are dealt with briefly but include the results of all recent work, and there are many references to sources of information. An appendix contains descriptions of about forty varieties commonly found to-day. While all the characters are given, including tuber, foliage and flower, identification is assisted by using italics for the more typical features.

The book is based on the author's intimate knowledge of the potato or on recent literature. It cannot have been an easy task to steer the middle course between the intricacies of expert knowledge and a simple presentation of the matter in a readable form. Those who have tried to keep pace with the recent huge output of literature on the potato will welcome the book as one that comes well up to the ideal of being at once intelligible, comprehensive and reliable. Published at a moderate price, it should be in the hands of all students and others interested in one of our most important crop plants. W. G. S.

Farm Soils—Their Management and Fertilisation. By Edmund L. Worthen, M.S., Extension Professor of Soil Technology at Cornell University. (New York—John Wiley & Sons; London—Chapman & Hall, pp. 410. Price 13*s*. 6*d*. net.)—In this book, written for American farmers, Professor Worthen discusses practical crop growing from the special standpoint of soil management. He treats in detail the problem of selecting a soil suitable for the particular form of agriculture contemplated, the control of its water supply, and the best methods of tillage, manuring and liming. Special chapters deal with the management of pastures, gardens and lawns, and fruit orchards.

Each chapter is divided into two sections; the first describes in detail the various practical operations required; in the second, the reasons for these operations are discussed, the scientific explanations being given in as clear, simple and non-technical language as possible.

In the section on liming and fertilisers, for example, the composition of the various materials used is first described; standard mixtures for various crops and types of soil are suggested, and a clear account is given of what a farmer should look for in an analysis of a fertiliser.

The book refers specially to American conditions, and there is necessarily much of it which deals with crops which are not grown and problems which do not arise in this country. Notwithstanding this, the general information on the structure of soils and their management, and the results of efficient and economical manurial treatment, could be read with profit by many farmers in this country. The book is very fully illustrated, and, while the illustrations are admirably reproduced, many of them add to the pictorial rather than to the scientific value of the book.

The whole work is written in a quiet, very attractive style and the information is modern and accurate.

Manures and Manuring. A Handbook for practical Farmers, Students and others. By Frank Ewart Corrie, B.Sc., N.D.A. (London, Chapman & Hall, Ltd., 1927. pp. 168. Price 5*s.* net.)—In his introduction Mr. Corrie expresses the opinion that little serious attempt has been made by agricultural writers to bring the results of recent agricultural investigations to the notice of the farmer in simple non-technical language which he can understand. It is doubtful if there will be general agreement with this view; there is an abundance of clearly written articles, both in journals and leaflets, dealing with the various problems of modern agriculture and with recent advances in agricultural research, designed specially for the farmer, whose complaint more probably is not of a lack of suitable literary material, but that he is rather overwhelmed with what he is expected to read. In any case, there is the further doubt raised on looking through Mr. Corrie's book as to whether he has been any more successful than those he censures in avoiding the use of unexplained technical terms, the use of which he very rightly condemns.

The book is divided into five sections dealing respectively with (1) soil and plant nutrition; (2) manurial ingredients—their sources and use; (3) the manurial treatment of farm crops; (4) the legal and commercial aspects of manuring; (5) the influence of manuring on animal nutrition.

Speaking generally, Mr. Corrie attempts to deal with too much material for the size of his book, with the result that the treatment in many cases is too condensed and not easy to follow for the non-technical reader for whom it is specially written; indeed the first section is not a bad example of the kind of writing which he deplores in his introduction.

In the other sections Mr. Corrie has collected a large amount of useful information from the results of recent investigations and experimental work dealing with the sources of supply and the composition of the more important fertilisers and their economical use in farming; the discussion of these is on conventional lines and calls for no special comment.

The last two sections of the book are the best; the provisions of the old (1906) Fertilisers and Feeding Stuffs Act are explained, and while references are made to the changes foreshadowed in the new Act, this side of the subject might have been more adequately dealt with. The valuation of fertilisers and of manurial residues is explained. In the last section Mr. Corrie rightly lays great stress on the quality of the crop produced as distinguished from its mere weight, and refers in particular to the deficiencies in mineral matter found in certain crops and pastures. The recent work carried out at the Rowett Research Institute is described and references given to original papers for those who desire fuller information.

As already indicated, Mr. Corrie has collected a great deal of useful information in the 160 pages of his book, much of which will be valuable to the farmer for purposes of explanation and reference.

Sugar Beet Crop in Scotland.

THE weather conditions in 1927 were generally much less favourable than in the previous year. The germination and growth of the crop in the early stages were retarded by a long period of dry, cold weather during the sowing season, followed later by abnormal rainfall. In many parts of the country a tendency to "bolt" was prevalent.

While the area under sugar beet in Scotland increased from 3,649 acres in 1926 to 10,352 acres during the past season, the average yield per acre generally was lower than in the preceding year. Enquiries made by the three Agricultural Colleges indicate that in some counties the average yield would not exceed 6 tons per acre. On several farms in East Lothian, Fife, Forfar, Kirkcudbright, Midlothian and Perth, however, the yield exceeded 8 tons per acre. On the whole it would appear that the 1927 crop has not been a profitable one for most farmers in Scotland; a similar remark, however, would probably be equally applicable to many of the standard crops.

With regard to cultivation and manuring, the systems followed would appear in most cases to have been those which are generally recommended by authorities to produce the best results. It is noted that in Aberdeenshire the use of lime for the crop was more general than in previous years, and that comparisons of returns from limed and unlimed land respectively proved conclusively the benefits of the dressing.

With regard to the sugar content of the crop, high percentages were obtained in East Lothian, where on twelve farms it reached 17 per cent. and in eight cases exceeded this figure. In Fife the sugar content varied from 15 to nearly 18 per cent., in Forfar, Midlothian and Perth from 15 to over 17 per cent., and in Berwick from 15·6 to 17·6 per cent.

Economics of Scottish Farming.

It is the desire of the Board of Agriculture for Scotland to obtain, for the purpose of publication as an addition to the annual Agricultural Statistics issued by the Board, reliable information as to the economic position of farming in Scotland. The object in view is to put the government of the day, the farming community, and all interested in the prosperity of the industry, in possession of accurate information, based upon authentic records, concerning the more important types of farming, which can be used as a foundation upon which the consideration of agricultural policy can be based.

In the first instance the enquiry will be confined to the three types of Scottish agriculture that are characteristic of the south-eastern and eastern, south-western and north-eastern areas, namely, cropping for the sale of arable produce, the production of milk and cheese, and the production of fat cattle respectively. It is hoped that the more widely spread sheep industry and other aspects of Scottish agriculture may be dealt with in due course.

It is realised that for obtaining the data required the Board is dependent upon the goodwill and confidence of the Scottish farmers. In return the Board undertakes that information given will not be used in any way so as to reveal the names and the personal affairs of any co-operating farmers, and that the results obtained will be stated in the form of summaries and averages in which the identity of individual records will be lost.

The particulars it is desired to obtain will be concerned with the capital invested in the different types of farming, the labour employed, the annual incomings and outgoings, and some details of acreages, stocking and cropping. The Board will issue to all co-operating farmers either schedules which can be compiled from accounts and records already kept, or account books and diaries for the use of farmers who have not hitherto kept accounts, or who may be willing to adopt the methods suggested by the Board. It is the intention that any such schedules or account books should provide for duplicates being kept as a permanent record on the farm, copies being sent to the advisory officer in farm economics at the Board under a code number in order that their origin may not be disclosed.

The county organisers attached to the agricultural colleges, with the consent of their respective governing bodies, have undertaken to give their assistance to any co-operating farmer who so desires in preparing the annual statements or in filling up the account forms. In such cases the identity of the farmer need be known only to the county organiser. Any farmer who so desires will be furnished with a copy of the results worked out for his own farm and with average figures obtained for similar farms, but not with the separate figures for any other individual farm.

The Board hopes that the information obtained will be of value to all the farmers who join in the scheme, and for the promotion of the industry in general.

Any farmer who would be willing to co-operate for one year or for a longer period, either directly or through the medium of his professional accountants, is invited to communicate with the County Organiser for his district, or with the Board of Agriculture for Scotland, York Buildings, Queen Street, Edinburgh.

Notes from Craibstone.

Potato Trials, 1927.—Probably the most interesting feature of the 1927 trials was the effect of blight on the shaws early in the season, and the consequent reduction in the yield of late varieties. Although the shaws of all varieties with the exception of Irish Chieftain went down early, the amount of blight on the tubers, except in a few varieties, was not nearly so much as one would have expected. Even British Queen, which is generally supposed to be among the most susceptible varieties, had only a comparatively small percentage of diseased tubers.

While the early and second early varieties produced generally quite good crops, many of the late varieties planted on the same day—3rd May—did very poorly, the amount of ware being very small.

Kerr's Pink, Up-to-Date and Field Marshal were among those with a comparatively large proportion of ware, indicating that they form the tubers early, while Roderick Dhu, Ben Cruachan, Irish Queen, Golden Wonder and Langworthy had only a very small proportion.

Time of Planting.—In former trials, when Great Scot and Golden Wonder were planted at fortnightly intervals, those planted at the middle of May, when the soil conditions were suitable, produced quite as heavy crops as those planted either at the beginning or middle of April, and heavier than those planted in March. In 1927 the crops produced by Golden Wonder planted in March and April were practically the same, and were distinctly superior to those planted at the beginning of May, which were again better than those planted in the middle of the month. With the Great Scot the April plantings were better than either the March or May.

In the above trial half of the seed was sprouted and half unsprouted. In all former trials there were increases due to the sprouting, whether planted late or early, but in 1927 sprouting gave only a small or no increase when the tubers were planted in March, but those planted late gave much larger increases.

	Great Scot.	*Tons*	*cwts.*		Golden Wonder.	*Tons*	*cwts.*
1st March.	Sprouted ...	11	16	1st March.	Sprouted ...	10	18
	Unsprouted ...	11	3		Unsprouted ...	10	15
1st April.	Sprouted ..	14	9	1st April.	Sprouted ...	10	17
	Unsprouted ...	12	7		Unsprouted ...	10	11
2nd May.	Sprouted ...	13	8	2nd May.	Sprouted ...	9	6
	Unsprouted ...	11	2		Unsprouted ...	7	8
1st June.	Sprouted ...	9	4	1st June.	Sprouted ...	5	5
	Unsprouted ...	6	1		Unsprouted ...	3	2

Treatment.—The results of good as against poor treatment with selected and unselected stocks of Golden Wonder have already been given in these notes. The trial was again carried out in 1927, when they were planted on 2nd May. The results were as follows :—

	Good Treatment. Without Mosaic. Sprouted. Well manured.		*Poor Treatment.* With Mosaic. Unsprouted. Lightly manured.	
	Tons	*cwts.*	*Tons*	*cwts.*
Ware	6	10	1	5
Seed	5	9	3	7
Small	0	10	0	15
	12	9	5	7

As previously explained, practically all stocks of Golden Wonder are affected with Mosaic, and the best results cannot be expected unless one has a stock which is free, or nearly so, from this disease.

Manuring Trials.—In the first of these, different forms of nitrogen were put under test, the variety of potato used being British Queen. To all plots the same quantity of nitrogen was applied, and in addition 3 cwt. superphosphate, ½ cwt. steamed bone flour and 1 cwt. muriate of potash. As will be seen from the following table, sulphate of ammonia gave the best result. This confirms the results of previous experiments of this kind. Evidently the soil at Craibstone, so far at least as the potato crop is concerned, is benefited by the application of acid manures. The nitro chalk, which has given the next best result, is neutral in character and is considerably superior to the alkaline nitrate of lime. The comb dust has given a comparatively poor return, but we must remember that it is slow in its action and that a considerable residue of nitrogen would be left behind, whereas the other forms would be entirely exhausted in the year of application.

	Ware.		Seed.		Small.		Total.	
	Tons	cwts.	Tons	cwts.	Tons	cwts.	Tons	cwts.
No Nitrogen	2	16	2	15	0	13	6	4
2½ cwts. Comb. Dust	2	12	3	8	0	17	6	17
3 ,, Nitro Chalk	3	11	3	13	0	17	8	0
2 ,, Nitrate of Lime ...	3	8	3	11	0	13	7	12
2 ,, Sulphate of Ammonia	3	16	3	13	0	17	8	6

In the second trial, the varieties used being Great Scot and King Edward, different quantities of the same mixture of manures were used. The mixture used was 1½ cwt. sulphate of ammonia, 3 cwt. superphosphate, ½ cwt. steamed bone flour and 1 cwt. sulphate of potash, along with dung, and it was applied at rates varying from 3 cwt. to 9 cwt., the control plot, of course, getting no artificial manure.

	Over 2 inches.		Over 1¼ inches.		Under 1¼ inches.		Diseased.		Total.	
GREAT SCOT.										
Cwts.	Tons	cwts.	Tons	cwts.	Tons	cwts.	Tons	cwts.	Tons	cwts.
0	2	15	4	1	0	9	0	6	7	11
3	4	9	4	1	0	11	0	8	9	9
6	7	11	3	11	0	10	0	9	12	1
9	7	7	4	0	0	12	0	9	12	8
KING EDWARD.										
Cwts.										
0	3	3	3	3	1	6	...		7	12
3	4	6	3	17	1	9	...		9	12
6	5	7	3	13	1	5	...		10	5
9	4	9	4	10	2	4	...		11	3

The Destructive Insects and Pests Act, 1927.

THIS Act received the Royal Assent on 22nd December 1927. In its application to Scotland it provides that by an Order made under the Destructive Insects and Pests Acts, 1877 and 1907, the Board of Agriculture may take such measures as they may deem expedient in connection with any agricultural or horticultural " crop " for preventing the spread of any destructive " insect " which has been introduced into Great Britain, and may require the removal or destruction of any crop infected with such insect, or any crop to or by means of which the insect is likely to spread. For the purpose of the Acts " crop " shall include seed, plant, or any part thereof, while " insect " shall include bacteria and other vegetable or animal organisms, and any agent causative of a transmissible crop disease.

Provision is made for the payment, out of moneys provided by Parliament, of compensation for crops so removed or destroyed, but there is a proviso that the amount of compensation, &c. so paid in Scotland and England shall not in any one year, without the consent of the Treasury, exceed the sum of £2,000.

The maximum penalty that may be imposed in respect of a second or subsequent offence against an Order made under the Destructive Insects and Pests Acts is increased to £50, and the period within which proceedings for such an offence may be instituted is extended to twelve months when the offence is in connection with the movement, sale, planting, &c. of potatoes. The Act also empowers the Board to impose a fee in respect of any certificate given in pursuance of an Order made under the Acts after an inspection.

Labour on Scottish Farms.

THE Agricultural Returns collected on 4th June 1927 give the following numbers of workers employed at that date on holdings exceeding one acre in extent. The occupiers of holdings, their wives and domestic servants are excluded, but members of the occupiers' families other than their wives are included.

	Regular Workers.	*Casual Workers.*
Males, 21 years old and over ...	59,826	5,859
Do. under 21 years old ...	22,273	3,379
Total of Males	82,099	9,238
Women and girls	19,486	8,452
Total	101,585	17,690
Grand Total ...	119,275	

The grand total is about 6,800 below that recorded in 1926. This is due mainly to a decrease in the number of casual workers. who are fewer by 5,400, while regular workers have diminished by 1,400. The former figure has little significance, as the number of casual workers employed on 4th June depends on seasonal needs. Of the regular workers, males over 21 are fewer by 977, or 1·6 per cent., those under 21 by 210, and women and girls by 206, or about 1·0 per cent. in each case. These figures confirm the statement made a year ago that Scottish farm staffs have remained fairly stable since the post-war adjustment. It happens that the number of regular male workers returned in 1927 is precisely the same as that returned in 1921. The numbers for the intervening years show a range of only 1·5 to 2·5 per cent. on either side of this figure, and there is reason to believe that the lowest totals, which were returned in 1923 and 1924, were not quite complete. Regular female workers show a decrease since 1921 of 2,286, or nearly 11 per cent., but for the last three years their number has been fairly steady.

Annual Estimates of the Produce of Crops.

THE following statement regarding the produce of crops for 1927 was issued on 27th December :—

Preliminary Statement showing the ESTIMATED TOTAL PRODUCE and YIELD PER ACRE of Wheat, Barley, Oats, Beans, Hay. Potatoes and Roots, in SCOTLAND in the Year 1927, with

COMPARISONS for 1926, and the AVERAGE YIELD PER ACRE of the Ten Years 1917–1926.

CROPS.	Estimated Total Produce.		Acreage.		Average Estimated Yield per Acre.		Average of the Ten Years 1917-1926.
	1927.	1926.	1927.	1926.	1927.	1926.	
Wheat ...	*Tons.* 65,000 *Quarters.* 305,000	*Tons.* 56,000 *Quarters.* 256,000	*Acres.* 66,577	*Acres.* 53,777	*Cwt.* 19·6 *Bushels* 36·6	*Cwt.* 20·8 *Bushels.* 38·1	*Cwt.* 21·4 *Bushels.* 39·1
Barley (including Bere) ...	*Tons.* 94,000 *Quarters.* 509,000	*Tons.* 109,000 *Quarters.* 567,000	117,369	122,297	*Cwt.* 16·1 *Bushels* 34·7	*Cwt.* 17·9 *Bushels* 37·1	*Cwt.* 17·5 *Bushels.* 36·3
Oats ...	*Tons.* 620,000 *Quarters.* 4,366,000	*Tons.* 750,000 *Quarters.* 5,031,000	897,370	940,073	*Cwt.* 13·8 *Bushels.* 38·9	*Cwt.* 15·9 *Bushels.* 42·8	*Cwt.* 14·7 *Bushels.* 40·2
Beans ...	*Tons.* 3,000 *Quarters.* 14,000	*Tons.* 2,900 *Quarters.* 13,100	3,574	3,290	*Cwt.* 16·9 *Bushels.* 31·2	*Cwt.* 17·7 *Bushels.* 31·9	*Cwt.* 18·8 *Bushels.* 34·6
Hay from Rotation Grass	*Tons.* 647,000	*Tons.* 719,000	399,672	413,680	*Cwt.* 32·4	*Cwt.* 34·8	*Cwt.* 31·4
Hay from Permanent Grass ...	162,000	167,000	118,290	116,697	27·3	28·6	25·7
Hay from Timothy Meadows ...	105,000	112,000	48,922	49,560	42·9	45·1	42·3
Potatoes	799,000	899,000	147,184	141,871	*Tons* 5·4	*Tons.* 6·3	*Tons.* 6·7
Turnips & Swedes	5,937,000	6,893,000	376,693	390,778	15·8	17·6	17·0
Mangolds ...	20,400	22,900	1,124	1,108	18·1	20·7	18·4

NOTE.—Owing to wet weather in the autumn of 1926 it was generally found difficult to obtain a good seed-bed for the sowing of wheat; in December, however, a considerable acreage was seeded under satisfactory conditions. The crop brairded well, even where sown in unfavourable weather, and at the end of January the young plants had a strong healthy appearance. Growth was at first slow owing to the cold weather in April and May, but the crop made good progress during July and at the end of that month the plants were generally reported to be healthy, with a good head and an average length of straw. In

August, however, some of the grain was lodged by heavy rain. Cutting began during the last week of August but was not general until the middle of September, and in some districts the work was not completed until the latter part of October. The sowing of barley was somewhat delayed by unfavourable weather in the early spring but the work was practically completed by the end of April. Where seeded late the plants were at first stunted and lacking in colour but the crop made good progress during July and August. As a consequence of the lack of sunshine, however, some of the grain did not ripen satisfactorily. During August and September considerable portions of the best and heaviest crops were laid and twisted by storms, and when the grain was threshed much of it was found to be discoloured and below the average in bushel weight. The sowing of oats was completed later than usual and, as with wheat and barley, growth at first was slow. In July and August, however, the crop made rapid progress and at the end of August there were prospects of a good yield in most districts. The straw was soft and during the autumn months much of the crop was lodged by wind and rain, while owing to the lateness of the harvest an unusually large proportion of the grain was lost in handling. The sample is generally below the average in quality and the straw is deficient in feeding value.

The planting of potatoes, both early varieties and main crop, was carried out under fairly favourable conditions. In May and June, however, many of the young plants suffered damage by frost, but during July the warm damp weather proved of much benefit to the main crops and the tubers generally made satisfactory progress. With the long continued wet weather, however, blight became prevalent during August and September and the haulms died down prematurely, especially with some varieties. In most parts of the country there is a higher proportion than usual of small tubers, and in many cases the quality of the potatoes is below the normal. Turnips and swedes were sown later than usual and, owing to damage caused by the inclement weather, resowings were necessary in many cases. Where sown early the plants developed well but on heavy land and where sown late growth was at first slow. In some cases the bulbs benefited from the excessive rainfall but generally speaking growth was retarded by the lack of sunshine. "Finger-and-toe" was rather widespread, especially in the eastern counties.

The total produce of wheat, 65,000 tons, exceeds that of last year by 9,000 tons, or 16·1 per cent. The area under the crop is greater than last year by 12,800 acres; on the other hand, the average yield per acre, 19·6 cwt., is less than that of 1926 by 1·2 cwt. and is 1·8 cwt. under the decennial average. Barley, with a total produce estimated at 94,000 tons, shows a decrease of 15,000 tons, or 13·8 per cent. on the previous year's total. As compared with 1926 the area harvested is less by 4,928 acres, the average yield per acre by weight, 16·1 cwt., is lower by 1·8 cwt., and is below the ten years' average by 1·4 cwt., while the average yield by measure, 34·7 bushels, is 1·6 bushels less than the decennial average. The total production of oats is shown as 620,000 tons, a decrease as compared with the previous year of 130,000 tons, or 17·3 per cent.; the area under the crop has decreased by 42,703 acres, while the yield per acre, 13·8 cwt., is less than that of last year by 2·1 cwt., and is below the ten years' average by 0·9 cwt. The produce of beans, 3,000 tons, is 100 tons greater than in 1926, the area under the crop, 3,574 acres, being greater than last year by 284 acres. The yield per acre, 16·9 cwt., is less than in 1926 by 0·8 cwt., and is below the decennial average by 1·9 cwt.

The total produce of hay, taking all kinds together, is 914,000 tons, being 84,000 tons, or 8·4 per cent., less than the previous year's tonnage. Hay from rotation grass shows a total production of 647,000 tons, a decrease of 72,000 tons, or 10·0 per cent. The yield per acre, 32·4 cwt., is less than in 1926 by 2·4 cwt., but exceeds the decennial average by 1·0 cwt. The total produce of other hay, which amounts to 267,000 tons, or 12,000 tons less than in 1926, comprises 162,000 tons from ordinary meadows and 105,000 tons from timothy meadows. The yield per acre of ordinary meadows, 27·3 cwt., is 1·3 cwt. less than last year's figure, but is 1·6 cwt. above the decennial average, while the yield per acre of timothy meadows, 42·9 cwt., is 2·2 cwt. less than in 1926, but 0·6 cwt. greater than the ten years' average. The average yield of the two together, which is not shown in the table, is 31·9 cwt., or 1·2 cwt. above the decennial average.

The total produce of potatoes, amounting to 799,000 tons, shows a decrease of 100,000 tons, or 11·1 per cent.; the area under the crop, 147,184 acres, is 5,313 acres greater than in 1926, while the yield per acre, 5·4 tons, shows a decrease of 0·9 ton as compared with last year, and is 1·3 ton below the ten years' average. The produce of turnips and swedes, 5,937,000 tons, has decreased by 956,000 tons, or 13·9 per cent., while the area, 376,693 acres, is 14,085 acres less than last year and is the lowest on record. The yield per acre, 15·8 tons, is 1·8 ton less than last year, and is 1·2 ton below the decennial average. Mangolds show a total produce of 20,400 tons, or 2,500 tons less than in 1926. The area under the crop, 1,124 acres, is 16 acres greater than last year; the yield per acre, 18·1 tons, is 2·6 tons less than last year, and is 0·3 ton below the decennial average.

Every crop shows a lower yield per acre than last year, and only wheat and beans show increased total produce as a result of increased acreages. Hay from permanent grass, potatoes and mangolds show increased acreages, but this is more than counterbalanced by the lower yields per acre.

Potato Varieties and Stocks.

Miscellaneous Publication No. 3. (Revised Edition, 1927.)—THIS publication, which has been revised and enlarged, is intended for use as a handbook by potato growers and farmers and furnishes all the information necessary for the identification of potato varieties, the roguing of common varieties, the identification and control of common diseases and the maintenance of pure and vigorous stocks.

The introduction dealing with botanical features has been simplified, and the descriptions of the varieties have been revised so as to omit all unimportant details and at the same time emphasise the chief characteristics.

The list of varieties described has been enlarged to include all approved immune varieties and all common rogues, and the rogues to be looked for in particular crops are tabulated to show at a glance their distinguishing characteristics.

The section dealing with diseases gives succinctly the information required for the identification and treatment of the principal potato diseases. In particular the notes on the virus diseases, Mosaic and Leaf Roll, present the most up-to-date information available for the maintenance of stocks free from these diseases. This section also deals with the production of "stock seed."

The publication contains some new illustrations and a complete index.

Copies may be obtained from the Secretary, Board of Agriculture for Scotland, York Buildings, Queen Street, Edinburgh. Price 1*s*. net, post free.

Acreage under each Variety of Potatoes in 1927.

A STATEMENT is printed on p. 116 showing the acreages under certain varieties of potatoes in Scotland in 1927, as returned by growers of one acre or over. These returns cover 129,964 acres out of the total acreage of 147,184, the difference being accounted for by the total exclusion of certain districts in the Highlands and Western Islands, and by the exclusion of holdings on which less than one acre is grown. The total acreage shows an increase of 5,313 acres over that of last year, and the acreage included in the returns of varieties an increase of 5,871 acres.

The area under First Earlies, 15,984 acres, shows an increase of 784 acres, or 5·2 per cent., over that returned in 1926, and is practically equal to that returned in 1925. Epicure, with 8,605 acres, or 689 less than last year, accounts for 54 per cent. of the total. Eclipse, with a notable increase of 1,279 acres, covers 3,285 acres, which exceeds the combined acreage of the next two varieties—Duke of York, 1,703, and Sharpe's Express, 1,412. These four varieties cover 94 per cent. of the whole area under First Earlies.

Second Earlies again show a substantial increase, the acreage being 21,377, which exceeds last year's by 1,592, or 8·0 per cent.

Great Scot, with an increase of 1,706 acres, now covers 12,732 acres. While British Queen has decreased to 4,939 acres, 847 less than last year, Ally has risen from 815 acres to 1,540. These three varieties account for 90 per cent. of the total.

The area under Maincrops, 92,603 acres, shows an increase of 3,495 acres. Kerr's Pink, with an increase of 4,888 acres, or 16 per cent., easily leads with 35,359 acres, while King Edward VII, with a practically unchanged acreage of 20,130, is again second. Arran Chief retains the third place with 9,718 acres, a reduction of 1,404. Majestic, having increased 3,254 acres, or 57 per cent., is now the fourth in order with 8,938 acres, while Golden Wonder has fallen to the fifth place with 8,342 acres, 1,244 less than last year. These five varieties account for 89 per cent. of the Maincrop acreage. All the other varieties that had over 1,000 acres in 1926 show substantial decreases, as do also all the minor varieties except four. Thus the tendency is to an increasing concentration on a few standard varieties. Arran Consul, which appears in the list for the first time, has 693 acres.

Varieties immune from wart disease cover in all 74,714 acres, or 57·5 per cent. of the total acreage included in the returns; non-immune varieties cover 54,488 acres, or 41·9 per cent.; while the varieties not specified in the table account for only 762 acres, or less than 1 per cent. The returns have now been taken for the tenth time. The proportion under immune varieties has increased since 1918 from 19·5 per cent. to nearly three times that amount. A full account of the figures for the years 1918 to 1924 was given in the issue of this JOURNAL for January 1925.

Agricultural Returns, 1927.

THE Abstract of the Agricultural Returns printed on pp. 117–124 shows that the total area under all crops and grass amounts to 4,681,221 acres, a decrease of 11,949 acres as compared with 1926, the arable land being less by 25,911 acres, while the area under permanent grass is greater by 13,962 acres. The land under rye-grass and other rotation grasses and clover has increased by 11,384 acres, the decrease in the area under other crops being thus 37,295 acres.

The total area under the cereal crops is 1,086,424 acres or 35,706 acres less than last year. The area under wheat shows an increase of 12,800 acres or 23·8 per cent. Barley has decreased by 4,928 acres or 4·0 per cent. and oats by 42,703 acres or 4·5 per cent.; the areas under these crops, 117,369 and 897,370 acres respectively, are the lowest on record.

Beans show an increase of 284 acres or 8·6 per cent., while potatoes have increased by 5,313 acres or 3·7 per cent. The area under turnips and swedes is less than in 1926 by 14,085 acres or 3·6 per cent., while that under mangolds is practically unchanged. Cabbage shows an increase of 237 acres or 6·0 per cent. and rape

417 acres or 3·3 per cent., while flax shows a decrease of 259 acres or 55·7 per cent. The area under vetches, tares, &c. for fodder has decreased by 728 acres or 5·9 per cent., while that under sugar beet has almost trebled, the increase being 6,703 acres or 183·7 per cent.

Rye-grass and other rotation grasses and clover show a net increase of 11,384 acres or 0·8 per cent., the area for hay being less by 14,008 acres while that for pasture is greater by 25,392 acres. The area under permanent grass has increased by 13,962 acres or 0·9 per cent., the area for hay being greater by 955 acres and that for pasture by 13,007 acres.

The area under wheat, barley, oats and potatoes this year is 1,228,500 acres, which is 29,518 acres less than last year and is the lowest aggregate recorded.

The live stock returns show that the numbers of cattle, sheep and pigs have increased while horses have decreased. Horses used for agricultural purposes are less numerous by 2,524, unbroken horses of one year and above by 1,743, and those under one year by 919. " Other horses " have decreased by 1,407, the total decrease in all classes being thus 6,593 or 3·7 per cent. Cows in milk have decreased by 1,855 or 0·5 per cent., while cows in calf have increased by 6,405 or 14·9 per cent. Heifers in calf show a decrease of 1,679 or 2·9 per cent. Bulls being used for service have increased by 375 or 2·2 per cent. Other cattle of two years and above have decreased by 8,798 or 4·1 per cent., while those of one year and under two have increased by 11,182 or 4·2 per cent.; other cattle under one year have increased by 6,992 or 2·9 per cent. The total number of cattle has thus increased by 12,622 or 1·1 per cent. Sheep are more numerous than in 1926 by 332,343 or 4·6 per cent. and the total number is the largest recorded since 1899. Breeding ewes have increased by 123,872 or 4·0 per cent. and rams by 4,409 or 5·1 per cent. Other sheep, one year and above, have increased by 47,360 or 5·0 per cent., while those under one year are more numerous by 156,702 or 5·1 per cent.

The number of pigs, 196,613, is greater than last year by 51,194, or 35·2 per cent., and, with the exception of 1924, is the highest on record. Sows have increased by 8,387 or 45·9 per cent., boars by 699 or 34·7 per cent. and other pigs by 42,108 or 33·7 per cent.

The acreage under rough grazings, 9,896,854 acres, is greater by 186,673 acres than last year. This acreage includes 630,688 acres of deer forest land used for grazings, which was formerly returned by sheep farmers as rough grazings, but which, on investigation, has been found to be actually deer forest land made available for grazing. The figures for cattle and sheep include 4,039 cattle and 86,582 sheep grazing in deer forests. Of these totals 2,201 cattle and 48,329 sheep were included in Agricultural Returns and are this year, for the first time, brought under the heading of deer forest stock. The remainder consists of cattle and sheep grazing in deer forests and not included in any

Agricultural Returns. In respect of these, this year's totals are not comparable with the totals given in previous years.

The returns include statistics of the acreage owned by occupiers of holdings and particulars relating to poultry. These figures are not included in the printed abstract.

The total area of land under crops and grass returned as owned by occupiers of holdings this year amounts to 1,226,393 acres as compared with 1,094,706 acres in 1926, an increase of 131,687 acres.

The poultry figures are as follows :—

Fowls hatched before 1927	2,531,859
Fowls hatched this year	2,788,374
Ducks hatched before 1927	161,368
Ducks hatched this year	92,162
Geese hatched before 1927	7,630
Geese hatched this year	17,416
Turkeys hatched before 1927	16,229
Turkeys hatched this year	59,371

The returns of labour employed on farms are summarised elsewhere.

Agricultural Conditions in 1927.

Weather.—During January the weather conditions throughout Scotland were very changeable, snow, frost, rain and bright sunshine alternating until the last week of the month, when an unusually violent gale swept over the whole country. During February and the first half of March dry and open conditions were general and excellent progress was made with all outdoor work; from the middle of March until the last week of April, however, the weather was showery and colder, and in most districts the sowing of barley and oats and the planting of potatoes were interrupted. A wintry spell occurred during the last few days of April, when frost, snow and sleet were prevalent in all parts of the country, and outdoor stock, especially hill sheep, suffered considerable hardship. Then for about six weeks the weather was cold and dull but fairly dry generally; during this period seasonal work was pressed forward satisfactorily, but the growth of the crops was slow, while pastures remained unusually bare for the time of the year. During July and the first three weeks of August the temperature was moderate, but the weather was abnormally wet and unsettled. This spell of broken weather seriously interfered with haymaking, while cereal crops, which matured slowly, were badly lodged by storms. In northern areas, however, dry and bright conditions were general during August and crops made very good progress. A few fine days at the end of August and the beginning of September allowed the harvesting of cereal crops to be commenced under favourable conditions, but for the greater part of September and October the weather was very wet and stormy, and much of the grain was seriously damaged by wind and rain before it was finally secured. In consequence of the lateness of the harvest and the wet condition of the soil autumn cultivation was much in arrear in all districts at the end of November.

Wheat.—Owing to wet weather in the autumn of 1926 it was generally found difficult to obtain a good seed-bed for the sowing of wheat; a fair proportion of the work was, in consequence, delayed. In December, however, a considerable acreage was seeded under satisfactory conditions. The crop brairded well, even where sown in unfavourable weather, and at the end of January the young plants had a strong healthy appearance. Growth, however, was slow owing to cold weather in April and May, while on wet and heavy land the plants were thin and patchy. The crop made satisfactory progress during July, and at the end of that month the plants were generally reported to be healthy, with a good head and an average length of straw. In August some of the grain was lodged by wind and rain, but on the whole wheat withstood the storms much better than the other cereal crops. In a few southern areas cutting began during the last week of August, but the work was not general until the middle of September, and in some districts harvest was not completed until the latter part of October. The crop was secured in only fair order and the loss of grain in handling was greater than usual. The reports on the quality of the grain vary considerably, but, on the whole, the sample is more or less below the average. No damage was reported either from disease or insect pests.

Barley.—The sowing of barley was somewhat delayed by unfavourable weather in the early spring, but in most districts the work was practically completed by the end of April. In late-sown fields the plants were at first stunted and lacking in colour, but the crop made good progress during July and August; in many cases, however, as a consequence of the lack of sunshine, the grain did not ripen satisfactorily. Harvest became general during September, but considerable areas of the best and heaviest crops were laid and twisted by storms, and when the grain was threshed much of it was found to be discoloured and below the average in bushel weight; the straw was of good length but soft and broken. No damage was reported from disease or insect pests. Bere, which is grown in the north and west of Scotland, was a fairly good crop, and in most cases was cut and stacked before the end of September.

Oats.—The sowing of oats was completed later than usual in consequence of the unfavourable weather that prevailed during the spring months. As in the case of wheat and barley, growth at first was slow, but in July and August the crop made rapid progress and at the end of August there were prospects of a good yield in most districts. The straw, however, was soft, and as a result of stormy weather during the autumn months much of the crop was lodged. Where secured early the grain threshed out fairly well, but in most cases harvest was unusually protracted and a considerable amount of the grain was damaged by the weather. In many areas a fairly large proportion of the crop failed to mature properly, while, owing to the late harvest, there was an unusual amount of loss in handling. The sample varies considerably in quality, but much of the grain is below the average and the straw is generally deficient in feeding value. Comparatively little damage was caused by disease or insect pests, although in the early summer months the leather-jacket grub was rather prevalent in a few districts.

Beans.—The sowing of beans was carried out in fairly good order and the work was practically completed at the end of March. Early morning frosts at first retarded the development of the plants, but growth was vigorous and healthy during the summer months and the crop podded well.

Potatoes.—In most districts the planting of potatoes, both early varieties and main crop, was carried out under fairly favourable conditions. As a result of the low temperatures in May and June, however, growth was slow at first and many of the young plants were damaged by frosts. The warm damp weather in July proved of much benefit to the main crops and the plants generally made satisfactory progress. In September the crop was vigorous and healthy in most of the northern districts and the western islands, but elsewhere the haulms showed marked signs of blight, while, with some varieties, disease spread rapidly and growth ceased. A small proportion of the crop was sprayed, but in no district was this done on a large scale. The unfavourable season adversely affected the growth of the tubers and the yield per acre has proved to be lower than in 1926. Some reports of rotting and brown scab have been received, and in most parts of the country there is a higher proportion than usual of small tubers. In late districts little progress had been made with the lifting of the crop at the end of October, while in some cases the work was only then commencing.

Turnips.—The sowing of turnips and swedes was later than usual and owing to damage caused by the inclement weather re-sowings were necessary in a considerable number of cases, while on some farms the work had to be done a third time. Where sown early the plants developed well, but on heavy land and where sown late growth was at first slow. Weeds were unusually prevalent, and while in some cases the bulbs benefited from the excessive rainfall, in others growth was retarded by the lack of sunshine. "Finger-and-toe" was rather widespread, especially in the eastern counties.

Mangolds.—The prospects for mangolds were at first encouraging, but during the later stages of development growth was retarded. The roots are of good quality, but the yield is estimated to be somewhat below the average for the preceding ten years.

Sugar Beet.—This crop was sown much more widely than last year, the acreage being almost trebled. The crop brairded well, but in some districts the fields soon became overrun with weeds and on wet land many of the plants decayed. "Bolting" was prevalent in practically all districts, and at the end of October it became apparent that the yield and quality of the roots would be less satisfactory than in 1926. The weather during November was not very favourable for lifting, but at the end of that month about three-fourths of the crop had been secured. The roots are generally reported to be much smaller than last year and in most districts the yield per acre is rather disappointing.

"Seeds" Hay.—In the early spring young grasses and clover were generally fresh and healthy; in a few cases, however, fields were patchy owing to some of the plants being smothered by the cereal crops of last year when these were lodged. Severe weather during April checked the growth of the plants and in some districts the crop was browned and scorched by the frost. In May and June the weather conditions were more favourable but growth was retarded by the lack of sunshine, while clover was deficient generally. Broken weather at harvest time rendered this work difficult and protracted, and although the crop bulked rather better than was at one time expected, much of the hay was spoilt by exposure to wet weather.

Meadow Hay.—The yield of meadow hay varied considerably, but in most districts there was a deficiency of from 5 to 10 per cent. as compared with the average of the last ten years: taken on the whole, however, the yield was rather better than for "seeds" hay.

Cultivation.—At the beginning of November farm work was much in arrear in all parts of the country, and the weather during the month gave little or no opportunity for overtaking any of these arrears. In most districts at the beginning of December autumn cultivation and the sowing of wheat were unusually backward, while a report from Inverness-shire stated that in that district outdoor work was fully a month behind the normal. Stubble ploughing had commenced in most of the eastern and southern counties, and in Roxburgh, Selkirk and Kirkcudbright the work was well forward; the reports received from Central Aberdeen and Berwick stated that in those districts many farmers were ploughing the lea first on account of the wet condition of the stubble land.

Live Stock.—At the end of November grazing cattle were generally reported to be in fairly good condition, although in most cases they made only moderate progress during the month. In the south-western districts pastures were still fresh and green, but most of the cattle were housed before the end of November. Supplies of hay and straw are plentiful everywhere, but it is possible that turnips may be scarce later on in the season. Dairy cows have thriven well, but in some districts it has been found difficult to maintain the milk yield at the usual seasonal level, owing to the inferior quality of the fodder; in some eastern districts the yield is reported to be below the average for the season. The reports on sheep are varied. Hill sheep have progressed satisfactorily in most districts. Sheep on arable farms have, however, been adversely affected by the wet and cold weather, and in Orkney and several of the eastern counties the condition of the stocks is only moderately good. Liver-fluke is rather prevalent in Wigtown, while foot-rot is reported from Dumbarton.

Labour.—The supply of labour is generally sufficient and in some cases is in excess of present requirements. In Dumbarton, North Ayr and Dumfries, however, dairy workers are rather scarce, and in Roxburgh and Selkirk casual workers are short of requirements.

SCIENCE AND PRACTICE.

The following extracts and summaries are supplied by members of the staffs of Scottish agricultural colleges and scientific institutions or are taken from recent bulletins of the International Institute of Agriculture. Full references to the original publications may be obtained on application to the Secretary, Board of Agriculture, York Buildings, Edinburgh.

CROPS AND SEEDS.

Red Clover Investigations. *R. D. Williams, M.Sc. Bulletin No. 7, Series H, University College of Wales, Aberystwyth.*—The difference in the botanical characteristics and cropping powers of red clovers have been the subject of much careful study at the Welsh Plant Breeding Station, and this publication, which is a report of this study for the seasons from 1919 to 1926, will be of considerable interest and value to the agricultural scientist and to the practical farmer.

The first section of the bulletin deals with the morphological and physiological character of different varieties and nationalities of red clover, and its interest is mainly scientific, but the practical farmer will find a great deal of valuable information in the second part, which is devoted to a comparison of different varieties and nationalities of red clover under hay and pasture conditions.

Late Red Clovers.—The Late Red Clovers showed a more tufted, more dense and more prostrate habit of growth, and were from two to four weeks later in starting active growth than the Early Reds. The Lates were capable of producing a heavy crop, and, provided the hay was cut early, a good aftermath, and they stood up well to heavy grazing. The following was the order of earliness of the varieties of Late Red Clover tested :—

English.
Vale of Clwyd.
{ Danish.
Altaswede.
Swedish. }
American Mammoth.
{ Montgomery.
Cornish Marl. }
Norwegian.

The English Late Red Clover gave the best yield of hay and aftermath, but the Montgomery and Cornish Marl, which may be regarded as one and the same variety, held the ground better in the second and subsequent years. The Danish, Swedish and Altaswede varieties made very slow progress in the seeding year.

Early Red Clovers.—Compared with the Lates, the Early Red Clovers showed a more upright and more open habit of growth. They produced two full crops of bloom annually, but none of the varieties showed any marked ability to hold the ground well into the second year. In general, they were more productive in the seeding year but less productive in the first harvest year than the Lates.

English Broad Red, from which Vale of Clwyd Early is indistinguishable, gave the best yield among the earlies in the seeding year, and it was also superior to all the varieties tested, both early and late, in the amount of winter and early spring growth it produced. The American Medium and Canadian Red Clovers were very similar. They were late in starting growth, but they flowered early, and American Medium proved to be superior to all other foreign varieties in

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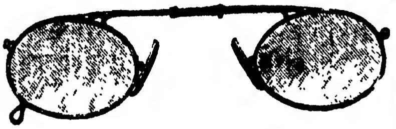

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It is of interest to note that the results obtained at Aberystwyth are in general agreement with the conclusions arrived at in a prolonged series of trials that have been carried out in Scotland.

Leaf-roll Disease of the Potato Plant. *Gg. Schweizer, Berichte der Deutschen Botanischen Gesellschaft. Band XLIV. Heft* 9.—The results of introducing various nutrient solutions into leaf-roll plants are described. With a complete nutrient solution, the young green leaves at the tip of the shoot and, in some leaf-axes, healthy shoots, had been formed, but the older leaves remained curled as before, and did not change their yellow colour much. The same condition was noted in a plant treated with calcium nitrate, but sometime later, however, the leaves of the new shoots showed signs of curling and there was no trace of a normal growth. Application of potassium, sodium, &c., to other diseased plants produced the same appearance, a light green colouring, formation of new shoots, but no uncurling of the already diseased leaves. Some nitrogenous organic substances however, particularly albumen and pepsin, had a decided effect on a diseased plant. After treating a diseased plant for four days, an uncurling of all leaves became noticeable. During the application and before the uncurling of the leaves commenced the green had become very distinct. With the disappearance of the curling, the leather-like hardness of the leaves also disappeared. A microscopic examination of the leaves of such plants, as well as a test with iodine, proved that translocation of the starch from the leaf had taken place. After the application of the nitrogenous compound no curling of the leaves took place during the whole of the growing period. By the introduction of albumen solution without the addition of pepsin a recovery of diseased plants also took place. Pepsin solution without a mixture of albumen was able to produce an appearance of recovery but the effect took place somewhat slower than when the solution contained both albumen and pepsin. The introduction of trypsin solution caused diseased plants to die and hindered the growth of healthy plants. A microscopic examination of plants which had recovered showed that where phlœmnecrosis was present before the application, the diseased tissues remained unchanged. In the new shoots, however, which had formed during and after the application of albumen and pepsin, notwithstanding the necrosis present, the translocation of starch out of the leaves took place and there was a gradual recovery to health of the whole plant. It was ascertained that in the leaves of strongly curled leaf-roll plants, the chlorophyll activity was completely stopped, but in plants which were in the first stage of the disease a slight activity of assimilation was noticeable.

The writer concludes that through the application of albumen or pepsin the plant gained renewed chlorophyll activity with the result that the starch was translocated from the leaves and that this was followed by complete recovery of the plant.

The Immediate Effect of Cross-pollination on the Size and Shape of Bean Seed. *S. A. Wingard, Virginian Agricultural Experimental Station, Blacksbird, Virginia. Genetics, Vol.* 12, *No.* 2.—The first generation seed of a cross between two varieties of Phaseolus vulgaris was found to be much larger than naturally selfed seed grown on the same plants. The seeds were carefully weighed and measured in comparison with the seed of the parent plants. Cross-pollination of certain varieties of beans had immediate effect on the size and shape of the seed. This increased size was held to be a manifestation of hybrid vigour in the embryo; it is very rare in beans, and does not occur commonly in an easily recognisable form. A noteworthy increase in weight and size of first generation seed was obtained in only one of the varietal crosses, Marblehead crossed with Powell Prolific. The first generation seed of the Marblehead-Powell Prolific cross showed a marked increase in size over the selfed seed of either parent. The increase in size of the first generation seed in the reciprocal cross was very slight and probably without significance. The first generation seed of other crosses was not weighed in comparison, but none of them showed any notable increase in size over the seed of the parents.

Seed Selection as a Factor in the Improvement of the Yield of Crops. *H. Nilsson-Ehle. Svenskt Land, Stockholm,* 1927, *No.* 7.—During the last forty years (1881–85 to 1921–25) the area under cultivation in Sweden has increased by 27 per cent., and the yield, measured in food-units, by not less than 64 per cent.[1] Calculating the value of one food-unit at 15·7 öre, the average value per year of the entire harvest for the five-year period 1921–25 amounts to 1,000 million crowns, and for the cereal crops alone to 400 millions, more than 100 millions of the latter sum being the result of the crop increase during the last four decades. According to the calculations of Professor Nilsson-Ehle, this increase, to the value of 70 million crowns, is due to the extension of the area under crops and to the improvement in manuring and cultivation methods, while Swedish seed selection work accounts for 37 millions.

If it be reckoned that, out of the average annual value of the crops other than cereal crops, a further 13 million crowns may be attributed to Swedish seed selection work, it will be realised that the annual profit of 50 millions is an exceedingly satisfactory result on an outlay of 2½ millions, the total sum allowed by the State up to the present for this particular branch of research.

The Sweetest Plant in the World, ***Stevia Reboudinna*** **Hemsl.** *Chacaras e Quintaes, S. Paulo,* 1927, *Vol. XXXV, n.* 4.—This plant belongs to the *Compositæ* and originates in Paraguay, where the inhabitants call it "*kadheé.*" It is of an erect habit and reaches a height of 70–90 cm. Its leaves contain a substance whose sweetening power is 200 times that of common sugar.

This substance is incapable of fermentation and is consequently very useful for diabetics and for sweetening syrups, &c. Its harmlessness, however, still remains to be proved experimentally.

The plant was discovered in 1899 and was introduced into the botanical garden of Rio de Janeiro in 1918, where it has grown well. A certain number of plants obtained from seed are undergoing experiments in the United States.

Its propagation is easily effected by cuttings, even by a single internode, which a week after planting sends out a shoot, the latter reaching a length of 15 cm. in a month's time.

SOILS.

Effect of Applications of (Calcium) Cyanamide on the Nitrate Content of Field Soils. *F. E. Allison. Journ. Agric. Res., XXXIV,* 657 (1927).—The nitrification in soils is shown by experiments to be retarded by the application of calcium cyanamide. Soils so treated showed a lower amount of nitrates present than did the untreated soils even after 61 days' incubation.

Relation of Soil Reaction to Active Aluminium. *A. W. Blair and A. L. Prince. Soil Science, XXIV* 3, 205 (1927).—The effect of increasing the acidity of a normal soil by the application of acids or acid-forming substances is to increase the amount of active and hence toxic aluminium. The application of basic materials or superphosphates on the other hand reduces the acidity and also the amount of active aluminium. It is pointed out that lime and basic slag are more effective in decreasing the active aluminium than is superphosphate.

Measurement of Physical Characteristics of Soils. *Lynn H. Stauffer. Utah Agric. Expt. Stn. Soil Science, XXIV* 5, 373 (1927).—An attempt has been made to obtain more exact means of expressing the physical properties of soils, so that figures may be given instead of vague descriptive terms such as heavy, loamy, sticky or friable. Simple methods which aim at measuring such things as cohesion and shrinkage have been devised.

A Biological Measurement of available Soil Potassium. *D. E. Haley and F. J. Holben. Pennsylvania Agric. Expt. Station. Soil Science, XXIV* 5, 345 (1927).—An attempt was made to measure the availability of the potassium in certain soils by a method based on that of Neubauer, viz.—by growing plants in sand and soil and determining by analysis of the plants the amount of potassium absorbed. The plant used in these experiments was buckwheat, and the soils were from the fertiliser plots of the Pennyslvania Experiment Station. One of the soils investigated had received 18 applications of muriate of potash (applied biennially) whilst the other had received none during that time. The

[1] 1 food-unit=the fodder value of 1 kilo barley.

results indicated that the potassium available for plant growth in the treated soil was more than double that in the untreated, and the figures obtained showed agreement with results obtained by other workers using the same soils, and estimating the potassium after extraction with dilute hydrochloric acid.

ANIMAL BREEDING.

General.

Alcohol and Eye Defects. *F. B. Hanson and F. Heys.* 1927. *Journal of Heredity.* 18.—Fifteen rat generations ago, two rats, brother and sister of an inbred race, produced a litter of ten young. The litter was divided into two groups of five, each of which were inbred, brother to sister, for fifteen generations. One group was for ten generations subjected to alcohol fumes daily (except Sundays). The direct effects of the alcohol were disastrous. "There were cases of paralysis and gross tumours. The normally white, well-groomed coats of the animals became discoloured and unkempt. In appearance they were thoroughly degenerate. The eyes exhibited the most striking abnormalities. After only a few treatments they became totally blind. . . . By the time the alcoholic rats were mature and mated, nearly all were blind."

Notwithstanding these *direct* effects all the young, with one exception, were born normal, especially as to the eyes. The exception proved to have a non-heritable eye defect. In the control group of untreated rats, two defective eyed individuals were produced.

"Allowing three generations to the century, an experiment of equal duration in man would have begun five hundred years ago, or half a century before Columbus discovered America. If within a single human family line half of the individuals born in every generation from 1427 A.D. to 1927 A.D. had been under the influence of alcohol daily from the age of weaning until maturity, that would constitute an experiment somewhat comparable in extent with the one herein reported for albino rats."

This is but one more of a long list of experiments designed to enquire into the heritability of acquired characters. Like the majority of them it gives no hope to the geneticist of being able to control or to modify the qualities inherent in the germplasm.

Cattle.

The Inheritance of Horns in Cattle — Some further Data *A. D. Buchanan Smith.* 1927. *Journal of Genetics,* 18. *(Paper from the Animal Breeding Research Department, Edinburgh.)*—The normal mode of inheritance of horns in cattle is for the polled condition to be dominant, that is, the mating of two horned beasts will never throw a polled one, and also a purebred (homozygous) polled animal, e.g. Aberdeen Angus mated to a horned one, e.g. Shorthorn, will produce only polled calves. In this paper are noted some apparent exceptions to the established rule. A cross of Aberdeen-Angus on native cows of Northern Rhodesia produces polled heifer and horned bull calves. In this case the inheritance of horns appears to be conditioned by sex. Exceptions in crosses involving the White Park Cattle of Great Britain are also noted. In the discussion it is pointed out that in an early form of cattle the males appeared horned and the females polled. It is interesting to speculate whether, because the crosses involved were made with cattle not of the domesticated breeds, there was therefore a harking back to the primitive type. The purpose of this paper is to show that there appear to be factors which modify the normal mode of inheritance. It is interesting, but of no economic importance—at least in this country.

Sex and Horns in Cattle. *O. O. Churchill,* 1927. *Journal of Heredity, vol. XVIII.*—It is a curious coincidence that this account should appear almost simultaneously with that reported by Buchanan Smith above. A horned Hereford bull whose sire was a polled Hereford was mated to high-grade Hereford cows. From these matings all the male calves were horned and the females polled. Another horned Hereford bull was used and he came of pure horned stock. When mated with the same cows only horned offspring were the result. When mated to the polled heifers by the first bull, all the bull calves were horned and all the heifer calves were polled. Another pure horned Hereford bull was used. Again only horned calves were obtained from the original cows, but from the heifers of the first and second bull, the calves came again in the same way, bulls horned and heifers polled. There were about 100 animals so produced. No females ever had scurs, though some of the males had.

Correlations between Milk Yield and Butterfat Percentage in Ayrshire Cattle. *G. Bonnier*, 1927. *Hereditas* 10.—It is known that milk yield and butterfat percentage are inherited though there is considerable ignorance as to the mode of inheritance. The writer, working with the results of 79 cows of the Swedish Ayrshire breed, seeks to find out what, if any, is the correlation in one animal of these two points. He finds a quite definite correlation, and affirms that the correlation co-efficient of any single cow between her yield and butterfat percentage is definite and heritable. He also postulates from his figures that there is some form of genetic linkage between the factors for the amount of butterfat and for correlation of yield of milk with butterfat percentage. There appears to be no correlation between yield of milk and the correlation of quantity of milk and butterfat percentage.

Horses.

The Role of Inbreeding in the Development of the Clydesdale breed of Horses. *A. Calder, B.Sc., Ph.D. Proc. Roy. Soc., Edin., v.* 47, *Part II, No.* 8.—The paper under review is the first breed analysis that has been made in this country and the results obtained from the study show that breed records supply a very fertile field for the application of genetics.

The extent to which an animal is inbred can be determined mathematically and expressed as a percentage of inbreeding. The foundation period of the Clydesdale breed is arbitrarily taken as the period when the systematic recording of pedigrees first commenced—viz., about 1865. The co-efficient of inbreeding is calculated for a representative sample of the population recorded subsequent to the foundation period.

The results of this study being determined as a mathematical basis, it is interesting to note how far they substantiate or disprove existing beliefs. It is found that during the early history of the breed the average percentage of inbreeding is very low; this, however, is contrary to the belief of some authorities on Clydesdale history. It is in cases such as these that the precision of a mathematical analysis proves so useful. What the author actually found is that during the foundation period there are a very few isolated cases of close in-and-inbreeding, but the author seems justified in saying that when the average of all co-efficients for that period is determined very little inbreeding was practised during the foundation period of the Clydesdale breed. The general term for relationship matings is inbreeding and it should be noted that in this study the term inbreeding is used, until sufficient evidence is procured to show that with regard to breeding practice in the Clydesdale, inbreeding could be particularised with line-breeding.

The first marked rise in the average percentage of inbreeding for the breed occurs during the period 1880–1890, and this is mainly due to the influence of the two famous sires, Darnley (222) and Prince of Wales (673). From that time onwards, there is a gradual but constant increase in the breed average, reaching its highest level at 6·25 per cent. inbreeding for the period 1920–1925. The graph of the average percentage of inbreeding for the breed manifests the more accentuated rises 20 to 30 years subsequent to the birth of Baron's Pride and the two contemporaries, Darnley and Prince of Wales. For the purpose of this study a method has been devised by which a measure would be obtained of the contribution of each sire whose blood has been concentrated in the breed to the graph of the average percentage of inbreeding. This method is also a measure of the degree of concentration of the blood of any particular sire in animals inbred in him, and a measure of the rate at which his blood has been diffused through the breed.

That the Darnley blood line predominates in the Clydesdale breed is evident from the fact that all those sires to which there has been most inbreeding were of the direct line of descent from Darnley except Prince of Wales, whose relationship to Darnley is of the half-cousinship degree. It is shown that the blood of Baron's Pride had been concentrated in the breed more rapidly and at a higher level of inbreeding than the blood of any other sire. Prior to 1912, Darnley made the greatest contribution to the average percentage of inbreeding for the breed, and subsequently Baron's Pride has been the chief contributor. Although there has been a considerable amount of inbreeding to Prince of Wales, few instances are obtained of inbreeding to sires of his line of descent. From the analysis of the random samples it is found that at the present time 100 per cent. of the population are inbred to Prince of Wales, Darnley and Top Gallant.

A comparison of the graphs of the average percentage of inbreeding in mares and stallions respectively demonstrates that the average inbreeding for mares maintained a lower value than that for stallions, except during the two periods when the rise in the average for the breed is most accentuated. The suggested explanation of this is that selection for stallions of the best breeding is at all times keen, while selection for brood mares is equally keen only during the period when there is most inbreeding to a sire of outstanding merit. The effect of a difference in popularity of two famous contemporary sires, as instanced in the case of Prince of Wales and Darnley, is investigated. The result of this analysis shows that there is very much keener selection for stallions of the more popular blood line than for mares, while both stallions and mares are almost equally inbred to the less popular sires.

The most popular system of matings in the Clydesdale breed were also investigated. Half-cousinship matings have been of very frequent occurrence subsequent to the period when inbreeding to Darnley and Prince of Wales first commenced. More especially since inbreeding to Baron's Pride began, matings of daughter to grandson and son to granddaughter have been very popular.

The purity (homozygosity) of the Clydesdale breed relative to the condition existing in the foundation stock has been increased by 6·2 per cent., due to inbreeding alone. Line-breeding, being practised almost exclusively to the members of one line of descent, viz., that from Darnley together with careful selection, appears to explain the remarkable purity of the breed at the present day. The author strongly emphasises the rapidity with which purity can be established without much recourse to in-and-inbreeding when one blood line predominates in a breed.

Pigs.

The Litter Size of Improved Landschwein. *H. A. Bartram. Züchtungskunde,* 1 (1926), *No.* 5.—The average sizes of successive litters of sows from the first to the twelfth have been tabulated from herd book records, together with calculations of the standard deviation and probable errors of the mean and standard deviation. These results, as well as other tabulations for the sows having litters in all groups, show that the sixth and seventh litters were generally the largest. The variability in litter size appeared to increase with age.

Poultry.

Six Consecutive Generations of Brother to Sister Matings in White Leghorns. A Preliminary Report on Studies in Inbreeding in Poultry. *H. D. Goodale.* 1927. *Poultry Science, vol. VI.*—The offspring of the first mating of brother to sister were prolific egg producers, thirteen pullets hatched from March 23 to May 26 giving an annual average egg yield of 224 eggs.

The next year the best pullet of the preceding generation, with a record of 280, was again bred to a brother, but the five daughters completing the year averaged only 113 eggs. Nine daughters had been hatched and lived through the winter, their winter records being 43 eggs against 79 for the thirteen daughters of the preceding generation. But the 43-egg average is practically the same as the 41-egg average made under adverse conditions by the original unrelated pair of parents.

The second generation of brother to sister matings seemed to have reached the bottom at one bound so far as egg production is concerned, for it has remained at roughly the same amount ever since, one family of eight in the fifth generation laying 41 eggs last winter, another of three laying 32 eggs. The high individual record last winter was 65 eggs.

The hatching quality of eggs has had its ups and downs. In the third generation there were but two daughters in the direct line, but fortunately five appeared in the next and eight in the fifth. However, since a full brother was unavailable, the line has been continued through a second family of three, with what appear to be the most successful results since the experiment began, for these three have produced for the sixth generation a total of 67 chicks with a reserve of 42 from the same male mated with two half sisters.

Other lines have been started, one after four generations of brother to sister matings being even more successful than the preceding, a branch of the line having produced a family of full sisters, April hatched, which gave an average winter egg yield of 62 eggs, with a high record of 89. From another member of the line, 34 chicks were hatched during our regular season of ten weeks; a full sister gave 25 chicks and another 24. The several lines or sublines are becoming rather homogeneous for definite egg characters; i.e., a given family being all either early or late maturing, or all with or without a winter pause. There is, then, every prospect that lines of poultry genetically pure for egg production characters will eventually become established.

Inbreeding in Poultry. *Chr. Wriedt,* 1926. *Nordisk Jordbrugsforskning. Beretning fra N.I.F. s Kongres i Oslo, Juni* 1926.—At the poultry breeding station of Rogoland, Norway, the whole stock of animals descends from one pair, cock No. 1 and hen No. 26, of a local race. Their son, No. 3, was mated to his mother, and of the animals so produced a brother and sister were mated together. The offspring was thereafter inbred and at the same time selected, the original No. 1 and No. 26 being used several times. The result has been very good. No case of degeneration has been found at the station, nor by any of the private breeders who obtained eggs from this inbred strain; the egg production and egg weight was very high, the average surpassing that of the white Leghorn strain of the station.

From this well-founded experiment it may be concluded that inbreeding in certain cases leads to better results than the method of "blood refreshment." Only by inbreeding can one obtain certainty about the presence or absence of hidden bad characters, and if they are absent, why should one risk their re-importation by using animals of other origin?

Egg Records of Birds which Die during the First Laying Year. *J. Arthur Harris.* 1927. *Poultry Science, vol. VI.*—This investigation dealt with the problem of the differences in the mean monthly egg production, and in the variability of monthly egg production, of birds which died at some time during the first laying year and of those which survived throughout this period.

The constants show that in the Rhode Island Red and White Wyandotte breeds (here considered for the first time in relation to the problem of differential mortality) the mean egg production is lower and the variability of egg production is higher in birds which subsequently died than in birds which survived.

The facts that the average production of the birds which subsequently died is lower than that of birds which survived throughout the period under consideration, while both the absolute and the relative variabilities of the egg records of birds which died are larger than those of the birds which survived, show that the relationship between egg record and mortality is a definite but probably highly complex one.

It seems probable on *a priori* grounds that three groups of factors may determine the inter-relationships. (*a*) Low egg production may in some cases be associated with low physical vitality which ultimately finds expression in the death of the organism. (*b*) Conditions of morbidity induced by causes largely independent of the constitutional vigour of the organism may tend both to lower egg production and to shorten the life of the individual. (*c*) Excessive egg production may so lower the vigour of the organism as to be a direct or a contributory cause of subsequent death. Factors (*a*) and (*b*) would tend to lower the mean egg production of birds which subsequently died. Factors (*a*), (*b*) and (*c*) would tend to produce the high variability of egg production in birds which subsequently died as demonstrated in the investigation.

The results of this and of the preceding investigation are of direct importance in relation to the commercial flock in that they show that loss due to mortality is not merely the loss of the birds which died, but a loss due to decreased egg production during the period preceding death. They are of indirect importance in that anything in the analysis of the factors to which mortality is due must ultimately have its bearing on the problems of commercial production.

Selective Fertilisation in Fowls. *L. C. Dunn.* 1927. *Poultry Science, vol. VI.*—Eleven Leghorn hens were mated in rapid succession to their full brother and to a cock of another breed, Rose Combed Hamburg; 464 eggs were obtained, of which 159 proved to be infertile. The paternity was determined in the case of 237. Of these, 212 or 89·5 per cent. were sired by the full brother, while 25 or 10·5 per cent. were sired by the unrelated cock. Two sets of sisters were, however, involved in this experiment. Nine came from one family and 97 per cent. of the eggs of these were sired by the brother, while the two from another family produced 33 per cent. of chicks sired by the brother.

In another experiment White Wyandotte hens were mated to both a White Wyandotte cock and either a Silver Spangled Hamburg or a Pit Game cock; 107 eggs were laid, of which 92 were fertilised by the related sperm and 15 by the unrelated.

This work confirms the observations of Dr. Crew at the Animal Breeding Research Department that selective fertilisation does take place.

The Laying Hen with Cock's Plumage. *F. A. E. Crew.* 1927. *Proc. Roy. Soc. Edin., vol.* 101. *Paper from the Animal Breeding Research Department, University of Edinburgh.*—Among the many fowls exhibiting abnormality of the sex characters which have been presented to this department by breeders sympathetic to the view that a study of the abnormal may lead to a better understanding of the normal processes of development and maintenance, have been two which were in every way similar to the cock which, in 1474, was sentenced by the magistrates of Basle to be burned at the stake " for the heinous and unnatural crime of laying an egg." It is recorded that the executioner on cutting open this cock found three more eggs within him, but this has been doubted by some, who have held that it was impossible and absurd, and that these eggs were not formed by nature, but were created by the fevered imagination of the superstitious. Such was the fate of the sexually abnormal, even up to the year 1730. But times have changed, and to-day, instead of being burned at the stake, the offender is called upon to make its contribution to our knowledge of the sex physiology of the fowl.

The bird (No. 2) now to be described, then a year-old Rhode Island Red, was sent to this department because it was thought to be a cock which laid eggs. It certainly at the time had the plumage characteristic of the male of the breed, was laying actively and had well developed spurs. But it did not crow; it did not exhibit the male behaviour, but behaved as a female; normal cocks did not recognise it as a male, nor did the hens; its head furnishings were typically female in their size (save about the time of the moult, when they shrank until they were as those of a capon).

The explanation of such cases as this would seem to be that these birds are hens; that at the time of the moult the ovary of the hen undergoes a process of involution, and that for a short period of time the sex-gland is physiologically relatively inactive. If the new plumage begins its growth and differentiation in the absence of the controlling influence of the sex-gland, it will assume the characters of the plumage of a capon. The bird which has male plumage and which lays eggs is not a cock at all, then, but a hen, normal in every way, save that her plumage is as that of a capon, tightened by the physiological action of certain of the endocrine glands.

The Exportation of Sugar Preserved Eggs. *Farming in South Africa. Pretoria*, 1926, *Vol. I, No.* 4.—Sugar preservation of liquid eggs is a new method of putting eggs on the market, which offers the advantages of economy in packing and transport and of preservation without the need for cold storage or of any antiseptic.

The eggs, which must be hen eggs, are broken under ordinary hygienic conditions. The yolk and white are mixed and 50 per cent. of refined sugar added before closing in new tin boxes weighing 14 lbs. or 18 lbs. net. This product finds a ready sale on the British market for use in pastries and is sold at 9*d*. to 11*d*. per lb.

Sheep.

Corriedale Sheep in Great Britain. *J. E. Nichols.* 1927. *Journal Ministry of Agriculture,* 34 : 246–251. (*Paper from the Animal Breeding Research Department. Edinburgh.*)—The writer might well have substituted " Scotland " for " Great Britain " in the title of this paper, since, apart from the show sheep at Wembley, the Corriedales have been entirely confined to Scotland, where to Mr. James Piper of Burntisland belongs the credit of bringing them to this country and conducting experiments on wool improvement. As is fairly well known, the Corriedale is a breed of some twenty-five years' standing, having evolved in New Zealand from crosses between Romney Marsh and Merino sheep to which was later added blood from the Lincoln, and also, to a lesser degree, from the Leicester, Border Leicester and more Romney Marsh. The ideal was a sheep with a heavy fleece and a useful fat lamb.

Mr. Piper has managed his herd of Corriedales, which at first consisted of some 12 rams and 23 ewes, under precisely the same condition as the rest of his flocks. The lamb is born with a kempy protective coat which is rapidly shed, leaving a desired uniform fleece. The wool of the adult has not been properly examined, but appears to average about 9 lbs. and is of good quality. When shorn, the sheep display a good mutton type.

In crosses with other breeds, Cheviot, Halfbred, Dorset Horn and Crossbred, lambs have been examined at the age of 6–8 weeks. They were all of good mutton type, the Dorset Horn crosses looking particularly well in this respect. In the Cheviot cross, there are distinct traces of the neck folds, and compared with the Halfbred cross the latter have a more uniform coat with fine wool down the legs and a more typical Corriedale crimp.

DAIRYING.

Dried Brewers' Yeast *versus* Linseed Oil Meal as a Protein supplement for Dairy Cows in Milk. *H. Barton, A. R. Ness and E. W. Crompton. Macdonald College, M'Gill University, Tech. Bul.* 3, 1926.—Two trials by the double reversal method. Each trial of three periods of twenty-one days each in the first trial and thirty days in the second. The ration consisted of maize silage, hay, and a grain mixture including either brewers' dried yeast or linseed oil meal. It was found that the dried yeast was of about equal value pound for pound with linseed oil meal. It is suggested that the dried yeast be mixed with brewers' dried grains and be sold in this way as it would improve the feeding value of the grains.

Experiments in the Self-Feeding of Dairy Cows. *W. B. Nevens. Ill. Sta. Bul.* 289, 1927.—When cows in milk were allowed access to a self feeder containing a variety of concentrates they ate more than was required for maintenance and milk production. This method of feeding is not economical but it is of some use in studying the preferences of the cows so far as the various feeds are concerned.

Soya Bean Meal and Ground Soya Beans as Protein supplement for Dairy Cattle. *A. E. Tomhave. Del. Sta. Bul.* 148, 1927.—Both ground soya beans and extracted soya bean meal were compared with decorticated earth nut meal as supplements for milk cows. In each trial the reversal method was used. It was found that the earth nut meal was about 3 per cent. better than the soya bean meal or cracked soya beans. In other words, the three feeds were practically of the same feeding value.

Acidophilus Milk, a fermented milk preparation of high therapeutic value is described by Dr. Herman N. Bundensen, the Commissioner of Health for Chicago, in a recent issue of "Chicago Health." The bacillus acidophilus cultured in milk makes a beverage that is specially palatable and invites the use of milk by those who might otherwise decline it. The use of milk artificially soured by acid-producing germs is not of recent practice. Good buttermilk has always been held in high esteem, and its virtues have been upheld by physicians and dieticians. In recent years Rettger and Cheplin have shown that the ingestion of milk soured by a lactic acid organism called bacillus acidophilus has proved effective in the treatment of intestinal troubles and chronic constipation. Dr. Arthur I. Kendall, formerly Dean of the North Western Medical School in Chicago, is of the opinion that the successful changing of the germs of the colon from a poisonous to a non-poisonous type which can be effected by the use of acidophilus milk would considerably add to the span of life of the average citizen.

For adults the amount of acidophilus milk recommended is a quart a day at the outset. After the first few days, this quantity may be slightly decreased, but on the average, a pint a day at least should be consumed. The following regime is recommended. Take one quart of acidophilus milk daily for the first three days, and one pint daily thereafter. The milk may be taken at or between meals according to individual preference. According to some authorities, however, the best results are obtained by taking acidophilus milk with the meals, the idea being to mix the living acidophilus germs thoroughly with the food. A glass of acidophilus milk with each meal usually gives good results.

Milk as an Antidote to Lead Poisoning. *Milk Plant Monthly* 16 (4) 23. —The regular consumption of milk in adequate quantities is the best antidote to lead poisoning, which workers in the metal trades are liable to contract. In a dietary experiment among lead workers, among whom the incidence of lead poisoning was high, it was found that the individual consumption of one quart of milk per day practically eliminated the trouble.

Parchment Paper as a Source of Moulds in Butter. *H. Macy, University of Minnesota.*—Parchment paper contaminated with mould spores may be an important source of moulds in butter. A simple treatment, namely, boiling the parchment paper in water or saturated brine for ten minutes, will eliminate this source of moulds in butter.

Separator Slime. *Le Lait. March* 1927.—The composition of a separator slime derived from centrifuging 2,500 gallons of milk was as follows:—water 73·26 per cent., fatty matter 3·34, protein 17·60, ash 2·98, non-nitrogenous organic matter 2·62. Most of the ash is composed of CaO (27 per cent.), and phosphoric acid (37 per cent. P_2O_5). The fatty substances represent not only ordinary milk fat, but also a substance rich in chloresterin and lecethin.

Vitamin C in Raw and in Pasteurised Milk. *Chemical Abstracts* 20, 3717.—Raw milk fails to prevent scurvy unless it is quite fresh. In contact with air, and especially if shaken with it, vitamin C in milk soon becomes inactive. Oxidation rapidly destroys vitamin C, even at ordinary temperatures.

"Sterilising" Milking Machines. *Annual Report. Bureau of Dairy Industry, U.S. Department of Agriculture.* 1926.—The milking machine units were heated in water (after the usual preliminary cleaning) at a temperature of 160° to 165° F. for 20 to 45 minutes, at the end of which time they were placed either (*a*) in a refrigerator, (*b*) in weak chlorine solution—about 1 in 20,000 available chlorine, or (*c*) in a warm room. A check unit was allowed to remain in hot water between the milkings. Milk from the units placed in the refrigerator averaged 3,100 bacteria per cubic centimetre; from those placed in a weak solution of chlorine between the milkings the average count was 2,200 per c.c., whilst from the unit placed in a warm room the average count was 5,540 per c.c.

The teat cup liners were the first rubber parts to wear out, the tubing outlasting them considerably. When the units were heat-treated to a temperature of 160° to 165° F. and allowed to remain in hot water between milkings, the teat cup liners lasted from 178 to 188 milkings. When the water was only 145° to 150° F. (the resultant bacterial count from the treated unit being 11,930 per c.c.) the liners lasted 218 milkings, while when the units were pasteurised to 160° to 167° for 35–20 minutes, and then placed in a cold storage room, the liners lasted 315 milkings.

Tests were also made on units kept between the milkings in a saturated brine solution with added chlorine to make up to 1 in 5,000 parts available chlorine. The teat cup liners at the end of 537 milkings were still in good condition.

The Influence of Sun or Artificial Ultra-Violet Ray Treatment of Cows on the Secretion of Anti-rachitic Milk. *W. Voeltz, A. Kirsch and C. Falkenheim. Landwirtschaftliche Jahrbücher, Berlin,* 1927, *Bd. LXV, Heft* 3.—The question as to what factors produce milk of anti-rachitic properties or increase these properties, and whether this property of milk can be artificially induced or prevented, has for many years been studied by numerous investigators and has formed the object of more or less exhaustive enquiries.

The writers draw the following conclusions from the results of their work :—

Pasture milk differs from normal stall fed milk in its anti-rachitic properties. Normal winter feeding provides either very scanty anti-rachitic properties or none at all. The anti-rachitic effect of pasture milk could be attributed partly to the direct action on the cow of the sun's rays, partly to the content in vitamin D of the pasturage.

The writers consider that the use of artificial ultra-violet rays on the farm under given conditions is worth a trial.

MISCELLANEOUS.

First Attempts at anti-Foot-and-Mouth Disease Inoculation by means of Foot-and-Mouth Vaccine Complexes. *M. Belin. Comptes rendus des Séances de la Société de Biologie, Paris,* 1927, *t. XCVI,* n° 14.—The writer gives an account of his notes on the effect of the inoculation of some 1,000 cattle with foot-and-mouth vaccine complexes capable of producing foot-and-mouth lesions in guinea pigs. The virus used was a stable foot-and-mouth virus in different stages of virulence, which can be made in large quantities and presents no difficulty in use.

Inoculation with foot-and-mouth complexes, which contain a suitably attenuated virus, involve no danger and, at the same time, provide a definite immunity which is of practical service both in the byre and in infected areas.

This first inoculation prepares the way for inoculation with a complex containing a virulent foot-and-mouth virus, which, used as a second vaccine, can give a more marked and lasting immunity.

Diminution in the Average Consumption of Flour in the United States. *Agricultural Review, Vol. XX, No. 2. Kansas City, Missouri, February* 1927.—The Food Research Institute of Leland Stanford University reports that the *per capita* consumption of flour in the United States fell off 10 per cent. between 1904 and 1919, and 12 per cent. more between 1919 and 1923. The *Journal of the American Medical Association* estimates the decrease in the *per capita* consumption at over 21 per cent. in 21 years. The reasons given are as follows :—

1. There has been a tendency to replace the cereals with sugar. Increased sugar consumption is probably the continuation of a change that has been in progress for 20 years or more;
2. The total *per capita* food requirements have declined, probably because

there is more machine and office work and less manual labour than formerly;

3. The greater prosperity of labourers since the war has led to diversification of diet and increased consumption of more expensive foods. Flour has thus been replaced to some extent by fruits, vegetables and dairy products.

If the *per capita* consumption of flour had been as large in 1925 as it was in 1904, there would have been little wheat for export from the States and the domestic market would have been much stronger, the annual consumption being 90,000,000 bushels more.

The Social and Economic Work of the Belgian "Boerenbond." *Le Paysan, No.* 24, *Louvain,* 12 *June* 1927.—Under the guidance of its Higher Council the work of the *Boerenbond,* which at the end of 1926 included 1,174 local guilds with 112,686 members, becomes every year more strongly developed both in the social and in the economic field. While its economic activities take the usual forms, there is a constant stimulus to new and various social activities which is due to the real desire that is felt for the moral, religious and cultural training of the members. One of these movements, which seems assured of success, is the organisation of young persons in country districts, the intention of which is to provide the sons of members with opportunities of instruction and wholesome recreation. The organisation consists of 296 sections, and there are more than 10,000 members on the books. Special short courses (*journées d'étude*) were attended by more than 500 members. Particular attention is given to vocational instruction and education, and with this object, 4,780 lectures were given on various subjects and a number of leaflets issued. As many as 260 vocational continuation classes were held. A distinct impetus to training in the technique of agriculture was given by crop and live stock competitions and by agricultural and horticultural shows. The number of rural libraries has increased to 212.

Agricultural Contracts. *France.*—A law of 9 June 1927 (*Journal Officiel,* No. 134, of 10 June 1927) authorises the raising of leasehold rents. This revision may only be applied to leasehold contracts under negotiation or concluded before 1 January 1924 for a period of at least 9 years. The increase will take effect from the day of application for revision, which must be made within six months after the publication of the law. It is laid down that the revision procedure shall only affect the present holder of the lease, even if the grant of the lease is later than 24 October 1919. The holder has, however, the right to summon the grantor to prove his title and every person so summoned may in turn summon his own predecessor. The judge shall, if necessary, divide between the parties the increase which the present holder will have been ordered to pay. No increase will be granted owners who, since 31 December 1923, have acquired the land leased for valuable consideration, unless the person acquiring it, having been unable to take possession of the land owing to the non-expiry of the lease, accepts himself the increase resulting from the present law on the farm he now occupies as lessee. Nevertheless, all lessors who are not entitled to revision and whose rent expressed in money will not have undergone an increase exceeding 100 per cent. on the 1914 figure, may demand from their tenants an increase of 10 per cent. on account of increased charges and the extra taxes due them from 1 January 1927 or from the date of their acquisition of the land if acquired after that date. The application for increase shall only be entertained if the price stipulated in the contract is less by more than one quarter than the price fixed by arbitration as representing on the day of application the fair rent. No increase will be allowed owners whose rent is payable entirely in kind. The new rent will be based on the rent value in 1914 on the rents or values obtaining in the district at that period, increased by 200 per cent, account being however taken of the extra taxes and charges legally incumbent on the lessor and payable by the tenant as well as all other factors of appreciation. Lastly, the tenant has the right, if he does not wish to accept the increase, to cancel the contract. This power of cancellation can, however, be applied only to contracts which have still two years to run after the promulgation of the law.

Living Expenses of Farmers in the United States. *E. L. Kirkpatrick. United States Department of Agriculture Bulletin, No.* 1466. *Washington, November* 1926.—The United States Department of Agriculture has published a study of the living expenses of 2,886 farm families in selected localities of eleven States. The data were gathered by means of personal visits, the period of these visits ranging from 1922 to 1924. Typical farm homes were visited, the selection of households of any one size or level of living being avoided.

The average annual living expenses per family of all families included in the study were found to be $1,598, the lowest average per State being South Carolina, $1,482, and the highest being Massachusetts, $1,948. This figure included food, house rent and fuel. The average size of the family was 4·4 persons. More than two-fifths of the general average of $1,598 was covered by goods supplied by the farm. The value of food supplied by the farm was almost twice the value of house rent and fuel supplied.

The various items included in the $1,598 were found to be apportioned as follows :—

		Per cent.
Food	$659	41·2
Clothing	235	14·7
House rent	200	12·5
Furniture and equipment	40	2·5
Farm requisites	213	13·3
Maintenance of health	61	3·8
Life and health insurance	41	2·6
Advancement (education)	105	6·6
Personal	41	2·6
Unclassified	3	0·2
	$1,598	100

The expenditure for clothing was about the same, viz., $59 each, for husbands and wives. The average costs for sons of the age groups over 24 years, 19 to 24 years, and 15 to 18 years were respectivly 1·26, 1·54 and 1·24 times as high as the average costs for clothing for the male heads of families. The average costs in this respect for daughters of the same age groups were 1·42, 1·67 and 1·36 times as high as the average costs for female heads of families.

The average length of the working day of the farm operator was found to be 11·3 hours, and of the women of the farmhouse 11·4 hours, exclusive of meals or resting.

The average number of years the operator has been a farm owner is closely associated with expenses. Mortgage indebtedness on the farm, taken generally, however, seems to have no bearing on the expenses.

STATISTICS.

PRICES of AGRICULTURAL PRODUCE, FEEDING STUFFS and FERTILISERS in September, October and November 1927.

AVERAGE PRICES OF LIVE STOCK IN SCOTLAND.

(Compiled from Reports received from the Board's Market Reporters.)

Description.	September.			October.			November.		
	1st Quality	2nd Quality	3rd Quality	1st Quality	2nd Quality	3rd Quality	1st Quality	2nd Quality	3rd Quality
FAT STOCK:—									
CATTLE—	per cwt. l.w. s. d.	per cwt. l.w. s. d.	per cwt. l.w. s. d.	per cwt. l.w. s. d.	per cwt. l.w. s. d.	per cwt. l.w. s. d.	per cwt. l.w. s. d.	per cwt. l.w. s. d.	per cwt. l.w. s. d.
Aberdeen-Angus ...	63 7	56 0	44 2	62 8	55 9	43 9	63 0	55 10	39 0
Cross-bred (Shorthorn)	57 0	50 3	35 5	56 2	49 0	33 3	56 8	48 9	32 1
Galloway	53 0	48 3	...	50 2	45 3	..	52 4	46 7	...
Ayrshire	53 0	48 3	35 0	51 3	44 0	33 3	51 2	41 7	34 2
Blue Grey	...	...	...	50 6	...	...	52 0	..	...
Highland	...	...	...	58 0	...	...	.	...	...
	per lb. d.	per lb. d.	per lb. d.	per lb. d.	per lb. d.	per lb. d.	per lb. d.	per lb. d.	per lb. d.
VEAL CALVES	16	8½	5	16	8½	5	16	8½	5
SHEEP—	under 60 lb. per lb. d.	60 lb. and upw'ds. per lb. d.	Ewes per lb. d.	under 60 lb. per lb. d.	60 lb. and upw'ds. per lb. d.	Ewes per lb d.	under 60 lb. per lb. d.	60 lb. and upw'ds. per lb. d.	Ewes per lb. d.
Cheviot	12¾	11½	9½	12¼	11	9¼	12	10¾	9
Half-bred	12½	11½	7¾	11¾	10¾	7½	11¾	10½	7¼
Blackface	12¾	11¾	9¼	12	11¼	8¾	12	11	8¾
Greyface	12¾	12	8¾	12½	11½	8	12½	11½	7¾
Down Cross	12¾	11¾	6¾	12¼	11½	6	12½	11½	6
PIGS—	per stone. s. d.	per stone. s. d.	per stone. s. d.	per stone. s. d.	per stone. s. d.	per stone. s. d.	per stone. s. d.	per stone. s. d.	per stone. s. d.
Bacon Pigs	12 10	11 11	...	12 4	11 5	...	11 10	10 10	...
Porkers	13 8	12 8	..	13 1	12 2	...	12 7	11 7	..

Average Prices of Live Stock in Scotland—*continued.*

Description.	September.			October.			November.		
	1st Quality	2nd Quality	3rd Quality	1st Quality	2nd Quality	3rd Quality	1st Quality	2nd Quality	3rd Quality
STORE STOCK :—									
Cattle—	Per head.	Per head.	Per head.	Per head.	Per head.	Per head.	Per head.	Per head.	Per head.
Aberdeen-Angus :	£ s.	£ s.	£ s.	£ s.	£ s.	£ s.	£ s.	£ s.	£ s.
Yearlings	18 3	15 6	13 9	17 15	14 18	13 1	16 16	14 3	11 11
Two-year-olds ...	23 17	19 6	18 0	22 18	18 19	16 10	21 14	18 2	15 10
Cross-bred (Shorthorn) :									
Yearlings	17 3	14 9	12 10	16 12	14 2	12 2	15 5	13 1	10 16
Two-year-olds ...	22 14	18 10	17 5	21 11	18 2	16 1	20 18	17 7	15 0
Galloway :									
Yearlings	15 8	12 0	...	18 3	16 5	12 10	15 1	12 0	...
Two-year-olds ...	20 10	17 0	...	22 6	18 14	14 5	...	18 15	...
Ayrshire :									
Yearlings	11 15	...	..	12 10	...	...	...	...	...
Two-year-olds ...	...	...	...	16 10	...	...	14 10	...	...
Blue Grey :									
Yearlings	17 10	...	.	...	...	...	15 10	...	...
Two-year-olds ...	...	...	...	...	...	...	...	...	...
Highland :									
Yearlings	9 10	8 10	...	12 0	10 8	8 16	10 13	8 18	7 8
Two-year-olds ...	16 18	14 10	...	16 8	14 12	13 1	15 9	14 0	11 15
Three-year-olds ...	20 15	18 0	...	21 18	18 16	16 10	18 0	15 12	14 7
Dairy Cows—									
Ayrshire :									
In Milk	30 0	21 17	12 0	30 7	21 12	12 0	30 1	22 17	12 16
Calvers	27 10	21 4	14 9	28 7	21 14	14 10	30 3	22 13	15 4
Shorthorn Cross :									
In Milk	32 13	24 5	22 0	32 4	23 18	...	33 1	24 17	...
Calvers	31 9	22 19	17 8	31 13	22 12	16 16	31 6	22 16	17 6
Sheep—	s. d.	s. d.	s. d.	s. d.	s. d.	s. d.	s. d.	s. d.	s. d.
Cheviot Hoggs ...	68 6	48 3	...	55 11	54 3	40 5	...	...	...
Half-bred Hoggs ...	74 6	61 8	60 0	71 9	55 2	...	...	...	...
Blackface Hoggs ...	60 9	50 0	33 0	47 6	36 4	31 6	...	..	...
Greyface Hoggs ...	58 0	55 9	53 6	61 2	47 2	...	...	...	...
Down Cross Hoggs	...	...	...	..	...	...	...	...	...
Pigs—									
(6 to 10 weeks old)	29 11	19 8	...	27 3	17 11	...	21 10	14 4	...

AVERAGE PRICES OF DEAD MEAT AT DUNDEE, EDINBURGH, AND GLASGOW.

(Compiled from Reports received from the Board's Market Reporters.)

Description.	Quality.	September.			October.			November.		
		Dundee	Edinburgh.	Glasgow.	Dundee.	Edinburgh.	Glasgow.	Dundee	Edinburgh.	Glasgow.
		per lb. d.	per lb. d.	per lb. d.	per lb. d.	per lb. d.	per lb. d.	per lb. d.	per lb. d.	per lb. d.
BEEF: —										
Home-fed—										
Bullock or Heifer ...	1	8⅞	9⅜	11	8¾	8¼	10¾	8⅝	7¾	10⅞
	2	8½	...	10⅛	8⅛	..	9¾	7⅝	...	9⅞
Bull	1	7⅜	7½	7¼	7¼	6⅞	6⅝	6¾	7¼	6⅜
	2	6⅞	5⅞	6⅛	6¾	5⅝	5½	6¼	5⅞	5⅜
Cow	1	5½	5¾	7	5½	5⅝	6¼	5¼	5⅝	6¼
	2	5	5	6⅛	5	...	5¼	4⅞	...	5¼
Irish—										
Bullock or Heifer ...	1	...	...	8⅛	...	...	7⅜	...	...	6½
	2	...	...	7½	...	...	6⅞	...	...	6⅛
Argentine Frozen—										
Hind Quarters ...	1	6½	6⅝	6½	6¼	6⅛	6¼	5¾	6¼	6
	2	5⅞	5½	...	...	5⅜	5½	...	5½	5½
Fore ,, ...	1	4⅛	4⅛	4	4¼	4⅜	4	4½	4½	4
	2	...	4	...	...	4¼	...	...	...	...
Argentine Chilled—										
Hind Quarters ...	1	7⅜	7	7	6⅞	6⅝	6⅜	7⅛	6⅞	6½
	2	...	6½	6½	....	6¼	5⅞	...	6¾	6
Fore ,, ...	1	4½	4	4⅜	4⅝	4⅜	4⅝	4⅝	4⅝	4⅝
	2	...	...	4⅛	...	4¼	4¼	...	4½	4⅛
Australian Frozen—										
Hind Quarters ...	1	...	...	6	...	...	5¾	...	...	5½
	2	...	...	...	...	...	5	...	...	5
Crops	1	...	...	4	...	...	4	...	...	4
	2	...	...	...	...	...	...	...	...	...
New Zealand Frozen—										
Hind Quarters ...	1	...	...	6	...	...	6	...	...	6
	2	..	...	...	...	...	5½	...	...	5½
Fore ,, ...	1	...	...	3½	...	...	3⅝	...	...	3¾
	2	...	...	...	...	...	...	...	...	...
MUTTON: —										
Hoggs, Blackface ...	under 60 lb.	12	11	10⅜	11½	10⅛	10	11	10⅛	10⅜
	60 lb. & over	11	...	9⅞	10⅝	...	9½	10	...	9⅞
,, Cross	under 60 lb.	12	10⅞	10⅜	11½	10⅛	10	11	10⅛	10⅜
	60 lb. & over	11	10	9⅞	10⅝	...	9½	10	...	9⅞
Ewes, Cheviot	1	...	7⅛	7¼	...	5⅞	6½	6½	6⅜	7⅛
	2	...	...	6¾	...	...	6	6	...	6⅝
,, Blackface ...	1	7¼	7⅛	7⅛	6⅞	5⅞	6¼	6⅝	6⅜	6¾
	2	7	...	6⅛	6	...	5¾	6	...	6⅛
,, Cross	1	5¼	7	6¼	4½	5⅞	5½	5	6⅜	5¾
	2	5	5½	5¾	...	...	5	4	...	5¼
Argentine Frozen ...	1	...	...	5	..	...	5¼	...	...	5½
	2	...	...	4½	...	...	4½	...	...	4½
Australian ,, ...	1	...	6	4¾	...	6	4¾	...	6	4¾
	2	...	5⅝	3¾	...	5⅝	3⅞	...	5⅝	4
New Zealand Frozen ...	1	...	...	5½	...	...	6	...	...	6½
	2	...	...	4½	...	...	4½	...	...	4¾
LAMB: —										
Home-fed	1	12	12	11¼	11½	11¼	11⅛	...	11⅛	11¼
	2	11	...	10¼	11	...	10⅛	...	...	10¼
New Zealand Frozen ...	1	...	10½	9¼	...	10½	9⅝	...	10½	9¾
	2	...	9¼	9	...	10	9¼	...	10	9¼
Australian Frozen ...	1	...	...	7½	...	...	7¾	...	...	7¾
	2	...	...	7¼	...	...	7⅛	...	...	7⅛

Average Wholesale Prices of Provisions at Glasgow.

(Compiled from Reports received from the Board's Market Reporter.)

Description.		Quality.	September. s. d.	October. s. d.	November. s. d.
Butter:					
Irish Creamery	per cwt.	1	177 0	178 0	179 7
,, (Unsalted) ...	,,	1	185 0	188 0	189 7
Australian	,,	1	182 0	182 6	178 10
Danish	,,	1	196 9	198 9	204 2
,, (Unsalted) ...	,,	1	201 9	203 9	209 2
New Zealand	,,	1	186 3	188 0	184 10
,, (Unsalted) ...	,,	1	190 9	194 4	193 8
Swedish	,,	1	192 6	191 3	198 7
Cheese:					
Cheddar	,,	1	108 0	119 3	117 10
		2	102 0	111 6	106 10
Cheddar Loaf	,,	1	116 0	126 6	129 7
		2	114 0	122 6	125 7
Dunlop	,,	1	104 6	113 0	111 7
		2	97 0	107 0	104 0
Canadian...	,,	1	104 6	109 6	109 2
New Zealand (Coloured)	,,	1	104 0	110 3	111 2
,, (White)	,,	1	104 0	110 3	111 2
Bacon:					
Ayrshire (Rolled) ...	,,	1	140 6	138 6	123 7
Irish (Green)	,,	1	137 0	112 6	108 5
,, (Dried or Smoked)	,,	1	143 0	118 6	114 5
,, (Long Clear) ...	,,	1	128 0	119 6	107 7
Wiltshire (Green) ...	,,	1	136 0	122 6	112 0
,, (Dried or Smoked)	,,	1	142 0	128 6	118 0
American, Long Clear Middles (Green)	,,	1	101 0	105 6	97 0
,, Short Clear Backs...	,,	1	95 6	96 6	93 0
Canadian Sides	,,	1	107 0	99 0	86 5
Danish Sides	,,	1	112 9	98 9	86 2
Dutch, Wiltshire Style (Green)	,,	1	105 0	91 3	82 2

Description.		Quality.	September. s. d.	October. s. d.	November. s. d.
Hams:					
Irish (Smoked)	per cwt.	1	207 0	199 6	165 0
		2	189 6	180 6	150 5
American, Long Cut (Green)	,,	1	112 0	113 6	106 0
American, Short Cut ...	,,	1	113 6	99 0	97 2
Eggs:					
Country	per doz.	1	2 3	2 8	3 1
		2	2 2	2 6	2 11
Irish	per 120.	1	19 5	22 9	27 7
		2	17 11	21 0	26 8
,, (Cold Stored) ...	,,	1	14 0	16 4	16 6
		2	13 6	...	...
,, (Duck)	,,	1	...	16 11	19 4
Australian	,,	1	...	21 3	21 8
		2	...	18 9	18 5
Belgian	,,	1	17 5	18 11	23 4
		2	...	...	21 6
Danish	,,	1	19 4	20 6	26 6
		2	17 9	19 1	25 5
Dutch	,,	1	17 2	18 7	20 10
		2	...	17 6	...
Polish	,,	1	11 4	11 10	13 2
		2	10 3	10 6	10 6
Russian	,,	1	12 8	13 4	14 8
		2	10 5	11 1	11 2
Swedish	,,	1	19 2	20 2	26 6
		2	17 7	18 10	24 8

Average Wholesale Prices of First Quality Fruit and Vegetables at Glasgow.

(Compiled from Reports received from the Board's Market Reporter.)

Description.		September.	October.	November.
Fruit:—				
Apples—		s. d.	s. d.	s. d.
British:				
Bramley Seedling	... per cwt.	...	23 6	24 0
Lord Derby ...	... ,,	22 0	21 0	22 0
Other cooking...	... ,,	18 0	18 8	19 0
Imported:				
American ...	... per case.*	13 0	17 0	†31 7
Canadian ...	... ,,*	...	17 0	18 0
Pears, *British* ...	... ,,§	...	10 0	...
,, *Calfornian*	... ,,*	28 0	26 9	23 7
Blackberries ...	... per lb.	...	0 6	0 6
Damsons	... ,,	0 5	...	...
Plums, Victoria ...	... ,,	0 8	0 6	...
Grapes, Gros Colmar ...	,,	...	1 1	1 6
,, Muscat ...	... ,,	...	2 2	4 6
Vegetables:—				
Beans, Dwarf ...	... ,,	0 3½	...	...
,, Scarlet Runner ...	,,	0 3½	...	...
Beet	... per cwt.	7 0	7 6	6 7
Brussels Sprouts...	... ,,	35 2	24 0	20 5
Cabbage, Coleworts	... per doz.	1 6	...	...
,, Savoy ...	... ,,	2 6	3 0	3 0
Carrots, *British* ...	... per cwt.	8 0	8 0	7 3
,, *Dutch* ...	... ,,	6 0	...	...
Cauliflowers ...	... per doz.	4 2	4 9	4 4
Celery	... per bunch.	2 3	3 0	2 11
Cucumbers ...	... per doz.	7 0	...	...
Leeks	per doz bunches.	3 0	3 0	3 1
Lettuces, Cos. ...	... per doz.	1 4	...	...
,, Cabbage	... ,,	1 3	1 6	1 10
Onions, *Dutch* ...	... per bag.**	7 0	...	...
,, *Valencia*	... per case.†	13 8	14 8	13 11
Parsley	... per cwt.	15 0	16 0	16 0
Parsnips	.. ,,	9 0	10 6	8 0
Peas	... ,,	14 0	...	...
Radishes ...	... per doz. bunches.	2 0	...	...
Rhubarb	... per cwt.	6 0	...	...
Spinach	... ,,	32 0	...	...
Tomatoes, *British*	... per lb.	0 9	0 8½	0 8
,, *Channel Islands*	,,	0 5	0 4¾	0 5
,, *Canary* ...	... ,,	...	0 5	0 5¾
Turnips	... per cwt.	3 8	3 6	3 0
Vegetable Marrow	... per doz.	4 2	5 0	...

* 40 lbs. (approx.). § 24 lbs. (approx). ** 7½ stones (approx.).
† 9 stones (approx.).

Average Prices of Potatoes at Dundee, Edinburgh, and Glasgow.

(Compiled from Reports received from the Board's Market Reporters.)

Market.	Quality.	First Earlies.	Second Earlies.	Late Varieties. Red Soils. Langworthy and Golden Wonder.	Late Varieties. Red Soils. Other.	Late Varieties. Other Soils. Langworthy and Golden Wonder.	Late Varieties. Other Soils. Other.
		£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.
		SEPTEMBER.					
Dundee per ton.	1	...	4 5 0	...	...	...	...
Edinburgh ,,	1	...	4 10 0	...	...	...	...
Glasgow ,,	1	...	4 2 0	...	5 9 0	...	...
		OCTOBER.					
Dundee ,,	1	...	5 3 0	...	...	...	5 10 0
Edinburgh ,,	1	...	5 16 0	...	...	...	...
Glasgow ,,	1	...	6 0 0	...	6 0 0	10 7 0	6 13 0
		NOVEMBER.					
Dundee ,,	1	...	...	...	...	...	5 6 0
Edinburgh ,,	1	...	5 10 0	...	...	...	5 10 0
Glasgow ,,	1	...	...	...	...	10 0 0	6 13 0

Average Prices of Roots, Hay, Straw, and Moss Litter at Dundee, Edinburgh, and Glasgow.

(Compiled from Reports received from the Board's Market Reporters.)

Market.	Quality.	Roots. Carrots.	Roots. Yellow Turnips.	Roots. Swedes.	Hay. Rye Grass and Clover.	Hay. Timothy.	Straw. Wheat.	Straw. Barley.	Straw. Oat.	Moss Litter.
		s. d.	s. d.	s. d.	s. d.	s. d.	s. d.	s. d.	s. d.	s. d.
		SEPTEMBER.								
† Dundee ... per ton.	1	...	20 0	...	105 0 (a) 82 6 (b)	...	70 0	...	62 6	51 11¶
‡ Edinburgh ,,	1	...	...	...	100 0 (a) 85 0 (b)	...	50 0	...	48 2	...
‖ Glasgow ,,	1	...	...	...	75 0	80 0	44 1	...	44 1	32 6§
		OCTOBER.								
† Dundee ... ,,	1	...	20 3	...	102 6 (a) 87 6 (b)	...	67 6	...	61 3	52 0¶
‡ Edinburgh ,,	1	...	...	...	93 9 (b)	...	55 0	...	51 3	...
‖ Glasgow ,,	1	...	...	...	75 0	80 0	45 0	...	45 0	32 6§
		NOVEMBER.								
† Dundee ... ,,	1	...	20 2	25 0	104 0 (a) 90 0 (b)	...	61 8 50 0*	...	60 0 55 0*	52 2¶
‡ Edinburgh ,,	1	...	...	...	105 0 (a) 100 0 (b)	...	55 0	...	55 0	...
‖ Glasgow ,,	1	...	...	...	75 0	80 0	45 0	...	45 0	32 6§

† Quotations for Straw, baled and delivered.
‡ ,, ,, delivered loose in town.
‖ ,, for baled Hay and Straw f.o.r.
* Bunched.

(a) Baled and delivered.
(b) Delivered loose.
§ Home.
¶ Imported.

Average Prices of Feeding Stuffs at Glasgow and Leith.

(Compiled from Reports received from the Board's Market Reporters.)

Description.	September.		October.		November.	
	Glasgow.	Leith.	Glasgow.	Leith.	Glasgow.	Leith.
	per ton. £ s. d.	per ton. £ s. d.	per ton. £ s. d.	per ton. £ s. d.	per ton. £ s. d.	per ton. £ s. d.
Linseed Cake—						
Home	11 17 6	11 5 0	12 0 0	11 5 0	11 17 0	11 4 0
Foreign	11 10 8	10 15 0	11 15 0	10 15 0	11 17 6	10 15 6
Crushed Linseed ...	22 15 0	...	22 13 9	...	20 15 0	...
Decorticated Cotton Cake	11 5 8	11 0 0	11 5 0	...	11 9 0	...
Undecorticated Cotton Cake—						
Bombay (Home-manufactured)...	7 15 0	6 15 0	7 15 0	6 12 6	7 17 6	6 17 0
Egyptian (do.) ...	7 15 0	...	7 15 0	7 0 0	7 15 0	...
Soya Bean Cake ...	...	...	...	11 10 0	...	11 10 0
Groundnut Cake, Undecorticated—37 per cent. Oil and Albuminoids	9 8 2	...	9 10 0	...	9 12 6	...
40 per cent. do.	9 12 6	9 2 6	9 12 6	9 0 0	9 14 5	9 3 6
Maize Germ Cake Meal	...	...	10 15 0	9 5 0	10 0 0	...
Barley Meal ...	12 5 0	..	12 11 3	...	12 13 4	...
Bean Meal	13 1 3	12 5 0	13 1 11	12 5 0	13 2 0	12 5 0
Beans—English ...	12 11 3	..	12 0 0	...	12 6 8	...
China	11 9 5	...	11 16 3	...	11 12 0	...
Rangoon (White)	9 14 2	...	9 13 2	...	9 18 0	...
American (White)	9 12 6	...	8 15 0	...	...	...
Pease—China (White)	12 5 0	...	12 5 0	...	12 10 0	...
Maize Meal—						
Home Manufactured	10 3 2	9 5 0	10 4 5	9 5 0	10 2 6	9 9 0
South African (Yellow)	9 5 0	8 15 0	9 1 3	..	9 0 0	8 15 0
Do. White ...	9 15 8	9 15 0	9 13 2	8 15 0	9 18 2	...
Rice Meal	8 5 0	...	8 5 8	...	8 8 4	8 10 0
Locust Bean Meal ..	9 5 0	8 9 5	9 5 0	8 7 6	9 12 0	8 7 6
Maize Gluten Feed (Paisley) ...	9 0 0	...	9 0 0	...	9 1 8	...
Maize—						
Plate	8 14 5	8 10 0	8 16 11	8 7 6	8 13 6	8 9 6
African (Flat) ...	9 5 10	...	9 5 0	...	9 5 0	...
Oats—						
Home	10 4 5	11 0 0	10 2 6	9 0 0	10 9 0	9 4 0
Plate	10 1 11	...	10 10 0	...	10 13 9	...
Barley—						
Feeding	11 6 3	...	11 1 11	12 0 0	10 19 0	11 14 0
Bran	10 17 6	...	10 14 2	...	10 15 10	...
Malt Culms... ...	7 5 0	6 10 0	7 6 3	6 15 0	7 11 6	6 15 0
Distillery Mixed Grains Dried	...	8 11 3	9 5 0	8 15 0	9 10 0	8 17 0
Brewers' Grains—Dried	8 6 3	7 6 3	8 6 3	7 7 6	8 16 0	7 7 6
Distillery Malt Grains—Dried ...	8 3 2	...	8 7 6	...	8 13 4	...
Wheat—						
Middlings (Fine Thirds or Parings)	11 13 2	10 6 3	11 10 8	10 15 0	10 16 0	10 5 0
Sharps (Common Thirds) ...	8 14 5	8 11 3	8 15 0	8 15 0	9 2 0	8 10 0
Bran (Medium) ...	8 7 6	8 2 6	8 16 3	8 2 6	9 4 6	8 8 0
,, (Broad) ...	8 10 8	8 17 6	8 18 9	8 17 6	9 7 0	9 3 0
Feeding (Scotch)	13 7 6	13 0 0	12 17 6	11 10 0	11 15 0	11 6 0
Feeding Treacle ..	7 7 6	7 0 0	7 7 6	7 0 0	7 7 6	7 0 0
Fish Meal	...	20 0 0	...	20 0 0	22 10 0	20 0 0

AVERAGE PRICES OF FERTILISERS AT GLASGOW AND LEITH.

(Compiled from Reports received from the Board's Market Reporters.)

Description.	Guaranteed Analysis.	September. Glasgow.	September. Leith.	October. Glasgow.	October. Leith.	November. Glasgow.	November. Leith.
	%	per ton. £ s. d.	per ton. £ s. d.	per ton. £ s. d.	per ton. £ s. d.	per ton. £ s. d.	per ton. £ s. d.
Nitrate of Soda ...	N. 15½	...	11 0 0	...	11 0 0	...	11 6 0
Calcium Cyanamide	N. 19	...	...	...	...	...	8 12 0
Sulphate of Ammonia (Neutral and Granular) ...	N. 20·6	10 0 0	10 0 0	10 2 0	10 2 0	10 4 5	10 5 0
Bone Meal—Indian	N. 3¾ I.P. 45	...	...	...	...	...	8 15 0
Steamed Bone Flour	N. 1 I.P. 60	...	...	...	...	...	6 5 0
Superphosphate ...	S.P. 30	...	2 10 0	2 7 6	2 10 0	2 7 6	2 10 0
,,	S.P. 35	...	2 15 0	2 12 6	2 15 0	2 12 6	2 15 0
,,	S.P. 38	...	3 0 0	...	3 0 0	...	3 0 0
Ground Mineral Phosphate ...	I.P. 56	...	†2 2 6	...	...	...	...
,, ,, ...	I.P. 74	...	†3 5 0	...	†3 5 0	...	†3 5 0
,, ,, ...	I.P. 58/60	...	†2 5 0	†2 3 6	†2 5 0	†2 3 6	†2 5 0
,, (with Potash)	I.P. 40 Pot. 5·4	...	...	3 10 0	...	3 10 0	...
Basic Slag	T.P. 24	...	...	...	...	...	2 2 6
,, ,, ...	,, 26	..	...	*2 8 0	...	*2 8 0	**2 5 0
,, ,, ...	,, 28	...	...	*2 11 6	...	*2 11 6	**2 8 0
,, ,, ...	,, 30	...	...	*2 16 6	...	*2 16 6	**2 13 0
,, ,, ...	,, 40	...	...	...	‡3 5 0	...	‡3 3 6
Sulphate of Potash (on basis of 90 per cent. purity)	Pot. 48·6	10 2 6	10 2 6	10 7 6	10 7 6	10 11 6	10 10 6
Muriate of Potash... (on basis of 80 per cent. purity)	Pot. 50	8 5 0	8 5 0	8 8 6	8 8 6	8 11 8	8 10 11
Potash Salts ...	Pot. 20	...	3 3 6	3 5 6	3 5 6	3 7 1	3 6 8
,, ,, ...	Pot. 30	4 11 0	4 9 6	4 11 0	4 11 0	4 13 0	4 12 6
Kainit (in bags) ...	Pot. 14	2 18 6	2 16 0	2 17 6	2 17 6	2 18 8	2 18 5
,, (in bulk) ...	Pot. 14	...	...	2 9 0	...	2 10 2	...

Abbreviations:—N. = nitrogen; S.P. = soluble phosphate; I.P. = insoluble phosphate; T.P. = total phosphate.

* Carriage paid (4-ton lots) to Ayrshire and Renfrewshire; quotations for delivery in Lanarkshire and Stirlingshire 2s. per ton higher.

** Carriage paid (4-ton lots) to stations in the Lothians and Berwickshire.

† Fine grist 80 per cent. through standard 100 mesh sieve. ‡ Foreign slag at Leith.

Statement showing the Acreage under each Variety of Potatoes in Scotland in 1927.

Variety.	Acres.	Variety.	Acres.
A. First Earlies.		*C.* Maincrops.	
1. Arran Rose *	55	25. Sutton's Abundance (including Admiral, Balmuir, Bloomfield, Culdees Castle, Kerr's New White, Laing's Prolific, Lomond, Twentieth Century, Osborne Seedling, Just in Time, &c.)*	1,111
2. Dargill Early *	60	26. Arran Consul *	693
3. Di Vernon *	26	27. Arran Victory *	567
4. Immune Ashleaf * ...	79	28. Bishop *	108
5. Snowdrop (including Witch Hill) *	112	29. Champion *	978
6. Beauty of Hebron (including Puritan) ...	133	30. Crusader *	240
7. Duke of York (including Midlothian Early and Victory)	1,703	31. Early Market *	64
8. Eclipse (including Sir John Llewelyn) ...	3,285	32. Golden Wonder (including Peacemaker) * ...	8,342
9. Epicure	8,605	33. Irish Queen *	307
10. May Queen	199	34. Kerr's Pink *	35,359
11. Ninetyfold	216	35. Langworthy (including Maincrop and What's Wanted) *	526
12. Sharpe's Express ...	1,412	36. Lochar *	93
13. Sharpe's Victor	43	37. Majestic *	8,938
14. Other First Earlies not specified above ...	56	38. Rhoderick Dhu * ...	567
Total First Earlies ...	15,984	39. Tinwald Perfection * ...	574
		40. White City (including Carnegie) *	28
		41. Arran Chief	9,718
		42. Evergood	134
B. Second Earlies.		43. Field-Marshal	1,426
		44. General	93
15. Ally *	1,540	45. King Edward VII. (including Red King) ...	20,130
16. Arran Comrade * ...	526	46. Northern Star (including Ajax, Allies and Aeroplanes)	134
17. Catriona *	118	47. President (including Iron Duke and Scottish Farmer)	203
18. Edzell Blue *	328	48. Up-to-Date (including Dalhousie, Factor, Glamis Beauty, Scottish Triumph, Stephen, Table Talk, Laing's Imperial, &c.)	1,653
19. Great Scot *	12,732	49. Other Maincrops not specified above ...	617
20. Katie Glover *	62		
21. King George V. * ...	581		
22. British Queen (including Pioneer, Macpherson, Maid of Auchterarder, Scottish Standard, English Beauty, &c.) ...	4,939		
23. Royal Kidney (including Queen Mary)	462		
24. Other Second Earlies not specified above ...	89		
Total Second Earlies	21,377	Total Maincrops ...	92,603
Total Area Classified, ...			129,964
Acreage Not Included, ...			17,220
Total Acreage Grown, ...			147,184

Notes.—(1) The following districts are excluded:—In the county of Inverness, Skye, Harris, North and South Uist; in the county of Ross and Cromarty, Western, South-Western, Lewis.
(2) Returns showing a total area of less than one acre under potatoes are not tabulated.
(3) Varieties marked thus * are immune from Wart Disease.

ABSTRACT OF AGRICULTURAL RETURNS FOR SCOTLAND, 1927.

Collected 4th June 1927 (and comparison with 1926).

CROPS.

Distribution.	1927.	1926.	Increase.		Decrease.	
	Acres	*Acres.*	*Acres.*	*Per Cent.*	*Acres.*	*Per Cent.*
Total Area (excluding Water)	**19,069,683**	19,069,683	..	..	..	..
Mountain and Heath Land used for Grazing (*b*)	**9,896,854**	9,710,181	186,673	1·9	..	..
Total Acreage under Crops and Grass..	**4,681,221**	4,693,170	..	..	11,949	0·3
Arable Land	**3,168,624**	3,194,535	..	..	25,911	0·8
Permanent Grass — For Hay	**167,212**	166.257	955	0·6	..	..
Permanent Grass — Not for Hay	**1,345,385**	1,332,378	13,007	1·0	..	..
Permanent Grass — Total ..	**1,512,597**	1,498,635	13,962	0·9	..	
Wheat	**66,577**	53,777	12,800	23·8	..	..
Barley (including Bere)	**117,369**	122,297	..	..	4,928	4·0
Oats	**897,370**	940,073	..	..	42,703	4·5
Mixed Grain	**1,240**	1,072	168	15·7	..	..
Rye..	**3,868**	4,911	..	..	1,043	21·2
Beans (to be harvested as Corn)	**3,574**	3,290	284	8·6	..	..
Peas	**422**	430	..	..	8	1·9
Potatoes	**147,184**	141,871	5,313	3·7	..	..
Turnips and Swedes	**376,693**	390,778	..	..	14,085	3·6
Mangolds	**1,124**	1,108	16	1·4	..	..
Sugar Beet	**10,352**	3,649	6,703	183·7	..	..
Cabbage	**4,197**	3,960	237	6·0	..	..
Rape	**12,916**	12,499	417	3·3	..	..
Vetches or Tares, for Seed	**220**	185	35	18·9	..	..
Vetches, Tares, Beans, Peas, Mashlum, etc., for Fodder	**11,589**	12,317	..	..	728	5·9
Carrots	**326**	314	12	3·8	..	..
Onions	**137**	141	..	..	4	2·8
Flax	**206**	465	..	..	259	55·7
Small Fruit	**8,064**	7,811	253	3·2	..	..
Rye-grass and other Rotation Grasses and Clover — For Hay	**399,672**	413,680	..	..	14,008	3·4
Rye-grass and other Rotation Grasses and Clover — Not for Hay ..	**1,096,691**	1,071,299	25,392	2·4	..	..
Rye-grass and other Rotation Grasses and Clover — Total	**1,496,363**	1,484,979	11,384	0·8	..	..
Other Crops	**2,688**	2,488	200	8·1	..	..
Bare Fallow	**6,150**	6,125	25	0·4	..	..
Orchards (*a*)	**1,288**	1,264	24	1·9	..	..

LIVE STOCK.

	1927.	1926.	Increase.		Decrease.	
	No.	*No.*	*No.*	*Per Cent.*	*No.*	*Per Cent.*
Horses used for Agricultural purposes (including Mares for Breeding)	**129,526**	132,050	..	..	2,524	1·9
Unbroken Horses (including Stallions). — One year and above ..	**17,244**	18,987	..	..	1,743	9·2
Unbroken Horses (including Stallions). — Under one year ..	**5,671**	6,590	..	..	919	13·9
Total	**152,441**	157,627	..	..	5,186	3·3
Other Horses	**19,661**	21,068	..	..	1,407	6·7
Total of Horses	**172,102**	178,695	..	..	6,593	3·7
Cows in Milk	**355,460**	357,315	..	..	1,855	0·5
Cows in Calf, but not in Milk..	**49,273**	42,868	6,405	14·9	..	..
Heifers in Calf	**55,584**	57,263	..	..	1,679	2·9
Bulls being used for Service	**17,578**	17,203	375	2·2	..	..
Other Cattle :—Two years and above ..	**208,416**	217,214	..	..	8,798	4·1
,, ,, One year and under two ..	**276,817**	265,635	11,182	4·2	..	..
,, ,, Under one year	**247,322**	240,330	6,992	2·9	..	..
Total of Cattle	**1,210,450**	1,197,828	12,622	1·1	..	..
Ewes kept for Breeding	**3,239,143**	3,115,271	123,872	4·0	..	..
Rams to be used for Service in 1927	**90,701**	86,292	4,409	5·1	..	..
Other Sheep :—One year and above	**995,005**	947,645	47,360	5·0	..	..
,, ,, Under one year	**3,210,628**	3,053,926	156,702	5·1	..	..
Total of Sheep	**7,535,477**	7,203,134	332,343	4·6	..	..
Sows kept for Breeding	**26,662**	18,275	8,387	45·9	..	..
Boars being used for Service	**2,711**	2,012	699	34·7	..	..
Other Pigs	**167,240**	125,132	42,108	33·7	..	..
Total of Pigs	**196,613**	145,419	51,194	35·2	..	..

(*a*) Any Crop or Grass grown in Orchards is also returned under its proper heading.
(*b*) Includes land on Deer Forests used for grazings.

ACREAGE under WHEAT, BARLEY (including BERE) and OATS in each COUNTY on 4th June 1927, with COMPARISON for 1926.

COUNTIES.	Wheat.		Barley (including Bere).		Oats.	
	1927.	1926.	1927.	1926.	1927.	1926.
	Acres.	*Acres.*	*Acres.*	*Acres.*	*Acres.*	*Acres.*
ABERDEEN ...	42	60	14,138	14,494	181,179	185,425
ARGYLL	...	...	815	1,049	15,258	15,562
AYR	1,438	854	109	144	35,585	39,480
BANFF	...	...	6,806	6,338	45,577	47,424
BERWICK	2,691	1,464	12,496	13,029	26,245	28,169
BUTE	2	...	12	9	4,456	4,712
CAITHNESS ...	...	...	568	544	28,346	28,993
CLACKMANNAN ...	286	316	103	93	2,768	2,882
DUMBARTON ...	487	388	7	4	6,409	6,689
DUMFRIES ...	45	32	63	64	35,370	36,841
EAST LOTHIAN ...	7,201	4,846	12,400	13,269	14,217	16,293
FIFE	13,651	12,223	10,736	11,016	40,423	44,861
FORFAR	12,879	10,086	12,164	13,890	55,614	57,862
INVERNESS ...	39	33	4,000	4,121	28,630	29,327
KINCARDINE ...	1,213	1,046	6,987	6,979	30,388	31,516
KINROSS	310	240	101	65	6,539	6,707
KIRKCUDBRIGHT...	50	37	28	10	20,312	21,643
LANARK	2,072	1,896	86	75	35,232	37,195
MIDLOTHIAN ...	6,088	5,372	3,155	3,752	19,102	21,105
MORAY	794	430	8,482	7,905	24,164	25,356
NAIRN	...	...	1,993	2,008	6,444	6,502
ORKNEY	...	...	3,475	3,454	31,812	32,519
PEEBLES	...	...	26	47	5,685	5,899
PERTH	8,533	7,377	2,217	2,793	64,581	67,779
RENFREW ...	1,732	1,562	1	2	8,852	9,755
ROSS & CROMARTY	1,065	692	6,516	6,506	31,927	31,759
ROXBURGH ...	1,259	443	7,189	7,634	22,865	24,286
SELKIRK	...	...	144	156	3,499	3,781
SHETLAND ...	...	...	606	603	6,063	6,174
STIRLING	1,841	1,827	452	568	16,876	17,985
SUTHERLAND ...	...	...	226	248	7,111	7,294
WEST LOTHIAN ...	2,819	2,494	1,172	1,291	9,749	10,636
WIGTOWN	40	59	96	137	26,092	27,662
TOTAL ...	66,577	53,777	117,369	122,297	897,370	940,073

ACREAGE under POTATOES, TURNIPS and SWEDES and SUGAR BEET in each COUNTY on 4th June 1927, with COMPARISON for 1926.

COUNTIES.	Potatoes.		Turnips and Swedes.		Sugar Beet.	
	1927.	1926.	1927.	1926.	1927.	1926.
	Acres.	*Acres.*	*Acres.*	*Acres.*	*Acres*	*Acres.*
ABERDEEN ...	7,847	7,403	79,057	79,870	366	149
ARGYLL	2,726	2,904	4,814	4,946	180	75
AYR	8,578	8,636	6,953	7,204	760	668
BANFF	1,839	1,725	19,160	19,395	77	23
BERWICK	2,532	2,430	18,579	20,061	504	109
BUTE	984	1,061	1,204	1,236	...	7
CAITHNESS ...	1,142	1,180	10,470	10,900	1	1
CLACKMANNAN ...	396	353	725	752	37	17
DUMBARTON ...	2,323	2,196	1,307	1,411	2	11
DUMFRIES ...	3,230	3,200	14,360	14,861	7	6
EAST LOTHIAN ...	8,013	7,931	11,643	12,535	1,130	163
FIFE	16,922	16,831	18,919	20,633	3,819	1,178
FORFAR	19,880	18,554	28,281	29,372	777	227
INVERNESS ...	5,121	5,236	8,844	8,940	...	...
KINCARDINE ...	4,656	4,356	14,508	15,010	258	95
KINROSS	1,248	1,196	2,176	2,229	68	32
KIRKCUDBRIGHT	1,341	1,297	9,053	9,288	15	4
LANARK	6,008	5,290	9,061	9,490	20	12
MIDLOTHIAN ...	6,748	6,313	8,598	9,523	383	112
MORAY	1,564	1,524	13,037	13,336	267	112
NAIRN	275	284	3,730	3,761	27	3
ORKNEY	2,230	2,263	13,030	13,152	...	...
PEEBLES	318	306	2,726	2,797	...	...
PERTH	18,889	17,424	22,235	23,594	674	237
RENFREW	3,313	3,068	1,898	2,029	5	4
ROSS & CROMARTY	6,975	7,318	13,439	13,521	167	68
ROXBURGH ...	1,150	1,142	15,619	16,346	253	97
SELKIRK	162	147	1,934	2,079	3	1
SHETLAND ...	1,996	2,033	1,006	1,006	...	...
STIRLING	3,378	3,108	3,473	3,751	107	55
SUTHERLAND ...	1,058	1,088	2,582	2,588	...	...
WEST LOTHIAN ...	2,778	2,522	2,880	3,064	147	27
WIGTOWN	1,564	1,552	11,392	12,098	298	156
TOTAL	147,184	141,871	376,693	390,778	10,352	3,649

ACREAGE under RYE-GRASS and other ROTATION GRASSES and CLOVER, and under PERMANENT GRASS in each COUNTY on 4th June 1927, with COMPARISON for 1926.

COUNTIES.	Rye-grass and other Rotation Grasses and Clover.				Permanent Grass.			
	For Hay.		Not for Hay.		For Hay.		Not for Hay.	
	1927.	1926.	1927.	1926.	1927.	1926.	1927.	1926.
	Acres.	*Acres.*	*Acres.*	*Acres.*	*Acres.*	*Acres.*	*Acres.*	*Acres.*
ABERDEEN ...	50,634	52,669	243,657	238,796	883	246	42,518	42,525
ARGYLL	12,183	12,589	15,082	14,608	16,328	15,109	52,948	55,953
AYR	27,114	28,489	51,192	45,045	22,745	23,320	152,244	154,378
BANFF	9,584	10,551	60,922	59,587	381	223	11,754	11,050
BERWICK ...	11,141	11,897	50,671	49,831	3,762	2,537	57,943	57,235
BUTE	2,294	2,370	5,242	5,833	497	439	10,071	9,543
CAITHNESS ...	9,838	9,971	29,051	28,585	762	955	23,811	23,563
CLACKMANNAN	1,282	1,399	1,772	1,784	1,238	1,193	6,192	5,922
DUMBARTON ...	5,112	5,304	4,703	4,970	2,800	2,654	21,789	21,740
DUMFRIES ...	19,341	20,506	50,046	48,459	19,498	20,154	99,278	98,492
EAST LOTHIAN	8,909	9,558	18,244	16,862	1,307	1,228	22,880	23,342
FIFE	25,815	26,296	29,141	27,784	4,159	4,180	72,810	72,266
FORFAR	22,167	23,041	61,233	60,743	1,694	1,244	27,296	27,237
INVERNESS ...	11,039	11,451	22,662	21,441	9,314	9,438	58,583	58,191
KINCARDINE ...	12,847	13,128	34,989	34,172	428	516	11,005	10,600
KINROSS ...	2,881	3,024	6,481	6,369	1,000	791	13,536	12,398
KIRCUDBRIGHT	10,171	10,902	40,074	51,266	13,272	13,441	86,556	73,203
LANARK ...	30,410	31,057	35,327	33,637	14,264	14,882	104,172	103,921
MIDLOTHIAN ...	11,358	10,963	18,136	16,318	2,108	1,808	39,737	40,861
MORAY	5,753	6,093	34,632	34,329	131	212	7,866	7,564
NAIRN	1,762	1,623	8,932	9,416	32	9	1,781	1,583
ORKNEY ...	10,924	11,432	30,932	29,252	601	580	14,376	14,520
PEEBLES ..	2,360	2,329	11,017	9,882	1,175	1,233	26,870	27,498
PERTH	32,160	32,912	60,139	58,902	11,811	12,544	94,448	92,408
RENFREW ...	8,658	8,438	5,959	5,256	6,519	6,889	44,348	45,086
ROSS AND CROMARTY ...	12,396	12,864	34,176	33,431	3,401	3,334	26.536	27,392
ROXBURGH ...	9,758	10,706	48,912	47,910	6,415	6,659	60,042	58,373
SELKIRK ...	1,298	1,331	7,148	7,144	1,854	1,811	13,456	12,687
SHETLAND ...	1,451	1,395	518	480	1,910	2,015	11,337	11,018
STIRLING ...	10,395	10,807	10,520	8,631	8 551	8,281	52,764	53,364
SUTHERLAND ...	4,598	4,498	5,784	5,677	1,425	1,550	8,124	8,000
WEST LOTHIAN	6,653	6,814	5,520	4,768	1,238	1,131	21,669	21,935
WIGTOWN ...	7,386	7,273	53,877	50,131	5,709	5,651	46,645	48,530
TOTAL ...	399,672	413,680	1,096,691	1,071,299	167,212	166,257	1,345,385	1,332,378

NUMBER of HORSES, CATTLE, SHEEP and PIGS in each COUNTY on 4th June 1927, with COMPARISON for 1926.

COUNTIES.	Horses.*		Cattle.		Sheep.		Pigs.	
	1927.	1926.	1927.†	1926.	1927.†	1926.	1927.	1926.
	No.	*No.*	*No.*	*No.*	*No.*	*No.*	*No.*	*No.*
†ABERDEEN ...	23,825	24,248	175,019	177,818	305,207	264,434	27,195	17,161
†ARGYLL ...	4,556	4,800	55,493	55,014	747,885	722,761	4,200	3,808
AYR	7,357	7,664	108,702	106,481	400,111	368,959	13,326	10,170
†BANFF	6,873	7,059	43,961	44,764	89,581	82,359	7,339	4,846
BERWICK ...	3,967	4,177	25,082	23,277	381,092	370,961	4,526	3,453
BUTE	1,027	1,063	8,802	8,522	44,560	39,527	742	567
†CAITHNESS ...	4,449	4,546	19,971	20,141	174,001	161,516	2,282	1,696
CLACKMANNAN	532	574	3,644	3,708	13,443	12,990	955	888
†DUMBARTON ...	1,398	1,426	13,397	13,281	71,982	72,428	1,221	862
DUMFRIES ...	5,702	5,946	68,908	68,209	593,251	575,877	11,511	9,319
EAST LOTHIAN	3,165	3,164	14,188	11,917	153,355	141,888	5,178	3,508
FIFE	7,736	8,158	44,796	42,261	133,383	123,087	8,197	6,380
†FORFAR... ...	7,992	8,246	48,341	47,329	196,493	188,231	7,938	5,961
†INVERNESS ...	7,044	7,333	47,833	46,992	507,196	500,905	2,507	1,966
†KINCARDINE ...	4,091	4,193	26,528	26,592	66,767	61,945	4,227	2,862
KINROSS ...	955	995	6,397	6,188	34,237	33,443	968	713
†KIRKCUDBRIGHT	4,093	4,229	58,288	57,852	404,532	393,004	13,421	11,858
LANARK ...	6,522	6,685	70,024	69,906	243,087	235,224	8,158	6,260
MIDLOTHIAN ...	3,099	3,265	17,094	16,405	188,137	184,183	15,482	12,619
MORAY	4,000	4,077	23,902	24,142	53,879	49,857	5,300	3,843
NAIRN	1,124	1,151	6,581	6,604	14,829	14,728	1,015	687
ORKNEY ...	5,493	5,584	32,781	31,649	46,038	40,789	3,427	2,126
PEEBLES ...	792	854	6,895	7,010	209,548	212,260	835	524
†PERTH	10,441	10,751	69,796	68,843	662,589	625,171	10,692	7,511
RENFREW ...	2,221	2,277	24,268	24,645	46,967	41,249	3,984	2,744
†ROSS AND CROMARTY ...	5,781	6,001	38,153	40,498	321,189	294,463	4,462	3,001
ROXBURGH ...	3,408	3,523	24,374	22,814	575,557	567,655	4,068	2,887
SELKIRK ...	502	536	3,839	3,857	195,257	193,969	595	380
SHETLAND ...	2,401	2,425	11,530	11,550	154,287	152,508	259	196
STIRLING ...	3,522	3,758	32,993	31,709	128,943	123,648	3,806	2,052
†SUTHERLAND ...	1,921	1,938	9,870	9,774	217,515	202,501	649	482
WEST LOTHIAN	1,785	1,961	11,421	10,891	22,951	21,211	1,900	1,252
WIGTOWN ...	4,667	5,020	57,579	57,190	137,628	129,403	16,248	13,337
TOTAL ...	152,441	157,627	1,210,450	1,197,828	7,535,477	7,203,134	196,613	145,419

* Horses used for agricultural purposes, mares for breeding, and unbroken horses (including Stallions). "Other Horses" on agricultural holdings are not included; the total for these in Scotland is given in the summary table on p. 117.

† Including cattle and sheep grazed on Deer Forests.

Acreage of Crops and Number of Live Stock in each County District of Scotland on 4th June 1927.

County	District of County	Wheat.	Barley (including Bere).	Oats.	Potatoes.	Turnips and Swedes.	Sugar Beet.	Rye-grass and other Rotation Grasses & Clover. For Hay.	Rye-grass and other Rotation Grasses & Clover. Not for Hay.	Permanent Grass. For Hay.	Permanent Grass. Not for Hay.	* Horses	† Cattle.	† Sheep.	Pigs.
		Acres.	Acres.	Acres.	Acres.	Acres.	Acres.	Acres.	Acres.	Acres.	Acres.	No.	No.	No.	No.
ABERDEEN	Aberdeen	6	4,041	17,778	1,891	9,322	42	7,164	26,091	125	3,875	2,792	20,050	16,016	5,828
	Alford	..	443	16,299	329	7,564	..	4,941	22,501	46	5,580	2,146	16,740	46,671	1,336
	Deer	..	1,755	41,186	2,123	16,141	154	12,209	49,260	198	8,944	5,278	39,028	46,569	5,541
	Deeside	3	1,244	14,311	561	6,904	6	5,606	19,055	66	5,399	2,090	15,211	59,256	1,898
	Ellon	33	1,820	26,421	966	11,826	49	7,549	37,455	76	5,069	3,019	25,620	47,283	3,796
	Garioch	..	2,124	22,983	692	10,417	39	6,252	31,405	83	5,019	3,182	22,732	21,964	2,899
	Huntly	..	682	14,865	375	6,106	34	2,418	22,660	293	5,464	2,020	12,085	41,163	1,919
	Turriff	..	2,029	26,836	910	10,777	42	4,495	35,230	1	3,168	3,303	23,553	26,885	3,978
ARGYLL	Ardnamurchan	..	..	388	206	40	..	448	161	1,126	1,529	137	3,184	63,859	27
	Cowal	..	..	1,196	232	402	..	1,068	722	1,405	6,571	306	4,158	140,066	279
	Islay	..	9	3,733	506	1,174	35	2,833	2,504	2,573	16,404	927	9,999	69,586	643
	Kintyre	..	218	4,593	370	1,977	126	1,807	9,199	1,454	11,393	1,148	13,355	127,480	2,330
	Lorn	..	..	1,923	565	530	14	2,648	804	3,996	5,918	700	9,072	173,825	283
	Mid-Argyll	..	..	1,547	324	471	3	1,738	1,206	3,034	6,872	500	7,411	103,103	343
	Mull	..	588	1,878	523	220	2	1,641	486	2,740	4,261	838	8,314	70,016	295
AYR	Ayr	219	19	9,336	1,695	1,757	395	7,380	13,840	6,789	41,214	1,836	29,256	114,295	3,852
	Carrick	94	79	8,558	3,560	2,721	70	5,141	13,044	4,100	34,703	1,867	23,244	200,534	3,949
	Kilmarnock	586	11	8,946	1,108	1,192	169	7,758	14,094	6,055	39,361	1,866	30,685	37,534	4,064
	Northern	539	..	8,745	2,215	1,283	126	6,835	10,214	5,801	36,966	1,788	25,517	47,748	1,441
BANFF	Banff	..	6,058	25,518	1,328	11,674	73	5,446	35,194	113	2,672	4,077	27,471	27,525	5,073
	Keith	..	748	20,059	511	7,486	4	4,138	25,728	268	9,082	2,796	16,490	62,056	2,266
BERWICK	Eastern	956	4,825	8,053	1,191	6,145	213	3,803	14,205	1,521	18,108	1,343	8,521	101,227	1,610
	Middle	1,467	6,208	8,876	907	6,862	247	4,759	14,435	1,405	21,802	1,549	9,767	134,894	2,014
	Western	268	1,463	9,316	434	5,572	44	2,579	22,081	836	18,033	1,075	6,794	145,471	902
BUTE	Arran	..	6	2,154	599	431	..	1,230	2,094	235	4,673	527	4,106	33,129	347
	Bute and Cumbrae	2	6	2,302	385	773	..	1,064	3,148	262	5,398	500	4,696	11,431	395
CAITHNESS (not divided)		..	568	28,346	1,142	10,470	1	9,838	29,051	762	28,811	4,449	19,971	174,001	2,282
CLACKMANNAN (not divided)		286	103	2,768	396	725	37	1,282	1,772	1,238	6,192	532	3,644	13,443	955
DUMBARTON	Eastern	405	7	3,182	1,147	607	..	2,715	2,219	1,412	9,399	722	6,084	13,574	728
	Western	82	..	3,227	1,176	700	2	2,397	2,484	1,388	12,390	676	7,363	58,408	493
DUMFRIES	Annan	..	1	11,742	1,010	4,672	2	5,882	14,264	2,872	16,725	1,673	16,425	57,053	2,729
	Dumfries	40	32	8,483	1,067	3,229	..	4,143	12,799	2,355	14,822	1,201	14,022	57,763	2,835
	Langholm	..	3	2,135	154	982	..	1,325	2,629	3,057	8,378	413	5,155	125,200	558
	Lockerbie	..	19	7,809	582	3,373	..	4,369	12,786	6,116	25,784	1,420	18,151	157,024	2,083
	Thornhill	5	8	5,201	427	2,104	5	3,622	7,618	5,098	33,569	995	15,155	196,211	3,361

* See Note on p. 121.

† Including Stock grazed on Deer Forests.

ACREAGE of CROPS and NUMBER of LIVE STOCK in each COUNTY DISTRICT of SCOTLAND on 4th June 1927.

County and District of County.		Wheat.	Barley (including Bere).	Oats.	Potatoes.	Turnips and Swedes.	Sugar Beet.	Rye-grass and other Rotation Grasses & Clover. For Hay.	Rye-grass and other Rotation Grasses & Clover. Not for Hay.	Permanent Grass. For Hay.	Permanent Grass. Not for Hay.	* Horses	† Cattle.	† Sheep.	Pigs.
		Acres.	*Acres.*	*Acres.*	*Acres.*	*Acres.*	*Acres.*	*Acres.*	*Acres.*	*Acres.*	*Acres.*	*No.*	*No.*	*No.*	*No.*
EAST LOTHIAN	Eastern	2,122	5,092	4,520	3,408	4,414	290	3,078	7,325	545	8,577	1,196	5,019	74,502	1,522
	Western	5,079	7,308	9,697	4,605	7,229	840	5,831	10,919	762	14,303	1,969	9,169	78,853	3,656
FIFE	Cupar	4,285	3,456	13,430	6,177	6,585	1,311	7,388	13,696	931	15,274	2,311	12,479	50,366	2,314
	Dunfermline	1,428	589	6,885	1,863	2,375	105	4,389	2,843	1,220	23,194	1,258	9,112	28,538	1,396
	Kirkcaldy	2,921	1,778	9,279	3,611	3,852	421	6,317	5,748	1,044	14,570	1,880	10,283	22,295	2,561
	St. Andrews	5,017	4,913	10,829	5,271	6,107	1,982	7,771	6,854	964	19,772	2,237	12,922	31,884	1,926
FORFAR	Arbroath	3,376	3,749	10,253	4,416	5,909	130	4,584	10,773	256	3,213	1,680	9,326	11,430	1,287
	Brechin	3,019	4,217	17,767	4,675	8,779	240	6,909	20,089	566	7,332	2,307	14,681	74,555	2,302
	Dundee	3,381	1,569	10,055	5,117	5,465	159	4,501	10,219	290	3,921	1,598	9,504	20,437	2,008
	Forfar	3,103	2,629	17,539	5,672	8,128	248	6,173	20,152	582	12,830	2,407	14,830	90,071	2,341
INVERNESS	Inverness	6	1,519	7,148	440	4,133	..	2,596	11,123	262	4,651	1,314	7,043	42,634	1,186
	Aird	30	53	5,489	461	2,478	..	2,840	5,834	369	5,092	930	6,312	46,470	957
	Badenoch	..	17	3,836	167	1,576	..	2,128	4,546	1,113	9,491	678	4,722	96,926	263
	Lochaber	3	..	961	421	199	..	1,269	276	2,238	3,051	370	5,042	135,807	120
	Skye	..	3	5,059	1,369	352	..	1,994	759	3,602	5,427	960	10,695	125,321	23
	Harris, N. & S. Uist ..	..	2,408	6,137	2,263	106	..	212	124	1,730	30,871	2,792	14,019	60,038	8
KINCARDINE	Laurencekirk	375	1,290	9,219	1,592	3,917	141	3,277	10,028	148	2,375	1,018	6,393	23,389	1,059
	Lower Deeside	..	762	3,590	793	1,717	..	2,056	3,460	57	752	572	3,409	1,836	935
	St. Cyrus	674	1,584	5,957	1,105	2,868	25	2,304	5,807	38	2,654	763	4,118	13,395	583
	Stonehaven	164	2,147	7,954	896	3,958	74	3,636	9,643	123	3,805	1,119	8,396	19,171	1,112
	Upper Deeside	..	1,204	3,668	270	2,048	18	1,574	6,051	62	1,419	624	4,212	8,976	538
KINROSS (not divided)		310	101	6,539	1,248	2,176	68	2,881	6,481	1,000	13,536	955	6,397	34,237	968
KIRKCUDBRIGHT	Eastern	11	4	8,479	904	3,573	4	4,329	13,632	3,669	28,333	1,534	19,823	78,694	4,888
	Northern	..	..	1,637	111	744	..	881	3,291	3,012	10,491	441	5,517	148,154	911
	Southern	39	6	8,345	257	3,955	5	3,934	20,786	5,011	36,230	1,755	27,508	92,115	7,084
	Western	..	18	1,851	69	781	6	1,027	2,365	1,580	11,502	363	5,440	85,569	533
LANARK	Lower Ward	788	7	3,677	1,405	509	10	2,664	1,213	2,540	7,134	736	4,663	1,350	3,610
	Middle Ward	1,212	58	15,146	2,445	3,031	10	16,371	11,617	7,149	51,785	3,188	35,345	35,619	2,832
	Upper Ward	72	21	16,409	2,158	5,521	..	11,375	22,497	4,575	45,253	2,648	30,016	206,118	1,716
MID-LOTHIAN	Calder	1,605	460	5,750	1,815	1,611	63	3,531	2,407	416	13,515	833	5,103	40,244	3,644
	Gala-Water	855	953	5,200	447	3,264	41	1,707	11,655	569	13,394	660	3,868	101,279	611
	Lasswade	1,604	1,238	4,861	1,879	2,476	158	3,418	3,775	595	8,823	884	4,409	37,564	2,223
	Suburban	2,524	509	3,291	2,607	1,247	121	2,702	299	528	4,005	722	3,714	9,060	9,004
MORAY (not divided)		794	8,482	24,164	1,564	13,037	267	5,753	34,632	181	7,866	4,000	23,902	58,879	5,300
NAIRN (not divided)		..	1,993	6,444	275	3,730	27	1,762	8,932	32	1,781	1,124	6,581	14,829	1,015

* See Note on p. 121.

† Including stock grazed on Deer Forests.

ACREAGE of CROPS and NUMBER of LIVE STOCK in each COUNTY DISTRICT of SCOTLAND on 4th June 1927.

County and District of County.		Wheat.	Barley (including Bere).	Oats.	Potatoes.	Turnips and Swedes.	Sugar Beet.	Rye-grass and other Rotation Grasses & Clover. For Hay.	Rye-grass and other Rotation Grasses & Clover. Not for Hay.	Permanent Grass. For Hay.	Permanent Grass. Not for Hay.	* Horses.	† Cattle.	† Sheep.	Pigs.
		Acres.	Acres.	Acres.	Acres.	Acres.	Acres.	Acres.	Acres.	Acres.	Acres.	No.	No.	No.	No.
ORKNEY	Mainland	..	1,007	17,587	1,196	6,661	..	6,082	16,949	304	7,734	3,000	17,280	20,497	1,916
	North Isles	..	2,196	9,551	719	4,593	..	3,892	10,161	212	5,353	1,808	11,283	19,017	1,189
	S. Ronaldshay & Walls	..	272	4,674	315	1,776	..	1,450	3,822	85	1,239	685	4,268	6,524	322
PEEBLES (not divided)		..	26	5,685	318	2,726	..	2,360	11,017	1,175	26,870	792	6,895	209,548	835
PERTH	Blairgowrie	2,790	923	14,914	5,823	5,765	283	6,752	15,345	641	13,650	2,188	13,048	61,401	2,913
	Central	726	91	14,396	3,700	4,490	35	6,867	13,373	1,400	19,544	2,149	13,247	137,970	2,168
	Highland	..	27	6,227	810	2,374	2	4,321	6,226	2,313	14,982	1,223	9,464	200,601	1,247
	Perth	4,590	977	19,643	6,810	7,602	324	9,542	17,696	1,986	27,641	3,026	20,770	70,044	3,247
	Western	427	199	9,401	1,746	2,004	30	4,678	7,499	5,471	18,630	1,855	13,267	192,573	1,119
RENFREW	First or Upper	957	1	3,691	1,263	821	3	4,183	2,142	3,977	22,457	1,039	11,662	22,271	2,112
	Second or Lower	775	..	5,161	2,050	1,077	2	4,475	3,817	2,542	21,891	1,182	12,606	24,696	1,872
ROSS & CROMARTY	Black Isle	157	2,228	6,641	815	3,877	47	2,882	9,007	190	2,634	1,163	6,275	17,158	1,240
	Easter Ross	798	1,310	9,273	1,759	4,988	117	3,960	13,743	339	6,116	1,601	8,932	78,701	1,753
	Mid Ross	110	820	8,829	710	4,079	3	3,824	10,911	510	7,014	1,499	8,973	83,375	1,376
	S.-W. and Western	..	13	1,743	594	184	..	1,367	408	1,555	2,654	320	4,386	72,791	56
	Lewis	..	2,145	5,441	3,097	311	..	363	107	807	8,118	1,198	9,587	69,164	37
ROXBURGH	Hawick & Liddesdale	9	73	3,171	158	1,736	..	1,324	5,183	3,625	12,302	527	5,617	184,551	576
	Jedburgh	114	1,395	6,770	247	4,332	57	2,838	16,867	1,550	18,110	1,025	7,100	164,265	744
	Kelso	980	4,904	7,629	562	6,252	173	3,843	15,551	654	15,778	1,188	7,384	160,447	1,718
	Melrose	156	817	5,295	183	3,299	18	1,753	11,306	586	13,852	668	4,273	76,294	1,080
SELKIRK (not divided)		..	144	3,499	162	1,934	3	1,298	7,148	1,854	13,456	502	3,339	195,257	596
SHETLAND	Mainland	..	594	4,934	1,608	882	..	1,094	398	1,268	8,418	1,574	8,779	117,838	168
	North Isles	..	12	1,129	388	124	..	357	120	642	2,919	827	2,751	36,449	91
STIRLING	Central	860	140	6,750	1,353	1,485	74	3,508	3,869	4,578	18,525	1,507	13,347	44,475	1,255
	Eastern	834	307	5,854	895	1,033	31	3,767	3,055	2,044	15,855	1,084	3,778	8,208	1,331
	Western	147	5	4,272	1,130	955	2	3,120	3,596	1,929	18,384	931	10,898	76,260	1,230
SUTHERLAND (not divided)		..	226	7,111	1,058	2,582	..	4,598	5,784	1,425	8,124	1,921	9,870	217,515	649
WEST LOTHIAN	Bathgate	339	191	5,026	773	1,125	6	3,329	2,764	661	13,105	883	6,302	9,566	464
	Linlithgow	2,480	931	4,723	2,005	1,755	141	3,324	2,756	577	8,564	902	5,119	13,385	1,436
WIGTOWN	Machars	36	57	9,560	311	4,088	290	4,628	20,782	3,796	30,978	2,080	26,944	77,833	4,392
	Rhins	4	39	16,532	1,253	7,304	8	2,758	33,095	1,913	15,667	2,587	30,685	59,795	11,856

* See Note on p. 121.

† Including stock grazed on Deer Forests.

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SPECIES in RELATION to the MANAGEMENT and IMPROVEMENT of GRASS LAND.

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Recent work at Cambridge, Aberdeen, and Aberystwyth and on the continent has concentrated attention on the high nutritive value of young pasturage. It has been shown that when herbage is short and young there is relatively little difference between the apparent feeding value of one sward and another, judged merely in terms albuminoid ratio and starch equivalent, even although the contributing species may be very different. Swards consisting predominantly of bent grasses, or even predominantly of sedges[1] when sampled in a young and succulent condition, have given high nutritive values.

There is some risk that these interesting disclosures may tend to cause graziers to come to the view that the precise species which contribute to their grass lands is wholly without significance, and that all that matters is to retain a closely or evenly grazed sward of any species whatsoever that are palatable or at all events eatable. At this stage in the development of grass-land science it is therefore very important to endeavour to arrive at a correct estimate of the true bearing of the differences between species and species in relation to enlightened methods of management. It is necessary, however, to examine the implications of the new teaching, if possible, with a mind freed from views long held as to the so-called valuable species and the so-called inferior species. The question as to whether certain grasses are of extreme value and others well nigh worthless has evidently to be fairly and squarely faced.

The endeavour in this article is briefly to show some of the directions in which botanical composition does influence to a marked degree the economic value of our swards, and to indicate some of the directions in which management can be made to exert a profound influence on the development of the most desirable species.

Desirable Characteristics. — The following are essential characteristics in which it is so much to be desired that our

[1] See Odelien, M., in Årbok fer Beitebruk i Norge, 1924-25.

swards should excel: (1) high nutritive value; (2) an adequate mineral content; (3) a satisfactory clover-grass ratio; (4) high aggregate productivity; (5) providing as long a grazing season as possible; (6) continuation from year to year in an improving and not in a gradually deteriorating condition; (7) high average of palatability and eatability.

Brief reference to each of the above desiderata will at once show that species *qua* species do in fact influence the all-the-year-round value of our swards to an overwhelming degree.

Nutritive Value and Aggregate Productivity.—It is the leaf of pasture grass that counts in the scale of nutritive value; consequently a sward that is both of high nutritive value and productive power is one that produces the maximum yield of young leaf per acre per annum. The species vary vastly in their leaf-yielding ability. The larger grasses like cocksfoot, timothy and perennial rye-grass may produce under reasonable soil conditions from 20 to 30 cwt. of dry leaf per acre per annum, while the smaller grasses like crested dogstail will be unlikely to produce more than 5 to 10 cwt.

Seasonal Productivity.—The earning power of our grass lands is determined by nothing so much as the length of the grazing season. November to May is the period when grazing is most desired; species that will " hold late " and " start early " are therefore of extreme importance. The species vary amongst themselves to a remarkable extent with reference to " winter burning." It is the winter green species that alone are valuable for the non-growing season. Not only do the species vary amongst themselves in this respect, but the strains within the particular species vary to an even greater degree. The most winter green species are Italian rye-grass, perennial rye-grass, crested dogstail, certain strains of meadow foxtail, certain strains of Yorkshire fog, and the little " weed " grass *Poa annua*. Winter greenness and early productivity are both largely controllable by management. Old and ungrazed herbage burns off much more quickly than younger herbage, but even in respect of old herbage the species vary much amongst themselves. Neglected cocksfoot, bent and fine-leaved fescue burn off much more quickly than neglected rye-grass or Yorkshire fog, for example. Adequate drainage is of course an essential factor favouring winter greenness and early productivity. The earliest grasses are larger species like cocksfoot and Italian rye-grass, while timothy from the point of view of leaf production is also comparatively early. The earliest grazing should always be provided by short term temporary grass, since very heavy early grazing is bad for permanent swards, and a field grazed very early one year will not graze so well early the next.[1]

Mineral Content and Clover-Grass Ratio.—The importance of the mineral content of herbage has been made abundantly clear

[1] Tall oat grass and tall fescue are two of our earliest grasses; the former, however, does not long persist under heavy spring grazing, while the latter is only palatable under somewhat exceptional conditions.

to readers of this JOURNAL as the result of the fundamental researches at Aberdeen. This work bears very closely indeed on the species question, for, as has also been shown by extensive analyses at Aberystwyth, the clovers tend to be considerably richer in minerals, especially in lime, than the grasses. It has also been shown that herbages decidedly poor in mineral content have almost invariably been devoid or almost wholly devoid of leguminous plants. It is evident, therefore, that clovers as such are of definite value and importance in herbage, and this entirely independently of their reaction on the fertility of the soil and of their effect in keeping weeds in check and giving density to the sole of the sward. From this it follows that recent developments in our knowledge of pastures renders it even more important to endeavour to increase the leguminous content of very poor swards on mineral deficient soils than even the teaching of the famous pre-war basic slag experiments and propaganda would have led us to suppose. Looked at only from the point of view of the albuminoid ratio of young herbage it might seem justifiable to regard clovers with less favour than they have come to be regarded. Looked at from all points of view, and particularly from the point of view of our more inferior grass lands, modern research, properly understood, has, however, tended to add to the status of the clovers rather than the reverse.

Palatability and Eatability.—The relative palatability of the species contributing to a sward has a profound influence on the general stability or the reverse of the sward as a whole. Any particular method of grazing long continued on a more or less uniform plan exercises a cumulative and ultimately very well-marked effect on the botanical composition of the sward, chiefly because of the different extent to which the several species are eaten as the result of differential palatability. The aggregate and the seasonal productivity of a sward are therefore very largely dependent upon the palatability of the several species, and upon the skill exercised in grazing particular fields in relation to the seasonal palatability phases of the species most abundantly present. Palatability, it must be insisted, is very largely dependent on growth stage, and speaking generally all plants are palatable in proportion as they are young, growing fast and relatively immature. It is at this stage that very heavy grazing tends to weaken the plants. Thus it is that hard heads or knapp weed, for example, can be largely suppressed by very heavy grazing early in the spring by sheep. This process, be it noted, if too long continued, has precisely the same effect on tall oat grass, cocksfoot, timothy and other larger grasses.

The combined influence of growing stage and palatability as affecting species reaction to grazing is a fundamental matter all too little understood by practical men. The case of domination by bent grass is very illuminating in this connection. The bent grasses start growth very late in the spring, and therefore relative to other species are harmed not at all by extra hard early spring grazing. These grasses do not attain to their critical stage until well into May or even June—at a time, that is to say, when growth is so rapid and abundant that unless bent-swards are grazed extra heavily at this period with the definite object of keeping the species in check the individual plants grow right away, soon reach maturity, and remain unpalatable and uneaten for the rest of the season. The result of the standing bent crop is to smother the less favoured species, to check the circulation of air, and to shade such important sun and light demanders as white clover and perennial rye-grass, the former of which should be starting active growth at this period—in short, to spell complete sward deterioration. It is true that young bent well grazed may be as nutritious as any other grass in practice, but probably not one bent sward in ten is properly managed. Bent must be heavily grazed in June; it can then be made a very valuable late summer and autumn grass, but under the best management possible its aggregate productivity is not of the highest.

On the basis of these considerations one may perhaps venture to define a superior grass as one " which under all conditions of management—good, bad and indifferent—will never do harm," e.g. perennial rye-grass, and an inferior grass as merely one " which under conditions of poor management will do harm "—grasses being inferior in proportion to the sward spoliation for which they can be responsible under outrageously bad management. Such grasses are the bent grasses, and all over Britain they stand, white, withered and neglected, not so much as silent monuments to soil, climatic and other troubles, but as depressing witnesses of cumulative neglect and bad management.

Persistency.—Agricultural research in general suffers from the defect that to a very large extent experiments and trials are conducted on soils of reasonable to high fertility. It is thus true that many of our views as to the value of various species of grasses and clovers tacitly assume favourable conditions for growth and development. We are prone to think in terms of nutritive value, leafiness, palatability and productivity, and to ignore that most important property of all, namely, " persistency," or the power to thrive and to compete with definitely undesirable species. It has to be realised, however, that unless a particular species can grow to reasonable luxuriance under the conditions with which it has to contend it is valueless, no matter how palatable or how luxuriant it may be when judged by good soil standards.

When it is remembered that a very large proportion of our grazings occur on soils of inherent infertility and on exposed situations, it may be conceded that over an exceedingly large proportion of these Islands, persistency, if also associated with eatability, is to be regarded as the most important, indeed as the essential, property of a herbage plant. This fact has been insisted upon by Bruce Levy in connection with his important researches in New Zealand.[1] The ideal to aim at is to bring

[1] Levy, E. Bruce, The Grasslands of New Zealand: Preliminary Ecological Classification of Species, Vol. 30, *New Zealand Journal of Agriculture.*

soil fertility up to the standard required by such high fertility demanders as perennial rye-grass and by cocksfoot and white clover at maximum luxuriance. On many situations, however, although this may be possible scientifically speaking, to do so is certainly not an economic proposition. It is important, therefore, to realise that on difficult situations far more useful keep will be produced by luxuriant "inferior" grasses than by starved and stunted "superior" grasses. The reason for this is obvious, and may be explained in a word by saying that the "inferior" grasses under such conditions will produce a higher yield of leaf per acre per annum than will the "superior" grasses.

The improvement and management of areas in poor grass on infertile soils may then take two very definite directions. Either heroic, and as likely as not utterly uneconomic, efforts at building up fertility to the standard of the "superior" grasses, or methods of management designed to make the most of the "inferior," albeit persistent, species. In practice, by adopting the second method before the first, it will be found that gradually and almost imperceptibly a habitat favourable to the more superior species will ultimately be created.

If attention is confined to our lowest grades of grass land, the representatives of four species, two grasses and two clovers, are to be regarded as the most important of the so-called inferior varieties, and these undoubtedly are the bent grasses, Yorkshire fog, wild red clover, and the various bird's foot trefoils. These are all forms capable of relative luxuriance under conditions too infertile, too wet or too dry to accommodate successfully perennial rye-grass, cocksfoot and other superior grasses or even white clover in a really productive condition.

The successful management of the poorest grass land is then very largely a matter of a proper understanding of how to encourage these species, and how to deal with them in order to maintain them at maximum luxuriance and in a leafy and palatable condition.

The case of the bent grasses has already been considered. Yorkshire fog is a very rapidly growing grass which should never be allowed to run to seed and which quickly grows out of a palatable condition. If it grows away from the animals it should therefore be immediately run over with the mowing machine. The mowing machine is in fact the most important implement that it is possible to use on rough and poor grazings—the greatest defect of which swards is the unpalatable condition to which the herbage rapidly attains.

The value of leguminous herbs has been already insisted upon; these must at all costs be encouraged upon poor leguminous-deficient swards. On many types of rather heavy waterlogged soils the bird's foot trefoils and wild red clover are the natural leguminous herbs. Both are encouraged by phosphatic manures. Both are, moreover, vastly encouraged by any action that makes for a better aeration of the soil and by access of light and sun to the leaves. Two methods of treatment should therefore be adopted—heavy treading, trampling and grazing by animals, and resort to the use of a heavy scarifying implement. In New Zealand bird's foot trefoil seed production is always led up to by a heavy discing and harrowing (tined implement) of swards on which the species occur. Recent trials conducted by Mr. S. M. Bligh of Cilmery Park, Builth Wells (Central Wales), on waterlogged soils have been particularly interesting in connection with increasing the leguminous content of poor swards on stagnant soils and are in complete agreement with New Zealand practices. An area was slagged, a second area was slagged and heavily disced, and a third area was slagged and had little furrows drawn out about two feet apart and about three inches deep with the point of a plough. On the area only slagged, the bird's foot trefoils were not materially increased and made a contribution of hardly 3 per cent.; on the disced and furrowed areas, also receiving slag, these leguminous herbs increased to over 20 per cent. and the whole aspect of the sward was greatly improved.

The beneficial effects of heavy tearing and aeration of the ground, as of heavy treading and trampling, have also been demonstrated by Mr. Bond in Derbyshire, while the benefits of controlled "hoof cultivation" have been amply proved by the success of the procedure adopted by Mr. Hosier in Wiltshire; "hoof cultivation" for that matter is an accepted method of grass land improvement in New Zealand.

The value of complete aeration and breaking receives complete justification from the results that have been obtained at Aberystwyth and elsewhere by ploughing old sod-bound swards and immediately re-sowing on the upturned turf. These benefits have by no means been due only to the successful introduction of wild white clover and "superior" grasses, but also to the fact that the re-colonising bent and Yorkshire fog that have come on to the sward naturally have sprung away in a fresh condition and have been kept well grazed while in a nutritious and palatable stage of growth. The poorer types of grazing, consisting largely of the bent grasses, Yorkshire fog, bird's foot trefoils and wild red clover, no matter how cleverly managed or how much improved, cannot of course be made to give a long grazing season. They can, however, be made to contribute very appreciably to summer and autumn grazing, and by that much the more allow of increased hay production on the better fields. In this connection it should be remembered that light hay crops (fields "put up" late and cut reasonably early) taken from fertile fields greatly favour extended winter and early spring grazing on such fields. In short, a proper understanding of the behaviour and peculiarities of the several herbage species makes possible a really scientific management of the grass lands of the country, and is therefore the sure foundation of successful stock farming.

GLIMPSES OF OLD-TIME SCOTTISH FARMING.

Professor J. A. Scott Watson, M.C., B.Sc.

An Ancient Weed Act.—A very early Scottish law is directed against the "Guld," or Yellow Corn Marigold (*Chrysanthemum segetum*), singled out evidently as the most obnoxious of weeds. The original of the statute reads as follows[1] :—

> "Giff the maler (tenant) puttes guld in the land and will not deliver it and clenge (clean) it, he aw (ought) to be pungst as he that ledis ane host in the Kinges land or the barounis, and gif the natiff man (serf) or the bonde haf fylit the land with guld for ilk plant of it he sal gif to the, or ony overlord a mutone to the forfalt (forfeit) and never the less he sal clenge the land of the guld."

The date of the original law is unknown, but a slightly different and probably later version is ascribed to the reign of Alexander II (1214–1249).

There are frequent references to Guld Law in the leases granted by the Abbot of Coupar Angus during the fifteenth and sixteenth centuries.[2] Thus in 1472 the Abbot let the farm of Little Pert, in Forfarshire, to John Sperk under the condition, amongst others, that "the said John sal kepe his land fra guld efter his power." Again in 1473 the five joint tenants of Balgersho obtained a lease on condition "Heratour the land that is clein fra guld upon the burn at Keithick tha sal kep clein : and other guldy plaices that ar fouyl tha sal labour to cleynge with chayng and reneuyng of seyd and sifting of thar avying (own) seyd." Penalties were actually exacted upon occasion. "On 24th November 1479 it was agreed between the Lord Abbot and Symon Tailzoure of Kemphill that henceforth the latter should keep his lands from guld, and his lands to be purged on the feasts of St. John the Baptist and of St. Peter and in time of harvest; and if his land be found foul, he shall pay the penalty of the law; and for the foulness of the present year he shall pay 10*s*."

Andrew Wight,[3] describing the Barony of Stobhall in this same neighbourhood in 1773, gives the following account of what was evidently a survival of the machinery of the old law :—"Now that I have explained the bad practices of these tenants, in justice to them I must not overlook one good and singular practice which is called *Riding the guild*, performed in the manner following. A committee of their number, upon a certain day in August, examine every field of those that are under the guild law; and for each stalk of that weed found at this time among the corns, the committee fine the tenant in one penny or two pence, which is paid most pointedly; and by the observance of this salutary practice the whole lands under its influence are perfectly clean; whereas if we turn our view to the neighbouring

[1] Acts of the Parliament of Scotland, vol. i. [2] Register of Coupar Abbey.
[3] Present State of Husbandry in Scotland, vol. i (1778).

lands many of the fields are covered with more guild than corn. . . . The people have no tradition relative to the time and manner of the beginning of this law; only that in times out of mind such has been the practice; and that in old times the custom was to pay for each stalk of guild a weather sheep or two pence halfpenny." In this particular parish the practice of "gool riding" survived a good deal later, and is fully described by the writer of the new Statistical Account[1] in 1841.

There is plenty of other evidence of the widespread distribution of the weed. In Buchan[2] during the earlier half of the eighteenth century "Yarrs, Skellachs and Gule" are mentioned, along with Wild Oats, as the most troublesome annual weeds; and a Morayshire proverb runs :—

"The Gool, the Gordon and the Hudy Craw
Are the three greatest curses Moray ever saw."

In Scotland Corn Marigold is now a comparatively rare weed, and in many of the better arable districts it is scarcely to be met with in a day's journey. It is a plant of sour land, and its prevalence in earlier times reflects the widespread and intense lime-hunger of Scottish soils. The general use of lime seems to have had more to do with its disappearance than the Guld Law.

How Scotland was Limed.—When the value of lime came to be generally realised, as it did during the latter half of the eighteenth century, the task of liming was undertaken in the most wholehearted manner. In those fortunate districts where both coal and limestone were known to exist, great numbers of kilns were built and plentiful supplies of quicklime were produced. The chief difficulty was transport. Large quantities were in fact carted over distances of 20 miles or more on roads that were often hardly worth the name. Some even had to be carried on pack horses. The coastal districts were supplied by sea; Perth, for instance, imported 13,000 tons in 1794, when activity in liming was at its height. The large prospective lime traffic was one of the main arguments for the construction of the old canal that ran from Aberdeen to Inverurie, and during the early years of its existence nearly half the total tonnage carried was lime.[3] The usual dressing in most districts was 20 or 30 bolls per Scots acre, equivalent to three or four tons per statute acre; and many a lease granted in the period about 1800 required that the whole farm be dressed at some such rate within a stipulated period. In particular cases dressings of six or seven tons per acre were given, and sometimes even repeated in successive tacks.

In districts too far removed from sources of quicklime a diligent search was made for substitutes. Before 1800 the Commissioners of the annexed estates set up at Struan, in

[1] Perthshire Statistical Account, Parish of Cargill.
[2] A True Method of treating Light Hazely Ground, by a small Society of Buchan Farmers, 1735.
[3] General View of the Agriculture of Aberdeenshire, 1811.

Rannoch, a mill for pounding raw limestone for manure[1]; "only before the consequences of this experiment were diffused and felt in the country a torrent in the stream that drove the machinery was allowed to sweep the whole away; which accident put an end at once to future trials and future benefit."

Here and there beds of clay marl were discovered and worked, but since analytical chemists were then not over plentiful, the value of these deposits was often a matter of controversy. Some of the earths used, in amounts of a hundred loads or more per acre, were found, when they were ultimately analysed, to contain negligible quantities of lime.

A commoner and more satisfactory source of lime was discovered in the deposits of shell marl occurring either in the bottoms of existing fresh water lochs or under layers of peat moss in places where lochs or swamps had formerly been. The Monks' Mire near Coupar Angus was one noted example of the latter class, and supplied shell marl to a wide area of Strathmore; Whiterigg Moss near St. Boswells was another, but was hardly developed when the "peace and beggary" that followed the Napoleonic wars put a severe check on costly and laborious improvements. From several of the lochs in Strathmore, from that of Ochtertyre in Strathearn, and from many more, marl was dredged by means of boats and sold at highly remunerative prices. The Loch of Logie and Lundie Loch in Forfarshire were drained at great expense in order to secure the marl; the former was calculated to contain some two million bolls—in any case a good deal more than was ever used. At Forfar Loch a still more ambitious scheme was devised by the Earl of Strathmore about 1770.[2] He cut a great drain, which lowered the level of the water by 16 feet and laid dry a large supply of marl; and by putting locks in the drain he made possible the carriage of the material by water to his own estate at Glamis. Wight[3] writing in 1775 says that a sum of about £1,000 a year was being realised by the sale of marl to the neighbourhood. A few years later the same writer remarked that if the good work were but continued the county of Forfar might in time become one of the richest in Scotland, and vie even with the Merse or with his own East Lothian. It is clear, however, from subsequent accounts that marling was sometimes overdone; in particular, Robertson[4] makes the interesting observation that whereas barley or bere would still grow on the over-marled land, oats were found to fail completely and repeatedly.

During the early days of liming there was a good deal of misconception regarding the real function of lime in the soil, and a good many disappointing results are recorded, especially in the case of second or subsequent applications. By the beginning of the nineteenth century, however, some of the agricultural writers had formed wonderfully sound notions on the subject.

[1] General View of the Agriculture of Perthshire, 1813.
[2] Do. do. Forfarshire, 1813.
[3] Present State of Husbandry in Scotland, vol. i.
[4] General View of the Agriculture of Perth, 1813.

For example, Findlater, in his " General View of Peebles " (1802), after setting forth a number of cases that had come under his notice, says : " These facts seem to indicate that lime fertilizes by acting upon pre-existing materials in the soil, whether by neutralizing acids inimicable to vegetation and thus removing obstructions impeding the operation of vegetative powers, or whether by stimulating these powers into action."

The Sma' Oat.—There is good reason to believe that the original cultivated oat of Scotland was *Avena strigosa*, now known as the Shetland or Sma' Oat or " corc beag," and cultivated only on the poorest land in Orkney, Shetland and the Outer Hebrides.[1] It is unmistakably and accurately described by many of the old writers; the grey or nearly black colour, the long awns, small grains, low bushel weight, and the fact that the grain never shed in the latest or stormiest harvest are often mentioned. It is also noted that the yield of meal was about half that obtained from the white oat; that is to say it took two bolls (12 bushels) of grain, more or less, to produce a boll (140 lb.) of meal. Mackintosh of Balnespick[2] in Speyside, in his corn accounts of the period about 1770, reckons his white oats at full measure but his small oats usually at half measure. The old oat went by various names—Black Oat, Old Grey Oat, Country Oat, Sma' Oat, Shiachs, Flaver, &c. The commonest designation of " black " is, in the later writings, not always unambiguous, because latterly black varieties of *Avena sativa* were introduced. But in earlier records " Black Oats " seems invariably to mean the old species and " White Oats " the new.

It is not known when the white oat was introduced. Tradition says the seventeenth century, and there is at least one circumstantial story[3] that it was brought to Scotland by one of Cromwell's officers named Blith who settled in Scotland in the time of the Commonwealth. But this date is almost certainly too late. In the leases granted by the Abbot of Coupar Angus up till 1540 only " aits " are mentioned, but in those of 1542, 1547 and onwards " black aits " and " white aits " are occasionally specified. In 1735 the old oat was widely cultivated in Buchan, and in the " True Method of Treating Light Hazely Ground " precise recommendations are given as to the conditions under which it was advisable to sow white or black or " brockit " (mixed black and white) oats respectively. Broadly speaking, White Oats were to be sown under the best conditions and Black only on the poorest or most exhausted land.

At the time of the County Surveys drawn up for the old Board of Agriculture (1794–1813) the Sma' Oat had disappeared throughout the whole of the southern counties, though it was still remembered by old people in Dumfriesshire. In the glen districts of Forfarshire a little was still grown. In Aberdeen " the ancient native oat, commonly called small oats,

[1] It also survives in Wales.
[2] Miss I. F. Grant, Everyday Life on an Old Highland Farm.
[3] Agriculture of the County of Berwick (1794), p. 129.

were very commonly raised on the poorer lands in the Garioch and Formartin, previous to 1782. It was not raised in the lower parts of Marr, and the Reporter never saw it till 1778 when he settled in the Garioch. . . . It has been on the decline since 1782, and since our agriculture was improved is now entirely discontinued. The sheriff could find no proof of its being bought or sold for the past three years."[1] In the whole of the Highland area and in Caithness the Sma' Oat was still well known. In Inverness it was the sort usually grown by the smaller tenants, and in Caithness it was the normal variety for outfield land. In the Hebrides the White Oat had been introduced in 1748 "by a public spirited gentleman who had just returned from England and the south of Scotland,"[2] and by 1811 had very largely displaced the old sort. Since those days the cultivation of the old species has continuously declined, and it is now grown under the poorest of conditions in the Northern and Western Isles. It is notably more resistant than the common oat to alkaline soil conditions, and it succeeds on land that has been overdressed with sea ware or shell sand, and on which the white oat fails.[3]

Some Old Rotations.—Roots, potatoes and sown grasses were unknown to Scottish agriculture until the seventeen hundreds, and it was not until after 1800 that their cultivation became general in the more backward districts. The old standard cropping scheme is well known; it is described by Dickson[4] as follows:—"The arable lands of Scotland are divided into infield and outfield. Formerly the infield was kept constantly under tillage and a crop sown every season; upon this land was laid all the dung produced by the farm. The outfield was in tillage and pasture alternately, commonly three crops of corn taken and allowed to ly for three to six years in natural grass. Seldom any dung was laid upon this land; sometimes indeed the cattle were folded upon it and then four or five crops were taken instead of three. On this land oats were the only kind of grain that was sown." The actual course of cropping on the infield varied from district to district. Perhaps the commonest was that described by Wight[5] as it existed at Stobhall in Perthshire in 1773. "That which they call infield they crop with bear and oats alternately, always using what dung they have to the bear crop; sow a few pease, some half a boll, others a boll, and frequently lintseed upon their best land." In Buchan the regular thing was one crop of bere and two of oats, the latter being known as "bear root corn" and "awal infield corn" respectively; again all the dung was applied to the bere. In East Lothian "the infield land (where wheat is sown) is generally divided by the Tennent into four Divisions or Breaks as they call them, viz. one of wheat, one of barley, one of oats

[1] General View of the Agriculture of Aberdeenshire (1811).
[2] Do do. the Hebrides (1811).
[3] M'Donald, Agriculture of the Outer Hebrides, *Scottish Journal of Agriculture*, vol. ii, and M'Gillivray, Agriculture in Shetland, ib., vol. iii.
[4] Adam Dickson, A Treatise on Agriculture, 1770.
[5] Present State of Husbandry in Scotland, vol. i.

and one of pease, so that the wheat is sown after the pease, the barley after the wheat and the oats after the barley. . . . In these grounds where no wheat is sown where the ground is good the infield land is ordinarily divided into three divisions or breaks, pease, barley and oats: so that the barley is sowen after the pease and the oats after the barley."[1] All crops were of course sown broadcast. As to how any land, farmed in this way, could be kept clean, the answer is mainly that it was not; the infield land seems to have been in a state of chronic and almost indescribable foulness. But bere or barley was always regarded as the cleaning crop, the land intended for it being generally given three furrows; the last ploughing was done very late, so as to destroy seedling weeds, and the seed was rarely sown before the latter half of May. Moreover a certain amount of hand weeding was done, the "thistles and other garbage" being gathered and fed to the work horses. The author of the "Country Man's Rudiments" condemns this practice not because thistles were unuseful horse fodder, but because the men wasted their time in collecting them, and did much damage to the corn in the process.

On the outfield the only variations were in the length of the periods that the land was cropped or lay idle, in the treatment it received preparatory to breaking up, and in the kind of oats that were grown upon it. "Three year oot and three year in" was the proverbial system, but where outfield land was both poor and plentiful the period during which it lay under grass and weeds was extended. In "A True Method of Treating Light Hazely Grounds" the small society of Buchan Farmers lay down precise rules for the treatment of various sorts of outfield land; the best sort of haugh lands were to lie five or six years in grass and might accordingly bear four to six rich crops, all of white oats. Hard ground lying at moss sides, on the other hand, might reasonably be expected to carry only two crops after breaking up, and those of small corn.

As regards the preparation of the outfield land for corn, it might, if it had been long rested, be merely ploughed and sown. Occasionally it was dunged, or still more rarely limed, while the Buchan Farmers speak of paring and burning in certain cases. But the commonest practice was "tathing" or "toth folding"; here the portion that was to be taken in was enclosed by a turf dyke, and the stock was driven into this enclosure at nights throughout part of the summer. When the land was judged to be sufficiently manured the dykes were cast down and the turf was spread over the surface of the land, which was then ploughed. In still other cases, where the turf was thick and tough, the land was "fauched" or bare fallowed for a summer season, not so much with the idea of cleaning it as with that of rotting the turf and securing a tilth. This was the only set of circumstances under which bare fallowing was done.

[1] The Country Man's Rudiments, or an Advice to the Farmers of East Lothian, 1699. (Attributed to Lord Belhaven.)

THE CROFTING PROBLEM, 1780-1883.

MARGARET M. LEIGH, M.A.

II.—THE GROWTH OF CAPITALIST SHEEP-FARMING AND THE HIGHLAND CLEARANCES.

IN the agricultural history of every nation the time comes, sooner or later, when small-scale family farming gives way to large capitalist enterprises in which a smaller proportionate expenditure of money and labour will secure a higher return from the land. The process of adaptation is not an easy one, and unless overseas settlement or other alternative occupations are open to the displaced small cultivator, there is bound to be much difficulty and hardship. The agricultural revolution, however satisfactory to the economist, is less pleasing to the social reformer. Tracts of good arable laid down to grass, which moved Tiberius Gracchus to take up the land question, vast slave plantations that Pliny, 200 years later, considered the ruin of Italy, and once populous Highland glens given over to a few shepherds and their dogs, form the reverse or social aspect of capitalist farming. Unfortunately this theme is only too easily sentimentalised, and well-meaning reformers often fail to realise that the impersonal working of economic laws rather than human cupidity is responsible for the change, and that a mere redistribution of land will bring no remedy if the small holding system is in itself unprofitable. Three acres and a cow for everybody is a sound scheme, provided that there are enough plots to go round and enough grass on them to support the cow. Here we come to the heart of the Highland problem, and the study of it is not simplified by the clouds of controversy and misconception that so often gather round the question of small holdings. But one fact emerges clearly : that the land fit for cultivation was not capable of supporting the large and ever-increasing crofter population that sought to live from it, or more accurately to exist upon it.[1] The available arable land had very soon reached the limits of reasonable sub-division, while much of the hill-pasture was unsuited to any stock but sheep. The advocates of the crofting system contended that individually held sheep-walks should be cut up to enlarge the common grazings of adjacent townships, or divided for small men to hold on the club-farm principle. They alleged, and with truth, that the larger farmers occupied not only the hill-pasture, but extensive tracts of good arable in the valleys for the wintering of sheep, land which might be used to create more small holdings. Thus at the present day in one district known to the writer the fertile low land in the glen is occupied by one large sheep farm and three smaller ones, while a crofting township of 7 or 8 families is confined to a small strip of gravelly soil near the shore. But the difficulty is that sheep-farming is one of the most speculative branches of agriculture.

[1] A discussion of the size of the economic Highland holding at various periods will be found in the next issue of this JOURNAL.

Not only is the ingoing very costly, but the fluctuations of the market are frequent and severe, so that a larger amount of capital is required in proportion. Club-farm sheep stocks, even with a good shepherd, are as a rule less efficiently managed, and the small co-operators have less reserve to tide them over a period of depression and enable them to hold back wool or stock.

Progress of Sheep-Farming in the West.—Until the latter part of the eighteenth century, sheep of the native breed described above had been kept in small numbers to supply their owners with mutton and wool. They were not considered rent-paying animals, and their value, compared with that of cattle, was low.[1] The first indication of a change came in 1762, when sheep-farmers from Annandale took farms in Perthshire and Dumbarton, a district adjoining the Highlands.[2] From this time onwards there was a steady flow of settlers from the Border districts, chiefly from Clydesdale, Nithsdale and Tweeddale. The newcomers introduced their own breed, the so-called Linton or black-faced sheep, though these were of the "brockit" or speckle-faced variety. The Black-faced were superior in size and fleece to the old Highland breed, though equally hardy. In milder and more favourable situations, Cheviots were successfully reared; in the early nineteenth century this breed was numerous in Sutherland. According to the Statistical Account, Argyllshire was the first West Highland district to adopt large scale sheep-farming. In 1793 the parish of Inverchaolain contained 14,000 sheep, 400 cattle, 140 horses. Three-year-old wedders fetched 10*s*. to 14*s*., draft ewes from 6*s*. to 8*s*., lambs from 3*s*. to 5*s*., washed wool 7*s*. to 8*s*. per stone. The Society for Extending Fisheries and Improvements was offering premiums of £14 for the best group of six tups.[3] In Morven 17 gentlemen tacksmen were occupied in sheep-farming, and the stock numbered 14,000.[4] In Kilmanivaig there were 50,000 sheep to 1,500 cattle; the population numbered 2,400. But Wester Ross was less advanced. In the parish of Lochalsh, the proportions of live stock were cattle, 1,554; horses, 275; sheep, 1,789.[5] By 1807 sheep-farming was becoming common in Sutherland,[6] but on the extreme western seaboard and in the islands the new husbandry did not become general till 1828.[7]

High Profits of Sheep-Farming.—Like most enterprises on practically virgin soil, sheep-farming was at first very profitable. It came in time to meet the increasing demands of the English woollen manufacture. There was as yet little serious competition from overseas, and even after the removal of the duties on foreign wool, British farmers had little to grumble at. William

[1] In 1795 the value of a cow was ascertained by oath before the Court of Session to be equal to that of 16 blackfaced ewes. (Transactions of Highland and Agricultural Society, iii, p. 576.)
[2] Walker, i, p. 67.
[3] Statistical Account, v, p. 468. In this parish other livestock prices had risen. Black cattle fetched £4 to £5 and horses £10 to £12.
[4] Ib., x, p. 226.
[5] Ib., xi, p. 424.
[6] Loch, Sutherland Improvements, p. 70.
[7] Walker, ii, p. 357.

Youatt, writing in 1837, remarks :—" The domestic consumption and exportation of woollen goods increased, so that wool prices rose in 1836 to 1*s*. 10*d*. and 2*s*. for hogg wool, and 1*s*. 4*d*. and 1*s*. 8*d*. for clothing wool, which was acknowledged by farmers to be a remunerative price."[1] Porter reckoned that the whole quantity of wool applicable to manufacture had increased between 1800 and 1849 by 115 per cent.[2]

The sheep-farmer, if the capital required for stocking was large, had a small labour bill. The profits to be made attracted men from the Lowlands and the north of England, as well as intelligent Highland gentlemen with money to invest.[3] Extravagant hopes were raised, and the moors and mountains of the north-west were compared to a vast expanse of country reclaimed for tillage from the sea. A few more cautious spirits feared that the supply of sheep products might outrun the demand[4]; but there was no lack of enterprise, and competitive bidding forced up the value of the land. " The demand for the raw material of wool by the English manufacturers," says Loch, " enabled the Highland proprietor to let his lands for quadruple the amount they ever before produced to him."[5] The same thing happened whenever capitalists from the south offered for Highland farms.

A typical instance can be taken from the Argyll estates, though the holding in question is not a sheep but a dairy farm; but the process and its effects are the same. In 1847 the farm of Hillipol in Tiree was divided into 20 small crofts, five with a rent of less than £2, six of less than £3, and none exceeding £5, the total rental being £62. The Duke of Argyll, taking advantage of the exodus that followed the potato famine of 1846, took most of the farm into his own hands, consolidated it, and let it to a Lowland dairy farmer. By 1860 the rent had risen to £376. In 1847 the total rental of Tiree was £700 : in 1853 it was £2,260.[6]

Advantages to Landlords.—The extension of large scale sheep-farming came as a godsend to indigent landlords. Not merely were rents doubled or trebled, but they were regularly paid by substantial tenants. The expense and vexation of collecting trifling sums from a host of small crofters was reduced to a minimum. A large pasture farm requires less expenditure upon buildings, fences and drains than any other kind of agricultural holding; and though most Highland proprietors devolved these duties on the tenant,[7] yet those who let to large tenants had

[1] Sheep, their Breeds and Management, p. 229.

[2] Porter, Progress of the Nation, p. 328. (New edition, 1912.)

[3] Of the 29 principal tacksmen in Sutherland in 1820, 17 were natives of the county, 4 came from Northumberland, 2 from Moray, 2 from Roxburgh, 2 from Caithness, 1 from Midlothian, 1 from the Merse. (Loch, p. 63.)

[4] Marshall, Survey of Central Highlands, p. 56.

[5] Sutherland Improvements, p. xvii.

[6] Duke of Argyll, Farms and Crofts, pp. 27, 32. The Duke had spent £1000 on fencing and draining. This increase is entirely due to the appreciation of land values, for the profits from kelp manufacture had by this date ceased to count.

[7] But some proprietors spent large sums in relieving their tenants in the time of famine. In 1812 Clanranald of Uist spent £353 on meal for the people, and in 1815 to 1818 upwards of £6000. (Dalriad, Crofter in History, p. 88.)

the satisfaction of knowing that the capitalist would have the means and intelligence to keep his farm in order. And many landlords were genuinely persuaded that in stocking their moors and mountains with sheep and sending the inland crofter to seek a living on the coast they were doing a work of national importance.

Methods of Sheep-Farmers.—It may be of interest here to quote a letter written in 1820 by Patrick Sellar to James Loch, who seems to have asked the former for an account of his experiences as a sheep-farmer.[1] Sellar lived in Morayshire, and hitherto had known nothing of Sutherland. He took the farm of Culmaily, comprising 300 Scots acres, together with the pasture of the adjoining hill, at 25*s*. per acre, with an advance of £1,500 at 6½ per cent. to assist in the improvements. When he first arrived he was convinced "that the growth of sheep and wool in the Highlands of Scotland was one of the most abominable and detestable things possible to be imagined." Two year's residence in the midst of the Sutherland improvements seems to have brought him to the contrary opinion. "I was at once a convert to the principle now almost universally acted upon in the Highlands of Scotland, viz. that the people should be employed in securing the natural riches of the sea-coast, and that the several hundred miles of Alpine plants, flourishing in these districts in curious succession at all seasons and out of reach of anything but sheep, be converted into wool and mutton for the English manufacturer."

"Messrs. Atkinson and Marshall, the first adventurers in stock-farming in the earldom of Sutherland, are stock and crop farmers, who reside near the River Aln in Northumberland. They breed and buy lean stock, which they feed for Morpeth and the Yorkshire markets, and within the last ten years they have embarked, if I may be allowed to compute the operations by the rule of proportion with my own, not less than £20,000 in putting breeding stock upon the mountain in Sutherland. These flocks are divided into separate parcels or hirsels, each under the care of one, two or, as the case may be, three shepherds, and their whole number of shepherds again are under the direction of one steward or overseer, who corresponds with the stockmasters and directs and superintends every movement on the farm."

About the same time[2] associations of large sheep-farmers were formed in Ross, Sutherland and Inverness to guard their common interests. They secured an annual fair at Inverness in June for the sale of sheep and wool, which was attended by wool-staplers from Leeds, Huddersfield and Wakefield, and by Yorkshire stock-dealers. The three associations appointed a committee of three deputies, which met at Inverness at the close of the market, to discuss the regulations of the fair, the preservation of ancient drove roads, the suppression of theft, and other matters of common interest.

[1] Loch, Sutherland Improvements, Appendix vii.
[2] Loch, p. 66.

The Clearances.—In most districts the introduction of sheep-farming was accompanied by wholesale removals of small tenants. As has been already suggested, competition was not for the vast hill pasture, but for the limited areas of cultivable land, which were as necessary to the sheep-farmer for the wintering of his stock as to the crofter for the raising of corn and potatoes. The landlords were convinced that the continued existence of struggling townships on the verge of starvation was not merely unprofitable in itself, but an obstacle to all improvement and development of the resources of their estates. The crofters must go. The question was, whither? There were three possibilities —(1) emigration; (2) the creation of some industry other than agriculture; (3) the provision of new holdings. Of these the two first were the most promising, and will be discussed more fully in another section. The third could be nothing but a perpetuation of the existing state of things under even more unfavourable conditions, for there was no land from which new holdings of a sufficient size could be made. To meet this difficulty it was proposed to remove the surplus population to the coast, where they could combine fishing with the cultivation of their plots. This policy is clearly stated by Loch.[1] "As there was every reason for concluding that the mountainous part of the estate, and indeed of the county of Sutherland, were as much calculated for the maintenance of stock as they were for the habitation of man, there could be no doubt as to the propriety of turning them into sheep-walks, provided that the people could be at the same time settled in situations where, by the exercise of their honest industry, they could obtain a decent livelihood and add to the general mass of national wealth, and where they should not be exposed to the recurrence of those privations which so frequently and so terribly afflicted them in the mountains." Thus the hill country was to provide raw material for the staple industry of England, while the coastal districts were to increase the national food supply by the labour of a race of crofter-fishermen. The scheme sounds well on paper, but there were many practical difficulties. Fishing and farming are whole-time occupations, and are rarely combined with success. Moreover, the West Highlanders do not as a rule take kindly to the sea, and men bred inland can rarely be trained to this calling when already mature and accustomed to other work. Fishermen's holdings are not well cultivated, and often depend altogether on the labour of wife and children. Nor were the new holdings adequate either in size or in quality of land. It is true that in these regions the coastal strip is often the most fertile, and, though exposed to storms, has a lower rainfall than a glen surrounded by high mountains; so that transportation to the coast, so bitterly commented on by the crofters'[2] partisans, need not necessarily have been an evil. But the holdings were rarely large enough to support a family, and often consisted of wild ground which needed

[1] Sutherland Improvements, p. 70.
[2] Mackenzie, Highland Clearances, p. 30.

cleaning and draining before any cultivation could begin. A contemporary observer of the Sutherland clearances, General Stewart, writes :—"Ancient respectable tenants, possessing stocks of 10, 20 or 30 breeding cows, with the usual proportion of other stock, are pining on one or two acres of bad land, with one or two starved cows, and for this accommodation a calculation is made that they must support their families and pay the rent of their lots, not from their produce, but from the sea. When the herring fishing succeeds, they generally satisfy the landlords, whatever privations they may suffer; but when the fishing fails, they fall in arrears and are sequestrated and their stocks sold to pay the rent. Their lots are given to others, and they and their families turned adrift on the world."

New Holdings.—After the first few years the holdings were purposely reduced in size, so as to induce the people to fish, yet enough was left to prevent them from becoming full-time fishermen. As Loch puts it :—"If the people had subsisted altogether or chiefly on their lots, they would never have gone much to sea. . . . If, on the other hand, they had become active fishermen, their lots would have been imperfectly cultivated."[1] He gives some information about the new holdings on Dornoch Muirs and Brora Links, to which a number of crofters evicted from Farr and Kildonan were removed.[2] The plots were too small, but the conditions of tenure do not compare unfavourably with customary arrangements. On Dornoch Muirs the holdings did not exceed 12 acres, and were rented at 1*s*. per acre. Leases were given for seven years absolutely, with the possibility of a further seven years for any land brought under cultivation. An allowance of £5 per acre was given for all land brought under the plough. Lime was supplied by the landlord for two years at prime cost. At Brora the lots were smaller and dearer—two acres a head at 2*s*. 6*d*. per acre, with grazing on the links. The lots were ploughed by the landlord or principal tacksman. At Helmsdale one acre of old arable with hill-grazing was rented at 30*s*.[3] Families to be removed in 1819–1820 received notice in 1817, and arrears of rent were remitted. They were allowed to hold their crofts rent free during the last year of the old tenancy on condition that they settled quickly and quietly into their new homes.

Crofters in inaccessible places were able to sell the timber of their huts to the landlord, who supplied them with new wood after removal.

Whatever the economic advantages of consolidating small holdings into large farms, there is no doubt that the clearances were made without proper provision for the evicted tenants. The remote consequences of the policy, depending upon such incalculable things as the vicissitudes of the herring fishery, the

[1] Loch, Sutherland Improvements, p. 105.

[2] Ib., pp. 86, 107. It must, however, be remembered that Loch was factor of the Sutherland estate, and his book is an apologia for the improvement policy

[3] In all these estimates the measurement is by Scots acres, ¼ larger than the statute acre.

possible productivity of waste lands, and the human reactions to changed conditions, were neither foreseen nor provided for. It is true that in 1812 Lord Selkirk made a tour through Sutherland preaching his panacea of emigration. The policy was a sound one, and Selkirk himself had an unusually firm grasp of the needs of the situation. But the hardships and uncertainties of the emigrant's lot were immeasurably greater than they are to-day, and in any case the majority of the people did not want to emigrate. They not unreasonably preferred to live their own lives in a Highland hovel rather than be shipped away for the cultivation of an unknown soil. In many cases the evictions were carried out with needless barbarity. The pages of Mackenzie's account of the Highland clearances are melancholy reading, and the patient fatalism with which the people yielded to their doom is surprising when one remembers the succession of agrarian crimes in Ireland. Some of the new sheep-farmers complained of theft and violence, and in 1811 a military demonstration was made from Fort George to check any possible reprisals. Yet there was little to fear but the curses of old women. In Sutherland most of the blame lies at the door of one man, Sellar, the notorious under-factor, who was tried at Inverness in 1816. In many cases the landlords did much harm by entrusting the business of removal to underlings from the south, who knew nothing of local conditions and did not understand the mentality of the people. Anglo-Saxons find it difficult to deal with the Irish and other Celts because they do not realise that a man who sleeps under the same roof with his cattle may be a gentleman, and that the crofter's independence is not necessarily synonymous with laziness, nor is he alone industrious who works for an employer.

On the other hand, there is no doubt that the "atrocities" of the clearances were exaggerated by armchair patriots, who in London or Glasgow declaimed against the iniquities of the landlords, without being able to appreciate the financial difficulties with which they had to contend. As Loch puts it (p. 2) :— "Such regret (i.e. for the old state of things) has always been felt by those who had themselves long abandoned their paternal homes and habits, and did not depend for their support on the rents of a Highland estate."

Disadvantages of Land exclusively under Sheep.—From the purely agricultural point of view, the devotion of great tracts of country to sheep alone was not an unmixed blessing. In many places woods and plantations were cut down, and the hills stripped bare of shelter. Black cattle were much reduced in numbers. This was a loss, for they provided excellent beef, and their milk, though small in quantity, kept up local supplies. They provided work for many people in dairying, and, where improved methods of winter feeding were adopted, in tillage and haymaking. Moreover, cattle were useful in maintaining the quality of pastures. Land stocked with sheep alone inevitably deteriorates in the course of time, for sheep exhaust the soil by what they take out of it for the production of bone and tissue, and especially of wool, which contains much nitrogen. Their droppings have small manurial value in compensation. Moreover they are fastidious close grazers; the best grasses are eaten down, and the pasture is overrun with coarse tussocky growths. It was urged that the droppings of cattle had a higher fertilising value, while their less discriminating habits of grazing kept the hill ground in better condition. This point was laboured by the opponents of pure sheep-farming.

Mixed Husbandry.—The advantages of a system of mixed husbandry were put forward by the Rev. Mr. Singers, minister of Kirkpatrick (Dumfries), in a thoughtful prize essay,[1] in which sheep-farming, cattle-raising, arable cultivation and forestry[2] were all to play their parts in appropriate zones. The low land near the steading was to be ploughed for winter fodder, the coarser pastures to be stocked with cattle; plantations should occupy the intermediate hill ground and sheep the highest levels. At the end of the century the same arguments about the utility of cattle were brought forward by the advocates of small crofts, and the Crofters' Commission heard much evidence. They concluded[3] that the manurial value of cow-dung on extensive pastures was negligible, but that the grazing habits of cattle made them a valuable addition to the sheep-farmer's stock. In any case the crofters gained no point, for the small-holder has no monopoly of hill cattle. They can be raised better and more cheaply by the capitalist, since they need but little individual attention.

Appendix to Section II.

Estimate of the number of sheep in the county of Sutherland in 1820 (from Appendix VIII, Loch's Improvements).

	Cheviot.	Blackfaced.	Total.
Sutherland Estates	64,100	9,000	73,100
Other Estates—			
Reay	39,000	1,600	40,600
Bighouse	4,000	...	4,000
Sir Charles Ross	8,000	...	8,000
Achanry	...	300	300
Lord Ashburton	500	1,000	1,500
Mr. Dempster's	1,000	...	1,000
Cadbol's	600	..	600
Pointzfield's	1,200	400	1,600
	118,400	12,300	130,700

[1] Transactions Highland and Agricultural Society, vol. iii (1807).
[2] It is noticeable that all the writers of this period are interested in afforestation, while there is no word of it in the Crofters' Commission Report of 1883.
[3] Crofters' Commission Report, sect. 162.

Estimate of Wool exported annually.

	Stones.
Sutherland Estates	9,700
Other Estates	7,600
Total	17,300 or 415,200 lbs.

Number of Sheep sent south annually.

	Wedders.	Ewes.	Total.
Sutherland Estate	9,700	6,530	16,230
Other Estates	7,700	5,800	13,500
	17,400	12,330	29,730

III.—INCREASE OF POPULATION IN THE WEST HIGHLANDS AND ISLANDS, 1750–1850.

In urban and industrial areas a rapid growth of population is the normal consequence of commercial expansion. But when in a purely rural district, where the large majority are occupied in agriculture, the population is nearly trebled in three generations, there is some cause for surprise. This remarkable increase, more than any single factor, is responsible for the economic difficulties in the West Highlands. The causes are various. As usually happens, low diet and insanitary conditions stimulated rather than checked the natural fertility of the race. Especially in the Outer Isles, marriage was early and universal, barrenness almost unknown. The practice of sub-dividing crofts encouraged grown-up sons to marry and stay at home. The ravages of small-pox, which had formerly carried off large numbers, were checked by the spread of vaccination, to which the Highlanders took very kindly. The natural limits of the food supply were extended by the introduction of the potato, which in the last years of the eighteenth century provided one-half of three-quarters of the ordinary diet. At the same time the development of the kelp industry provided work and wages for large numbers of people. Population increased steadily until the famine of 1846, when the failure of the potato crop, combined with the previous decline of the kelp trade, produced a state of things no longer tolerable. A stream of emigration began, and population began to fall in all districts except Lewis, where it has been steadily increasing until the present day. The following abstract of census returns from 1755 to 1881 will show the scale of increase to 1846, and the subsequent decline.

[ABSTRACT.

ABSTRACT OF CENSUS RETURNS, 1755–1881.

Year.	Skye.	Lewis	Harris, the Uists, Barra, Benbecula.	Western Mainland of Ross.	Western Mainland of Sutherland.
1755	11,252	6,386	7,237	7,682	...
1791	14,470	8,371	10,808	11,557	5,206
1801	15,788	9,168	12,526	17,398	4,856
1811	17,029	10,092	14,371	14,111	4,781
1821	20,827	12,231	17,221	18,070	5,036
1831	22,796	14,541	17,490	18,476	6,279
1841	*23,082*	17,037	*18,553*	*19,010*	5,986
1851	22,532	19,694	16,274	18,351	5,717
1861	19,748	21,056	15,353	18,235	5,928
1871	18,151	23,483	15,973	17,088	5,585
1881	17,797	*25,487*	17,317	15,642	5,293

From this table some interesting facts emerge. In Western Sutherland, in spite of the clearances, the population shows but small variation throughout the period, the highest number (6,279) occurring in the decade 1831–41, and the lowest (4,781) in the decade 1811–1821. As might be expected the kelp-burning districts show the greatest increase. In Skye, Western Ross, and the Harris group, the population in 1841 was about 2½ times as numerous as in 1755, while in Lewis the numbers rose from 6,386 in 1755 to 25,487 in 1881. The fact that in Lewis the population continued to increase while in all other districts it was steadily falling, makes the difference between the totals for all districts in 1841 and 1881 less marked. In 1841 the total was 83,688; in 1881 it had not fallen below 81,536.

A few details of the increase of population in various parishes will not be without interest. In Kilmuir, a parish in N.W. Skye which has always been closely settled, the figures are as follows :—

Year.		*Population.*
1755	... ...	1,581
1791	... ...	2,060
1831	... ...	3,415
1836	... ...	4,000

For Tiree some interesting details of the increase in population, especially in connection with the sub-division of holdings, are given by the Duke of Argyll (Farms and Crofts in the Hebrides, p. 10). Between 1769 and 1802 the population rose from 1,676 to 1,776. In 1802 Mr. Maxwell of Aros made a report to the Duke upon the condition of the island. He found that 319 tenants had holdings too small to support a family, and recommended that 1,000 persons should emigrate. But in response to the anti-emigration policy of the Highland Society, the sub-division of large farms was proposed, and in the following year the farm of Balmartine was divided into 38 crofts of 8–10 acres. In 1822 Maxwell made a fresh report. Lands which had long been occupied by small tenants were now supporting 2,869 people, while the newly divided farms held 1,080.

By 1846 the population had risen to 5,000, thus showing a fourfold increase in 89 years. At this time there were 380 small crofts, nearly all with a rental of less than £10. Of these, 218 were rented below £5, and most of them had an annual value between £3 and £1, 10*s*. Between 1846 and 1850 the congestion was relieved by the emigration of about 1,000 persons to Canada. In 1851 there were only 3,706 inhabitants, while in 1881 this number had been further reduced to 2,700. The consolidation of crofts became now the policy of the proprietor, and its success may be judged by the following table :—

Year.	Crofts under £5.	Crofts between		
		£5–£10	£10–£20.	£20–£50.
1846	218	102	38	5
1880	34	68	72	26

In 1880 not only is there a far smaller proportion of holdings in the lowest class, but the total number of holdings has fallen from 363 to 200.

INSECT PESTS.—No. I.

R. Stewart MacDougall, M.A., D.Sc.

Insects injurious to Farm Animals.

The chief insect pests of animals are embraced in four Orders, viz. the true Flies (*Diptera*); the Fleas (*Siphonaptera*); the Sucking Lice (*Anoplura*) and the Biting Lice (*Mallophaga*) often called the Bird Lice, for birds are their commonest hosts. In this article it is not proposed to include such insects as wasps and bees, which on occasion sting domesticated animals.

Flies: Order Diptera.—Flies are two-winged insects, the two wings being borne by the second segment of the thorax; the next thoracic segment carries a pair of balancers or halteres which are complex sensory organs. The mouth-parts of dipterous insects are fitted for a liquid diet; in the blood-sucking flies the mouth-parts are modified for piercing and sucking; in other flies the mouth-parts are not piercing, and such flies suck up honey or other liquid food. In a few exceptional cases the mouth-parts of the adult are so degenerate that the flies cannot feed at all. In all flies the metamorphosis is complete; that is, all flies have four stages in their life-history, viz. an adult sexual stage, an egg stage, a larval or chief feeding stage—often in this order known as the maggot stage and a resting pupal stage during which the changes are being completed which will result in the adult fly. No true fly possesses a sting in the sense in which bees, wasps and ants have stings, any pain inflicted by the adult being due to the mouth-parts.

A complete review of flies troublesome to animals would include the mosquitoes or gnats, the midges, and the black flies or buffalo gnats. These three families contain blood-sucking species, of much greater economic importance abroad. Here we limit ourselves to the true gadflies, the bot flies, the sheep-maggot fly family, and the sheep ked family.

Gadflies or Tabanidæ.—The flies of this family (Fig. 1), sometimes known also as breezeflies and horseflies, are rather large or bulky flies which are creatures of the sunshine. The head is large and in the male is almost completely taken up by the two compound eyes, which actually meet; in the female there is a space between the two eyes. A helpful mark of the gadfly family to any interested student is the nature of the antennæ; these are two small projecting structures which under

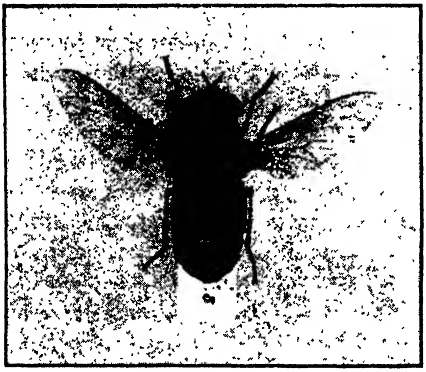

Fig. 1.

Tabanus (from a specimen).

the microscope are seen to consist each of three varying joints, the third joint being made up of several incomplete rings. The mouth-parts are formidable, well adapted for stabbing and cutting; two dagger-like piercers, two sharp-pointed lancets (mandibles), and two pointed barbs with saw-like edges (maxillæ) lying in a coarse fleshy or leathery labium; a short hairy sensitive palp with swollen end-joint hangs on each side of these parts. The mouth-parts of the male are less formidable, the males nourishing themselves on honey, honey-dew, and plant juices. The females, for a meal of blood, pierce hide or clothing and skin. The loud hum of a large Tabanus and the following wound make stock stampede. The narrower clegg has a more stealthy approach. It is to shake off these and other flies that the muscles of horses and cattle keep contracting, while the tail is brought into play as a fly-brush or fly-switch.

It is only in the adult flying stage that the Tabanidæ come into relation with farm animals or with man. The eggs are laid on plants growing in wet places or in some situation near moist soil or water. The larvæ that hatch are carnivorous in diet, feeding on grubs, worms, and such animal life as they meet with in their habitat. Fig. 2 shows the larva of a large African species; the body is elongated and tapers to the two ends; the head has jaws—mandibles and maxillæ—fitted for seizing and holding the prey; eleven joints follow the head, the abdominal ones being encircled by fleshy projections most prominent on the under surface, where they aid in locomotion. The full-fed larva pupates in the soil near its feeding-place.

The best known Tabanid with us is probably the clegg (*Hæmatopota pluvialis*—the first name means blood-drinker), a somewhat narrow half-inch-long fly with speckled wings and wonderfully coloured eyes. The clegg is specially prevalent in the neighbourhood of woods and marshes; it takes full toll of blood from men and horses. I have more than once been asked if the frothy spittle-like collections found sticking to grass and other herbage are not due to the clegg. This so-called witches' spittle or cuckoo-spit if examined will be found to enclose the immature stage of an insect; but this insect, the Frog

Fig. 2.
Larva of Tabanus biguttatus.
From nature. Natural size.

Hopper, has no connection with the clegg; it belongs to the same order as the aphids or green flies.

The gadflies with their power of come and go and their active flight are not easy to fight. Repellents—liquids with an odour unpleasant to the flies—are sometimes tried and are more or less successful until the odour goes, as, in the open, it soon does. A correspondent, in September 1919, recommended a few drops of oil of white birch on a hat or ribbon or on a rag tucked in a hat-band as a preventive against midges and other flies. I have recommended this for trial on a number of occasions against blood-sucking flies, and reports made to me have been all in favour.

The Family Muscidæ.—In this family, which contains the house fly (*Musca domestica*), we have some very harmful species, either by blood-sucking, or by acting as agents in the spread of disease or for both reasons; or again the larva may be the cause of the trouble.

The Stable Fly (*Stomoxys calcitrans.* Stomoxys means sharp mouth).—Here it is the adult fly which is the cause of trouble. Its mouth-parts are quite different from those of the gadflies, but there is a very efficient modification for piercing. The stiff, slender proboscis projects horizontally in front of the head; the wound is made, in this fly, by the lower lip or labium, at whose tip are cutting teeth; the rest of the labium is gutter-like, and the blood from the wound made by the tip of the labium flows up the gutter into the mouth; the gutter is closed above by certain other mouth-parts, but mandibles and maxillæ are absent. Farm workers, horses and cattle suffer much from these flies; the hard proboscis can go through clothing and skin. The ordinary house fly (*Musca*) has a soft proboscis which cannot inflict a wound; when one is "bitten" indoors by a fly, *Stomoxys* is the culprit and not *Musca domestica*. The latter, though not a blood-sucker, has grievous sins to answer for on account of its disease-spreading habits.

The stable fly (Fig. 3) measures just over a quarter of an inch in length, and half an inch in spread of wings; the proboscis is

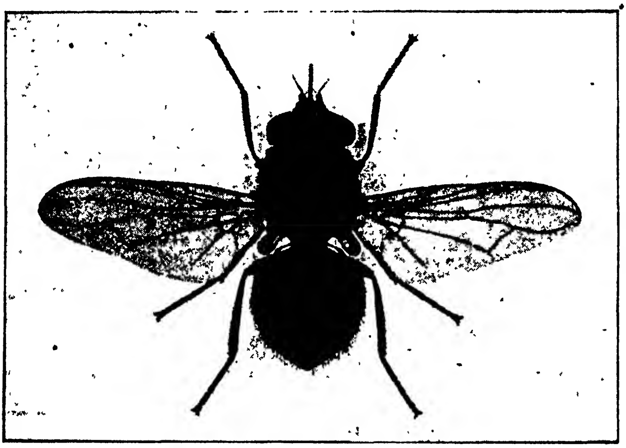

FIG. 3.
Stomoxys calcitrans.
Female magnified (after Austin).

dark-brown or black; the thorax is darkish grey with four dark stripes down it; the abdomen is greyish yellow-brown with dark spots on the upper surface except on the last joint. The flies may be seen in numbers about stables and cowsheds and resting on gates and rails in pastures. They may come into houses for shelter from cold or coming rain. The females lay their eggs in manure but perhaps more willingly in decaying straw or rotting plant material, e.g. in heaps of mown grass left lying or on grain that has been left over at the bottom of a feeding trough and has begun to ferment. The elongated curved eggs are laid in clusters and hatch in a day or two. The larva is a white, legless maggot with pointed head end and thicker, blunt hind end; on the hind face of the last joint and nearer its upper edge are three somewhat triangular horny plates. Under the microscope three slits are visible on each plate; these slits are for breathing purposes, and are in association with two other respiratory structures, one on each side, behind the head. The full-grown maggot measures over a quarter of an inch. The maggot is a scavenger, nourishing itself on the fermenting material in which it lives. The length of larval life depends on the conditions; it may be completed in about three weeks, but in Newstead's[1] experiments with larvæ fed on partly-dried food and some light admitted, the larval life extended to 78 days. The full-fed maggot pupates under cover of its last dry and hardened moulted skin, this puparium or pupa-case being barrel-shaped and brown in colour. The whole life-cycle can be completed in a month, but is much lengthened out in unfavourable environment.

Although *Stomoxys* is named the stable fly it can be abundant quite away from stables. Unlike the house fly, its presence near stables is not for egg-laying purposes in the excrement but for

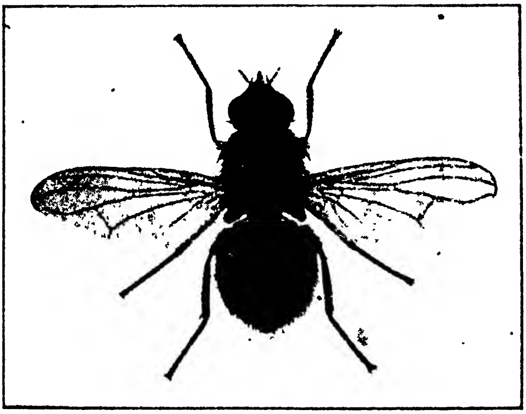

FIG. 4.

Hæmatobia stimulans.
Female magnified (after Austin).

feeding purposes. In 1926, from two different parts of Scotland, complaints came regarding the blood-sucking habits of *Stomoxys* in byres and in the fields to workers and stock alike, and there is no doubt that in hot weather the flies can be a pest.

The best control measures are the removal of the materials described above as the favourite egg-laying places of the fly, or where immediate removal is impracticable, the heaps or collections of material for egg-laying should be spread out thinly so that drying would be rapid. Larvæ cannot complete their growth in dry material nor will eggs be laid in it. Bishopp[2] has shown that *Stomoxys* breeds willingly in such wet hay or straw as may be allowed to lie or collect at the base of stacks. Where exposed manure with a considerable admixture of straw has been used for egg-laying, it should be sprayed with powdered hellebore in water. The formula is powdered hellebore 3 lbs., water 10

[1] Newstead, R., 1907, Ann. Trop. Med. and Parasitology, vol. i, p. 76.
[2] F. C. Bishopp, 1913, The Stable Fly, an important Live Stock Pest, *Journ. Econ. Entom.*, vol. 6, No. 1, pp. 112-127.

gallons, stirred well and allowed to stand for twenty-four hours before use. This quantity suffices for 10 cubic feet of manure. The spray fluid kills larvæ, and experimentally, in the United States, has been proved harmless to the dung for manurial purposes.

In samples of flies reaching me as annoying stock, *Hæmatobia stimulans* (Fig. 4) is sometimes represented. This is another blood-sucker related to and very like *Stomoxys*. The student of flies distinguishes it as having a smaller head and a pair of orange-coloured palps[1] as long as the proboscis; in the *Stomoxys* the palps are very short.

The Sheep Maggot Fly (*Lucilia sericata*).—This is one of the greenbottles close in relationship to the so-called bluebottles of the genus *Calliphora*. A number of farmers are inclined to the view that in Scotland it is the bluebottle fly which is the chief cause of sheep maggot. In the years 1905 to 1908 I undertook on behalf of the Highland and Agricultural Society[2] an inquiry into this matter. Maggots from live sheep, taken at work in every county in Scotland save Sutherland, Nairn and Renfrew, and from the northmost counties in England, were fed by me on mutton, and the adult flies bred out for examination. In every case save six the pest proved to be *L. sericata*. In these six cases the fly proved to be the bluebottle, three times working by itself and three times associated with the greenbottle. The greenbottle (*L. sericata*) was also bred out from maggots taken from a horse's leg that had been fired and blistered, and from maggots on a stirk suffering from angleberries on neck and withers. Where carrion abounds the greenbottle (*L. sericata*) is a true carrion feeder like the blueflies, but competition is keen in our country among the carrion feeders, and *L. sericata* has changed her normal habit and taken to laying her eggs on live sheep.

The glossy or brassy green fly (Fig. 5) lays her eggs on the wool of the sheep, in clusters of twenty or more. These soon hatch; the maggots feed at first externally, and then by aid of their mouth-hooks break into the flesh. When full fed the maggots leave the wound, drop to the pasture and, entering the soil, pupate. In my various breeding experiments, the whole life-cycle from adult to adult in very favourable conditions was completed in from 25 days to a month, but considerably longer times were common. By June, in an ordinary season, the *sericata* maggots can be found at work; attack is at its height in August; the bad period for the farmer extends from the middle or end of July to the beginning of September. No breed or class of sheep escapes.

That sheep are affected may be recognised by a continual wagging of the tail, a rubbing and biting by the sheep in their efforts to allay the irritation, a looking back over the shoulder, the matting of the wool fibres, the oozing from the sores of an

[1] Palps are sensory structures forming part of the mouth apparatus.
[2] Transactions of the Highland and Agricultural Society of Scotland, 1909.

evil-smelling sticky fluid, discoloration of the wool where the maggots are at work and a falling out of the wool. In neglected cases there is a rapid loss of condition and, it may be, death.

Control.—The careful shepherd is a treasure, with his constant oversight and revision of the sheep. Sheep should be

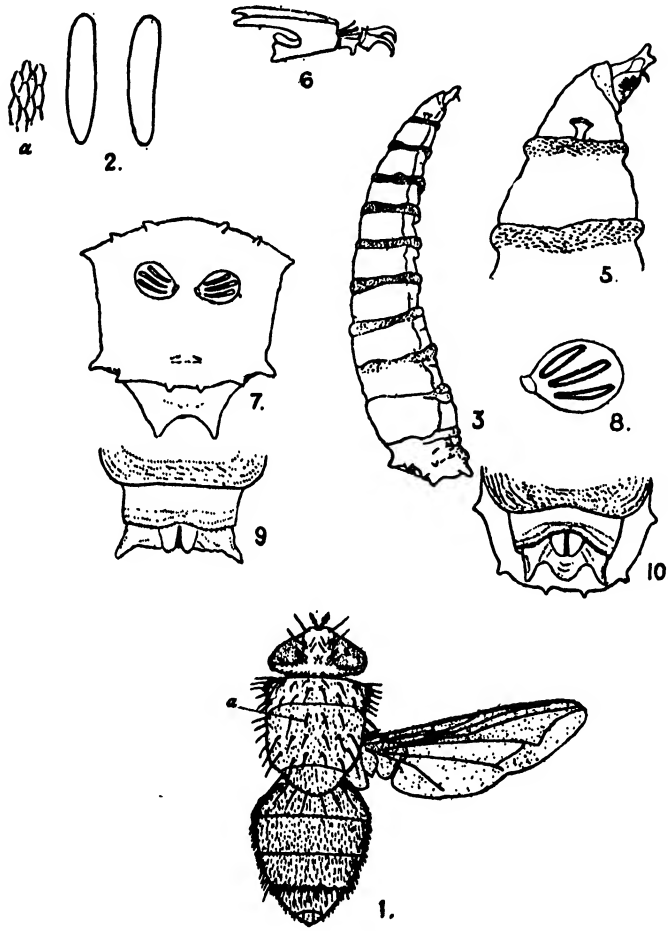

FIG. 5.

Lucilia sericata. (Professor Carpenter's Figure.)

1. L. sericata female (four times natural size). 2. Eggs (ten times natural size. a=sculptured surface of egg). 3. Larva from side (four times natural size). 4. Larva from above (four times natural size). 5. Head end of larva showing on joint behind head a fan-shaped spiracle (twelve times natural size). 6. Mouth armature of larva (twelve times natural size). 7. Tail end of larva (twelve times natural size). 8. Right spiracular plate (twenty-five times natural size). 9. Tail end of larva from beneath with protruded anal region (sixteen times natural size). 10. The same with anal region retracted (sixteen times natural size).

kept as clean as possible, with the free use of the sheep-shears about the hindquarters to remove wool that may be filthy, or any dried blood or discharges which may remain attached to the wool after lambing. The purpose is to prevent the fly from being attracted by odours. In cases where the flies abound perfectly clean sheep are " struck," and the egg-laying is not confined to the hindquarters. Some good observers are inclined to blame the starling for the increase of sheep maggot. Starlings, which in recent years have increased enormously in numbers, settle on the back of the sheep and search for insect parasites. The starling excrement is left behind and it is possible that the flies may be so attracted.

Apart from the ordinary farm practice of dipping, flockmasters are forced to dip for maggot alone. Proprietary and more or less local dips are common and satisfactory, but unfortunately protection does not last for long. Maggots should be picked off or rubbed off where they have got to work; the wool may be shorn a little and the affected parts dressed with a mixture of turpentine and rape oil in equal parts, finishing off with a dressing of sulphur. There are some proprietary oils which effectually kill the maggots and serve to keep the fly off for a short time. Sometimes to prevent the work of maggots behind the horns of rams oils are used, e.g. olive oil or pitch-oil, and then the oiled parts are dusted with sulphur.

There is some help from nature. In experiments with bluebottle larvæ,[1] on several occasions I found the maggots parasitised by the larvæ of a four-winged insect of the wasp order. From such parasitised material I bred out the adults—both males and females. The species proved to be *Alysia manducator*, which is also a parasite of the greenbottles. At present special efforts are being made in Australia to combat sheep maggot, and numbers of this parasite have been reared in Britain and have, under the auspices of the Imperial Bureau of Entomology, been despatched to Australia for breeding and liberation against *L. sericata* and related species.

Bluebottles.—There are two bluebottles or blow flies in Britain, *Calliphora erythrocephala*, which has red cheeks and a black beard, and *Calliphora vomitoria*, which has black cheeks and a red beard. I have stated above that sometimes the bluebottle lays her eggs on live sheep. To distinguish between the maggots of the greenbottle and the bluebottle requires the use of the microscope, for careful comparison of the spiracles of the maggot. The microscopic differences are outwith the purpose of this article, but it may be said generally that as far as naked eye examination goes the maggots of the bluebottle are larger and are more surface feeders. In real habit, however, the bluebottles are true carrion feeders or scavengers, laying their eggs on dead animals. In experiments regarding the life-history done in August and September, both species of bluebottle completed their life-cycle in from 29 days to 32 days, the larval or maggot stage occupying 11 or 12 days of this time.

Tsetse Flies.—These notorious flies of the genus *Glossina* belong to the family *Muscidæ*. None of them are British, and so receive short notice here. They are typically African species, of great importance to man. Both sexes are vicious bloodsuckers, the mouth-parts resembling in general those of the

[1] Transactions of the Highland and Agricultural Society, 1910.

stable fly and of the sheep ked (see later), but their chief importance lies in the fact that several species are the carriers of minute animal parasites (Protozoa) which, introduced into the blood system of man and domesticated animals, are the cause of dread diseases. Thus sleeping sickness of man, and nagana, a fatal disease of the horse and other domesticated animals, are two such diseases. The protozoan parasite, reaching the blood stream and the nervous system of man or domesticated animal, causes death; so far these two diseases are without certain cure. The tsetse flies concerned are not just carriers as a porter carries and delivers luggage, but some necessary stages in the life-history of the protozoan parasite are passed in the body of the tsetse fly before conveyance for infection to a man or other animal.

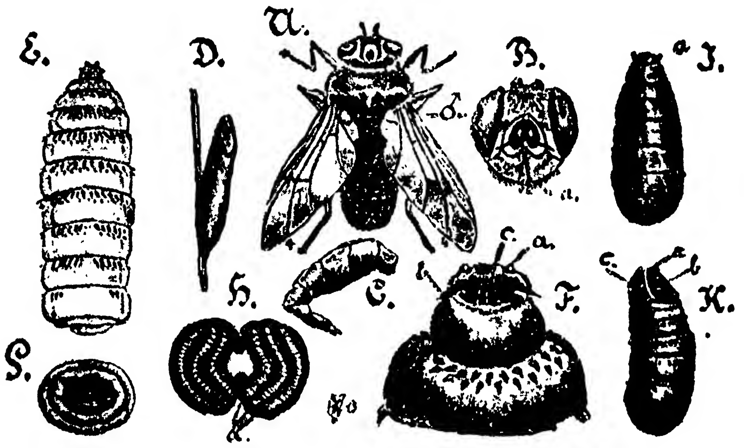

FIG. 6.

After Nitsche. Gastrophilus equi.

A. Male (twice natural size). *B*. Head, showing space between the compound eyes. *C*. Abdomen of female, showing ovipositor. *D*. Egg on hair (magnified). *E*. Larva (magnified). *F*. Head end of larva magnified to show (*a*) antennæ; (*b* and *c*) mouth hooks for attachment of larva. *G*. Last joint of larva from behind. *H*. Spiracular plates at hind end of larva (magnified). *I*. Pupa case. *K*. Pupal case from side to show opening by which the fly issues.

The Oestridæ or Bot and Warble Flies.—This family of moderately-sized flies is interesting because of the parasitism of the larvæ. The flies themselves have such reduced mouth-parts that they do not feed. They therefore offer a distinct contrast to the blood-sucking Tabinids. The Oestrids also make stock stampede, but by their buzzing note and by their come and go as they attempt to lay their eggs. Here we shall notice three kinds, one typical of each section, viz. the horse bot fly, whose larvæ are parasitic in the alimentary canal, the ox warble fly, whose larvæ are finally parasitic in the backs of cattle, and the sheep nasal fly, whose larvæ are parasitic in the nostrils of the sheep.

The Horse Bot Fly (Fig. 6) (*Gastrophilus intestinalis* or *equi*). —This is a widely distributed fly in Britain and Ireland. It is a thick-set yellowish-brown fly measuring from half to about two-thirds of an inch in length. The male has the end of the abdomen rounded; the abdomen of the female ends in a pointed ovipositor.

In summer and autumn the females lay their eggs on the hairs of the horse on places likely to be licked and easily reachable by the tongue. Collinge[1] has given a good description of the egg, noting its attachment to the hair by " a pair of lips or valves which close round the hair "; a cement aids in the attachment. At the attached end the egg is pointed, at the free hanging-down end, truncate, and at this free end there is a lid or cap whose edge overlaps the egg. The egg in this species is attached for

FIG. 7.
Larvæ of G. equi attached to stomach.
From nature. Natural size.

about a half of its length. The eggs hatch in a suitable temperature, in the presence of moisture, aided it may be by the friction of the horse's tongue or lips. The maggot conveyed to the horse's mouth may reach the stomach directly, or may first enter the lining membrane of gum[2] or lip, to reach the stomach later. The larvæ fix themselves to the lining membrane of the stomach by means of prominent mouth-hooks and feed on the inflammatory products. The larvæ of this species of horse bot fix on the first or left half of the stomach, this part being non-vascular and non-digestive; when the larvæ are in large numbers, they are

[1] Journal of Economic Biology, 1910, vol. v, part 1, Some Observations on the Eggs of the Horse Bot Fly, by W. E. Collinge.

[2] E. Roubaud, Auto-inooulation et developpment-primaires dans les muqueses buccales, de la larva du Gastrophile équin. C.R. Acad. Sciences, Paris, clxiv., 1917 pp. 453–456.

found more distributed over the stomach. In nine to ten months the full-grown larvæ leave go, pass along the alimentary canal and drop to the outside in the excrement. In shelter in the pasture or on the surface layers of soil the larva pupates and the fly comes away in a month to six weeks. There is one generation in the year.

A second species, *Gastrophilus hæmorrhoidalis*, darker and smaller, lays its eggs, which are stalked,[1] on the hairs of the lips,[2] and the larvæ reaching the alimentary canal attach themselves to the vascular end of the stomach, interfering with digestion, and later to the rectum where they may interfere with the passage of the fæces.

The amount of digestive disturbance depends on the number of larvæ present in the stomach and the region where they are fixed. Diagnosis is difficult from external symptoms; there is more certainty if the larvæ show in the fæces. Some veterinary surgeons are inclined to look upon bot larvæ as negligible, while others advise the giving of a dose of so-called bot medicine to every horse about October. A common treatment now in some districts is the administration of bisulphide of carbon in gelatin capsules. The dosage depends on the age and strength and kind of horse, and is best left to the veterinary surgeon. Reports made to me from various sources describe this treatment as satisfactory.

The Sheep Nasal Fly (*Oestrus ovis*).—This fly is a pest in some parts of England. I have no experience of it in Scotland. The females lay their eggs or live young larvæ inside the edge of the sheep's nostrils. Sheep show great uneasiness in the presence of the fly, racing over the pasture, tossing their heads, and beating the ground; they also collect together with noses to the ground in their endeavour to ward off the fly. Once in the nostril the larvæ ascend by aid of their mouth-hooks to fix themselves in the frontal sinuses. Here for a number of months the larvæ live, nourishing themselves on the serous exudate, the result of their presence and wounding. Both during their passage up the nostril and while *in situ* the fly larvæ are the cause of considerable irritation. The full grown larva leaves the nostril and pupation takes place in the soil.

AGRICULTURAL SURVEY OF FOUR PARISHES in the SOUTH of SCOTLAND.

(Continued.)

In the last issue of the Journal a summary was given of the reports on the agricultural survey of two parishes in Berwickshire, of which one was in an upland sheep district and the other in a more fertile lower district devoted partly to grain growing

[1] Bracy Clark, Observations on the Genus Œstrus. Trans. Linn. Soc., London, III, 1797.

[2] Hadwen and Cameron, A contribution to the knowledge of the Bot Flies. Bull. Ent. Research, vol. ix, part 2, Sept. 1918.

and partly to the production of cattle and sheep. The reports on the other two parishes embraced in the survey are summarised below. Parish C is in Dumfriesshire and was chosen as including various characteristic types of mixed farming, while Parish D is in Wigtownshire and can be regarded as typical of a large area of the dairying and cheesemaking districts in the south-west. In considering the reports it has to be borne in mind that the surveys were carried out in the spring and early summer of 1927.

Parish C.

The report deals with the agriculture of 33 holdings, of which one was under 50 acres, three between 100 and 150 acres, 16 between 150 and 300 acres and 13 over 300 acres. Except in the case of a small hill sheep farm, a proportion of the land on each of the holdings was cultivated and mixed farming of various types was carried on. One feature common to every holding was that sheep were kept. On 14 holdings there were dairy herds.

The reporters were in all cases readily supplied with information, and while the number of farms was too small for any definite conclusions to be drawn as to the returns from the different systems of farm management practised, the results arrived at by the reporters are of considerable interest. Speaking generally, in no case could it be said that over the two years 1925 and 1926 a satisfactory return was obtained. On only 30 per cent. of the holdings was a small margin of profit left after keeping the house going, insufficient to represent a return for management alone. Had it been necessary to pay a wage for work done by the tenant's family (the tenant excluded), then on only 10 per cent. of the farms would even a small margin of profit have been obtained. On 30 per cent. of the holdings the occupier and his family received only board and lodging or part thereof in return for their labour. On 21 per cent. the occupier and his family either received no return whatever for their labour or in some cases had a small loss. On the remaining 19 per cent. of the holdings a decided loss was incurred.

As already noted sheep were carried on every holding, and as this department showed a fair return it was the mainstay of the holdings. The results would appear to indicate that with a fair stocking of sheep and assuming good management :—

(1) Where a dairy stock was carried and no other cattle were kept a small margin of profit was obtained;

(2) Where a dairy stock was carried and cattle were bred for sale as stores, &c., there was no serious loss;

(3) Where cattle were bred for sale as stores, &c., or where only a few home-bred bullocks were fed, there was a reasonable opportunity of making ends meet;

(4) Where most of the home-bred bullocks were fed there was a loss in every case except one;

(5) Where cattle were purchased for feeding there was a loss.

In the last three groups no dairy stock were kept.

In considering the fluctuations in prices since 1912 the reporters bring out the result that while the main items of revenue, with the outstanding exception of sheep, have declined generally to about pre-war figures, the main items of expenditure still show a marked increase over pre-war figures, particularly in the case of wages.

The reporters state that the general standard of management compared very favourably with other districts, though there were wide variations in efficiency and production. The holdings were classified according to the general standard of management as follows :—

	A	*B*	*C*
No. of Holdings	10	18	5

Crops.—The most common rotation was a 6 or 7 course, lea corn being followed by turnips and potatoes, sow-out corn, hay, and two or three years' grass. In two cases a 5 course rotation was followed, while there were several cases of 8 and 9 course rotations. As in other districts there was difficulty with the lea corn owing to the widespread diffusion of wild white clover, and alternative systems of cropping were being earnestly considered. In recent years there had been a tendency to have more land in grass.

Oats was the only grain crop of any importance. Except on the poorer soils it was not customary to manure the lea corn, but a small top-dressing of sulphate of ammonia and superphosphate was often given to the sow-out crop.

Turnips and Swedes.—Great reliance was placed on this crop and it was well treated. The farmyard manure was nearly all carted in the autumn on to the stubble and ploughed in. In addition artificials at the rate of about 5 to 8 cwts. per acre were applied in the drill, the artificials consisting mainly of superphosphate and sulphate of ammonia, with perhaps some kainit, bone meal or slag. Except in outstanding cases of lime scarcity the crops were healthy, showing no finger-and-toe nor dry rot. The average crop would be about 16 tons per acre.

Potatoes.—Only a very small area, less than 100 acres, was devoted to the growing of potatoes, mainly for home consumption. The potatoes were usually dunged in the drill and artificials to the extent of about 6 to 7 cwts. applied at the same time. Kainit or potash manure salts were applied in conjunction with superphosphate and sulphate of ammonia.

Hay and Pasture Land.—Rye-grass and meadow hay formed an important crop in the parish, considerable quantities being sold in a normal year. Perennial rye-grass was the principal constituent in most of the grass seed mixtures, up to two bushels per acre being used, although there was a tendency to sow increasing quantities of cocksfoot. In only one case was wild white clover not sown. With the exception of one case, mixed grass seeds were purchased, a practice which is deprecated by the reporters. It was not customary to top-dress the rye-grass, although in backward years a little sulphate of ammonia was sometimes given. Considerable quantities of meadow hay were grown, but none of very great quality, as most of the meadows needed draining.

On about 30 per cent. of the holdings the pasture could be classed only as fair and on 16 per cent. it was poor. On the remainder of the holdings the pasture was good, some excellent soles of grass and clover being found. More attention was being paid to the treatment of grass land, both temporary and permanent, and in many cases artificial manures were applied, but there was ample scope for further improvement.

Live Stock.—*Dairy Stock.*—On 14 out of the 33 holdings there were dairy herds, the sizes of the herds being as follows :—

No. of Cows.	*10–20.*	*20–30.*	*30–40.*	*40–50.*
No. of herds	4	2	5	3

On 12 farms the milk was sent to a creamery all the year round, the cows being calved regularly throughout the year except during June, July and August in order to maintain as regular a supply of milk as possible. On one farm cheese was made, the cows being calved at the beginning of March with a view to the bulk of the milk being produced during the summer months, milk being sent to the creamery for six or seven weeks in the autumn and again for a short time in the spring. In four cases the dairy herds were worked by the farmer's family with extra milkers, while in eight cases a dairyman or cattleman or cattlewoman was employed. In the other two cases the dairy was let to a family. The average milk yield of the herds varied from 560 gallons to 790 gallons per cow, the difference in the return for milk actually sold to the creamery amounting to almost £11 per cow per annum. The owners of three herds were members of the Scottish Milk Records Association, the cows in respect of which milk records were kept being 20 per cent. of the total cows in the parish. On two farms 56 cows were being definitely rationed according to yield, on eight farms the heavier yielding cows were given more than the lighter yielding cows, while on the remaining four farms no attempt was made to ration according to yield.

Cattle Breeding.—Apart from the rearing of a sufficient number of heifer calves to maintain the dairy herds, cattle were bred and reared for sale on most of the holdings, in some cases the rearing of cattle being combined with the dairy herds. On farms where cattle were reared it was a fairly general practice to make some butter for sale. The system of management varied considerably. On some farms all the home-reared bullocks were fattened, on others breeding predominated and only a few bullocks were fattened, while on others the feeding of cattle predominated, additional store cattle being purchased for fattening. On two farms all the feeding cattle were bought in.

Sheep.—A good class of tup was used and the sheep were generally well managed. On the lower farms where fat lambs or turnip-fed hoggs were sold the practice was to give the ewes feeding stuffs from December until the middle of May and turnips for about six weeks before lambing. On the higher farms the ewes generally received turnips for about six weeks before lambing, or if turnips were scarce, bruised oats, &c. were given, the majority of the lambs being disposed of at the autumn sales. Where regular stocks of sheep were carried four crops of lambs were generally taken, and the ewes were either sold as store sheep for feeding or were fed off on turnips; in some cases where ewes were sound in the mouth they were sold as cast ewes for a further crop of lambs. The health of the sheep stock was a matter of some concern, the greatest losses being caused by fluke. A considerable part of the trouble could be attributed to neglect of the rough land, both in regard to draining and burning, while the heavy sheep stocking on some of the lower farms probably accounted for some of the losses. So far as the reporters could learn the recently suggested method of treatment by carbon-tetrachloride or of prevention by the application of powdered copper sulphate to the land had not been tested locally.

Pigs and Poultry.—Except on the cheese farm, only a few pigs were kept. Poultry were not as numerous as could be desired, but an increasing interest was being taken in this branch. As a general rule eggs were sold to the grocers, and at the time of inspection poor prices were being obtained. There is little doubt that the industry could be enormously developed if the marketing of the produce were organised.

Labour.—For married ploughmen the cash wage varied from 32*s*. to 42*s*. per week, with perquisites valued from 2*s*. 3*d*. to 8*s*. 6*d*. per week. Single ploughmen's wages ranged from 22*s*. 6*d*. to 43*s*. per week, the average being about 28*s*. Odd men were paid about 30*s*. and boys about 20*s*. per week. Married cattlemen were paid slightly better than ploughmen, some being paid up to 50*s*. per week, while single men received about 27*s*. Married shepherds and married dairymen rarely received more than 50*s*., but many were paid about that level. Casual women workers received a shilling or two over 20*s*. The average length of day worked was ten hours. Employers as a whole were well satisfied with the class of labour.

Drainage.—It was estimated that over 10 per cent. of the arable and permanent grass land and 25 per cent. of the hill land required draining. On several farms a good deal of work had recently been done under the Board's schemes. The cost of draining per acre would be from £8 to £10, 10*s*. for labour and from £9 to £11 for tiles according to the depth and width of drains and the nature of the soil, and assuming that new tiles were required throughout.

Liming.—As in the case of the Berwickshire parishes, the reporters relied chiefly on the " Soiltex " test, which indicated a serious lack of lime. Over 86 per cent. of the arable and permanent grass land appeared to be decidedly in need of lime, but these results would require to be confirmed by more exact scientific tests. There was apparently an increasing appreciation of the necessity for applying lime and of the beneficial results obtained. It was found that the application of shell lime at the rate of 2 tons per acre had the effect of greatly improving the herbage and of making it available for grazing earlier in the season. The stock-carrying capacity of land so treated was greatly increased. The reporters recommend that the whole question of soil acidity and the application of lime should be further investigated.

Marketing.—Except in the case of milk, marketing was all done individually, live stock being sent to the local markets. In every case where milk was sent off the farm it went to a creamery with a retail milk trade in several large cities. A contract is entered into with the producers for a fixed minimum winter supply, which is two-thirds of the summer supply. Where the amount of summer milk supplied is in excess of the contract figure a price penalty is exacted. The price for three winter months only is fixed in the contract, and the prices for the other months are regulated according to the market. The prices per gallon in 1926–7 were as follows :—

1926.	*May.*	*June.*	*July.*	*Aug.*	*Sept.*	*Oct.*	*Nov.*	*Dec.*
	9*d.*	8*d.*	9*d.*	11½*d.*	1*s.* 0½*d.*	1*s.* 1½*d.*	1*s.* 1½*d.*	1*s.* 1½*d.*

1927.	*January.*	*February.*	*March.*	*April.*
	1*s.* 1½*d.*	1*s.* 0½*d.*	1*s.*	10*d.*

In most cases milk was delivered to the creamery, one or two of the smaller outlying farmers combining for this purpose.

Butter and eggs were chiefly sold to the grocers on a contra account for groceries supplied, the merchants having a double profit on the transaction. The prices obtained in the spring of 1927 for butter were about 1*s.* 6*d.* per lb., this being equivalent to about 7*d.* per gallon for the milk. The production of butter at this price could not be economic.

Education.—Generally the farmers spoke favourably of the work carried out by the Agricultural College, which takes the form of courses of lectures at various centres by the county lecturer or county instructress, with individual advisory work. The reporters express the opinion that much good could be done by the institution of simple demonstrations and experiments.

General Conclusions.—The enquiry revealed that while the general standard of farming in the parish, and particularly the management of sheep, compared very favourably with that in other districts, wide variations in efficiency and production existed and there was need for further investigation, supported by careful recording and accounting. Labour was generally efficient but more cottage accommodation was required, and many of the existing cottages should be improved. There was ample scope for improvement of both temporary and permanent grass land. According to the results of a rough field test there was a decided lime deficiency, and it would be of advantage if further investigation into this problem could be carried out. There was also need for much drainage work. Some of the dairy herds could be graded to give much better results, and it is suggested that an experimental scheme of advice on rationing might be tried. At the prices obtained locally for milk, dairy farming was self-supporting; the sale of butter was unprofitable. Sheep had been the mainstay of the district during the last few years. Cattle breeding was able to hold its own, but cattle feeding was unprofitable. There was room for development of the pig and poultry industries.

Parish D.

This parish, which is in Wigtownshire, was devoted almost entirely to dairying. The report deals with 54 holdings. Of these, seven were under 50 acres, eight between 50 and 100 acres, seven between 100 and 150 acres, 19 between 150 and 300 acres, and 13 over 300 acres. All the holdings were mainly arable, the cropping land being cultivated in regular rotation. Fifty-one holdings (of which six were under 50 acres) were dairy holdings, one carried Highland cattle and sheep, one was a led farm rearing stock for a dairy farm, while one was a holding (under 10 acres) on which calves were reared. The smaller tenants sent their milk to the creamery the whole year round; on the larger farms, where the quantity of milk was sufficient, cheese was made from the beginning of March until November or December.

Accurate financial results were available in a few cases, and a comparative analysis of these with the production and efficiency on the other holdings showed that on most of the purely dairy holdings a loss was incurred. On no holding would a satisfactory return have been obtained during the last two years. The reporters classified the holdings according to the general standard of management as follows :—

	A	*B*	*C*
No. of holdings	9	31	14

Crops.—The rotation followed was either a 6 or a 7 course, lea corn, roots, sow-out corn, and three or four years' grass. Where a 6 course rotation was followed some of the farms were over-stocked in summer, the difficulty being obviated by summering young stock away. There were signs, however, that the existing rotations were not satisfying the more progressive farmers. Owing to the advent of wild white clover, the lea crop tends to become too heavy and to lodge, yielding excessive quantities of coarse straw and poor grain. Some farmers were proposing to make a trial of other rotations, viz. roots, corn, sow-out corn, and four years grass; or lea corn, roots, sow-out corn, grass, grass, grass, hay, the last year's hay being top-dressed with sulphate of ammonia in a definite attempt to impoverish the soil before ploughing up.

Oats.—As noted above difficulty was being experienced with the lea corn. Potato oats from the Lothians was the variety usually sown, though for the sow-out corn some of the newer varieties, e.g. Besseler's Prolific, Crown, Fortuna and Victory were in favour.

Turnips and Swedes.—Almost one-eighth of the arable land of the parish was under this crop. It was cultivated in the usual manner, but dung was seldom applied, either on the stubble or in the drill. On the other hand, it was lavishly manured with artificials, ranging from 10 cwts. to 1 ton per acre. A typical dressing was :—

8 cwts. bone meal.
6 cwts. superphosphate (30 per cent.).
2 cwts. kainit.
1 cwt. sulphate of ammonia.

It was practically the only crop in the regular rotation which received artificial manure. For the few past seasons the crop had suffered severely from dry-rot, about 30 per cent. of the total crop in 1926 being lost from this cause. Investigation of the disease is urgently called for. Notwithstanding a loss of this magnitude, very few of the farmers feared a shortage, so that in years when the yield is good, which is the rule, and when the crop keeps well there must be a surplus of turnips beyond the actual requirements of the cattle stock and consequently a waste of feeding material.

Potatoes.—Of the 182 acres under this crop in 1926, over 100 acres were devoted to early potatoes for sale, the balance being for home consumption. Planting of the early potatoes usually commences about the middle of January and lifting about the last week of May. Most of the early potato land is sub-let to merchants who supply the seed and manure and lift the crop, the tenants doing only the horse work. On an average the merchants pay a sum of £25 per acre.

Hay and Pasture Land.—Of the 6,000 acres of rotation and permanent grass land in the parish only some 200 acres were normally cut for hay. The grasses mostly in favour for sowing were perennial rye-grass, Italian rye-grass, cocksfoot, meadow fescue, rough-stalked meadow grass and timothy, and the clovers, broad-leaved English red, late flowering red, alsike and wild white. Generally speaking, too much perennial was sown, as much as two bushels per acre in some cases. In total quantities of seed per acre there was abundant evidence of oversowing, between 50 to 60 lbs. per acre being quite common. With only one or two exceptions the seeds were purchased ready mixed. All the dung made on the farm was almost invariably put on the second year's grass. Apart from this dressing, the rotation grass in some cases received dressings up to 10 cwts. per acre of basic slag, such application, especially on the boulder clay, being attended with good results. Insufficient attention was being paid, however, to the treatment of both temporary and permanent grass as regards seeding, manuring, general grazing, management, attention to drains, &c.

Live Stock.—*Dairy Cattle.*—On 51 holdings a dairy stock was carried, the cows in all cases being Ayrshire. On 31 holdings the herds ranged from 25 to 100 head, while on eight holdings there were over 100 head in the herds. The general practice in the case of the larger herds was to let the working of the dairy to a dairyman and his family, usually at a wage per cow and perquisites, the dairyman accepting full responsibility for all work in connection with the dairy stock, cheese-making, calf rearing and pigs, the farmer usually supplying one or two additional milkers. Generally calving commenced about the middle of February, the aim being to have the chief production of milk during the summer months when the cows were at grass, thus avoiding expensive winter feeding. Most of the cows were bred and reared on the farms. Heifers were bulled either at about 15 months, to calve in February, or at about 24 months, to calve about December, the latter system being, if anything, more general. On the whole it appeared to the reporters that the earlier maturing system was to be preferred, but in view of the many factors involved they suggest that further investigation is desirable.

In only one herd were the cows rationed carefully according to yield, while in 15 cases a rough attempt at rationing according to yield was made. In the remainder of the herds all the cows received the same ration. Only in the case of eight herds, representing 15 per cent. of the cows in the parish, were milk records kept, while there were no herds tuberculin tested. Insufficient attention was paid to the selection of sires in many of the smaller herds and even in a few of the larger herds. The health of some herds was good, but on the whole there was a considerable loss from disease. In 1926, in 15 per cent. of the herds, one or more cows were cast for tuberculosis. Hoose in calves was very prevalent, and in the spring of 1927 there were in one or two cases serious losses in calves owing to scour. Abortion had been serious for some years but some improvement had taken place.

The estimated average herd yields are shown in the following table :—

	Below 500 gallons.	*500–600 gallons.*	*600–700 gallons.*	*Above 700 gallons.*
No. of herds ...	5	23	14	9
Percentage of herds	10%	45%	27%	18%

From these figures it will be seen that there is ample scope for improvement.

Cheese was made on 32 holdings. On 20 of these winter milk was sent to the creamery from about the beginning of November until the first week in March, while on the other 12 butter was made for a short time in the spring until a sufficient quantity of milk was available for cheese-making. The milk from 18 holdings was sent to the creamery all the year round, while in the case of the remaining holding all the milk was retailed. The cheese made was either Cheddar or Dunlop. Discoloration of cheese was very common in the parish, the losses from this cause being considerable. The problem was under investigation by the West of Scotland Agricultural College.

Pigs were kept on 45 holdings, mainly on the cheese-making farms, there being about 150 breeding sows in the parish at the time of inspection. The care and management of the pigs was largely in the hands of the dairyman, who was usually paid a bonus of 6*d*. per pig reared, and 1*s*. per pig fattened. It was therefore in the dairyman's interest to fatten the pigs as speedily as possible and get another lot in. The result was that a wasteful system of feeding was adopted. The pigs generally got as much meal (Indian meal and thirds) as they could consume along with the whey. In few cases did the farmers control the quantity of meal fed per pig.

Sheep.—On only seven farms were ewes carried, and the reporters were of opinion that the number of sheep could be augmented considerably with advantage.

Poultry.—The statistics showed that there were only about 130 birds per 100 acres of arable land. The class of bird kept was not high, and they were mostly housed in or about the farm steading. There is room for development of this branch.

Labour.—Married ploughmen were receiving generally about 41*s*. per week, including value of perquisites, although as high as 47*s*. was paid. The average wage of a single ploughman was about 27*s*. 6*d*. The average wage for a dairyman and two workers, including all perquisites, over a number of farms was £3, 9*s*. 10*d*. per week, the lowest being £2, 18*s*. 6*d*. while the highest was £4, 1*s*. 6*d*. Married cattlemen were receiving about 37*s*. 6*d*. per week, including perquisites. The average length of day worked by the outside staff was ten hours, but a few worked only nine hours. The class of labour on the whole was good.

Drainage.—In recent years considerable repair had been done to old drains, but very few fresh tiles had been laid. About 20 per cent. of the arable and permanent grass land still required attention, either by way of repair of the existing drains or by redrainage, while about 27 per cent. of the rough grazing land would be improved by attention to open drains. The cost of drainage per acre would be from £6 to £10 for labour and from £8, 10*s*. to £10 for tiles.

Liming.—According to the "Soiltex" test, no less than 80 per cent. of the arable and permanent grass land was decidedly in need of lime. This condition was not apparent, however, from a botanical analysis, and further investigation into the question of lime hunger is called for.

Marketing.—The chief product marketed was cheese. In every case it was sold to merchants by private transaction, and as no grading was done the farmer was almost entirely in the hands of the merchants. There had recently been some talk of organising a grading centre but the proposal had a mixed reception. The makers of first class cheese feel that their product can command as good a price, if not a better, by private sale, and that they have nothing to gain by collective grading.

Other makers prefer to keep their affairs to themselves. There appears to be little doubt that if the cheese industry of the country is to compete successfully with imported cheese, standardisation of the product, collective grading, and organised marketing must be resorted to. A considerable amount of propaganda and education of the producer will be necessary before these objects are achieved voluntarily, although, unless there is a marked improvement in the financial results in the near future, serious consideration of the problem will be forced upon the producer by economic necessity.

The prices paid by the creamery for milk were fixed at the end of each month, and were based on the percentage of butter fat—a slight increase or reduction being made for every 0·2 per cent. variation from the standard figure. The standard prices per gallon in 1926 and the percentage of butter fat upon which they were based are shown in the following table :—

	Standard Price.	*Percentage of Butter Fat.*
January	1*s*. 1*d*.	3·6
February	11*d*.	3·4
March	9*d*.	3·4
April	7½*d*.	3·4
May	7*d*.	3·4
June	7*d*.	3·4
July	7¾*d*.	3·4
August	8*d*.	3·4
September	8¾*d*.	3·6
October	9*d*.	3·6
November	10*d*.	3·6
December	10*d*.	3·6

The creamery utilises the milk received as the market dictates, sometimes sending it off as whole milk, sometimes separating and sending off double cream, and in the case of summer milk converting large quantities into cheese.

Butter and eggs were sold mainly to grocers. The store pigs in many cases were supplied by merchants who later bought the fat pigs, the price of the stores often being quoted after delivery. There appeared to be a certain amount of financial accommodation in the arrangement.

Education.—Many of the farmers did not appear to understand the principles of manuring and feeding and the selection of grass seed mixtures, and further instruction in these subjects and simple experiments and demonstrations are desirable.

General Conclusions.—The outstanding features brought out as a result of the enquiry were the enormous variations in the efficiency and production of the various departments. While certain variations were due to causes outwith the control of the individual, e.g. differences in soil, there was no doubt that, assuming that sufficient capital was available, the chief factor was the efficiency of the individual farmer. The greater part of the land appeared to be decidedly in need of lime, and further investigation into this subject is recommended. About one-fifth of the arable and permanent grass land was in need of draining. The rough grazings were neglected and could be improved by regular burning and attention to open drains. The rotation in many cases might well be lengthened and the turnip break considerably reduced, while forage crops could be grown with advantage. Too much was left to the dairyman, who dealt with the most important revenue-producing department. The dairy herds could be graded up. The whole question of the pig industry required serious attention, while the poultry industry could be considerably developed. Education and demonstration in regard particularly to manuring, feeding and grass seed mixtures were urgently required. The buildings and water supplies in many cases were very poor and totally unsuited for dairying. The grading and organised marketing of cheese, eggs, &c., were urgently needed, and generally there was immediate need of further investigation into all the economic and other problems of the industry.

AGRICULTURAL INSURANCE.

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It is sometimes maintained that the economic institutions of to-day have either been created or adapted to meet the demands of the Joint Stock Company form of industrial organisation. Banking principles, for example, have been evolved to meet the credit requirements of our big industrial and commercial companies and not those of agriculture, and in the opinion of many people effective credit facilities for farming have yet to be evolved. Can we apply the same reasoning to insurance?

The sole object of insurance is to safeguard the insured against the many and varied risks which are present "in the ordinary business of life." There are certain risks in the agricultural industry which are common to all industry; for example, fire and accidents to workmen, and in these cases there is no doubt that the ordinary joint stock insurance companies and the mutual insurance societies adequately protect the farmer. Although insurance has been practised in this and other countries for centuries past, its economic and social significance was not realised by the mass of the people until comparatively recent years. This, to some extent, was due to an attitude of suspicion created in people's minds through the many disasters that befell insurance companies and incidently the insured. This was particularly true up to the beginning of the 19th century, when companies and individuals undertook to cover risks about which they had little if any scientific information to estimate their incidence and importance, and when severe losses occurred their financial status was such that they could not fulfil their part of the contract.

During the 19th century the development of practically all forms of insurance was rapid. The risks involved, particularly in some forms, were scientifically evaluated, and the rates of premium were calculated not so much on competition, but on the evidence of long periods of statistical investigation. With the rapid growth of industrial and commercial activity since 1850 the insurance offices have realised that only through efficient organisation and a strong financial standing is it possible to meet the increased demands for provision against loss of life and property. To-day a business man can insure his property, his workmen and his life for huge amounts with complete confidence that should the calamity against which he is protected happen he will obtain full satisfaction.

The farmer has every facility for insuring his house, farm buildings and stock against the hazard of fire and his workmen from accidents. Agriculture, however, in many respects is distinct from all other industries, and the principles which would apply in the one do not necessarily apply in the other. The special insurance business of farming has not received from the vast majority of insurance offices the treatment it deserves. Progress has been made in this field, but speaking generally, the insurance companies seem to feel that there is not sufficient profit to compensate for the precarious nature of this class of business. On the other hand, owing perhaps to the lack of adequate facilities, farmers have never realised to the extent that other business men have done the possible benefits of insurance other than that of fire and workmen's compensation.

Insurance and the Farmer.—Capital invested by the farmer in the form of buildings, harvested crops, growing crops, live stock and labour is even to-day open to many risks of partial or complete destruction. Within the last three decades considerable progress has been made in prevention of disease amongst stock and crops. This scientific progress lessens appreciably the risks of losses in production. There are, however, instances where the outbreak of a fire, ravages of a disease or the inclemency of the weather cannot possibly be foreseen. Under such circumstances the farmer is powerless and his only safeguard is insurance. In other words a number of farmers are prepared to sacrifice annually a small part of the value of their crops and stock in the form of premium payments to an insurance office. In the event of a big loss at any time the farmer is then in a position to claim full compensation for the loss incurred.

The essential principle of all forms of insurance is not the elimination of losses, but their distribution over a group of people sufficiently large to minimize the effects of a possible disaster to both the insured and the insurer. "The object of insurance is to spread the burden of loss, which to the individual would be crushing, over a large body of insured, and so render that burden easy to bear."[1]

The farmer has his capital invested in many different enter-

[1] Palgrave's Dictionary of Political Economy, p. 411.

prises, the risks involved varying in importance for each enterprise. Insurance of this kind, from the insurer's standpoint, demands a great deal of supervision to overcome what is often termed "moral hazard," which is not peculiar to agriculture more than any other industry, but is perhaps more difficult to overcome.

It is pertinent to ask if the present system of large joint stock insurance companies ever can overcome some of the difficulties peculiar to farming and at the same time cover their risks at a fair premium. As mentioned above, when farming risks resemble those found in other industries the present joint stock company form of insurance organisation can give complete protection with a reasonable premium per £100 property insured. When, however, the farmer wants to insure his crops against hail or disease and his live stock against the risk of mortality, the present system does not easily lend itself to meet this demand. Some other form of insurance organisation which can adequately and at a fair price safeguard the farmer against these risks and also provide a means of efficient supervision must therefore be considered.

The history of insurance in this country centres chiefly around the joint stock form of organisation, which necessarily carries heavy overhead charges, is usually centralised in administration, and is essentially a profit-making concern. This does not presuppose in any way that profits are the sole concern of these offices, but in estimating premium charges the directors have to take into consideration the demands of the shareholders. The other form of insurance (more generally practised abroad than in this country) is an association of farmers having as their object the insurance of their risks on a basis of co-operation without profits. These associations are usually called mutual insurance societies. This form of organisation has certain decided advantages in that it has not to provide for large sums of money for overhead charges and profits.

Apart from a number of small and special societies, the most important development in mutual agricultural insurance in this country is that of the National Farmers' Union Mutual Insurance Society. This movement, started by a few Warwickshire farmers nearly twenty years ago, has now developed into a society of considerable importance. The following table taken from the chairman's speech at the annual meeting of the above society is of interest in showing what can be done through a Farmers' Mutual Insurance Company :—

Year.	[1] *Gross Premiums.*	*Cash savings to Policy holders.*	*Reserve and Profit.*
	£	£	£
1911	366	55	106
1919	9,790	2,582	5,258
1920	73,308	21,585	18,535
1926	218,064	47,106	196,200

[1] Gross Premiums here include cost of re-insurance.

The farming risks covered by the above mutual society are similar to those of other companies, and it does not write any of those risks which are peculiar to agriculture. This society charges the ordinary premium rates of the other insurance companies, but the advantage to a farmer member when he insures against fire or workmen's compensation with this office is that he receives about 20 per cent. discount on his premium. Overhead charges are avoided by much of the business being transacted through the branch secretaries of the National Farmers' Union. Generally speaking, however, farmers' mutual insurance companies have not been developed in this country to the same extent as in the United States of America and the Continent of Europe. This can be ascribed to various factors,—for example, the provisions made by joint stock companies regarding fire and workmen's compensation risks; the comparative absence in this country of hail and windstorms; the diversity of the crops grown on our farms; the system of land tenure, and lastly, the size of holding, particularly as compared with the Continental countries, where special live stock insurances are widely effected on the smaller farms.

United States Experience.—The most important risks involved in farming covered by insurance in the United States are those of fire, live stock, hail and windstorms. Policies can be taken out either through the joint stock companies, farmers' mutual companies or the larger mutual companies not primarily interested in agricultural risks. It has been estimated that the farmers' mutuals underwrite about half of the farm fire insurance risks undertaken by all the insurance offices in the States. There are to-day about 2,000 of these companies insuring farm property to the value of over £1,600,000,000. In the majority of cases the area served by a mutual company is not large, covering roughly territories about the size of a large English county.

The companies are organised on a mutual basis and do not hold any capital stock, and the majority work on a basis of unlimited liability "whereby the insured obligates himself to pay his *pro rata* share of the losses and expenses of the company." In some mutuals premiums are collected, but it is far more general to "work under the assessment plan, whereby losses and expenses are pro rated as incurred."[1] As far as fire insurance is concerned the expenses of management have been low, and for a five year period the average cost annually per £100 insured was 5*s*.

Of the other risks hail insurance is by far the most important, and the protection against this risk has been developed to a far greater extent than any of the other forms except fire. In the grain-growing areas serious losses are often incurred by the partial or total destruction of the growing crops by heavy hail storms. This risk can be covered either by mutual companies, joint stock companies or State Hail Insurance Companies. In the year 1919 the total hail risks covered amounted to about

[1] U.S.D.A., Bulletin No. 915, pp. 241–242.

£112,000,000. Half of this amount was carried by joint stock fire insurance companies, and the other half was about equally divided between the Mutual and State Hail Insurance Companies.

The experience of joint stock fire insurance companies writing hail risks shows that within the last few years the ratio of losses to premiums varied from 41 per cent. to over 90 per cent., and in France for a period of 38 years the ratio varied from 31 per cent. to 141 per cent. This class of risk presents many difficult problems of incidence, valuation of losses, area to be covered, and so on, with the result that it is extremely difficult to arrive at a fair and just premium in relation to the losses, which vary so much from year to year. In the United States there has been a decline in this form of insurance recently owing to the severe losses, but the experience gained as regards the most economical area which can be covered by one company and the methods of assessment seem to indicate that more attention will be given to this form of insurance by both the farmer and the companies, particularly the State Hail Insurance Companies.

Continental Experience.—Agricultural insurance in all the European countries has been given a great deal more attention and has been more generally adopted by farmers than in this country. This is particularly true in case of risks such as hail, crop and livestock insurance, which are peculiar to the business of farming. The progress made in these countries may be attributed to a number of factors, among the most important being the peasant proprietor system of land tenure, which places the chief burden of responsibility on the shoulders of the farmer himself in the event of losses. In this country the tenant farmer, if he has suffered heavy losses, is in many instances indemnified by the landlord. The holdings in most of the Continental countries are small, and when losses occur they hit the farmer very heavily. Owing to the larger size of the holdings in this country the risks are distributed over a comparatively wider area, and in the case of live stock mortality for example, the loss is not so acutely felt. Lastly, the governments of most of these countries have encouraged and fostered the insurance of agricultural risks by means of subventions to the local mutual insurance societies, which in a large number of cases are affiliated to centralised societies.

The following table indicates the extent of the financial encouragement given to local agricultural mutual insurance societies in France :—

Year.	*No. of Societies subsidised.*	*Amount of subventions.* *Francs.*
1920	421	1,275,200
1921	507	1,393,600
1922	577	1,297,150
1923	598	1,296,050
1924	640	1,858,400

The above table refers only to those local societies receiving Government assistance. In all there were 16,584 agricultural

mutual insurance and re-insurance societies in France in 1924 writing live stock, fire, hail and accident risks.

On the continent there are three main types of insurance organisations through which the farmer can cover his risks—the joint stock companies, the general mutual societies, and the local agricultural mutual societies. As far as the peculiarly agricultural risks are concerned, the joint stock companies and the larger mutuals have not been able to compete successfully with the local societies. Owing to the difficulty of supervision and heavy overhead expenses they have been obliged to quote high premiums. The small mutual society, on the other hand, composed of local farmers, is in itself an effective means of supervision. This, together with the fact that these local societies are members of a bigger federation, makes possible the distribution of risks over a wide area and a large number of farmers, and has resulted in low premiums and adequate security. The following comparison between the premium charged by a local mutual society and that of one of the best of the big societies insuring live stock is significant[1] :—

	Value Insured.	*Premium.*
	Francs.	*Francs.*
General Mutual Society	1,000	40·30
Local Mutual Society	1,000	7·70

The organisation of the local mutuals varies considerably. In some instances fixed premiums are charged, and in case of losses compensation is paid usually at the rate of $\frac{8}{10}$ths the value of the loss. Other societies follow the system of annual levies in proportion to the damage suffered or the losses incurred. The levy is a given rate per pound on all members, and the compensation to be paid is fixed by the rules of the society. A number of societies combine the above systems, charging a fixed premium, some of which goes to reserve, and in the event of heavy losses making a further levy on all members in proportion to the loss.

A large number of these local societies are affiliated to provincial re-insurance societies, and in some instances these are again affiliated to a central re-insurance office. A small premium varying according to the risk is paid to the re-insurance office by the local society. In this way the danger of heavy losses crippling local insurance societies is overcome, and the risks are spread over a sufficiently wide area to minimise the effects of catastrophic losses. The forward movement of agricultural insurance on the continent is closely linked with the development of local mutual insurance and re-insurance societies.

Measurement of Risks.—In order that insurance may be effective the risks insured must be measurable. The fixing of premiums cannot be left to guesswork and the competition of the market. Considerable actuarial progress has been made in evaluating risks of various kinds since the famous " Northampton Mortality Tables " were drawn up in the year 1780. In life

[1] Jouzier—Économie Rurale, p. 294.

assurance to-day the mathematician is in a position to calculate the probable length of any individual's life from his present age. The calculation is based on past observation of a given number of individuals and the number of these still living at certain ages. Expectation of life for all ages between 1 and 100 can thus be ascertained. Estimation from statistical data of percentage losses to total losses based on complex mathematical measurement of probability is equally applicable to risks other than that of human life. In agriculture the farmer carries on his own shoulders the burden of many risks which are measurable, and insurance would appreciably lighten this load. The difficulty, however, in connection with such risks as hail, windstorm, disease and mortality of live stock is the paucity of information in this country regarding those risks. Hail risks are written by certain companies in this country, but the premiums are high, and in many instances it is better for the farmer on an average number of years to bear the loss himself. Although the risk from hail has to some extent been measured in other countries, it varies in incidence so much from one district to another that the experience gained in other countries is of very little value to a company undertaking to cover the risk in, say, certain parts of Lincolnshire. It would be a purely speculative business for any company to write some of the risks mentioned above until more information is obtained of the relative importance of the same risk in different parts of the country. For example, a company carrying on a business in hail insurance should have at its disposal statistics indicating over a long period the frequency of the occurrence of hail in different parts of the country during the months in which losses generally occur. The same is essentially true of the other risks to which the crops and live stock of the farm are subject.

Selection of Risks.—All kinds of risks are not equal, and even in the same class of risk there is a great deal of variation. To offer insurance for the same premium payments to all would result in an excessive number of the more precarious risks, whether of life or property, being undertaken with a consequent increase in losses above the estimated average for normally healthy men or well protected property. To overcome this danger insurance of the same risk is divided into a number of classes depending on age, condition of health, kind of work performed, and so on, in which the premium payment varies for each class. If this variation exists within the same general class, obviously it is even greater in the different kinds of insurable risks covered. A man who owns two ships and loses one is crippled, but a farmer who owns 1,000 head of cattle and suffers one loss is not seriously handicapped in his business. On an average-sized holding the farmer seldom suffers such a catastrophe as losing half his property under one risk, except in the case of foot-and-mouth disease, and in such an event he would be entitled to Government compensation. Generally speaking, the risks peculiar to agriculture can be looked upon as comparatively regular in their incidence, and as affecting a number of people in varying degrees of intensity depending on the size of the holding. This is particularly true of losses among the ordinary live stock of the farm, where some form of protection is clearly needed.

Problems of Organisation.—The organisation of insurance differs according to the nature of the risk. If the risks to be insured are small it is not necessary to have a big organisation with heavy overhead charges, which of necessity will mean higher premiums. Continental experience and practice favour some form of mutuality in the business of agricultural insurance. Cow and Pig Insurance Societies in this country are small mutual societies which have accomplished much in insuring the live stock of the smallholders. The area covered is small, and supervision is possible because members are well known to each other. The great drawback, however, in such an organisation as this if applied to the larger farms is the limitation of its sphere of activity. A mutual insurance society covering a parish or two will be successful provided no severe losses occur until a good reserve fund has been built up. If heavy losses have to be met in the initial stages the chances are that the society will prove a failure. The affiliation of these small societies to a centralised society would solve the problem of distributing risks over a bigger area, but it is very doubtful if the bigger farmers would participate in such a scheme until they have realised more fully the value of co-operation. An organisation having as its main objects the writing of agricultural risks must be in close touch with the farmer. The big tariff offices undoubtedly have the financial status to tackle the farm insurance problem, but their organisation does not easily lend itself to meet the risks involved in farming. The problem of supervision is a very real one, and unless an insurance office can efficiently and inexpensively deal with this aspect of management the problem of protection for those risks peculiar to agriculture will remain unsolved. A mutual company such as the National Farmers' Union Mutual Society is in a far better position to overcome the difficulty of supervision than any of the other offices, which would have to set up local agents solely for this purpose. The National Farmers' Union already have at their command through their branch and county organisations an effective medium of supervision, but up to the present even this society has not ventured far into the field of agricultural insurance.

Insurance of the ordinary live stock of the farm presents many difficult problems of organisation which to some extent are common to other agricultural risks. The absence of reliable statistical information regarding incidence of losses referred to above is particularly applicable to the losses suffered in the live stock department of the farm. In another article dealing exclusively with live stock insurance greater attention will be given to questions of mortality, distribution of risks, management problems, and the form of organisation which is most likely to tackle this type of insurance successfully.

Generally speaking, non-farming risks are more profitable than the purely farming risks. The ratio of losses in the former are considerably lower, therefore it is extremely unlikely that the big tariff offices will devote more attention in the future to the risks peculiar to agriculture.

THE NUTRITIVE REQUIREMENTS OF POULTRY.

THE INFLUENCE OF CERTAIN NUTRITIONAL FACTORS ON THE SIZE OF THE EGG AND THE CONDITION OF THE BIRDS.[1]

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This investigation, which forms a part of the work of the Scotland and Northern Ireland Joint Committee for Research on Poultry Nutrition, was commenced with the object of obtaining information on the following points :—

(1) Whether a small addition of minerals (2 per cent.) to a dry mash consisting of mixed cereals had a beneficial influence on the egg record;

(2) Whether a vegetable food rich in protein fed in conjunction with minerals could be used to replace a fish meal;

(3) The benefit derived by the addition of 10 per cent. fish meal to a mash consisting of mixed cereals.

As the experimental work proceeded it became obvious that the results could not be measured solely in terms of the number of eggs laid. Big differences in the size of the eggs laid by the various groups, in the condition of the birds, as well as in the number of eggs became apparent. After the first experiment had continued for a year, all the eggs were weighed daily, and the effect of the rations on the condition of the birds was determined by weighing them at intervals of six months.

Experimental Details.—The birds used were pure-bred White Wyandottes of the same heavy laying strain, hatched on the same day, reared together under identical conditions, and selected by an expert from the flock available. Each of the four groups consisted of eight birds, and each was housed in one of the official Laying Trial Pens at Stormont, Belfast. The particulars of the rations were as follows :—

[1] *Preliminary Note.*—The data will be published in full in vol. ii of the *Journal of the Ministry of Agriculture for Northern Ireland.*

Mash.

Group 1. Basal ration (parts by weight : pollard 4, bran 2, maize meal 2, Sussex ground oats 1).

Group 2. Basal ration plus 2·2 per cent. mineral mixture.[1]

Group 3. Basal ration plus 1·7 per cent. mineral mixture plus 13½ per cent. extracted soya bean meal.

Group 4. Basal ration plus 10 per cent. fish meal.

The mineral addition to groups 2 and 3 was adjusted so that the total mineral content of the rations fed to groups 2, 3 and 4 was similar. The protein content of the rations fed to groups 3 and 4 was also similar.

An unlimited supply of the mash was constantly before the birds, and free access was also given to an unlimited supply of oyster shells. The scratch feed consisted of a morning feed of 1 oz. per bird per day of a mixture of equal parts by weight of cracked maize and oats. From 1st October to 30th April this was supplemented by an evening feed of 1 oz. per bird per day of cracked maize.

The first experiment commenced on November 16th, 1924, and finished on November 15th, 1926; the second on October 1st. 1925, and finished on September 30th, 1927. The birds were all trap-nested throughout the two years' duration of each experiment.

The Effect of the Rations on the Size of the Eggs.—*First Experiment, 16th Nov.* 1924 *to* 15*th Nov.* 1926.—No records of the weight of the eggs laid were kept during the first year of the experiment. During this period the average number of eggs laid per bird by the four groups was as follows :—

	Average number of eggs per bird, 1st Year.
Group 1. Basal (cereals only)	162·6
Group 2. Basal plus 2 per cent. minerals ...	186·9
Group 3. Basal plus minerals plus 13½ per cent. extracted soya bean meal	223·1
Group 4. Basal plus 10 per cent. fish meal	209·7

It will be observed that the addition of 2 per cent. of minerals to a cereal mash increased the egg yield substantially, and that extracted soya bean meal buffered with minerals proved quite as effective as fish meal.

The results for the second year of this experiment are set out in Table I.

[1] The mineral mixture consisted of 10 parts of chalk, 10 parts of salt, 25 parts of steamed bone flour, 2½ parts of sulphur, and 2½ parts of iron oxide plus a trace of potassium iodide. This mixture had been used successfully at the Rowett Institute with young pigs. It is not suggested that it is the best one for laying birds.

TABLE I.—Experiment 1 (1924–26), 2nd Year.

Average weight of Eggs per dozen.

Period.	Group 1. Basal.	Group 2. Basal + Minerals.	Group 3. Basal + Minerals + Soya Bean.	Group 4 Basal + Fish Meal.
	Oz.	Oz.	Oz.	Oz.
1st Month	20·4	27·5	25·5	28·5
2nd „	26·1	26·9	25·4	30·8
3rd „	26 2	25·2	26·3	24·7
4th „	24·9	26 6	26·4	25·7
5th „	24·0	27·0	25·6	26·6
6th „	23·8	26·3	26·7	27·7
7th „	23·0	26·4	26·4	28·6
8th „	23·9	26·4	25·6	27·2
9th „	22·5	26·2	26·0	26·9
10th „	24·6	26 8	27·2	28·9
11th „	22·8	26·4	27·1	27·1
12th „	25·5	27·0	27·2	27·6
Average weight per dozen, 2nd Year ...	24·3	26·5	26·4	27·6
Average number of eggs per bird, 2nd Year	100·7	137·1	173·6	142·5
Yield of eggs per bird in ozs.	203·9	302·7	381·9	327·7
Mash consumed per bird in lb. ...	63·25	63·4	65·25	63·6

The addition of 2 per cent. of mineral to a cereal mash had a very marked effect on the size of the egg. For six months of the year the birds in the control group laid eggs which on the average were below 2 oz. in weight. On the other hand the eggs from group 2 (minerals) only once fell below an average weight of 26·2 oz. per doz., the figure being 25·2 oz. Over the period of a year the eggs from group 2 averaged 2·2 oz. per doz. heavier than those from group 1, in addition to laying an average of 137·1 eggs per bird against 100·7 for the control group. The mash consumption for both groups was substantially the same and it would therefore seem—

(1) That even an unlimited supply of oyster shell does not supply sufficient minerals; and

(2) That the mineral additions to group 2 have enabled the birds to make a more effective use of the cereal ration.

The addition of extracted soya bean to group 3 has had no effect on the average size or weight of the egg, but it has, on the other hand, resulted in a very substantial increase in the egg yield and a corresponding increase in the total weight of eggs laid.

The interpretation of the results from group 4 (fish meal) presents certain difficulties. The relatively heavy weight of the eggs during the first two months is not significant, as the average number laid per bird was small, namely 8 and 9. It is doubtful if the average increase in weight per dozen of 1·2 oz. per bird over the period of a year is significant in view of the fact that this group only laid 142·5 eggs per bird compared with 173·6 for group 3. The actual weight of eggs laid by group 3 was considerably greater than in the case of group 4.

Second Experiment, 1st Oct. 1925 *to* 30*th Sept.* 1926.—The second experiment was an exact duplicate of the first experiment with the exception that the eggs were weighed daily from the commencement. The results are summarised in Table II.

TABLE II.—Experiment 2, 1925–27.

Average weight of Eggs per dozen.

1st Year (Pullets).

Period.	Group 1.	Group 2	Group 3.	Group 4.
	Basal.	Basal + Minerals.	Basal + Minerals + Soya Bean Meal.	Basal + Fish Meal.
	Oz.	Oz.	Oz.	Oz.
1st Month	21·9	21·2	21·3	21·5
2nd ,, ...	22·0	22·3	22·2	23·6
3rd ,, ...	22·7	23·5	24·4	23·5
4th ,, ...	23·6	24·5	23·7	24·3
5th ,, ...	23·8	24·9	24·3	24·5
6th ,, ...	23·0	24·4	23·2	21·9
7th ,, ...	22·4	24·7	24·2	24·2
8th ,, ...	22·9	25·3	24·2	24·4
9th ,, ...	23·3	25·8	24·6	25·0
10th ,, ...	23·2	25·7	26·0	25·2
11th ,, ...	24·3	26·0	25·1	25 0
12th ,, ...	25·8	26·0	24·7	25·3
Average weight per dozen, 1st Year ...	23·1	24·6	24·1	24·2
Average number of eggs per bird, 1st Year	159·4	217·5	193·7	232·1
Mash consumption per bird in lb., 1st Year	69·5	79·0	71·5	79·1
2nd Year.				
1st Month	24·0	25·7	25·0	25·5
2nd ,, ...	24·4	25·7	26·6	26·0
3rd ,, ...	25·4	24·8	26·2	25·6
4th ,, ...	25·2	26·0	23·9	26·2
5th ,, ...	21·0	25·0	24 9	25·9
6th ,, ...	20·5	25·7	25·9	25·7
7th ,, ...	23·7	26·0	25·9	25·5
8th ,, ...	24·2	26·7	25·5	25·4
9th ,, ...	24 5	27 2	26·0	25·7
10th ,, ...	25·4	26·8	25·5	25·2
11th ,, ...	24·4	26·9	25·5	25·7
12th ,, ...	25 5	26·4	25·9	25·9
Average weight per dozen, 2nd Year ...	24·6	26·3	25·6	25·7
Average number of eggs per bird, 2nd Year	134·5	130·1	155·8	164·3

The results are in substantial agreement with those recorded for the first experiment. The small addition of minerals (2 per cent.) made to the ration for group 2 has undoubtedly had a considerable influence on the size of the egg. During the first year the eggs for group 1 (control) were below an average weight of 24 oz. per doz. during ten months out of the twelve compared with the first three months in the case of group 2 (minerals). In the second year the eggs from group 1 were below 24 oz. per doz. for three months, and they reached an average weight of 25 oz. per doz. in only four months out of the twelve. On the other hand the eggs from group 2 (minerals) never fell below an average weight of 24 oz. per doz. (lowest figure 24·8 oz.) and during eleven out of the twelve months the average weight per doz. reached or exceeded 25 oz. The average increase in the weight per dozen of the eggs from group 2 over those of group 1 was 1·6 oz. for the first or pullet year and 1·7 oz. during the second laying year. The average egg yield of group 2 birds was considerably greater than in the case of group 1. Again, there is no evidence that the extra protein added to the ration for groups 3 and 4 has had any effect on the size of the egg. Compared with group 2 (minerals), group 4 (fish meal) gave a better egg yield. Group 3 (extracted soya bean meal) does not compare so favourably in egg yield with group 4 as in the previous experiment. This is probably due to the fact that all the birds in group 3 moulted when placed on their experimental rations on October 1st, 1925, and during the first year were unable to make up the lost ground.

In Northern Ireland, where close grading is the " law of the land," the size or weight of the egg is an important economic factor. The 2 oz. egg corresponds to a weight of 15 lbs. per 120 eggs. For the purposes of the following table all eggs below 2 oz. in weight have been termed " second grade." On this basis the results for the two experiments are set out in Table III.

TABLE III.—*Showing the percentage of 2nd grade Eggs in the various Experimental Groups.*

Groups.	1st Experiment, 1924-26.		2nd Experiment, 1925-27.	
	1st Year. (Pullets.)	2nd Year.	1st Year. (Pullets.)	2nd Year.
	Per cent.	Per cent.	Per cent.	Per cent.
1. Basal	...	41·2	55·4	30·6
2. Basal plus Minerals ...	No results available.	7·3	35·3	12·6
3. Basal plus Minerals plus Extracted Soya Bean Meal	...	5·7	35·7	6·4
4. Basal plus Fish Meal ...	...	4·2	35·0	12·4

The contrast is very striking, particularly in the second laying year. In experiment 1 the addition of 2 per cent. of minerals has reduced the second grade eggs laid during the second year from 41·2 per cent. to 7·3 per cent. The addition of protein rich feeds has not improved the figures for group 2 to any material degree. The figures for experiment 2 show a reduction in the second grade eggs during the first year from 55 per cent. to 35 per cent. as a consequence of the addition of minerals. The figures for the second year of this experiment amply confirm those for experiment 1.

The Effect of the Rations on the Condition of the Birds.—It is reasonable to expect that a deficiency in any nutritional factor may, as far as the laying hen is concerned, show itself in one or all of three ways, namely :—

1. In the number of eggs laid.
2. In the size or weight of the eggs.
3. In the condition of the birds.

If this is so, it is obviously inadequate to measure experimental results in terms of any one of the above three factors. A higher egg record from any particular group may not necessarily be attributable to the ration fed. It may be the result of a reduction in the size of the egg and/or a loss of condition by the birds.

Unfortunately in experiment 1 the birds were not weighed at the commencement of the experiment. As the birds were selected and placed in their groups by an expert there is every reason to suppose that the average weights of the groups were, for all practical purposes, comparable at the start of the experiment. All the birds were weighed individually six months after the experiment commenced and thereafter at intervals. The results are set out in Table IV.

TABLE IV.—Experiment 1. 1924–26.

Average weight of Birds at intervals during the experimental period.

Groups.	At start, Nov. 16, 1924.	May 13, 1925.	Nov. 11, 1925.	May 5, 1926.	Sept. 28, 1926.	Average number of eggs per bird per annum over a period of two years.
		Gms.	Gms.	Gms.	Gms.	Gms.
1. Basal	...	1,894	2,028	1,879	1,943	131·6
2. Basal plus Minerals	...	1,899	2,039	2,301	2,283	162·0
3. Basal plus Minerals plus Soya Bean	...	2,048	2,057	2,248	2,381	198·3
4. Basal plus Fish Meal	...	2,098	2,115	2,292	2,255	176·1

Whatever may have been the weight of the birds at the start the four groups finished the first year at approximately the same average weight. Groups 1 and 2 both gained weight from May till November 1925, and it is probable that they lost weight during the period November 1924 to May 1925. During the second winter the birds in group 1 lost weight and quite obviously drew on their reserves. Groups 2, 3 and 4 birds not only laid more and larger eggs but improved in condition. It is probable that had the groups been weighed at the beginning of March instead of May the difference between the weights of the birds in group 1 and the other groups would have been greater, as the condition of the birds in group 1 during February and March was so poor that several practical poultry keepers expressed doubts as to whether they would survive.

Perhaps the most interesting feature which emerges from the table is that the mineral addition to the ration for group 2 has not only resulted in a better egg yield, but has kept the birds in better condition than those in the control group; another indication that the mineral additions have resulted directly or indirectly in a better utilisation of the food.

The following table, in which is set out the corresponding figures for experiment 2, confirms this conclusion.

TABLE V.—Experiment 2, 1925–27.

Average weight of Birds at intervals during the experimental period.

GROUPS.	At start, Oct. 1, 1925.	April 24, 1926.	Aug. 25, 1926.	May 7, 1927.	Sept. 27, 1927.	Average number of eggs per bird per annum over period of two years.
	Gms.	Gms.	Gms.	Gms.	Gms.	Gms.
1. Basal	2,001	1,749	1,965	1,955	2,079	147·0
2. Basal plus Minerals	2,001	2,343	2,434	2,590	2,543	173·8
3. Basal plus Minerals plus Soya Bean Meal	2,002	2,341	2,346	2,385	2,367	174·7
4. Basal plus Fish Meal	2,002	2,428	2,445	2,420	2,528	198·2

The average weight of the birds in each group at the commencement was comparable. From October to April the birds in the control group (1) lost 252 gms. of their body weight, whereas the birds in group 2, receiving the same ration but with a 2 per cent. addition of minerals, increased in weight by 342 gms., and at the end of the first six months were in as good condition as groups 3 and 4, receiving a high protein feed. During the spring and summer, from April to August 1926, all the groups gained weight, the control group making a good recovery—due perhaps to the young grass supplying the mineral deficiency which undoubtedly existed during the previous winter period. During the second winter, when, of course, egg production was considerably less than the previous winter, the weight of the various groups remained stationary. By the end of the second summer all the groups gained weight. Group 1 finished at the end of two years at practically the same weight as they had started, whereas the mineral group (2) had increased in weight by no less than 25 per cent. and were in excellent condition. The birds in group 2, receiving mixed cereals and minerals and no protein rich feed, improved in condition to the same extent as the two groups receiving a protein rich feed.

Summary.—The data presented shows :—

(1) That when conducting nutritional experiments with laying birds it is essential that they should be carried over a period of two years. It is not sufficient to measure the results in terms of the number of eggs laid; cognisance must also be taken of the weight of the eggs and the condition of the birds.

(2) A ration consisting of mixed cereals fed in unlimited quantities and with oyster shell always available is not sufficient to meet the requirements of birds capable of laying in their pullet year 150 eggs. With such feeding there is a substantial fall in the weight of the eggs and the birds lose condition.

(3) The mineral requirements of laying birds are not satisfied by free access to unlimited supplies of oyster shell. The addition of 2·2 per cent. minerals to a mash consisting of mixed cereals not only improved the egg yield (20 per cent.), but increased the size of the eggs and improved the condition of the birds.

(4) The addition of a protein rich feed increases the egg yield by a further 10 to 20 per cent., but has no effect adversely or otherwise on the size or weight of the eggs or on the condition of the birds.

(5) Although not conclusive the data presented indicate that a vegetable protein rich food, such as extracted soya bean meal, can take the place of fish meal provided a mineral supplement is fed.

(6) It is probable that the addition to the mash of a protein rich feed beyond the extent represented by 13½ per cent. of extracted soya bean meal should be accompanied by an increase in the mineral supplement.

The writers desire to acknowledge their indebtedness to Miss Sheedy and Miss H. Walker for the care taken in the supervision of the experiments and the collection of the data.

AGRICULTURAL ADMINISTRATION IN SOUTH AFRICA.

J. A. Symon, D.S.O., M.A., B.Sc.

In the course of a recent tour throughout the Union of South Africa the writer was afforded many opportunities of gaining an insight into the nature and scope of the work that is being carried out by the Department of Agriculture for that country.

After the union of the different provinces in South Africa in

1910, the Union Parliament decided that the administration of all matters pertaining to agriculture should be placed under the control of the Minister of Agriculture—one of the members of the Union Cabinet. The Department itself, which took over the agricultural work hitherto carried on by the separate provinces, was organised largely on American lines. Apart from the work of administration and publication, the activities of the Department are now under the control of the following divisions, each of which is under the charge of its own technical officer :—(1) Veterinary; (2) Veterinary Education and Research; (3) Animal and Field Husbandry; (4) Botany and Plant Pathology; (5) Chemistry; (6) Entomology; (7) Extension Work; (8) Economics and Marketing.

At the head of all these divisions is the permanent Secretary of Agriculture, who is responsible to the Minister of Agriculture for the proper administration and work of the Department. The Department has its headquarters in the magnificent Union Buildings at Pretoria, but as Cape Town, the seat of the Government and the meeting place of the Parliament, is over 1,000 miles distant by rail, proper liaison arrangements between the Minister and the Department have to be provided. During the parliamentary session the Secretary of Agriculture is in residence at Cape Town.

Finance.—The administration of the Department costs the taxpayer a million odd pounds every year. But as agriculture is the backbone of the country, and as the agricultural produce of the Union is reckoned to be worth some £80,000,000 annually, the country is believed to be receiving adequate value for the expenditure incurred. Actually the fight against three of the chief enemies of progress in South Africa, viz. locusts, scab, and East Coast fever, has within the past year or two cost the country over £500,000 a year, or over half the amount of the total net expenditure incurred by the Department. The rest of the money raised is devoted largely to the prevention and eradication of other diseases and pests, to research, education and extension work, and to the encouragement of all ordinary means whereby stock and crops and agricultural produce generally may be improved and marketed to advantage.

Stock Diseases: Veterinary Divisions.—The Department of Agriculture for the Union is not concerned, as is the case in several European countries, with the problem of land settlement as understood by us. Consequently the Department is able to devote itself almost entirely to studying how to better the position of the farmer. As already indicated, the outstanding problems are those connected with the different plant and animal diseases and pests. In the past two separate Veterinary Divisions have dealt with stock diseases. The first of these—the Veterinary Division—dealt in an administrative and advisory capacity with the various stock troubles. Certain legislative measures dealing with the more serious diseases were enforced by this department, while advice as to the treatment and prevention of the less serious troubles was freely given. The other Division, Veterinary Education and Research, was instituted mainly for the purpose of investigating the cause of many of the diseases with which stock owners had to contend. As a result of its untiring efforts extraordinarily fruitful results have been obtained, and now one of the chief activities of the department is to manufacture and distribute some millions of doses of serums and medicines for preventing, or ridding stock of, certain pests. Educationally, this department is concerned merely with the training of just as many veterinary surgeons as can be conveniently absorbed within the Union.

The Veterinary Research Laboratories at Onderstepoort near Pretoria in which all this work is being carried on has already achieved world-wide fame owing to the remarkable results attained by Sir Arnold Theiler, its Director, and his able and enthusiastic band of co-workers. An account of this work was given in an article which appeared in this JOURNAL in July 1926

Field and Animal Husbandry.—This is a very large Division, and is split up into several sub-divisions such as dairying, horticulture, viticulture, tobacco and cotton, &c. The improvement of the quality and productiveness of the different animals and plants is naturally the chief concern of this division, while considerable attention is given to the regulations governing the exports of agricultural produce. South Africa is potentially a very important cattle country. At present its cattle population is just under 10,000,000 head, but although the quality of individual herds is as good as can be seen anywhere, the average quality of the cattle is disappointingly poor. A small export trade has been built up with Italy and other south European countries, where meat of inferior quality is in demand, but until there is a very marked all-round improvement in the quality of South African cattle there is little likelihood of a satisfactory export trade being established. In the matter of sheep and wool, however, gratifying results have been attained. South Africa has by selective breeding and by better methods of handling the sheep on the farms improved the yield and quality of its wool to an enormous extent. It is now the fourth wool-producing country in the world. In Field Husbandry the problems of this department are legion, ranging from such sub-tropical crops as sugar cane and cotton to the better known cereal crops such as oats and wheat. The export trade in deciduous and citrus fruits has made enormous progress within the past five or six years. In the case of citrus fruits a sixfold increase is recorded within that time.

The Departments of Botany and Chemistry.—The former department is naturally concerned with the economic importance of the various plants and their diseases, while the latter is largely taken up with the analysis and regulations governing the sales of manures and feeding stuffs. In a short paper like this one cannot hope to indicate the scope of these two divisions. The former division is meantime largely concerned with the introduction of plants of economic importance. Such a grass for instance as kikuyu grass from East Africa has already given very good results. The ordinary British grasses and clovers seem to be practically useless for economic purposes in South Africa.

Continuous war against insects is being waged by the Department of Agriculture. Enormous damage has in the past been caused by locusts, and in some seasons upwards of a million swarms have been destroyed at a cost of between £300,000 and £400,000. Poisons, both liquid and solid, have been freely employed. Every effort has been made to locate the egg deposit areas and to deal with the insects at their most vulnerable period, i.e. before the insects have reached the flying stage, when they are merely "voetgangers" or crawlers. The existence of vast, unoccupied, and almost inaccessible tracts of land in the outlying districts of the Union, of Bechuanaland and of South-West Africa, where locusts may hatch out and develop, is still a menace, but the locust problem is of small dimensions now compared with what it used to be.

The methods of dealing with some insect pests are certainly novel and interesting. Near Johannesburg powdered arsenate of lead was sprayed by aeroplanes on plantations affected with the Eucalyptus snout beetle. The woolly aphis is being attacked by means of a parasite which when introduced into a district can find its way unaided from one orchard to another. Strict laws are enforced to prevent the importation of foreign insects. South Africa has had cause to regret the introduction into the country of certain undesirable animals, plants and insects. The rabbit does not exist in the mainland, thanks to legislative measures, but certain weeds, such as khaki weed, and insects, such as the Argentine ant, are legacies of the South African war, and have spread since then in an amazing fashion.

The Division of Agricultural Education and Extension.—The work carried out by the five schools of agriculture in the Union is controlled by this Department. These schools are :—

I. Elsenburg, Western Cape Province.
II. Middleburg, Eastern Cape Province.
III. Cedara, Natal.
IV. Potchefstroom, Transvaal.
V. Glen, Orange Free State.

In addition to these, two of the universities have faculties of agriculture and teach agricultural subjects. Although these faculties are largely financed by the Department, they have not been hitherto under its control. At the present time certain changes in regard to the administration and control of the agricultural faculties at the two universities are in process. The Agricultural Department of the University of Stellenbosch is uniting with the College at Elsenburg, and as both institutions are within easy reach of each other, certain economies in regard to teaching and administration will be effected, while more time can be devoted to particular lines of research work. The future of the Transvaal University College at Pretoria, which has an agricultural faculty, has not yet been determined.

The five agricultural colleges, as distinct from the universities, cater primarily for the farmer's son. The duration of the diploma course has recently been reduced from two years to one. No student is admitted until he has been working for at least one year on a farm. Each school is situated at some considerable distance from a town and has attached a large farm varying in size from 2,000 to 25,000 acres. At these farms, the typical agriculture of the district is practised. Some of the special features of the agriculture practised at each school are indicated in the following table.

College.	*Special Features of Farm.*
Elsenburg,	Grain, vines, deciduous fruits, tobacco, and dairying.
Middelburg,	Merino sheep, Angora goats, ostriches. irrigation farming.
Cedara,	Cattle, maize, wattle growing.
Potchefstroom,	Cattle, pigs, maize, deciduous fruits.
Glen,	Dairying, sheep, wool, and maize.

From the preceding description of these schools it will readily be gathered that all are residential. The number of diploma students in attendance varies from over thirty to upwards of one hundred at the different colleges, but these numbers are greatly increased when one takes into consideration the attendance at the various short course and vacation classes held throughout the year. Altogether the five colleges had upwards of 1,600 people attending them in 1926, and in the case of one college it was calculated that 90 per cent. of the students were directly connected with farms. The fees for the diploma courses are £60 per annum. This covers instruction, board and lodging. For short courses a charge of six shillings a day is made for the above items.

A visitor to any of these schools is very much impressed by the agricultural atmosphere that prevails. Staffs and students alike seemed engrossed in their work, and all have a common interest in the working of the farm. The amenities of town life are of course less missed in a land of sunshine like South Africa than they would be in this country.

The vast extent of the Union has hitherto precluded any possibility of agricultural extension work assuming the relative proportions it attains in this country or in the United States. In South Africa the college is the centre from which emanates most of the extension work activities. Considering the numbers of staff available and the fact that colleges have also to do teaching and research, a surprisingly large amount of extension work is accomplished. It is interesting to note that use is made of a demonstration train, which tours throughout the different districts and on which the staff may be accommodated for weeks at a time.

In granting overseas bursaries to their own students the Department of Agriculture has adopted an enlightened policy. The beneficiaries, after spending some considerable time at various centres in the United States, Canada, Germany and other countries, take up official posts under the Department in their home country. As time goes on the need for specialised study overseas will become less evident, as facilities for such study will be available in the home universities and colleges.

The Division of Economics and Markets.—Business-like farming and good marketing are the aim and object of this division, whose activities are many and varied. With the collaboration of the Post Office a daily service of market intelligence is published throughout the Union. The requirements of overseas as well as internal markets are specially studied. Co-operation both in buying and selling is encouraged, but the Department has made no attempt to force it. If, however, in any district, 75 per cent. of the agriculturists produce 75 per cent. of the total produce of that district, and are themselves members of a co-operative society, then the Government may at the request of such a society compel all non-members in the district to sell their produce through the society. In four of the tobacco-growing areas in the Union this regulation has been enforced, and the marketing of tobacco in these areas is now in a much healthier condition than formerly.

Marked advances have recently been made in the methods of transporting and marketing both citrus and non-citrus fruits. Growers of export fruit pack their fruit in standard cases and rail it to the cold storage premises at the docks, where it is inspected and finally shipped. Fruit of inferior quality is ruthlessly set aside by the Government inspector, and the grower not only has to take the small price that is realised for it in a home market, but is further penalised by having to pay the full carriage for his fruit to the docks, whereas all fruit passed for export is charged on a half-rate basis. Individual societies go even further than this, and in every seventh box or so enclose a message asking the eventual purchaser to state the condition of the fruit, and give at the same time the number of the box so that the grower may be traced and notified if his fruit has not carried well. As a result of these stringent regulations only the best fruit is exported, while the market for such fruit is widening and increasing in a very healthy manner.

Publications.—Not the least important part of the work done by the Department in the interests of agriculture is the work of publishing literature intended for the guidance of farmers. In addition to the crop and market bulletins, numerous leaflets giving advice on different problems are issued, while a very readable, well illustrated and very informative monthly is issued by the Department. This paper, *Farming in South Africa*, is printed both in English and Afrikaans.

Reference must be made to the great work which is being done to further agriculture by the numerous agricultural societies

which form a network over the whole Union. Altogether there are some hundreds of these. One of their most important functions is the promotion of agricultural shows. The best known of these is the Witwatersrand Agricultural Society's show, held annually in the Milne Park at Johannesburg during the Easter season. Leading agriculturists from all parts of South Africa visit this show, which in respect of entries and exhibits of all descriptions is comparable with the leading shows in this country.

Most of these agricultural societies are affiliated to one or other of the four provincial agricultural Unions, which exist to discuss the agricultural affairs of the provinces with which they are connected. Each of these Unions in its turn appoints ten delegates to form the South African Agricultural Union, which in its turn appoints an Executive Committee to meet the Minister of Agriculture and to discuss with him all matters relating to agriculture within the Union. Matters of local interest are, of course, dealt with by the provincial agricultural Unions acting through the societies in their areas.

The march of events within recent years indicates that so far as agriculture is concerned rapid and healthy progress is being made. The various Governments that have existed have all realised the importance of the industry, and have all actively encouraged it. Although the prices of all kinds of agricultural produce have tended to move downwards, the total value of such produce in South Africa has gone steadily upwards. Since the Union very considerable increases in the numbers of cattle and wool-sheep have been recorded. The amount of maize grown is well over double what it was in 1910, while the total value of the fresh fruit exported shows a fortyfold increase. But however gratifying these figures are, the fact remains that South Africa, relatively speaking, is still capable of much further development. Its problems are many. Much of its rainfall is literally wasted; the cereal crop yields are amongst the lowest in the world; the quality of its cattle is disappointingly poor when taken in the aggregate. But its people are alive to these facts, and are earnestly striving to improve matters.

A SHORT HISTORY OF PASTURE-MAKING IN GREAT BRITAIN.

JOHN PORTER, B.Sc., N.D.A., N.D.D.

ALL through the centuries the so-called laying down of land to permanent pasture appears to have been regarded with more or less disfavour by the State. On many occasions the State has become alarmed and has passed Acts of Parliament to prevent farmers from laying down arable land to grass, and in some cases to compel the breaking up of grass-land recently laid down.

Many such cases occurred during the 15th and 16th centuries,[1] when, owing to the enclosure of land, there was a distinct tendency for arable land to be laid down to grass.

This article attempts to sketch briefly the early methods introduced and the early experiments conducted for the purpose of determining the best seeds mixtures and of improving pastures generally.

Development of Seeds Mixtures.—Prior to the middle of the 17th century there appears to be no information available that suggests the use of composite seeds mixtures other than ordinary hay seeds taken from a hayloft. In fact grass was a name given to any plants that grew in pastures and looked green, no matter whether they were true grasses (*Graminiae*), leguminous plants (clovers, trefoils, &c.) or miscellaneous plants (burnet, yarrow, chicory, &c.). In the latter half of the 17th and during the 18th centuries, however, a notable improvement in pastures took place. This was principally due to the introduction from various sources of a number of important pasture plants, which led to the development of temporary pasture mixtures.

This important change in farming practice seems to have been due originally to Sir Richard Weston, a Royalist exile in Flanders at the time of the Civil War in England, who studied Flemish methods of agriculture, particularly in regard to the growing of clover, turnips and flax. His observations were left to his sons as a "legacie," and were in 1645 published by Hartlib in a book "Agriculture in Brabant and Flanders," now known as "Hartlib's Legacie." It is probable that Weston introduced into this country what was first called the great clover[2] (*Trifolium pratense*) and turnips.

This record of Flemish methods of growing clover and turnips led Lord Townshend and Coke to alternate them with corn crops, and thus avoid on the lighter classes of land the necessity for bare fallows. This system of alternate husbandry became known in Great Britain as the Norfolk rotation.

Clover in the latter half of the 17th century was considered to be a crop for gentlemen to grow, but not for farmers who had to pay their rent. However, in Worcestershire, through the personal efforts of Andrew Yarrowton (1653–77), its use was established.[3] The interesting point to notice is that clover began to find its way into English rotations.

About the same time ray-grass (rye-grass) was receiving attention. In fact Worlidge in his book, the "Mystery of Husbandry" (1681), says "that ray-grass, by which they improve so many kinds of soil, especially those unfit for sainfoin, hath precedence of all other grasses." It appears that in 1677 the only grasses (i.e. pasture plants) cultivated in England were ray-grass, red clover, sainfoin, spurrey, trefoil and nonsuch.

[1] English Farming: Past and Present, by R. E. Prothero (1917).
[2] British Husbandry, vol. ii (1837).
[3] English Farming: Past and Present, by R. E. Prothero.

Trefoil, at this time, was a common name for plants with three leaflets on the leaf-stalk, and was a general name for clovers. It appears likely that trefoil here refers to what was sometimes called white trefoil, or what we now know as white clover. Nonsuch is a name still used for the common trefoil (*Medicago lupulina*).

During the 18th century the inclusion of clover in the farm rotations slowly spread over the country. Apparently the south eastern counties of England took up clover growing with some zeal, while other counties were prejudiced against its use. In fact in Westmorland (1794) the prejudice that existed against clover and rye-grass was said to be a great obstacle to the improvement of husbandry in that county.

In the south and midlands of England clover was found to grow quite well as a single crop; but in the colder and wetter climates of the north of England and of Scotland it was found beneficial to include rye-grass with clover, because it acted as a shelter and gave an early grass for the stock. These rye-grass and clover mixtures were apparently the beginning of the making-up of definite or regulated prescriptions with different pasture plants.

In 1760, Stillingfleet did very useful work by classifying pasture plants into those possessing good herbage and those with inferior herbage. His list gave the kinds best calculated to produce the richest hay and sweetest pasture.

The latter half of the 18th century saw meadow catstail (timothy) and cocksfoot added to the list of useful grasses.

From this time, writers and experimenters appear to have turned their attention to the more permanent or natural grasses for pasture-making.

The latter part of the 18th and the beginning of the 19th centuries stand out as a remarkable period in the development of improvements in agricultural practice. During this time the National Board of Agriculture was established (1793) with Sir John Sinclair as its first President. This Board and many agricultural societies formed about the same time began to stimulate a spirit of enquiry among farmers and the adoption of improved methods in agriculture.

Different Methods in England and Scotland.—In the early 19th century the English view appears to have been epitomised in the old maxim that " he who has once got a good turf is an idiot if he breaks it up again." There are many variations of this maxim, each of which emphasises the unwisdom of ploughing up old pasture. It was considered a highly speculative and expensive venture, and it usually was. The effect of this viewpoint was that the major part of the grass-land on English farms was kept as permanent pasture.

The opposite view obtained in Scotland, where they held that most of the old grass-land was not good enough to be left down to permanent pasture. Their policy was to reduce the area under permanent grass to a minimum, and by a system of long temporary leys provide a good proportion of the pasture on rotation land. The inferior nature of the herbage on natural pastures in Scotland as compared with the best in England and Ireland was considered to be due to the deficiency of lime in Scottish soils, which are therefore less suitable for the support of the best natural grasses.

In his evidence before the Select Committee in 1883, Mr. Robert Hughes stated: "There is a system, more especially in Scotland, of what farmers call up-and-down land. They plough it sometimes, and then lay it down for two, three, four or five years, but the moment the price of corn rises, they plough immediately and convert into tillage."

The system of long temporary leys did much for Scottish agriculture during the 19th century, and so far as the economical growing of farm crops and the feeding of live stock are concerned, it is very doubtful if this system can be improved upon at the present time.

Making Pastures by transplanting Turf.—Any development in the seeding of land down to grass during the 17th and 18th centuries appears to have been confined to what we understand to-day as temporary pasture mixtures, but during the early part of the 19th century a distinct advance was made in seeding land down to permanent pasture. It will be interesting, however, to note a method which was popular, for a short time only, of making pastures by transplanting turf. This method was invented by Mr. Whitworth, Acre House, Lincolnshire, and first practised on an extensive scale by Mr. John Blomfield, Warham, Norfolk, in 1812. For this purpose tillage land was thoroughly cleaned by summer fallowing. One of the best pastures on the farm was selected and alternate strips of turf ploughed out, the strips being 6 inches or 9 inches wide by 2½ inches deep. The cut turf was then carted on to the field to be planted, which had been marked out in 1 foot squares. The turves were cut into pieces of 3 inches square. Women and children placed one piece, turf upwards, at the corner of each square foot, and men followed with a ram to ram the turves into the surface soil. The turves soon rooted and spread laterally until a uniform pasture was secured. Composts or other suitable material was spread on the old pasture from which the strips of turf had been taken, with the object of filling in the strips and encouraging the herbage to spread laterally until a uniform turf was formed.

This laborious method of transplanting turf was, however, soon superseded by the sowing of special seeds mixtures, which Stillingfleet[1] had strongly advocated towards the end of the 18th century. His contention was that "when a farmer wanted to lay down a field to grass, what did he do? He either took his own seed indiscriminately from his own foul hay-rick, or sent to his next neighbour for a supply. . . . This is a slovenly method of proceeding, as one would think, and could not possibly prevail universally. Yet this is the case to all grasses, except the rye-

[1] English Farming: Past and Present, by R. E. Prothero (1917).

grasses, and what is known in some counties by the name of Suffolk-grass (*Poa annua*). Now if a farmer would only collect separately one-half to a pint of seed from a few of the best grasses and sow them separately on clean ground, he could very soon raise up sufficient stock seed for his purpose, and eliminate the weeds and inferior grasses which inevitably creep into ordinary hayseeds."

Coke of Norfolk is said to have been the first landlord to take advantage of Stillingfleet's suggestions on his own land. In May and June, when grasses were in flower, he taught the children of his tenantry to recognise them, and later on, when the seeds were ripe, sent them to gather seeds from those grasses he desired to include in his pasture mixtures.

Experiment Grass Garden at Woburn Abbey.—The Duke of Bedford was impressed with the need for conducting experiments to test the comparative merits and value of the various grasses found in the best pastures, and allocated land at Woburn Abbey for the purpose, which became known as the Experiment Grass Garden. These trials were supervised by the Duke of Bedford's gardener, George Sinclair, F.L.S., F.H.S., and about 97 different grasses were tested. The results of this work are given in Sinclair's book, "Hortus Gramineus Woburnensis." This book is a classic, including as it does analyses by Sir Humphrey Davy of soils from the best feeding pastures in the country, as well as analyses and relative nutritive values of each of the grasses included in the trials.

The general scheme of the work may be judged from the following points which were investigated :—

1. Actual yield of each grass produced (*a*) at flowering time, (*b*) when ripe, (*c*) when dead ripe. The amount of loss in weight on drying of the grass at each stage. The nutritive value of each grass at each stage was ascertained by Sir Humphry Davy.
2. The amount of aftermath produced by each grass and its nutritive value.
3. The permanent nature of each grass over a series of years.

There is probably no better example of careful experimental work carried out for the improvement of agriculture to be found at that time than this work at Woburn Abbey on pasture plants.

In this way Sinclair obtained a unique knowledge of the relative values of the various pasture plants. He also supplemented this work by examining the herbage of the richest and most fattening pastures in Devonshire, Lincolnshire and the Vale of Aylesbury, in order to ascertain the most useful grasses represented in these celebrated pastures. Portions of turves were also taken back to Woburn Abbey and planted in the grass garden. Sinclair appears to have been in touch with farmers in different parts of England and Scotland, and apparently advised them as to suitable mixtures for their purposes.

In the *Quarterly Journal of Agriculture*, vol. iii (1831–32), he refers to three cases where his seed mixtures had been highly satisfactory, viz., Vale of Aylesbury, Cumberland and Roxburghshire. The amount of seed sown per acre in each case was 4 bushels 1 peck, 3 bushels 1 peck and 2 bushels 3 pecks respectively.

The Aylesbury pasture was seeded down with a mixture of cocksfoot, perennial rye-grass, meadow foxtail, meadow fescue, timothy, rough-stalked meadow grass, dogstail, white clover and cowgrass (*Trifolium pratense perenne*), and in two years from sowing the grasses were equal to any old pasture on a similar quality of land. The Cumberland 10 acre field of strong loam on clay in a high and exposed situation was sown on clean fallow ground. The next year it carried upwards of 40 ewes, with 33 lambs and 20 yearling bullocks. The Roxburghshire field carried a similarly heavy stocking.

Sinclair remarks that such extraordinary results could hardly have been expected from so-called artificial grasses, even when sown without a corn crop. Further experiments proved to him "that by clean preparation of the soil and judicious manuring, any land may be brought in a couple of years into a state of permanent pasture nearly approaching to that of ancient pasture by sowing seeds from the appropriate grasses."

The author of "British Husbandry" (1834) in referring to these experiments doubts the accuracy of Sinclair's statements, as all available information goes to show that new pastures deteriorate after the first year or two.

Recent experiments have shown, however, that, where seeds from indigenous plants are sown, Sinclair's contention that a good pasture could be obtained in two years was quite feasible, provided that indigenous white clover was included. In the latter part of the 19th century Sinclair's work appears to have been entirely forgotten. No doubt the agricultural depression during that period was partly responsible for the indifference to his valuable discoveries.

The early part of the 20th century ushered in a great revival in pasture-making, very much on the lines of Sinclair's work, but with this difference. Sinclair used all his seeds from indigenous plants for pasture-making and got excellent results. He did not, however, stress the necessity of including wild white clover in the mixture, nor the disastrous results which followed when it was omitted, even when all the other seeds were indigenous. This discovery does not appear to have been made until the current century.

The above account has been mainly confined to a description of the evolution of our present-day seeds mixtures. Many of the books of a century ago or more emphasise the importance of pure seeds, methods of sowing and after-management.

Selection of Pasture Plants.—Sinclair (1825) states that failures to obtain good permanent pasture by seeding arise, not from the length of time that the plants require to arrive at perfection from seed nor from the injury the land sustains from a course of grain crops, but from the neglect of employing seeds of those grasses which are natural to the soil and constitute the produce of valuable pastures.

Sinclair found that the plants which mainly compose the herbage of the richest pastures at different seasons of the year numbered approximately twenty-six. These he divided into three groups or periods as follows :—

> *Principal grasses in spring.*—Meadow foxtail, cocksfoot, meadow fescue, meadow catstail (timothy), rye-grass, sweet vernal, &c.
>
> *A great part of summer produce.*—White clover, meadow-grasses (rough and smooth stalked), perennial red clover, crested dogstail, golden oat grass, hard fescue, &c.
>
> *Principally summer and autumn.*—Fiorin, yarrow, &c.

In his mixtures seeds from each of these groups were included, so as to provide a regular grazing throughout the season.

Importance of Purity, &c.—In " British Farming " (1834) " it is regarded as false economy to sow hay seeds or other impure seeds, for after the trouble of getting the land clean and in good condition the further expense of the best seeds should never be spared. It is, however, essential that the seeds be genuine and pure, as well as of the last year's growth, and thoroughly mixed for even distribution of the species, . . . then, with an appropriate selection of plants and proper management, there can be little doubt that the seedling grasses will hold the soil and assume the character of rich pasture or meadow."

Mixing Seeds by Weight.—In 1824 it was common practice to make up prescriptions by measure, except in the case of clovers. Messrs. Lawson, Seedsmen, Edinburgh, appear to have been pioneers in urging the advantage of making up prescriptions by weight. To this end they published an essay in the *Quarterly Journal of Agriculture* supplying several tables of prescriptions by weight.

Preparation of Soil, Nurse Crops, Sowing, &c.—In the early 19th century it appears to have been a common practice to sow grass seeds in a corn crop, usually barley; but although farmers may thus save a year's rent and tillage, it was said to be a losing game in the end.

A permanent sward of grass with bottom of richness and purity from weeds can be obtained only by a thorough summer fallow. The best time to sow the seeds is in the early autumn, but if the land is clean it may also be performed in spring. If sown in a corn crop, it should be thinly sown, and in barley rather than in oats.[1] . In some cases the seeds were sown with half a peck of rape instead of corn, as it was contended that cole did not rob the land so much as corn.

[1] British Husbandry (1834).

Sinclair writes in 1825: "I have sown seeds of grasses in every month of the year, and although much depends on the weather and state of the ground, the results were always in favour of August and early September; next to this, the middle or end of May was favoured. An expert sower should be employed, who will avoid sowing on windy days, or when the soil conditions are unfavourable. The light seeds should be kept separate from the heavy, and both sown separately; for although this will occasion more casts than one, yet the trouble of going several times over the ground is not to be put into competition with the equal distribution of the seed.[1]

In Wilson's "British Farming," a Mr. Stirling of Glenbervie gives the following interesting experiments, apparently from Morton's "Cyclopædia of Agriculture," as to the best depths of sowing grass seeds, &c. :—

Grasses, &c.	*Depth at which the*	
	Greatest number brairded.	*None brairded.*
Cocksfoot, tall fescue, Italian ryegrass, timothy, perennial ryegrass, poa trivialis, yarrow, birdsfoot trefoil, trefoil, alsike clover and white clover ...	¼ in.	1¼ ins. to 3¼ ins.
Meadow foxtail, red clover and perennial red clover . .	½ in.	2 ins. to 2¼ ins.
Burnet	½ in. to ¾ in.	4 ins.
Sainfoin	¾ in. to 1 in.	4¼ ins.

These results were obtained by sowing seeds in finely-sifted dark loam, kept moist throughout the process of germination, and tend to show that mixed grass seeds should not be sown at a greater depth than one inch, while a shallower covering in many cases may answer better.

Feeding Value of "Grasses" at different stages of Maturity.[2]—The first leaves or herbage of the spring is more nutritive than that produced in the autumn months, e.g. 64 drs. at the beginning of April afforded 69 grains of nutritive matter, while the same quantity in November afforded only 39 grains.

The herbage of cocksfoot when rank or old from want of sufficient stocking contains approximately one-half less nourishment than that of recent growth, e.g. 64 drs. of the leaves which had remained uncropped for four months afforded only 20 grains of nutritive matter, while the same quantity of leaves two, or at most three weeks old, afforded 36 grains of nutritive matter.

The fact that cocksfoot herbage tends to deteriorate as it increases in age emphasises the necessity of keeping this grass closely cropped, either with cattle or the scythe, in order to reap the full benefit of its superior merits as a pasture grass.

Sir Humphry Davy showed that the plants most liked by

[1] British Husbandry (1834). [2] Sinclair (1825).

cattle had either a saline[1] or sub-acid taste, as is the case in red and white clovers as well as in the superior grasses. Some plants, however, have an excess of bitter extractive[1] and saline substances when compared with the other pasture grasses. They may even be nauseous to the taste as in the case of yellow vetchling (*Lathyrus pratensis*).

Value of Treading, Close-Grazing, &c. — In "British Farming" (1834) it states that "on the Downs it is considered advisable to eat pasture down as bare as possible, because close feeding prevents the coarse grasses from running to seed and preserves a rich herbage much relished by sheep.

Where the finer grasses abound on these Down lands, the soil is frequently so loose and porous that nothing but close grazing and constant treading will prevent them from being choked by the coarser kinds; otherwise the coarse grasses get away and sheep refuse to eat the herbage.

The Down farmers of Sussex, Wilts. and Dorset[2] hold that they are chiefly indebted to close feeding for the sweetness of their pasture, which depends more on constant grazing than on any peculiar quality of the herbage. The same thing applies to the hard-grazed Lincolnshire pastures and Romney Marsh.

Sinclair (1825) states that "Coke of Norfolk is credited as having proved on an extensive scale that cocksfoot is superior to rye-grass." Cocksfoot, by itself, is not favoured for grazing purposes, and the remedy suggested is to combine the seeds of some of the earlier and later grasses. The same thing may be said of the superior grasses generally, as by mixing with other grasses they keep longer possession of the soil and are more productive in proportion as they are skilfully combined. In the celebrated fattening pastures, as well as those that carry most stock in Devonshire, Lincolnshire and the Vale of Aylesbury, cocksfoot was found in every instance in the herbage, along with foxtail, meadow grasses, rye-grass, and dogstail; but the hassocky appearance, which characterises this grass when cultivated singly or when unskilfully depastured, had in these pastures completely disappeared, although it constituted 5 per cent. of the herbage.

Rotation Grazing.—In "British Husbandry" (1834) the following account is given: "As to the stocking of enclosures, it is the opinion of the most intelligent graziers that the grass-land should be divided into four enclosures and grazed as follows:—

"No. 1. No Stock.
No. 2. For the fattening beasts, until moved to No. 1.
No. 3. For second-best cattle, until moved to No. 2.
No. 4. For store cattle and sheep, until moved to No. 3.

"The fattening cattle are moved on to the rested enclosure

[1] The nutritive matter (hot water extractive) was divided into five distinct vegetable substances, viz.:—mucilaginous, saccharine, albuminous, bitter extractive, and saline substances.
[2] British Husbandry, vol. i (1834).

each time, and when this takes place the rested enclosure is divided into two by hurdles. The cattle are allowed to graze one half for a week and the other half the following week. At the end of each fortnight they are moved on to the 'rested' enclosure. In this way each enclosure gets a fortnight's rest, and the cattle graze over the whole of the grass-land once in two months."

The writer has been informed that a farmer of the last generation at Stantonbury, Bucks, had a regular system of grazing whereby his cattle were moved into a fresh field every Monday morning.

Marling Young Grass on Stone-Brash Soils.[1]—There is a large tract of land called "Stonebrash," which extends from the north of England, through Warwickshire, Gloucestershire (Cotswold Hills), with some parts of Wiltshire and Somersetshire. Under the greater portion of this district there are beds of marl, which have been used extensively in the conversion of arable to grass, and with such success that the ground in some instances is said to have trebled and even quadrupled in value. The grasses usually sown were: 1 bushel perennial rye-grass, 3 lbs. white clover, 10 lbs marl clover and 1 lb. hop trefoil or trefoil.

The grasses are sometimes mown and sometimes grazed the first year, but the latter is considered the better practice. The marling does not take place till the following July, as the land must be covered with grass when the marl is laid on; for if applied to a naked surface, it will cake and the summer heat will burn up the young plants.

Stock Scouring on Clover.—Sinclair (1825) refers to several cases of white clover causing scour among cattle and sheep in cold moist weather in spring, and even red water in sheep is said to have been caused by white clover.

This trouble can be overcome quite easily by combining natural grasses to correct the over-succulence of the clover. This is shown in the following table, where 3,000 grains of green herbage were taken in each case:—

	Fibre.	*Water.*	*Nutritive Matter.*
White clover ...	557 grains.	2,250 grains.	193 grains.
Cocksfoot	1,135 „	1,740 „	125 „
Meadow fescue ...	1,260 „	1,590 „	150 „

Ellis in "The Modern Husbandman" (1744) states that many farmers prefer to sow clover and trefoil together, in order that the trefoil may so qualify the clover as to prevent the swelling that clover so often occasions and that proves fatal to cattle and sheep. In "British Husbandry" (1834) it is held that ribgrass sown with clover tends to prevent cattle from hoving.

The above account of the seeding and management of grass-land will be sufficient to show that some of the farmers of a

[1] British Husbandry (1834).

century ago did know something about the treatment of grass-land, and had in some cases adopted methods which we are re-discovering to-day.

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THE BIOLOGIST on the FARM.—No. XXIX.

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Lambs and Sheep.—As we have watched lambs in the springtime year after year, the same three thoughts always recur. The first concerns the maternal instinct which is so strong and yet so deeply automatised in many animals. The ewe is solicitous, patient, tolerant and devoted, yet is it not the case that a gimmer is sometimes frightened of her own newborn offspring, and will not mother it unless it be held to her mouth and nostrils, when the taste and smell pull the trigger of the strong instinct? Is it not the case that the taste of the amniotic fluid of another ewe's newborn offspring will induce "lamb-theft" on the part of a ewe that has not yet lambed, and that this may be fatal to the welfare of her own progeny? Of course we are observing domesticated animals, but we cannot but be impressed with the heavy price that animals have often to pay for instinctive automatisation.

Our second thought concerns the biological value of play. For (1) it is the safety-valve for overflowing spirits and motor energy; (2) it is a not too serious apprenticeship to the business of adult life, and thus the lamb's games are very different from the kitten's; (3) it is an opportunity for the expression and for the testing of variations or new departures in behaviour, before the criticism of more responsible life becomes too severe; and (4) it is for gregarious and social animals, as pre-eminently for man, a discipline in that give-and-take on which the success of communal life so much depends. Animals do not merely play because they are young; they remain young in order that they may play.

The third thought concerns the change from the lively, adventurous, experimental lamb to the stolid, respectable, acquiescent, domesticated sheep. This change is much less marked in the wild sheep, so we suspect that man is to blame. He makes the sheep too comfortable, too safe, all too thoroughly bereft of responsibilities. Therefore it suffers individual degeneration of mind, just as a hen usually does. Moreover, for a long time he has been eliminating rebellious, original and independent sheep, so that the race sinks into docility after a short youthful reminiscence of the old freedom and adventure. This is part of the price of mutton!

The Elephant at the Plough.—Although Hannibal used the African elephant in war and the Carthaginians in peace, the belief is still strong that *Elephas africanus* differs from *Elephas indicus* in being untameable. But this is an error, as experience in zoological gardens proved long ago. The point has recently become of practical interest, for during the last twenty years the experiments of the Belgian Government in the Belgian Congo have shown that the giant may become a very useful servant on the farm. Especially since 1921 it has been found practicable to capture young elephants and train them to make themselves useful. The captives must be well under ten years old, but this is just a child's age for the elephant, which may live to be a centenarian. Now that taming and training are established facts, those that have acquiesced are used with much effect in the capture of young recruits. Humane and well-thought-out treatment has been richly rewarded. Working from 5 a.m. to 11 a.m., an elephant can plough 2½ acres in two days. It can be used for collecting and piling timber. Two of them can draw a farm cart with a load of five tons. The cost of maintenance is low, for the elephant likes rough herbs, twigs, leaves and roots, which are everywhere available. Maintenance, including the pay of two men to look after "My Lord," besides harness, food luxuries, and other extras, works out at a little over a shilling a day. So the African elephant is far from being a white elephant.

The Dull Donkey.—There is no doubt that the donkey is the domesticated descendant of the African wild ass, a graceful, sprightly, high-strung, alert, swift, and very intelligent species of *Equus*. What has gone wrong with the donkey? The answer is bad breeding and bad feeding, for in many countries the domesticated ass has *not* fallen from the high estate of the wild ass so well portrayed in the Old Testament. Even if the picture in the Book of Job refers to the Asiatic wild ass or Onager, it is equally applicable to *Equus asinus africanus*. But our point is that the domestication of the wild ass does not necessarily lead to the dull donkey. The coster's "moke" is neither ugly nor stupid; but there are much lower depths, and our problem is the depressed donkey. As it seems to us, the depression of the donkey's body and mind is for the most part due to two factors, bad breeding and bad feeding. As the donkey is the poor man's horse, too little care has been taken of its breeding. The depressed donkey is a diagram in dysgenics.

The wild ass is accustomed to thrive on spartan fare, and advantage has been taken of this constitutional virtue to underfeed the donkey. It does not get enough of thistles! And along with the depressing influence of inappropriate nurture may be included the fact that the north of Europe is not genial enough for the asinine constitution, native to warm countries. The Arab horse would not weather our British climatic conditions unless it were coddled.

It is but a speculation, yet we venture, as a provocation to good-natured veterinarian experts, to some of whom we have long since given academic instruction, to inquire whether there is not in the depressed donkey some pathological perturbation of the activity of the endocrinal glands. We should not be surprised to find this suggestion confirmed.

The so-called Agricultural Ant.—For several years some of us have enjoyed the French edition of Auguste Forel's "Social World of the Ants," and now this is made available in English by the courage of Messrs. Putnam, who have published a translation in two stately volumes, generously illustrated. It is the finest book as yet written on the ways of ants,—the outcome of the leisure of a busy life. Forel is now over eighty, and he began to study ants before he was eight. We are far from agreeing with him in his enthusiasm for the state socialism of ants, or in his views on religion, which are surely irrelevant here, but he knows his ants, and the big book is extraordinarily good reading. The only fly in the ointment is the price of the volumes, for they cost three guineas,—too much for the farm just at present.

Everyone has heard of the "Agricultural Ant of Texas," originally described by Lincecum in 1862, and the subject of a book by McCook. The story Lincecum launched was that the agricultural ant intentionally and exclusively cultivates a kind of grass, known as *Aristida oligantha*, all round the bare domed nest. It stated that the ant cuts off all other plants within the circle of the little field. Thus this ant, which bears the euphonious name *Pogonomyrmex mollefaciens*, was the first farmer; so that it is a very fitting subject for the Biologist on the Farm to talk about. It was a pleasant story, but it suffered from the defect of not being true. There is no doubt that the ant makes a clearing around its domed nest, the object being to secure a warmed dry area where the young may be sunned and the seeds dried. There is no doubt that the Texas ant, like many another, gathers seeds and stores them. Among these seeds are those of the grass Aristida, which are afterwards used as food by the workers, or broken and salivated and given to the young ones. But the grass seeds frequently sprout in the ant-granaries, which may become stuffed with young plants. "The ants may then be seen removing the seedlings which have sprouted too far to be fit for food, and throwing them on the refuse heap which is always at the periphery of the crater or cleared circle." Here they sometimes take root along with other plants that have been rejected. But this only occurs in a minority of cases. The story is very interesting, but it is not so extraordinary as Lincecum's legend which even the Texas schoolboy hails as a good joke. It may be noticed that *Pogonomyrmex mollefaciens* has a bite worse than its bark, and was used by the ancient Mexicans in torturing their prisoners. Ants differ in their treatment of seeds, but some of them bite off the protruding tip when sprouting begins and then dry them dead in the sun. Others allow the sprouting to continue until the firm seed-envelope is burst, and then dry them thoroughly.

The Insect Menace.—One of the soundest of the many entomological books is Professor G. H. Carpenter's recently published "Biology of Insects," and of special interest to the farmer is the concluding chapter on "Insects and Mankind," for it discloses the manifold ways in which the circle of human interests is intersected by the circles of insect lives. We do not forget hive-bees, silkworms, lac-insects, and all those that play an indispensable part in the cross-fertilisation of many useful plants, but there is so much to be weighed on the other side that we come to think of insects as a menace to mankind. Their capacities for prolific multiplication suggest possibilities of disaster that make one shudder, and everyone knows that these disasters often occur locally. How careful man should be in interfering with the balance of nature which continually saves the situation for the world.

The Mexican cotton boll-weevil, *Anthonomus grandis*, is never more than a sixth of an inch in length, but it has shaken several continents since it crossed the border of the United States in 1892. It has overrun nearly the whole of the "cotton belt" in the course of some thirty-five years. The female beetle bites small holes in the buds or the flower of the cotton plant, and lays her eggs there. The eggs hatch out into hungry grubs which feed inside the blossom or the capsule ("boll"). They sink into the pupal phase, whence beetles emerge which recommence the destructive work, continuing to eat for weeks or months. In the northern parts of the invaded cotton belt only about 2 per cent. of the beetles survive the winter, and yet the annual loss due to their ravages in the States has been estimated at £50,000,000. Professor Carpenter quotes from the President of the New Orleans Cotton Exchange, who declared that "national prosperity is threatened by the ravages of this insect." Arsenical sprays are used on a vast scale and the price of arsenic increases threefold; disused tin-mines in Cornwall are re-opened for the sake of the arsenical by-products; aeroplanes are needed to spray the infested cotton, and the factories are busier; but we must not pursue the plus and minus ripples further. The big fact is a huge and disastrous loss and the shaking of an immense industry, and this is but a conspicuous instance of the intersection of human life by insects.

We were hearing the other day of a new menace on the continent which has been caused by the multiplication of another beetle, the "brass beetle" or Messingkäfer. Perhaps its ravages have been exaggerated in the newspapers, but they seem to be very unpleasant. The little beetle, a relative of our fur-beetles and death-watches, gets into houses and devours clothes and other fabrics. In a house in Heidelberg they were recently numerous enough to be a plague, but they yielded to a thorough treatment with fumes of prussic acid. Individually they seem to be unimportant, but in crowds they are menacing. Their recent multiplication seems to have occurred chiefly in old houses, granaries, stores and factories. The grubs and the adults shelter in wood that has been attacked by death-watches and the like, or has begun to be affected by fungi. Their appetite is especially for woven things, from carpets to silk stockings. Zoologically these beetles belong to the family of Ptinidæ, and they used, we think, to be called *Ptinus* or *Niptus hololeucus*. The name " brass "-beetle refers to the colour of the short silky hairs on the body. We have read that they have been known in Germany since 1873 but never regarded as of much moment. We have referred to them only because they seem to have created some sensation of late, and because they illustrate an ever-present menace. Like some better things, they come from the East.

TRIALS OF WEED-KILLERS ON GARDEN PATHS AT CRAIBSTONE.

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MANY experiments have been carried out on agricultural land on the effect of various chemicals as weed-killers, but few results are to hand on weed-killers on garden paths, drives, &c. Walks which become infested with weeds are very unsightly, and in gardens of considerable extent the keeping down of these weeds may involve large outlays for labour, when hoeing has to be resorted to.

The object of the trials at Craibstone, the Experimental Farm of the North of Scotland College of Agriculture, was primarily to find a substance which would be both efficacious and cheap, and further to compare the results with those obtained by employing several well-known proprietary weed-killers, which generally are far too costly to be applied in large quantities. Incidentally, the experiments have been of considerable value for demonstration purposes, as many enquiries have been received regarding weed-killers for paths, and a great deal of interest has been shown by the numerous parties visiting the experimental field. On this account it seemed advisable to give a resumé of the results since the inception of the experiment.

The trials were commenced in the early summer of 1924, and some of the results were so promising that it was decided to allow the plots to stand untouched during the season 1925. Subsequently other plots were laid out elsewhere in 1926 and 1927.

The chemicals used in the trials were :—common salt; washing soda; copper sulphate, in powder form and as a solution in water; iron sulphate, also in the form of a powder and as a solution; sodium arsenate; carbolic acid; sulphuric acid, and arsenical sheep-dip. Along with these several proprietary weed-killers were tested.

These latter may for convenience be placed in three types. Type A was a liquid coal-tar product containing arsenic, Type B was also a liquid coal-tar product but contained no arsenic, while Type C was an arsenical preparation, but is sold in sòlid form and has to be dissolved in the requisite amount of water for application. It consists chiefly of arsenic, along with caustic soda; a certain amount of heat is produced when the mixture is placed in water, and this aids in the solution of the arsenic.

In the 1924 experiments the weed-killers were applied to the plots on the 4th of June. The weather previous to the application was somewhat rainy, but on the day of application it was sunny, and this was followed by a period of fair weather with only occasional rain showers. The walk chosen for the tests was fairly evenly coated with weeds, mostly of a grassy kind, with a few sorrel plants, especially at the edges of the walk, which was bordered on both sides by grass verges. The area of each plot was 100 sq. feet, and to prevent overlapping while applying the weed-killers, a narrow strip was left between the plots. Where the weed-killers had to be applied in the form of solution, 2 gallons of the required strength were applied by means of a watering can. Where the material was applied in powder form, roughly 1–1½ lbs. was sufficient to cover the plot.

During 1925 no new plots were laid down, but in 1926 a similar set of plots was laid out on another walk on the experimental area at Craibstone, and most of the substances included in the 1924 experiment were again tested, together with some new ones not hitherto tried. Amongst these were gas liquor from the gas works; a proprietary weed-killer (Type D) and pure sodium chlorate. This weed-killer (Type D), which is sold in solid form and is non-poisonous, had then just been placed on the market. It has to be dissolved in a certain quantity of water for application. It was found by analysis that the essential constituent in this brand was sodium chlorate. A plot getting pure sodium chlorate was included in the experiment for comparison. In addition other brands of proprietary weed-killers of Types A, B and C were included in this year's trials.

Unfortunately for the 1926 trials, heavy rain fell just after the application of the weed-killers, so that some of the plots did not do so well as they might have done under more favourable conditions. The 1926 tests, however, drew attention to the value of sodium chlorate as a weed-killer, a point which will be further dealt with below.

Notes and Observations on the Plots.—*Common Salt.*—Common salt has long been used as a weed-killer, and has been employed in such forms as crushed rock salt, commercial salt, and as waste salt used in the fish-curing industry, particularly in the north-east corner of Aberdeenshire. Owing to the conflicting accounts of the utility of salt as a weed-killer it was decided to include it in the trials. The salt was applied at the rate of about 1 lb. per 100 square feet. It was applied broadcast and not in the form of a solution. The salt was rather slow in its action, but had the effect of "burning up" the small plants of grass. Where the plants, however, had grown to any considerable size and had gained a firmer hold, the salt had little or no effect. Towards the end of the season what little effect the salt had seemed to be lost and the weeds sprang up anew in even greater numbers. This bears out the experience of many who have been advised to use salt as a weed-killer on garden paths.

Washing Soda.—This was applied as a 5 per cent. solution, about 2 gallons of this strength being sufficient to cover and saturate the plot of 100 sq. feet. The washing soda had no effect on the weeds, and in spite of another dressing of like quantity and strength the plot became weedier as the season advanced.

Iron Sulphate.—This substance, as is generally known, is one of the constituents of "lawn sand" used as a moss-killer on lawns. Two plots were treated with this substance, one getting an application of 2 gallons of a 15 per cent. solution, while the other received 1 lb. of the dry powdered material at the beginning of the experiment, and a similar dressing about a fortnight later. Its use on lawns shows that it does not kill grass but only moss. On both plots iron sulphate exhibited no properties of a weed-killer. On the contrary, several weeks after the first application, both plots seemed to be getting exceedingly weedy when viewed from the end of the pathway on which the experiment was being conducted. On closer inspection this effect was seen to be caused by the iron salt imparting a dark-green colour to the weeds. These remarks refer to iron sulphate as a weed-killer only; its effect on moss will be considered later.

Sulphuric Acid.—Although it would not be advisable to recommend sulphuric acid as a weed-killer for general use on account of its dangerous properties, it was considered of sufficient interest to warrant inclusion in the trials. The results, however, were disappointing. The weeds were attacked for the most part around the collar, near the surface of the ground; the outer leaves died off but the centre of the plants still survived, and the whole plant was flourishing again in the course of a week.

Copper Sulphate.—Of all the substances used in the experiment, apart from some of the proprietary weed-killers, copper sulphate gave the greatest promise. The weeds on the Craibstone paths were on the whole practically unaffected by the use of a 5 per cent. solution of copper sulphate, but when applied as a finely ground powder, at the rate of 1 lb. per 100 sq. feet, it proved to possess strong weed-killing properties in the 1924 tests. This plot got two dressings of powdered copper sulphate during the season, one on June 4 and the other a fortnight later. The weeds were entirely destroyed and the plot remained free from weeds during the remainder of the year, and likewise during the whole of the succeeding season. When the 1924 and 1925 plots were discontinued the copper sulphate plot was allowed to stand for some time to observe how long it would remain without weeds. This plot, therefore, has not been treated in any way since the summer of 1924, and at the end of November 1927 it still has no weeds upon it. The other plots in the neighbourhood, even those getting proprietary weed-killers, arsenical and otherwise, have had to be hoed repeatedly. The success of ground copper sulphate seems to depend on applying it under suitable weather conditions. The plot which received this material in 1926 was not nearly so successful, as heavy rain fell shortly after the application and washed the copper sulphate down past the roots in too dilute a solution.

Sodium Arsenate.—Arsenic in the form of a 1 per cent. solution of sodium arsenate was applied to another plot, but it was soon apparent that the solution was not strong enough to affect the weeds, and a further dressing was applied, but the combined effect of the two dressings was simply to cause the leaves to wither, but the plants were not killed. A stronger solution was tried in the 1926 trials with somewhat better results, but with the disadvantages noted with all weed-killers containing arsenic. This point will be dealt with under the proprietary weed-killers.

Carbolic Acid.—A 1 per cent. solution of crude carbolic acid gave negative results.

Sheep-dip.—A plot was dressed with a sheep-dip containing arsenic, diluting it to the strength recommended for dipping and applying 2 gallons of the diluted dip to the plot, but the results obtained were not so good as those obtained with some of the proprietary weed-killers containing arsenic.

Proprietary Weed-killers.—The proprietary weed-killers of Types A, B and C were all decidedly good, but Types A and C, which contain arsenic, had the disadvantage of blackening the paths at Craibstone, and further, it was found necessary, if the weeds were to be kept in check, to make several applications during the season.

Trials during 1926.—The substances tested in the 1924 and 1925 trials were again put to the test in 1926. In addition to these, several other brands of proprietary weed-killers of Types A, B and C were tried, together with some other materials discussed below.

Gas Liquor from the Gasworks.—This liquid had been suggested by a correspondent as having been successful as a weed-killer, but the results obtained by using the liquor from the Aberdeen Gasworks were very unsatisfactory. This may be explained by the fact that the liquor distilled from any large gas-producing plant by up-to-date methods contains a very much lower percentage of plant poisons than was the case when older methods were employed. Many of the gasworks in our smaller towns are still employing old methods, and the gas liquor from these may contain sufficient plant poisons to render it valuable as a weed-killer.

Sodium Chlorate.—A new non-poisonous weed-killer, which contained sodium chlorate as the essential constituent, was placed on trial. This was tested against pure sodium chlorate, using the same strength as was recommended for the proprietary article, viz. a 1 per cent. solution (approximately). Both these plots were soon clear of weeds and remained so for the greater part of the season, but towards the autumn it was noticed that both were again becoming green. On inspection it was found that a particularly luxuriant growth of moss was appearing on both plots. This result has been confirmed by several correspondents during 1926 and 1927. This subsequent growth of moss does not appear to be confined to weed-killers containing sodium chlorate, but has also been reported after applications of weed-killers containing arsenic, although none of the "arsenical" plots at Craibstone developed moss in this way.

Trials during 1927.—The results which were achieved in former years with copper sulphate in dry form and with sodium chlorate solution merited a further trial in 1927 in the hope of throwing light on the problem as to the proper weather conditions before and subsequent to the date of application. Unfortunately the weather conditions prevailing during the past year were not conducive to good results.

In the following account of the plots laid down during 1927 are included some statistics relating to the weather preceding and following the dates of application of the copper sulphate and sodium chlorate. For these statistics I am indebted to Mr. John Craig, B.Sc. (Agr.), Assistant Director of Experiments and Meteorologist at Craibstone.

PLOT 1. *Copper Sulphate.* Date of application, April 16th, 1927.

Date.	*Rainfall.*	*Date.*	*Rainfall.*
April 12	5·0 m.m.	April 18	Nil.
" 13	2·4 m.m.	" 19	0·2 m.m.
" 14	1·7 m.m.	" 20	0·1 m.m.
" 15	4·0 m.m.	" 21	0·2 m.m.
" 16	Trace.	" 22	1·1 m.m.
" 17	Nil.	" 23	3·2 m.m.

The copper sulphate on this plot was very effective in eradicating the weeds. On the day of application the weather was bright, as was also the following day. The 18th was dull but no rain fell, and the 19th and 20th were for the most part bright and sunny. The conditions here were apparently ideal for the proper action of the copper sulphate.

Plot 2, *Copper Sulphate*, and Plot 3, *Sodium Chlorate*. Applied May 7th.

Date.	*Rainfall.*	*Date.*	*Rainfall.*
May 4	15·6 m.m.	May 9	Nil.
,, 5	Trace.	,, 10	Nil.
,, 6	Trace.	,, 11	1·6 m.m.
,, 7	Trace.	,, 12	Nil.
,, 8	Trace.	,, 13	6·6 m.m.

The weather at the time of application of the weed-killers was inclined to be foggy, but no heavy rain fell until the 13th. Here again the application of the copper sulphate was successful, while the sodium chlorate was not so successful in killing off the weeds. This is no doubt accounted for by the fact that the heavy rain before the date of application had saturated the pathway, and on account of the prevailing fog the path had very little chance to dry. The solution of sodium chlorate would therefore be very much diluted as it passed into the path. The copper sulphate, on the other hand, would lie on the surface as long as no heavy shower fell to wash it in, and the somewhat damp overhead conditions would only cause its gradual solution.

Plot 4, *Copper Sulphate*, and Plot 5, *Sodium Chlorate*. Applied June 18th.

Date.	*Rainfall.*	*Date.*	*Rainfall.*
June 12	4·2 m.m.	June 17	0·4 m.m.
,, 13	1·1 m.m.	,, 18	Trace.
,, 14	Nil.	,, 19	6·2 m.m.
,, 15	Trace.	,, 20	2·8 m.m.
,, 16	1·2 m.m.	,, 21	2·6 m.m.

Both plots were failures. Although the 17th and 18th were fairly bright days, a good deal of rain fell on the following days. In the case of plot 4, the copper sulphate powder was not allowed sufficient time on the surface, but was dissolved and washed into the path in too dilute a solution. So with the solution of sodium chlorate. Too much moisture was present and the solution became too dilute for proper action.

Several other plots were laid down later, extending to mid-July, but by this time the ground had become so sodden with rain that neither copper sulphate nor sodium chlorate were efficacious in killing weeds.

Conclusions.—None of the sodium chlorate plots in the 1927 trials could be classed as successful; the weather conditions were unfavourable. Further, it is necessary to recall the fact that sodium chlorate tended to favour the growth of moss on the walks at Craibstone.

Copper sulphate on the other hand has proved a very efficient weed-killer, provided the proper weather conditions are available at and subsequent to the date of application. The initial outlay may appear heavy; powdered copper sulphate is retailed at 4*d.* to 5*d.* per pound, but when one considers that two dressings in 1924 has kept a plot on the walks at Craibstone free from weeds up to November 1927, and there is every prospect that the effect of these dressings will continue to be felt for several seasons yet, then one is justified in recommending powdered copper sulphate as a weed-killer of some value for garden paths and drives.

Several points of interest which cropped up during correspondence on the subject of weed-killers, and which are of an allied nature, may with advantage be discussed in this article.

Moss on Walks.—There is the problem of moss and other lowly plants like liverworts developing on walks. An experiment on a small scale was initiated to find a means whereby these could be eradicated. Three substances were tried: copper sulphate, iron sulphate, and caustic soda. Of the three, iron sulphate gave the best results, the moss being blackened within 24 hours, but the liverworts proved much more resistant. Caustic soda proved quite good, but owing to its nature the path was left in a very sticky condition. One must also bear in mind that such a strongly alkaline substance on walks and drives might have a bad effect on shoe leather and rubber tyres. Copper sulphate, although it had an action tending to kill the moss, was exceedingly slow, and it had practically no effect on the liverworts.

Green Growth on Concrete Paths. — Concrete paths in positions which get little or no sunshine, and which in consequence often remain damp for considerable periods, are liable to become coated with a green growth which no amount of scrubbing will remove. In such cases the pathways can be renovated by sprinkling powdered caustic soda on the path and allowing it to absorb moisture from the air. The path should then be gone over with an old brush with strong stiff bristles, and finally well flushed with water. The path should not be walked on while the soda is on it, and paths which are completely concreted should be treated lengthwise in two separate portions, so that while one half is under treatment, the other half may be available for use. It is more than probable that other substances of a less troublesome character may be quite as effective as caustic soda, and it is intended to carry out further tests on this subject.

For valuable help and suggestions regarding these trials the writer expresses gratitude to Professor Hendrick, Director of Research, North of Scotland College of Agriculture, and to Mr. W. M. Findlay, Director of Experiments at Craibstone.

Some Observations on Liming in Scotland.

THE following notes on the liming of land have been contributed by Mr. J. A. Symon and Mr. J. Miller :—Within recent years there has been in the North of Scotland and elsewhere a marked renewal of interest in the question of liming land. Various causes have contributed to this. Some of the now defunct agricultural executive committees, alarmed at the extent to which the old practice of liming had gone into disuse, had suggested that steps might be taken to reopen existing lime kilns and so encourage liming; other agricultural bodies have from time to time advocated some form or other of Government subsidy in aid of liming; and there has been a general impression among farmers that more liming was needed.

Until recently this view was generally accepted by agricultural scientists, who seem to have held the invariable opinion that lime applied to an acid soil would increase its fertility. This view has been disseminated chiefly by agricultural text-books, whose authors were more familiar with English than with Scottish soils. Until investigation work had been carried out by Professor Hendrick at Aberdeen it seems to have been tacitly assumed that the characteristics of Scottish soils were more or less identical with those of English. The work done by Hendrick, however, shows that there are distinct chemical differences between them. In brief, typical Scottish soils differ from English in that they "contain much compound silicate in an unweathered or only slightly weathered condition, and that in these unweathered or partially weathered minerals they contain a great reserve store of valuable bases, such as potash and lime." The results of Hendrick's work are described in an article contributed by him to the 1925 Transactions of the Highland and Agricultural Society of Scotland. In spite of their containing these large reserves of bases, typical Scottish soils would be classed by a soil analyst as acid, and according to the teaching of the ordinary agricultural text-books would be expected invariably to yield larger crops as a result of liming. That this is not the case has been demonstrated by Hendrick, who, in an article in the 1926 Transactions of the Highland and Agricultural Society, describes the results of his investigations in regard, *inter alia*, to lime applications at Craibstone. In the case of this soil, which is acid, Hendrick found, in brief, "when dung is used, lime diminishes the crops of oats quite decidedly and of turnips and hay slightly, while barley is slightly, but not decisively, benefited by liming."

Although most farmers profess a profound belief in the efficiency of liming, it is rather remarkable that so few put their belief into practice, especially as liming has tradition to support it and is not an untried novelty. It would appear that although their professed belief is contradictory to the results of Hendrick's investigations, yet their practice seems to endorse these results, or at least to cast grave doubt on the economic soundness of applying lime. The late Dr. Shirra Gibb, a scientifically trained practical farmer, seems, after a lifelong experience of farming, to have found it a comfort in his old age to see so few people putting lime on the land by the big shovelful. After what he describes as a "long and costly experience" his advice is, "If you have too much money give your land some more food, but not the excess of lime which will merely waste it."

The present position seems to be as follows:—On the one hand there is the widely professed belief in liming, but this belief is not being largely put into practice. On the other hand we have a single recorded experiment scientifically carried out and controlled and extending over two rotations, the results of which appear to contradict this general belief. It seems, therefore, that the time is now ripe for more actual experimental work on the following points :—

(1) The behaviour of soils in other parts of Scotland as regards liming.

(2) Some practical method of determining when a soil could be benefited by lime.

(3) The response of the various field crops to lime.

(4) The optimum quantities of lime to use.

(5) The economic side of the question.

(1) In the North of Scotland very little experimental work has been carried out in regard to liming. At Glendye, Kincardineshire, applications of lime to an old pasture consisting largely of nardus and creeping bent grass showed certain, but not great, beneficial results; but with the exception of the experiment at Craibstone there have been few or no definite recorded experiments on arable land. It is interesting to note that recent widespread experiments in liming undertaken by the Irish Free State give very varied results. While at some centres very decided increases of crop were obtained, and while there were very few negative results, it is noteworthy that a large proportion of the increases obtained were so small that they may reasonably be regarded as insignificant. In over 40 per cent. of the 1926 results the increase was not more than 5 per cent.

One of the interesting facts that emerge from Hendrick's work at Craibstone is that while in the case of the dunged plots liming produced a decrease in every crop grown except barley, on the other hand, when no dung was applied, liming produced a heavier crop in almost every case. The full results of the experiment are detailed in Table II in the article above mentioned, but the following table shows the general results in an abbreviated form. For convenience the results of the two rotations have been averaged, and the increases or decreases due to liming have been expressed as percentages.

Crop.	Percentage Increase (+) or Decrease (−) due to Liming.	
	On plots receiving Dung.	On plots receiving no Dung.
Turnips	− 7	+ 7½
Oats—Grain...	− 10¾	+ ½
Straw	− 10½	+ 1
Barley − Grain	+ 4¾	+ 14
Straw	+ 8¾	+ 17
Hay	− 6	+ 25

Our own experience has been that certain fields (usually those farthest from the steading) to which little or no dung has been applied assume an appearance which suggests a decided lack of lime. The first crop to suffer in such fields is usually barley, which may sometimes be a complete failure. Red clover is nearly always absent. The ordinary pasture grasses and clovers tend to die out quickly, their place being taken by such weeds as sorrel, pluff grass and creeping bent grass. Such fields may give good crops of oats, potatoes and turnips (if free from finger-and-toe). The behaviour of these fields is in some degree comparable to that of the undunged plots in the Craibstone experiment, and it is probable, too, that the apparent lime starvation of these fields has been aggravated by the application of double doses of acid artificial manures. If it is the case that such fields are in a condition of lime starvation, it may be that the problem of lime investigation is not so much to discover what wide areas are in general need of lime as to find out what fields, or types of fields, on individual farms, would respond to lime. The above considerations point to the great necessity for

(2) *Some practical method of determining when a soil could be benefited by lime.*—Chemists express the degree of acidity of a soil by a scale known as the p.H. value. In this scale p.H. = 7 means that the soil is neutral. All values below 7 indicate acidity, and the lower the value the greater the acidity. The soil in the unlimed plots at Craibstone has a p.H. value = 6. It is possible that this p.H. scale method may be reliable generally in determining when a soil will respond to lime, but at present our knowledge is not full enough to enable us to state this definitely. It is conceivable that one type of soil with a p.H. value of, say, 5, might respond readily to lime, whereas another type of soil with the same p.H. value might not. At Craibstone the undunged plots responded to liming differently from the dunged plots, yet this difference in behaviour does not seem to be correlated with a difference in the p.H. value, and it would therefore seem that the p.H. value method might be unreliable in certain cases. This is a matter which must be decided by experiment. It is possible, however, that the p.H. value method might be used in conjunction with observation of the vegetation of, and behaviour of the various crops grown on, the soils under consideration. The latter test is a simple one which can be used by the ordinary farmer, but in this matter, too, the time is now ripe for carrying out more investigation work.

(3) *The response of the various field crops to lime.*—It is now well known that the common field crops respond differently to lime. For example, oats[1] will grow and potatoes will flourish on soils where barley is a failure. Sugar beet is said to be a lime demanding crop; on the other hand turnips appear to thrive in a fairly acid soil provided finger-and-toe is absent. At Craibstone, when dung is applied, a p.H. value of 6 is more favourable to the growing of oats, turnips and grass than a p.H. value of 6·4.

[1] The newer varieties of oats would appear to be more affected by lime deficiency than the older.

In investigating the lime requirement of any soil, regard must be paid to the normal cropping. If lime will benefit only one crop in a rotation and possibly reduce all the others, then the application of lime is a very questionable matter. On the other hand, if most of the crops, or the most valuable of the crops, will be benefited decisively by lime then liming should be practised. All this indicates the need for more experimental work, and postulates that in such work observations should be made and records kept for at least one full rotation.

(4) *The optimum amount of lime to use.*—In former years the common practice in liming land was to apply large dressings at long intervals. Recently the tendency has been to apply much smaller dressings at shorter intervals, and on most farms where liming is still practised it is customary to apply a small dressing once in the rotation. It is possible that this may be the more economical method, and in that event the question of what is the optimum amount becomes all the more acute. It would also be interesting to know whether the p.H. value is a true indication of the amount of lime required.

(5) *The economic side of the question.*—The disuse into which the practice of liming has fallen is explained by practical farmers as due to the present high cost of lime. This does not, however, explain why liming had gradually declined for many years before the war. The professed opinion of farmers as to the value of lime, and the fairly general idea that full benefit from the use of artificial manures is not being obtained because of lime deficiency in the soil, do not seem to tally with actual practice. In the North of Scotland most farmers spend money freely on artificial manures, but nothing at all on lime. The only feasible explanation of all this is that farmers are not so convinced of the benefits arising from lime as to purchase it extensively. The results of the experiment at Craibstone tend to show that there is some justification for this lack of confidence. Even where lime is generally beneficial to the crops throughout a rotation there is still the question of whether its application is economically sound. In any liming experiments, it is desirable that records should be kept of the cost and of the value of the increases (or decreases) in crop throughout the rotation.

In calculating the cost of liming the chief difficulty arises in connection with the question of residual values. When a large dressing is applied it is obviously wrong to charge the whole cost against one rotation. The annual wastage of lime probably varies considerably with conditions, e.g. type of soil and system of farming, and has been estimated at as high as 1,000 lbs. per acre per annum. In the "Report by a Joint Committee of Scientific and Professional Men" on the residual values of feeding stuffs and fertilisers it is recommended that exhaustion be allowed for at the rate of 4 cwts. of pure lime per acre per annum. This is obviously only an attempt at striking an average, but may be accepted as being based on the best information available. Thus, if average commercial lime, showing an analysis of, say, 80 per cent. pure lime, costs, say, £2, 10*s*. per ton, then the cost of liming would be 2*s*. 6*d*. × 100/80 × 4, or 12*s*. 6*d*. per acre per annum (to which, in order to be exact, should be added interest on the original total cost per acre).

It would be absurd to try to deduce from the Craibstone experiment any general conclusions as regards costings, but in the absence of any other data it might be interesting to attempt to arrive at an approximate idea of the probable costings of liming exactly similar land in the North of Scotland (though admittedly such land may possibly not exist). In the case of the dunged plots there was, over and above the cost of liming, a loss due to reduction of crop, so that calculation is unnecessary. In the case of the undunged plots the total increases of crop for two six-year rotations were as follows :—

Turnips	1 ton,	7	cwts.	per acre.
Barley—grain	0 ,,	3	,,	,, ,,
straw	0 ,,	5·6	,,	,, ,,
Oats—grain and straw ...	0 ,,	0	,,	,, ,,
Hay	0 ,,	14·3	,,	,, ,,

If these increases are valued as follows :—turnips 15*s*. per ton, barley 11*s*. per cwt., straw 30*s*. per ton, hay £3 per ton, the total value of the increase is about £5, 4*s*. per acre. If 12*s*. 6*d*. per acre per annum can be accepted as an average cost of liming in the North of Scotland, then the cost per acre for the two six-year rotations would be £7, 10*s*. Not included in the above calculations are four years' grass, regarding the improvement in which there are unfortunately no exact data on which to base a valuation. All that can be said is that the liming would only pay if the improvement in the grass for the four years was worth more than £2, 6*s*. per acre.

It has already been remarked with regard to individual fields which have received little or no dung that their behaviour is in some measure similar to that of the undunged plots at Craibstone. It seems probable that liming would benefit such fields, but it also seems probable that lack of dung explains the fact that they are different from other fields on the same farms. A question that suggests itself is whether liming or dunging is the more efficient and economical treatment for such fields. Here, again, it would be futile to try to draw general conclusions from a single experiment, but it might be interesting to compare the yields of the plots at Craibstone that received dung but no lime, with the yields of those that received lime but no dung. It must be admitted that a strictly accurate comparison cannot be made between these two sets of plots for the experiment was not laid down with a view to making such a comparison, and it happens that the artificial manuring of these two sets of plots was not quite the same. The difference, however, is so small that it could hardly make any great difference in the yields. The following table shows the total yields per acre per two rotations :—

Crop.	Dung without lime.		Lime without dung.		Difference in favour of dung without lime (+) or vice versa (−).	
	Tons	Cwts.	Tons	Cwts.	Tons	Cwts.
Turnips (2 years)	35	11	28	2	+7	9
Oats (3 years)—Grain		108·1		95·7	+	12·4
Straw		108·5		98·8	+	9·7
Barley (1 year)—Grain		22·8		24·4	−	1·6
Straw		36·0		39·1	−	3·1
Hay (2 years)		113·8		75·8	+	38·0

If turnips, barley, straw and hay are valued as before and oats are valued at 8*s*. per cwt., the nett difference in crop in favour of dung without lime is worth about £15, 17*s*. per acre for the two rotations. As regards the grass, again we have no exact data for valuation, but the general report seems to indicate that the grass on the plots that received dung without lime would be at least as good as on those that received lime but no dung. There are certain obvious objections to comparing the cost of dunging with that of liming if only on account of the fact that applying dung to one field normally involves applying less to some other. The following estimate of cost is therefore not altogether satisfactory. At Craibstone dung was applied at the rate of 12 tons per acre per rotation. If dung is valued at 10*s*. per ton the cost of dunging (apart from labour) would be £12 per acre for two rotations. If, as before, we put the cost of liming at £7, 10*s*., the nett difference in favour of dung as compared with lime is £15, 17*s*., plus £7, 10*s*., minus £12, i.e. £11, 7*s*. per acre for two rotations.

In one known instance some fields on a certain farm had received no dung for many years and had assumed all the usual symptoms of lime starvation, but by the application of dung these fields have been brought back to a state of good fertility. When liming experiments are carried out on such fields it would be interesting to test the effect of dung as against lime. Exact calculation of the costings would be difficult, perhaps impossible, but nevertheless valuable information might be obtained.

In the foregoing remarks attention has been confined to the question of the increase or decrease of crop produced by liming, As pointed out by Hendrick there are other aspects to be considered, e.g. the effect of liming on

(*a*) Finger-and-toe.

(*b*) The growth of certain weeds.

(*c*) The nutrition of stock.

(*a*) As regards finger-and-toe, observations were made in the Craibstone experiment, and the results are recorded in Table III of the article in the 1926 Transactions.

The following table shows the average results :—

Limed.			Unlimed.		
Good.	Slightly diseased.	Badly diseased.	Good.	Slightly diseased.	Badly diseased.
93·5%	5·7%	0·8%	83·9%	13·6%	2·5%

It will be seen that liming has considerably reduced the disease, though in the case of the dunged plots it may possibly be the case that the reduction in disease is not sufficient to compensate for the reduction in crop resulting from liming. It is interesting to note that in the case of plot 14, which received all its phosphate in the form of basic slag, there was very little disease either on the limed or on the unlimed portion. This suggests that on certain soils basic slag might be a more economical alternative to lime in keeping finger-and-toe in check. The above table shows, however, that finger-and-toe was not very severe at Craibstone, and there is probably a large amount of land in Scotland on which ordinary dressings of basic slag would not keep finger-and-toe in check, and on which liming might show a more marked effect in this direction than it did at Craibstone. Here, again, more experimental work is needed.

(*b*) In the Craibstone experiment it was noted that lime had the effect of reducing the growth of certain weeds, e.g. buttercups and chickweed in the grass, and spurry in the corn and turnip crops of the second rotation. Nevertheless in the case of the dunged plots the crops were heavier on the unlimed portions.

(*c*) The effect of the lime content of food on its nutritive value is being investigated at the Rowett Institute, and this promises to be a fruitful line of enquiry. A question, however, that seems to require investigation is the extent to which the lime content of arable crops can be increased by the application of lime to the soil. It appears that the lime content of pasture bears some relation to that of the soil, but this may be a secondary effect brought about by the influence of the lime content of the soil on the botanical composition of the pasture, e.g. lime favours the growth of clover, and the lime content of clover is higher than that of grasses. It does not necessarily follow that the lime content of an individual species can be increased by liming the soil.

In conclusion it is only necessary to remark that the purpose of this article is not to belittle the benefits of liming. The tried experience of former generations of farmers, the work done at Rothamsted and Woburn, and the more recent work done in Yorkshire, indicating that large stretches of land in that county are suffering badly from lime starvation, cannot be placed aside. Nor can we lightly disregard the evil effects which may arise from successive applications of acid manures. It cannot, however, be too strongly urged that many typical Scottish soils, presumably because of the relatively unweathered conditions of other mineral constituents, do not respond readily towards lime in so far as the common crops grown on them are concerned. It may be that the Craibstone soil is near the extreme end of the scale in this respect, and that the soils of the South of Scotland would respond more readily to lime. What is urgently required is more experimental work in order to discover what type of land and what kinds and varieties of crops will respond to lime, and to ascertain as accurately as possible the benefits derived from its use.

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Book of the Rothamsted Experiments. Hall.

Reviews.

Agricultural Parasitology, by C. L. Walton, M.Sc., Ph.D., and W. Rees Wright, M.Sc. Sidgwick & Jackson, Ltd., London.—This is a useful little book of 120 pages in which the authors have succeeded in dealing with all the important parasites of farm stock which occur in this country and some which are prevalent beyond it. As indicated in the preface, the authors have had in view primarily the needs of agricultural and veterinary students, and it is hoped the work will be of service to the stock breeder also. In this connection we might suggest that the authors have probably over-emphasised such points as scientific nomenclature, classification, and perhaps to some extent anatomical structure also. Undoubtedly for students the discipline of systematic study and a familiarity with scientific terminology is necessary, yet it is conceivable that the somewhat liberal use of the latter is likely to repel and perhaps discourage many for whom the real subject matter of the volume is of great practical interest and value. Further, it would be well in later editions of the book to remove, amongst others, such obvious misprints as "flagellæ" (page 13) and "diverticulæ" (page 36). Also spelling "shizogony" and "shizont," instead of "schizogony" and "schizont," repeated a number of times throughout the book, may be modern, but is scarcely good form. We have no desire to labour such points, but we may mention that a glance through the index has directed our attention to the fact that while scientific names of familiar parasites are exhaustively listed, the stock breeder who may not know these will look in vain for such common names as bot flies, tape worms, flukes, gape worms, thread worms, mange, &c., although these are quite adequately dealt with in the text.

Such matters, however, must not be allowed to obscure our appreciation of the real merits and usefulness of this little work. Here the reader may learn what is the agent producing redwater in cattle, where this parasite lives, how the characteristic symptom of redwater results from its destruction of the red cells of the blood, and how the organism is transferred by ticks in the act of blood-sucking, and what are the latest methods for control. The life story of the liver fluke with all its linkages is told well and fully, with additions not available in text books hitherto. Here the reader gets the benefit of direct expert advice in fluke control, since both authors have conducted valuable researches on the subject. The common species and manner of life of tape worms, thread worms, bot flies, flesh flies, the varied company of blood-sucking insects, mange mites, &c., with which domestic stock, poultry, and the like are afflicted, are briefly and clearly described. The results of the latest investigation on warble flies and their control are summarised in a useful way. In most cases control methods are explained, and an indication given where these are capable of adoption by the owner or where veterinary assistance is desirable.

Seed Production and Marketing. J. F. Cox and G. E. Starr. 450 pp., 193 figures. Cloth $4.00. New York—John Wiley & Sons, Inc.; London—Chapman & Hall, Ltd., 1927.—This book strikes a new line in agricultural manuals. Its purpose is to give to those commercially interested in seed production and distribution an account of essential practices in the handling of seeds, and to serve as a reference text book to teachers and students of agriculture in the seed-producing areas.

While it deals only with seed production in North America, the book emphasises many general principles directly or indirectly applicable to crop improvement in this country, and much of the subject matter on particular plant subjects is distinctly informative to the general agricultural reader.

Embodied within its scope are the essentials of practical plant breeding; multiplication and handling of select seed stocks; variety testing; seed testing; cultural operations; descriptions and treatment of diseases and insect pests; harvesting, cleaning and grading of seed; selling and marketing organisations; sources of seed; characteristics of varieties.

Great stress is laid on the importance of adaptation of crop varieties, not only to climatic and soil conditions but also to market demands, which may as a result of fashion or economic circumstances in urban life be liable to rather sudden changes.

The first four chapters are of a general character. A chapter deals with the essential attributes of good seed—adaptation, strain, vitality, purity—and the necessary qualifications for economic efficiency of growers and dealers, namely, a knowledge of the essentials for the production and maintenance of high grade seed stocks and of the most effective methods of cleaning, storing, handling and distributing. Another has a concise summary of methods of plant improvement by breeding, selection and multiplication of improved stocks.

The development of these improvements in a wider field is dealt with in an account of the work of crop improvement associations and co-operative marketing agencies, and of the work of field inspection and certification of seed stocks. Special cultural practices, methods of harvesting and cleaning seeds are outlined and threshing and storage equipment described.

The remaining chapters deal with individual seed crops in more detail. Many of these have nothing more than a general informative interest to readers in this country, but the hints given on clover and grass seed production, on cereals and on potatoes, have a more special interest to Scottish readers.

There is necessarily a good deal of repetition with regard to practices of general fundamental importance; this is not to be regarded as a defect in view of the expressed didactic purpose of the book. An appendix deals with a few important plant pests and their control.

Features of the publication are its excellent lay-out in short sections with heavy type headings, and its informative and emphatic illustrations.

Poisonous Plants on the Farm. H. C. Long, B.Sc. Miscellaneous Publication No. 57, Ministry of Agriculture and Fisheries, H.M. Stationery Office, 1927. 54 pp.,with 51 illustrations. Paper covers 2*s.*; quarter bound 2*s.* 6*d.*; cloth 3*s.* (all post free).—This brochure is a short popular edition of the author's larger and more technical volume "Plants Poisonous to Live Stock," published in 1917.

An exhaustive collection and digest of all relevant records and information regarding native or commonly grown exotic plants which are harmful to stock, the subject matter is such as to be readily understood by the general reading public. The plants themselves are considered in detail and arranged in their natural botanical groupings.

A general feature of the discussion is that many of the plants are not inevitably harmful; a few well-known species are highly poisonous, while many are only dangerous in varied circumstances which cannot always be adequately defined. Poisonous effects, for example, may differ according to the amount consumed; the regularity of consumption (cumulative effect); the relative depravity of appetite; the class and age of stock; the district and the kind of soil; the period of growth; the season of the year; the part of the plant eaten and its condition, i.e. whether dry or green.

The toxic effects of certain imported feeding stuffs is dealt with; a list is given of plants which affect the quality of milk and dairy produce, and another of plants in which poisonous properties are suspected. A paragraph deals with plants which are internally mechanically injurious. The publication has a useful three-page index and 22 pages of excellent illustrations.

Notes from Craibstone.

Sugar Beet Trials in 1927.—In order to ascertain the effect of the time of sowing in the North of Scotland, duplicate plots of five varieties were sown at intervals of three weeks, viz. on 23rd April, 16th May and 8th June, on the flat in drills 18 inches apart. The plots were dunged at the rate of 12 tons per acre, and a complete dressing of artificial manures was applied just before sowing the seed. In addition, 1 cwt. of nitrate of lime was applied as a top-dressing to all plots after singling.

All three sowings brairded fairly regularly. The plants were singled early when they were quite small, care being taken to have all the plots as nearly as possible at the same stage.

The most noticeable result was that both the variety and the time of sowing had distinct effects on the number that bolted. The table shows the average of the duplicate plots, which agreed in every case.

TABLE I.

Effect of Variety and Time of Sowing on Bolting.

Variety.	Sown. *23rd April.*	*16th May.*	*8th June.*
	Per cent.	Per cent.	Per cent.
Garton's	15	2	0
Horning	33	6	·5
Klein E.	29·	5	·2
,, W.	30	7	0
Kuhn	18	2	0

Garton's and Kuhn appeared to be of similar type, being of a comparatively dwarf habit of growth, whereas the Horning and the two Kleins were of a more upright habit.

The crop was lifted in December and Table II shows the effect of the variety and time of sowing on yield and quality.

TABLE II.

Effect of Variety and Time of Sowing on Yield and Quality.

Sown—	*Washed Beet per acre.* Tons	cwts.	*Sugar per cent.*	*Sugar per acre.* Cwts.
23rd April.				
Garton's	5	11	17·6	19·5
Horning	4	2	17·4	14·3
Klein E.	4	14	16·6	15·6
,, W.	5	4	17·2	18·3
Kuhn	5	7	17·6	18·8
Average ...	5	0	17·3	17·3

	Washed Beet per acre. Tons	cwts.	Sugar per cent.	Sugar per acre. Cwts.
Sown—				
16th May.				
Garton's	7	2	17·6	25·0
Horning	6	0	17·3	20·8
Klein E.	6	11	16·6	21·8
,, W.	6	17	17·0	23·3
Kuhn	6	11	17·4	22·8
Average ...	6	12	17·2	22·7
8th June.				
Garton's	7	6	17·2	25·1
Horning	6	8	17·1	21·9
Klein E.	6	13	16·7	22·2
,, W.	7	6	17·1	25·0
Kuhn	6	16	17·6	23·9
Average ...	6	18	17·1	23·6

So far as the time of sowing in 1927 is concerned, there was very little difference in the percentage of sugar with any of the varieties. The latest sowing, however, gave the heaviest weight of washed beet and of sugar per acre, and the earliest the lightest crop and consequently least sugar per acre. The home-grown seed produced a heavier yield than any of the continental varieties. The three varieties that bolted most did better comparatively where they were sown late.

Manurial Trial.—Six plots were laid off and different artificial manures were applied, 12 tons dung per acre being used in all cases.

The table shows the manures used and the crop produced.

TABLE III.

Plot.		Crop per acre. Tons	cwts.	Sugar per cent.	Sugar per acre. Cwts.
1.	No manure	6	9	17·5	22·6
2.	1 cwt. Sulphate of ammonia 4 ,, Superphosphate ... 1 ,, Muriate of Potash ...	8	16	17·2	30·3
3.	As 2, but ground mineral ... Phosphate	7	17	17·4	28·3
4.	As 2, but no phosphate ...	8	1	17·5	28·2
5.	As 2, but no nitrogen ...	6	18	18·4	25·6
6.	As 2, but no potash	8	5	16·6	27·4

The chief points to note are :—

1. The complete manure produced the heaviest crop.

2. The lack of nitrogen reduced the yield more than the lack of phosphate or potash.

3. The use of nitrogen decreased the percentage of sugar but increased the total amount per acre.

4. The lack of potash reduced the percentage of sugar.

Oat Variety Trials, 1925 to 1927.

A SERIES of trials of selected varieties of oats, which has been conducted under the auspices of the Scottish Agricultural Research Council for the past three years, was completed in 1927. The object of the trials was to ascertain the soil and climatic conditions most favourable to the development of the respective types of oats.

The centres at which the tests were carried out were as follows :—

1925. Craibstone Experimental Farm, Aberdeen. North of Scotland College of Agriculture.
Boghall Experimental Farm, Edinburgh. Edinburgh and East of Scotland College of Agriculture.
Hatton Mains, Kirknewton, Midlothian. Wm. Crawford.

1926. Craibstone, Boghall, Hatton Mains.
Bangour, West Lothian. Edinburgh Board of Control.
Makerstoun Home Farm, Kelso. J. J. Bell-Irving, Esq.

1927. Craibstone, Boghall, Hatton Mains, Kelso.

The following tables indicate the average yields of grain and straw expressed as a percentage of Victory :—

GRAIN.

VARIETY.	Craibstone.	Boghall.	Hatton Mains.*	Kelso.†	Bangour.†
Victory	100	100	100	100	100
Crown	102	108	100·5	104	96·6
Superb	94·6	96·3	85	...	...
Radnorshire Sprig	82·9	90·5	75	83·38	84·1
Castleton Potato...	74·4	89·3	87	81·73	78·8
Sandy	73·3	92·5	85	71·43	88·7
Silver	109	...	...	...	...
King	108·7	103	97	97·35	79·9
Sovereign... ...	97·5	...	...	...	...
Nova	105·5	...	...	...	...
Record	97·5	107	100·5	99 25	86·9
Fortuna	97·5	104	94	...	93·2
Cropwell	94	96	...	..	...
White Odal ...	91	...	...	...	...
Abundance ...	85	...	89	...	88
Yielder	...	105	93	91·45	84·3
Glebe	...	93	...	...	89·9
Supreme	...	...	101	83·25	97·1

* Average of 1925 and 1926 figures. † 1926 figures.

STRAW.

Variety.	Craibstone.	Boghall.	Hatton Mains.*	Kelso.†	Bangour.†
Victory	100	100	100	100	100
Crown	98·9	108	95·5	98·83	71·6
Superb	81·1	96 3	94	...	...
Radnorshire Sprig	88·1	90 5	77	69·75	110·1
Castleton Potato...	108·4	89·3	107·5	116·63	90
Sandy	112·1	92·5	107·7	101 63	88 7
Silver	100·5	...	...	...	...
King	100·5	103	98	105·18	135·3
Record	89·4	107	93	96·48	81·7
Fortuna	104·8	104	95·5	...	81·1
Cropwell	100·3	96	...	...	...
White Odal ...	90	...	..	...	...
Abundance ...	90·9	...	89	...	86·5
Nova	91·7	...	...	...	...
Sovereign... ..	101·4	...	...	...	...
Yielder	...	105	94·5	90·20	71·5
Glebe	...	93	...	...	104·3
Supreme	...	...	92	72·53	87·6

* Average of 1925 and 1926 figures. † 1926 figures.

In addition to the estimation of yields of grain and straw, observations were made upon the capacity for tillering, time taken to reach maturity, standing properties, proportion of grain to straw and resistance to disease.

The following notes upon varieties have been compiled from the record of observations made over the three years of trial :—

Radnorshire Spring is a variety which is said to do outstandingly well in Wales under conditions of moderately high elevation and poor fertility. It has a tendency to lodge, and has to be replaced by a stiffer strawed type on good condition soils. It is an early oat, but appears far down in the tables both as regards grain and straw yield.

Superb is a very early variety possessing small, plump grain. The general conclusion made from the tests is that this variety is medium in grain yield and relatively low in yield of straw.

Silver is a selection from a cross between Danish Yellow Island Oat and Nova. It was put on the market in 1924 and was produced at Abed, Denmark. This variety is about ten days earlier than Victory.

Yielder is an early ripener and is probably best suited to heavy soils in late districts. It is not a profuse tillering variety, but is capable of producing good crops under favourable conditions. During the trial it was superior to Victory in yield of grain and straw at Boghall, and slightly inferior to Victory at Hatton Mains.

Castleton Potato, Sandy, belongs to a group of oats characterised by its fine quality of straw and moderate yield of grain of outstanding milling quality. The straw is long, lacks strength, and is inclined to lodge. These are types suitable for growth under conditions varying from average to poor. These are profuse tillering varieties.

Victory is medium early in ripening and under fertile conditions gives high yields of good quality grain and straw. The straw is moderately strong. This variety may be grown over a fairly wide range of soils and climate. It was produced at Svalof, Sweden.

Crown is later in ripening than Victory, but produces higher yields of grain and about the same yield of straw. It is a variety for very fertile conditions.

King was produced at Svalof, Sweden, and is characterised by slightly stronger straw than Victory, but is a few days later in ripening. It is slightly better in grain yield than Victory, but may be considered to be in the same class.

Cropwell is a cross between Black Tartarian and Abundance. It is moderately early in ripening at about the same time as Abundance, is medium in grain and straw yield. It is adapted to a moderately wide range of soil and climatic conditions.

Abundance possesses large-sized grain very like the quality of Potato. The straw is long and inclined to lodge on good soils. It holds a medium position in the foregoing tables as regards yield of grain and straw. It ripens a few days later than Victory.

Record produces grain a little coarser than that of Victory but straw of outstanding strength. The straw for this reason may be inferior in feeding quality. It is a variety which does exceptionally well on very rich land. It is later in ripening than Victory. The general conclusion from the trials is that Record is better in grain yield than Victory but inferior in yield of straw.

Fortuna is a moderate yielder of grain but produces more straw than Victory. It is late in ripening and has a tendency to lodge.

Supreme is an early spring black oat produced by Garton from Bountiful and Abundance. It was tested only once at each of three centres.

Nova was selected at Abed, Denmark, and is a variety of oats distinctly earlier than Victory.

Sovereign is also a Danish oat.

White Odal originated from Svalof, Sweden, and was got from a cross between Golden Rain and Dala.

The Marketing of Home-Grown Produce.

It is unfortunately the case that, in general, home-grown produce is still marketed in diverse and variable qualities without any effective co-operation among producers. Although much of it may be unsurpassed in quality, it suffers in competition with the imported supplies which arrive regularly from abroad in large standardised consignments of even quality. The foreigner has taken pains, first, to discover and then to produce exactly the types of goods favoured by British households, and by means of careful organisation among producers he has succeeded in obtaining a substantial share of the valuable produce trade of this country. There is little doubt, however, that if home produce, e.g. butter, cheese, eggs, bacon, &c., were prepared for sale by methods similar to those adopted by the foreigner it would receive some preference from the home consumer.

Obviously the individual alone can do little in the direction of furthering the common interest of home producers. It is only by organisation in any particular line of the industry that improved marketing methods can be successfully developed. Thus recently in England the Cheshire Cheese Federation and the English Cheddar Cheesemakers' Federation have been formed. These bodies test and grade according to quality the produce of their members, and to the buyer the brand of the Association is a hallmark of quality. In Scotland, Scottish Woolgrowers, Limited (19 Stobcross Street, Glasgow), which is purely a farmers' co-operative concern, has been formed by some of the principal sheep farmers in Scotland to organise the sale of home-produced wool. The shares of the Company are held by some 400 sheep farmers, and the Company arranges for the sale of the whole wool-clip of the shareholders. It is understood that last year over 1½ million pounds of wool were disposed of through this agency. In the egg trade there are vast possibilities of successful competition with foreign countries if, through district Associations of producers and others in the trade, eggs are carefully tested and graded according to recognised standards and marketed in terms of such standards. Over a year ago an Association of this type was established in Orkney from which some £220,000 worth of eggs are annually exported to the mainland. The Association controls the whole outgoing egg trade of the county, and its success in the development of this trade is practically assured. With a view to repeating the example of Orkney in other suitable parts of the country, the Board of Agriculture for Scotland have recently received a grant from the Empire Marketing Board, which will be available for assisting the formation of new Associations and for educational demonstrations in the grading and marketing of eggs. That there is ample scope for development in this direction is proved by the fact that over £15,500,000 worth of eggs are annually imported into this country from abroad.

A striking illustration of the beneficial effects of combination among producers and the standardisation of the various grades of produce was staged in the Home Produce section of the British Industries Fair held in London from 20th February to 2nd March 1928. This section of the Show was administered by the Empire Marketing Board in association with the Ministry of Agriculture and Fisheries. The branded exhibits of the English Cheddar Cheesemakers' Federation and the Cheshire Cheese Federation as well as the exhibits by several English firms of their own brands of fancy soft crustless cheeses were an impressive display. It is reported that a large amount of foreign as well as inland trade was attracted by these exhibits, orders being booked for the Continent, United States of America, India, South Africa, &c. A similar experience was shared by several English manufacturers who in recent years have specialised in the canning of home-grown fruit. It appears that foreign purchasers are familiar with the fact that the natural flavour of English grown varieties of fruit preserved in cans is superior to that of their own respective countries. Much of the success that has attended the development of the English fruit canning industry is due to the efforts of the Fruit Canning Council, 46 Charing Cross, London. The only examples of Scottish agricultural produce staged in the Home Produce Section of the British Industries Fair were wool by Scottish Woolgrowers, Limited, and Seed Potatoes by the Scottish Seed Potato Trade Association. Arrangements for the accommodation of these exhibits were made by the Board of Agriculture for Scotland with the Ministry of Agriculture and Fisheries. Both exhibits were suitably staged and attracted a large number of enquiries from both foreign and home buyers. There is every reason to believe that the objects in view, namely, the wider advertisement of graded home produce and the extension of the markets for it, have been advanced.

Yellow Disease of Hyacinths.

THE Yellow Disease of hyacinths is caused by *Bacterium Hyacinthi*. The disease attacks flower-stalk, leaves and bulb. The leaf symptoms are marked by the appearance of water-soaked streaks which run longitudinally in the leaf, starting at the tip and very gradually extending downwards towards the leaf base. The tip of the leaf dies and turns brown, and as time goes on the browning proceeds down the leaf. The flower stalk may also be attacked and shows water-soaked streaks comparable to those in the leaf. These streaks turn brown and the flowers also wither. In a bad case the stalk topples right over. In a bad and early attack the bud may be reduced to pulp while still in the bulb.

The bulb feels soft and flabby. The symptoms of the disease are best observed if a bulb is cut across and left for a short while. On examination of the cut surface small patches of yellowish, rotten tissue will be seen. These patches may be circular or irregular in shape or may take the form of long streaks. Small coils of slime which is at first colourless and then turns yellowish exude from the patches. If the bulbs are very badly infected, the whole of the interior of the bulb is reduced to a slimy, disintegrating mass, only held together by the outermost scales. Bulbs in this condition are exceedingly offensive. The slimy, soapy feel is very characteristic.

The Yellow Disease of hyacinths is known only in Holland

and appears in England in imported bulbs. Such is the gravity of the disease there that, to quote Dr. Erwin F. Smith :—" In Holland the Yellow Disease of hyacinths will eventually put an end to hyacinth-growing for export if means cannot be had for its control."

The only control for British growers is to insist on obtaining healthy bulbs. If hyacinths with the Yellow Disease have been grown in a greenhouse, the soil, boxes, beds, &c., should be thoroughly disinfected.

Spurious Wild White Clover.

THE origin of Wild White Clover seed can frequently be determined by comparing it with type samples of known origin. Evidence of origin is also frequently to be found in the impurities contained in the sample. Thus seed of Kentish Wild White Clover is characterised by its small size, roundness and, under magnification, its horny lustre. The impurities which are specially characteristic of it are seeds of Dogstail, Yorkshire Fog, Sweet Vernal Grass, Woodrush, Creeping Cinquefoil, Agrastis and Birdsfoot Trefoil.

In a recent instance it was found that spurious stocks described as Kentish Wild White Clover were of Polish or New Zealand origin. They were recognised as spurious by their similarity to these imported stocks, by the absence from them of the impurities characteristic of home-grown Wild White Clover and inclusion of other characteristic impurities.

Polish seed of White Clover is characterised by its colour, size and flatness, and by the occurrence of considerable Alsyke as an impurity, while seeds of various weeds characteristically Mid-European are common. New Zealand seed is this year of a bright yellow colour and may contain one or all of the following detectors :—

1. *Seed of Silene gallica.*—This is an English plant, but a plant which does not occur in lea. Indeed it is rather rare even in the south of England. On the other hand, it is one of the commonest introduced weeds in New Zealand. As an impurity of White Clover the seed is conclusive evidence of New Zealand origin.

2. *Seed of Phalaris bulbosa (Perennial Canary Grass).*—This is a grass which has been cultivated in the Antipodes and in regions of South Africa and America. It has become established in grass land in certain parts of New Zealand. As an impurity of White Clover seed it is conclusive evidence of New Zealand origin. The seed is a new impurity in White Clover seed.

3. *Sclerotinia trifoliorum.*—This disease, known as stem rot and sometimes as clover sickness, is not commonly in

evidence in clover seed. It is, however, abundant and obvious in samples of new crop New Zealand White Clover and also occurs in Polish seed. Samples of New Zealand White Clover have been examined containing as much as 4 per cent. by weight of diseased seed. In samples of bright coloured seed its occurrence is very strong confirmatory evidence of New Zealand origin. Seeds of white clover affected with this disease are not fully developed, being thin and shrunken; they have a noticeable unhealthy pink bloom, which appears on magnification by a strong lens as a white mould growing in flecks on the surface of the seed.

The Empire's Agriculture.

THE Report of the Imperial Agricultural Research Conference, just issued, contains a full account of the events leading up to the Conference, the recommendations (both in full and in summary form) there made, and the views expressed by the highest authorities in agriculture in all quarters of the Empire. The recommendations deal with the following subjects:—The establishment of an Imperial chain of Agricultural Research Stations; the establishment of Imperial clearing houses of information; the recruitment, training and interchange of scientific workers in agriculture for the whole Empire; the action immediately necessary to secure co-operative work in such specialist subjects as Veterinary Science, Animal Nutrition and Genetics, Dairying, Soils and Fertilisers, Plant Breeding and Pathology, Fruit Growing, Entomology, Preservation and Transport, and Agricultural Economics. The Report of 250 pages is issued at the specially low price of 1*s*. (with postage 1*s*. 5*d*.) in order that it may be within easy reach of all those affected. Copies should be ordered from H.M. Stationery Office, 120 George Street, Edinburgh.

Agricultural Conditions.

DURING the early part of December the weather was generally fine, and good progress was made with ploughing and the sowing of wheat. For the last two weeks of the year, however, practically the whole country was frost-bound, and the only field work possible was the carting and spreading of manure. The weather during January was to a great extent wet and stormy; frost and snow occurred at intervals, while flooding was general in low-lying areas. In many cases the land became too wet for the ploughing of stubble or the carting of manure, but in most districts a few fine spells allowed fair progress to be made with lea ploughing. In North-East Banff and North-West Aberdeen the weather was fairly dry and open during most of January, and in these districts good progress was made with cultivation; in the western islands, on the other hand, little outdoor work of any description could be undertaken during the month. Wet, cold and stormy conditions were general for the first half of February and outdoor work was more or less seriously interrupted in most districts. Towards the end of the month, however, fine dry weather prevailed throughout practically the whole country and excellent progress was made with cultivation and other field work. The improvement in the weather enabled some of the arrears of ploughing to be overtaken, while in several eastern districts the sowing of oats was begun under favourable conditions.

The winter sowing of wheat was delayed by unfavourable weather, and in most of the principal wheat-growing areas only about half of the work had been accomplished at the beginning of December, while in some districts little seeding had been done. Where sown early the plants brairded satisfactorily, but speaking generally germination was unusually slow and, where seeding had been delayed, the plants were only just showing above the ground at the end of January. During the first fortnight of February the crop made little progress owing to the inclement weather, but the dry spring-like conditions of the last ten days of the month favoured the development of the plants, and at the beginning of March the reports indicated that the braird had then a fairly vigorous and healthy appearance. On low-lying wet land, however, the braird was at that date unusually backward, and large bare patches showed where the seed had rotted in the ground. Towards the end of February considerable areas of wheat were sown under good conditions in Fife, Perth, Berwick and Roxburgh.

Reports vary considerably as to the condition of potato stocks, but, speaking generally, the tubers have kept better than was at one time expected. In many eastern districts an unusually large proportion of the potatoes rotted in the pits, especially where the crop was grown on heavy soils and where frosts occurred before lifting was completed. In most western and south-western areas, however, there are very few signs of disease or wastage and the tubers are generally of fair quality. Little progress had been made with the planting of early potatoes at the end of February.

From some southern and eastern districts it was reported at the beginning of March that sheep had wintered moderately well and that lambing prospects were favourable, but in many districts ewes were said to be below the average in condition. On several low-ground farms lambing had begun before the end of February and in most cases the results were satisfactory; a report received from Dumfries, however, states that in that district the lambs were not growing so strongly as usual. In South-West Forfar there has been a considerable mortality amongst ewes, while in Lewis, owing to the excessively wet weather, ewes were in unusually poor condition at the end of February, and the lambing prospects were, in consequence, not very favourable.

Turnips and swedes are scarce in most parts of the country, and on some farms the stocks were already exhausted at the end of February. In South-West Perth, North-East Fife, North Argyll and a few south-western districts turnips are keeping well; elsewhere, however, the roots are reported to be of inferior feeding value, and where they were left out in the fields a rather large proportion of the crop has rotted. Sugar-beet pulp is being used as a substitute for turnips in some districts. Straw is plentiful almost everywhere, but most of it is of inferior quality, while in some areas hay is becoming scarce.

The supply of labour is sufficient for present requirements, except in Dumfries, where capable and experienced men are difficult to procure.

SCIENCE AND PRACTICE.

The following extracts and summaries are supplied by members of the staffs of Scottish agricultural colleges and scientific institutions or are taken from recent bulletins of the International Institute of Agriculture. Full references to the original publications may be obtained on application to the Secretary, Board of Agriculture, York Buildings, Edinburgh.

CROPS AND SEEDS.

Field Roots in Canada: Classification, Improvement, and Seed Production. *G. P. M'Rostie, R. I. Hamilton, F. Dimmock, S. E. Clarke. Bulletin No.* 84 (*New Series*), *Department of Agriculture, Dominion of Canada.*—One of the objects of the bulletin was to present a classification and description of field-root varieties offered for sale in Canada that would enable the grower to select the variety suited to his needs with a better understanding of what he was purchasing than had been possible heretofore. The system of measurement adopted in classifying roots according to their shape is described. In mangels the types are designated as long, half-long, intermediate, ovoid and tankard. In swedes varieties are divided into four types as regards shape (globe, flat, ovoid and tankard). The most important difference between types of swedes was that of the length-width ratio. Very little difference was found in the average depth in the ground of the various swede types. As a result of pulling tests, it was found that the number and distribution of the main and secondary roots had a much greater correlation with the amount of pull required to extract the roots than had the type of root. Physiological considerations of yield, freedom from disease, and climatic adaptation were of greater significance in selecting a variety than was the particular type as differentiated in the mechanical classification. Tables of classification are included in the bulletin.

Experiments with Timothy. *R. Newton and J. Ficht. Bulletin No.* 3, *December,* 1926. *University of Alberta, College of Agriculture.*—Timothy is an important crop in the Foothills district of Alberta, which seems well adapted for the production of timothy seed. This bulletin was written for the purpose of analysing the possibilities of the timothy crop in relation to Alberta agriculture.

The improvement of timothy has been slow on account of its habit of cross-fertilisation, and very few well-defined strains had been developed by plant breeders. A strain of timothy, Svalof 523, had proved outstanding in the experiments and had been made the basis for further selection work.

On account of its lack of drought-hardiness, timothy as a hay crop was not so well adapted to parts of Western Canada as Western rye and brome grass. Timothy, however, had been grown with profit on irrigated lands. Sometimes a crop taken after timothy yielded poorly, but this might be avoided if the stand of timothy was not allowed to become too old, and the sward was broken up in such a way as to promote rapid decomposition. Under suitable conditions a good stand might be secured by a sowing at the rate of 4 lbs. per acre, but it was considered safer to use 8 lbs. when the seed was drilled in rows 6 inches apart, 10 lbs. when broadcast. Timothy meadows should not be left down longer than three or four years.

It was important to discriminate between hull and hull-less seed, as the latter lost its viability more rapidly than the hulled. No varietal differences had been found as regards the tendency for the seed to become hulled. Loss of hull seemed to be increased with the plumpness of the seed. Experiments had shown that the proportion of hulled seed might be reduced by cutting the crop when slightly immature, by curing thoroughly in the open before storing under cover, by threshing when the crop had been slightly re-moistened by dew or rain, by adjusting the threshing cylinder to run about three-quarter normal speed, and opening the concave as far as possible consistent with complete threshing.

Time of cutting Wheat and Oats in relation to yield and composition. —*A. C. Arny and C. P. Sun. Journal of the American Society of Agronomy, Geneva, N.Y.*, 1927, *Vol.* 19, *No.* 5.—Both wheat and oats were cut every day from nine days early up to estimated full maturity. Nine days before maturity wheat was in the following condition :—terminal spikelets green, kernels in thick milk stage, first and second 8 inches of straw green, leaves green, while oats showed the same phenomena except that the kernels were in the thin milk stage at this period.

Discussion and tables follow, describing the individual day results, and a summary concludes the article.

Subject to environmental conditions attending the experiment, the following results were indicated :—

1. Cutting wheat and oats before maturity resulted in decreased yield when the grain was cured in the shock.
2. Lower weight per bushel resulted from premature cutting, though the decrease resulting from not more than 7 days' anticipation of ripeness did not affect the grade of the grain.
3. There was an increase in weight per 1,000 kernels from the earliest date at which cut up to the time of cutting, 3 days early for wheat, and 4 days early for oats.
4. Cutting 7 days early produced many green kernels, which, however, disappeared entirely from wheat and largely from oats on slow curing in the shock.
5. The percentage of hulls of oats cut before maturity was higher than when cut at maturity.
6. The above points indicate that there was not much movement of materials from the straw to the grain after cutting.
7. Drying rapidly in the oven had the same effect on weight per 1,000 kernels as curing slowly in the shock.
8. Hull percentages in oats were also not affected differently by the two processes of drying.
9. Higher nitrogen content of straw dried rapidly in the oven as compared with shock drying indicated that nitrogen moves out of the straw.
10. Oat grains from oats cut 7 days early and left in the shocks showed an increased nitrogen content as compared with those from oats dried in the oven. No such increase was noted in wheat.

The Composition of flaked Maize. *H. E. Woodman and J. Stewart. The Journal of Agricultural Science. London,* 1927, *Vol. XVII, Part* 1.—Flaked maize is produced on an industrial scale by the steaming and rolling of maize grain; it is highly digestible and of high feeding value. Comparative analysis of five different brands gave the following results : crude protein 10·53 to 11·24 per cent.—true protein 9·83 to 10·96 per cent.—ether extract 3·92 to 4·97 per cent. —N.-free extractives 80·89 to 81·86 per cent.—crude fibre 1·59 to 2·06 per cent.—ash 1·05 to 1·42 per cent.—lime nil or trace—phosphate (P_2O_5) 0·45 to 0·81 per cent.

The moisture content of the samples displayed considerable variation, ranging from 6·61 to 14·43 per cent. The authors strongly recommend that the final process of drying the flakes should be so regulated that the moisture content at the time of weighing into the sacks should always have the same value. A 1-cwt. sack of flaked maize would then always contain the same weight of dry matter, and this would be unaffected by moisture taken up during storage or transport.

SOILS.

Incorporation of Burnt Lime in two Soil Zones. *W. H. MacIntyre, Tennessee Agricultural Experiment Station. Soil Science, XXIV,* 475 (1927).—The experiments were designed to study some of the effects of applications of lime at the rates of 250, 500, 1,000 and 2,000 lbs. oxide of lime per 2,000,000 lbs. soil. They were carried out in drainage tanks without crop, and in one series of tanks the lime was incorporated in the surface soil, whilst in the other it was introduced into the soil in the lower part of the tanks.

An examination of the drainage showed that the loss of lime from the tanks receiving lime at the rate of 250 and 500 lbs. was scarcely greater than from an unlimed tank. In the tanks with heavier dressings there was a considerable loss of lime, and this was particularly the case where the lime had been applied to the lower layers of soil.

The relative proportions of exchangeable Bases in some Scottish Soils. *A. M. Smith, Edinburgh and East of Scotland College of Agriculture. Journ. Agri. Sci., XVIII,* 68 (1928).—The proportions of exchangeable bases in nine soils from the East of Scotland were determined, and the changes in these bases brought about by treating the soils with dilute solutions of salts of calcium and potassium were studied. It was found that when fairly concentrated solutions were employed the changes were considerable, but with very dilute solutions comparable to those employed in manurial practice very little change took place, indicating that ordinary manuring is not likely to produce rapid changes in this important soil character.

The reaction, exchangeable calcium, and "lime requirement" of certain Scottish Soils. *W. G. Ogg and W. T. Dow, Edinburgh and East of Scotland College of Agriculture. Journ. Agri. Science, XVIII,* 131 (1928).—The examination of a large number of soils chiefly from the South-East of Scotland showed that the majority were decidedly acid and, according to the usual British method of determining the lime requirement, required quantities of lime ranging from about one-half to 2½ tons per acre (expressed as corbonate of lime).

Long unploughed soils, as a rule, were found to be more acid than ordinary cultivated soils, and woodland, hill and heath soils were still more acid.

Certain districts were much less acid than others, and this was traced in some cases to the influence of the underlying rock, e.g. limestone. It was also found that the surface was usually more acid than the subsoil.

The conclusion is arrived at that there is need for lime over a great part of the South-East of Scotland, especially if such crops as sugar beet and lucerne are to be grown.

ANIMAL BREEDING.

Cattle.

Baby Beef. *By A. N. Duckham, B.A.* 1926. *Jour. Roy. Agric. Soc., Eng., v.* 87.—There is a multiplicity of aspects to baby beef production, many in its favour and some against it. It cannot be averred that the author has neglected any one of these important aspects. In fact he has reviewed the whole question from beginning to end with consistent fullness and treated every detail in a masterly fashion. The scientific and practical aspects are well co-ordinated, and if any weighty criticism can be lodged against the brochure one feels at parts that enunciations of the salient points to the breeder are rather overshadowed by the wealth of detail.

Having made a historical survey of beef production in this country and the general tendency towards killing at an earlier age, the writer goes on to consider the relative efficiency of food conversion at the different ages. It is deduced that the baby beefling makes a more economic live-weight gain than the older animal, and in view of this fact it is suggested that slaughter should take place as soon as the desired quality is obtained. This would involve killing at somewhere between 7 and 10 cwts. live-weight.

As against this the writer duly emphasises the large amount of concentrates with a relatively high protein content required for the production of baby beef and the inability of the beeflings to utilise roughage such as straw, roots, and the poorer quality grass. At this point it may be expected that the new system of grassland management will be well suited to the producers of younger beef.

The section on the economics of baby beef production leaves the reader rather undecided as to the possibilities for the expansion of baby beef production in this country, and one feels that the scope is somewhat more limited than the author would lead one to believe. Of course it must be admitted that under ideal conditions of housing, management, environment and superior quality of the soil and its products, the production of baby beef can show a better net return than the production of mature beef. Moreover, it seems that specimens of the beef breeds, or at least of the dual-purpose breeds, are necessary for the production of baby beef, and this in itself is a limiting factor of no small consequence in view of the fact that our large milk market is most efficiently catered for by the purely dairy breeds. Also in many districts well suited to baby beef production the purchasing of stores is generally practised, e.g. some of the best areas in Scotland, such as the Lothians and Forfarshire. This procedure, unless replaced by the breeding of the stock on the farm, does not lend itself to the production of young beef. More silos and more soiling crops will require to go hand in hand with an increase in baby beef production, and this incurs increased capital expenditure, an outlay which the farmer of to-day can ill afford to make.

From the point of view of the butcher and consumer the increasing desire for and the economy of the small joint is dealt with in an exhaustive manner. This demand should be welcomed by beef producers in this country, for in it lies their best hope of keeping a substantial section of the beef trade in their own hands.

In conclusion it can truly be said that this treatise deals with the pros and cons of the subject in a thorough and impartial way, and that as a record of data concerning beef production in general and baby beef production in particular it can be strongly recommended.

Heredity and Milking Function. *W. E. Agar. Journal of the Dept. of Agric. of Victoria, Australia* (1926).—The only practicable method of determining how far milking quality is governed by hereditary characters lies in correlating the performance of mother and daughter. This may be done in respect of total milk, total butter-fat or butter-fat percentage (" test "), the latter being the most reliable since it is least affected by environmental factors. Also with regard to total milk and butter-fat it is necessary to make allowance for the age of the cow, production in the sixth year of life being at a maximum and thereafter falling off slightly. A corrective factor has therefore to be worked out for each year so that the yields of cows of different ages can be compared.

Correlating butter-fat percentage in 96 cows and their daughters, from the Red Poll herd at the Victorian Research Farm, Werribee, it was found that the daughters were influenced, but not absolutely, by the mothers. Where cows varied in " test " from the mean of the group as a whole, daughters on the average inherited approximately one-third (0·291) of their mother's deviation above or below the mean value for the daughters, e.g. where the average for all mothers was 4·40 per cent. and for all daughters 4·30 per cent., the daughter of a cow giving 4·62 per cent. (0·22 per cent. above the mean) would probably give (0·22 × 0·291), i.e. 0·06 per cent. above the mean for daughters, namely 4·36 per cent. Hence the " expected " test for each daughter can be calculated, and bulls can be compared as to whether their daughters come up to " expectation " or otherwise. Though this procedure is not infallible, it gives a better estimate of a bull's value than by merely considering the production of the daughters, while neglecting the possible influence of the mothers.

Similarly it was found that in total milk and butter-fat production, daughters while influenced by their mothers were not so closely dependent on them as in the case of butter-fat percentage. This may be due to the effect of environment. Also, as before, bulls can be compared in their capacity for getting daughters of superior quality, but it must be noted that though a daughter is inferior to the mother in production it does not necessarily mean that the bull has had a degrading effect on the stock as a whole.

Finally, with selection there will be a tendency to diminish genetic differences among the cows of the herd, but environmental differences will remain, causing the correlation co-efficients to fall.

Current Cycles in the Cattle Industry. (*Monthly Letter to Animal Husbandmen.*) *Armour's Livestock Bureau. October* 1927.—There are distinct periods of high and low prices of beef cattle. They were high compared with other commodities in 1885. They were again high in 1899 and 1915. The low points were 1891, 1906 and 1923. The periods of rising and falling prices each varied from six to nine years and averaged nearly eight years. The period of rising purchasing power beginning in 1906 lasted nine years. The decline that began in 1915 continued eight years.

Judging from the cyclical trend during the past forty years, a period of strong cattle prices in all probability lies ahead. From 1896 prices rose to reach a peak in 1899; from 1912 they rose to reach a peak in 1915. In each case the inclusive period was four years. A similar forecast at the present time would carry strong cattle prices to 1931, with the peak in 1929. According to Warren and Pearson (*Farm Economics*, October 25, 1924) the average prices would be reached by 1928, and cattle would be more profitable than the average from 1928 to 1936, with the peak about 1932. The rapid rate of liquidation since that time (1924) seems to warrant the prediction that the peak in cattle prices would likely be three years sooner, viz. in 1929, or even in 1928. This departure from precedent is based as much on the increased rate of turnover in the cattle industry as on the rate of liquidation. To-day much of the beef consumed is from 15 to 18-month-old cattle. In 1912 it was from three-year-olds.

In the years 1919 to 1925 feeder buyers did not constitute such an important competitive factor on the market, owing to the tremendous losses caused by the deflation and the fact that banks would not finance cattle raising and fattening as in the past. The lessened activity of feeder buyers during those years obliged killers to slaughter such numbers of unfinished stock that a surplus of these grades occurred, bringing about low prices. In the last two years there has been a revived demand for feeders, which is one of the essentials for a return of prosperity to the cattle industry, especially in the range country. From a consideration of figures relating to recent prices and supplies it seems inevitable that there is a period of light receipts and strong prices ahead in the cattle industry.

While the above relates to the Chicago market, it is not without a direct effect on the British. If it pays Canada to market her meat in the States rather than in Britain it is reasonable to assume that the price of cattle in this country, which is particularly low and unremunerative at the present, will probably rise gradually during the year. Certain authorities forecast a heavy importation of cattle from Canada for this summer. If this takes place prices cannot be expected to rise considerably in the Scottish market. If it does not we may anticipate a period of better prosperity for the home cattle producer, as it will definitely mark the transition of the U.S.A. from a cattle producing country to a consuming one in relation to the world market.

Sheep.

Current Cycles in the Sheep Industry. (*Monthly Letter to Animal Husbandmen.*) *Armour's Livestock Bureau. December* 1927.—Cyclical movements exist within the sheep industry as well as within the cattle business, and they may be followed with interest and profit by those actually engaged in the production of sheep, either for wool or mutton and lamb. At the present time the trend is upward in the cattle industry, while mixed factors suggest that a downward trend is impending in the sheep industry.

The low points in sheep values in U.S.A. occurred in the following years :—1869, 1879, 1886, 1895, 1903, 1912, 1922. It will be observed that there are two periods of ten years, one period of nine years, one period of eight years and one period of seven years required for the complete movement of the sheep cycle. One may draw the conclusion from these figures that the sheep business on the average *improves over a period of four to five years, and then declines for the same length of time.* If the record of the past is at all indicative, it would seem that, since sheep values have shown steady and marked improvement for five years following the post-war depression, we are a bit over half-way through a normal sheep cycle, being a little past the peak.

Eventually there is room for a much larger sheep production in the United States. It cannot increase blindly without regard to section of the country or time when lambs will be ready for market, but there is no question that the long-time upward trend of sheep production will continue for some time to come, and will not affect the general prosperity of the industry. Possibly the changes in regional production indicated in this letter are changes in adjustment toward this end.

Pigs.

Current Cycles in the Hog Industry. (*Monthly Letter to Animal Husbandmen.*) *Armour's Livestock Bureau. January* 1928.—In order to establish the fact that recurrent cycles in the American pig industry, a study was made of available statistical data on pig production. The noticeable feature to be emphasised is a slow, upward trend, with fairly regularly recurring deviations up or down from the general level. These swings, up and down, indicate the length of the hog cycle. In general, it can be seen that the length of the cycle from peak to peak, or from trough to trough, is three to five years. However, in the seventies and eighties of the last century the cycle was slightly longer, as the turnover in pig production was rather slower than at present.

From a peak of values in 1902 there developed a low level in 1903, 1904 and 1905, with a peak in 1906 of about the same height as that of 1902. A slight decline set in until 1908, when a rather sharp upturn occurred, carrying values to a new peak in 1910. Values ran low again in 1911 and 1912, higher in 1913 and 1914, and lower in 1915 until the summer months. From that low point there developed an abrupt and entirely abnormal bulge in hog values which lasted until the middle of 1919. Then a precipitous decline set in until mid-

1921. This war-bulge must be ignored to a large extent in a study of cycles in the hog industry because of the extraordinary conditions of war time. In 1922 there was a peak of about the same height as 1910. A low point developed in 1923, from which values climbed to a peak in mid-1926, with a decline into 1927.

In all probability, judging from previous cycles, there will be a continuation in America of low levels in the average hog price during the first part of 1928. The last hog cycle ran from a peak in 1922 to another in 1926, a period of four years. The outlook for an 11 per cent. increase in pigs farrowed in the fall of 1927 over those farrowed correspondingly in 1926, according to the United States Government pig survey, would indicate low priced hogs in the first half of 1928, and a slow rise to another peak in late 1929 or in 1930. According to past experience the size of the 1928 corn crop will be a vital factor in timing the arrival of the peak, but for the coming cycle the European situation will prove more than ordinarily influential.

Goats.

Care and Management of the Milk Goat, *by Edwin C. Voorhies. California Agricultural Extension Service Circular* 6. *Nov.* 1926.—In this publication a concise but interesting and valuable enunciation is made concerning the origin, characteristics and relative values for milk production of the more important breeds of goats. From the economic aspect it is strongly emphasised that the milk goat should be strictly regarded on the same basis as a dairy cow, and that unless during a lactation period the goat is capable of leaving a considerable plus margin between the value of the milk she produces and the cost of her keep, she is not a " worth-while " investment for her owner. To be a paying concern a goat requires to give 80 to 100 gallons during a lactation period. It is pointed out that although individuality of the animal is the greatest factor influencing milk production, breed is also of importance. The Swiss breeds are higher yielders than the Anglo-Nubian breed, but the latter score in producing a very high percentage of butter-fat. As in the cow, the butter-fat content of goat's milk increases through the course of the lactation period. Many regard the goat as closely akin to the sheep, and therefore it is interesting to note that the percentage composition of goat's milk as given in this paper, unlike sheep's milk, does not differ appreciably from the percentage composition of cow's milk.

Poultry.

Modification of the Waterglass Method of Preserving Eggs. *J. Podhradsky. Vestnik Cecoslovenské Akademie Zemedelské, Prague,* 1927, *v. III, No.* 3.—In the experiments here described, which were carried out in the Biological Section of the Moravian Zootechnical Experiment Station of Brünn, the writer has shown clearly that waterglass, which is a silicate of sodium or potassium, reacts with the constituents of the egg-shell, chiefly with the carbonate of calcium to form silicates of calcium, which block up the pores and considerably restrict the circulation of air within the egg. Hence the question arises whether the present method of preserving eggs in waterglass may not be modified by leaving the eggs in the solution, instead of up to the moment of sale, for a brief period only of 7, 14 or 21 days, and following this by draining, drying and preserving them in cases in a cool place.

Experiments checked by minute analyses proved that up to 98 per cent. of fresh eggs so treated kept well, preserving unchanged their colour, fragrance, taste and consistency. The experimental period of preservation was for 60 days.

This modification of the method permits a saving in space and in material, since one and the same solution of waterglass can be used to treat several lots in succession.

ANIMAL NUTRITION.

Mineral Supplements and Vegetable Protein in Bacon Production.—*R. G. Baskett. J. Min. Agr. N. Ireland, Vol.* 1, 1927.—Experiments planned to determine (1) whether there is any advantage in feeding mineral additions to a basal ration; (2) if separated milk is available, whether there is any benefit gained by feeding mineral supplements; (3) whether it is possible to obtain a good result by substituting a vegetable protein, e.g. soya bean meal for fish meal, thus avoiding a risk of taint.

Three groups of large whites were fed outdoors on a basal cereal ration. The ration of Group I was supplemented with 13 per cent. extracted soya bean meal, that of Group II with a similar addition plus 2 per cent. of a complex mineral mixture, while Group III had 10 per cent. fish meal. The rations of Groups II and III contained the same amount of protein and total mineral matter. Separated milk was fed to each group for the first month only, and during that time there was no significant difference in the rate of gain between the three groups. In the ensuing period, however, Groups II and III showed considerable superiority over Group I, both in live weight increase and in the smaller consumption of food per lb. live weight gain. The experiment lasted for 102 days, and during that time the rates of gain and the food consumed per lb. increase were as follows:—

Group 1 : 1·09 lbs. at 4·2 pence per lb. increase.
,, II : 1·32 lbs. at 3·87 pence ,, ,,
,, III : 1·32 lbs. at 3·91 pence ,, ,,

The author concludes that there is no benefit to be obtained from feeding mineral additions to pigs when separated milk is available, and that, providing the ration does not include animal food containing mineral matter, it is desirable to use a mineral supplement.

Department of Agriculture, Canada, Dominion Experimental Farms, Animal Husbandry Division. *Report for* 1926 *by G. B. Rothwell.—Milk and Milk Substitutes for Pigs.*—This investigation was carried out to compare different substitutes with skim milk and buttermilk for fattening hogs after weaning. The substitutes under trial were semi-solid buttermilk, " Prolac " (an American product sold as a milk substitute), ground flax and tankage. Results showed that skim milk and buttermilk groups made the largest gains in the experiment, 1·36 and 1·39 lbs. per pig per day respectively. The group fed semi-solid buttermilk followed closely with 1·34 lbs., while tankage was not far behind. The "Prolac" group made the smallest daily gains, 1·02 lbs. per pig per day. In economy of gain the tankage group came first, putting on 1 lb. live weight at a cost of 5·51 cents, followed by buttermilk 5·70 cents, ground flax 5·86 cents, " Prolac " 6·01 cents, and skim milk 6·06 cents. The semi-solid buttermilk group, although making good gains, did not make these as economically as the other groups, 1 lb. live weight increase costing 8·78 cents.

Winter Feeding Experiments with Swine.—The object of this experiment was to compare different types of winter housing, Yorkshires with Berkshires under winter feeding conditions, and to test semi-solid buttermilk against skim milk. Groups of Yorkshires and of Berkshires were fed indoors to compare with groups of the two breeds fed outside, and these four groups had a supply of skim milk added to their ration. In addition a group of Berkshires fed outdoors had semi-solid buttermilk substituted for skim milk. This latter group made fair gains, 1·00 lbs. per pig per day, but at a high cost, 10·57 cents, compared with 1·03 lbs. at a cost of 6·44 cents for the Berkshire group, also fed outside, but having skim milk. The Yorkshires fed inside made the highest and most economical gains, 1·23 lbs. daily per pig at 6·4 cents per lb., compared with 1·14 lbs. at 7·45 cents for the Yorkshires fed outside. The reverse was observed by the Berkshires, the outside group gaining on an average 1·03 lbs. at 6·44 cents, as against 0·81 lbs. at a cost of 7·94 cents. Comparing the two breeds under outside conditions, it was found that the Berkshires, although not making as rapid gains as the Yorkshires, made these more cheaply. Under more confined conditions the Yorkshires proved to be much the better.

Experiments on the Winter Feeding of Sheep. *Univ. of Leeds and the Yorkshire Council for Agric. Education. Bull.* 153, 1927.—These experiments were carried out to compare the returns obtained from several widely different rations fed to fattening hogs folded on roots. In the first experiment, over a period of five months, there were five groups of sheep, one group being fed on roots alone, a second group on roots plus seeds hay, while groups 3 to 5 had concentrates in addition to roots and hay, Group 3 a cheap mixture high in protein of decorticated earthnut cake and palm kernal cake, Group 4 a mixture low in protein of decorticated earthnut cake, palm kernal cake and rolled wheat and barley, and Group 5 a mixture high in protein of linseed cake and palm kernal cake. Group 5 showed the greatest average weekly gain in live weight, and obtained at the lowest cost 1·73 lbs. at 8·1 pence per lb., as against 1·15 lbs. at 10·0 pence in Group 1; 1·31 lbs. at 9·7 pence in Group 2; 1·41 lbs. at 9·8 pence in Group 3, and 1·41 lbs. at 9·5 pence per lb. live weight increase in Group 4. There was no difference in the rate of growth of the wool in the different groups.

A second experiment, extending over 4½ months, was carried out on similar lines. The control group was fed on roots and meadow hay, the additions to the other groups being for Group 2 earthnut cake 1 part, palm kernal 3 parts; for Group 3, decorticated earthnut cake 1 part, palm kernal 3 parts, and 14 parts each of rolled wheat and barley, and for Group 4, rolled wheat and barley 1 part each. The ration for Group 2 was high and for Groups 3 and 4 low in protein. Group 2 showed the best results, a weekly average of 1·75 lbs. per sheep as against 0·88 lbs. in the control group. The authors conclude that only when roots and meadow hay can be grown at a very low cost can they compete with rations which are more costly but which give higher gains in live weight. To maintain live weight increase over a long period it is necessary that the ration should be progressive both as regards actual amount of the concentrated food fed and its palatability. Palm kernal cake, for instance, was well liked in early stages of experiment but in later stages became unpalatable.

Effect of Cod Liver Oil on the Calcium and Phosphorus Metabolism of the Lactating Animal. *D. Harvey. Biochem. J.*, 21, 1927, *p.* 1268.—Previous experiments by the author had shown that cod liver oil affects the calcium and phosphorus metabolism of the growing animal, and the present paper gives the results of similar experiments on the lactating animal. Goats were used in the experiments, and analyses were made of the calcium and phosphorus content of the food, milk, urine and fæces. After a pre-period cod liver oil was introduced into the ration and the effect noted for a further period, after which the cod liver oil was withdrawn and the effect again noted. The results of six such experiments have shown that the feeding of cod liver oil to goats influenced the balance of calcium by reducing the amount in the fæces. The effect on phosphorus excretion was variable. In the case of animals in late lactation, the percentage and total amount of calcium in the milk was increased by feeding cod liver oil. The amount of iodine in milk was increased by feeding cod liver or potassium iodide, while the fat content of the milk showed no definite change. In an experiment in which cod liver oil was replaced by olive oil plus an equivalent amount of iodine as potassium iodide, the effects of the former were not reproduced.

The Effect of Irradiation and Cod Liver Oil upon Poultry. *E. W. Mercer and F. H. Tozer. J. Min. Agr.*, 34, *No.* 7, 1927, *p.* 624.—Recent research has shown that cod liver oil and ultra-violet rays have a beneficial influence on poultry under experimental conditions, and the following experiment was planned to determine whether such beneficial influence would be apparent under practical conditions where hens in winter have free access to open air, sunlight, green food and grass. Five pens of six Rhode Island Reds were used, each pen having access to a grass run and cabbage *ad lib.* The ration at first contained fish meal, but later this was discontinued to give a ration of less antirachitic content. Pen I was a control pen. Pen II received 5 c.c. fresh cod liver oil mixed with the ration. Pen III had part of the ration irradiated for 15 minutes. Pen IV received 5 c.c olive oil, containing freshly irradiated cholesterol. Pen V had the birds exposed to a mercury vapour lamp for 15 minutes daily. The experiment was carried on for eleven weeks and the records of the various pens were as follows:—Pen I, 259 eggs; Pen II, 237 eggs; Pen III, 232 eggs; Pen IV, 221 eggs, and Pen V, 211 eggs. The authors conclude that poultry farmers who keep their birds under proper healthy open-air conditions with suitable rations and plenty of green food will not benefit by feeding cod liver oil or by irradiating either the fowls or the feed.

Feeding Tests regarding the Nutritive Value of an oily Ground-nut Bran. *M. Monmirel. Le Lait, Lyons*, 1927, *a.* 7, *v. VII, n.* 65.—Ground-nut bran, which is greasy to the touch and has the same odour as the cake, is a residue of the manufacture of extra white ground-nut cakes; this bran consists of the outer pink-coloured integument of the ground-nut, mixed with fragments of the kernal, but not including any remains of the pod. The object of the experiment described was to determine, by feeding tests, the practical nutritive value of this product compared with that of a cake mixture. The results recorded seem to point to the following conclusions:—

(1) Milch cows can tolerate, without any bad effects, large doses of ground-nut bran amounting to as much as 5·5 kg. per head.

(2) At the market price at the time of the experiment ground-nut bran costs, for an equal food value, 15 per cent. less than cake.

(3) Regarded as an energy producer it may be admitted that the forage value of ground-nut is such that it requires 1·2 kg. of the product to replace 1 kg. of cake.

(4) The use of ground-nut bran as a sole concentrate in the ration of milch cows is not to be recommended, as a slight decrease in the milk yield may result accompanied by a considerable reduction of the butter-fat percentage.

DAIRYING.

Irradiation of Milk. *O. Schultz. Milchwirtschaftt. Forschung*, 4, 37-40. —The deterioration in the taste of milk produced by ultra-violet irradiation is caused by the action of hydrogen peroxide on the proteins, and does not run parallel with the activation. The taste of protein-free cream or of animal oils is not affected by prolonged irradiation.

Butter Aroma. *C. Lind. Le Lait, Vol.* 7, *July* 1927.—The aroma of good butter is largely due to volatile substances formed during the ripening of cream. Aroma-forming bacteria which form the major part of the volatile acids live in symbiosis with the normal acidifying type. It is only after the total acidity of the starter has attained a sufficiently high figure that any considerable quantity of volatile acids are formed. In other words, a pronounced aroma in butter cannot be obtained without an acidification of the cream. The quantity of volatile acids found in butter increases simultaneously with the acidification of the cream from which the butter is prepared.

Pasteurisation of Milk for Cheese-Making. *W. V. Price. Jour. Dairy Sc.*, X (2), 155.—Pasteurisation of the cheese-milk to 145° F. for 30 minutes produces better results than the flush method. In general, pasteurised milk produces a more uniform quality of cheese, which keeps better under storage conditions than raw milk cheese. Pasteurisation is relatively most effective when the raw milk is of inferior quality, but the quality of pasteurised milk cheese varies with the quality of the raw milk. Pasteurisation increases the yield of cheese. Large scale experiments show that pasteurisation of milk for cheddar cheese making is practicable, economical and profitable.

Trial of the Application of the 6-5-8 Method for determining Milk Yield. *L. Saiz. La Industria pecuaria, Madrid,* 1927, *a. XXVIII, No.* 918.—The so-called 6-5-8 method for determining milk yield consists in measuring the milk produced on the days 6 weeks, 5 months, and 8 months after calving. The production of these three days is added together and the total multiplied by a hundred, the product giving the number of litres of milk produced in a lactation year. The writer tested the process at the "Granja provincial" of Fraisoro on 10 cows coming from different parts, of different ages and periods of lactation, obtaining respectively the following annual productions, firstly measured accurately and secondly by calculation, as follows:—4,371 and 4,250—3,238 and 3,050—4,767 and 4,450—2,269 and 2,300—2,903 and 2,900—1,966 and 2,350—2,775 and 2,700—3,721 and 3,950—4,923 and 4,200—6,820 and 7,400 litres. The writer considers the approximation adequate for many practical purposes, and advises the adoption of the method where daily direct measuring is impossible.

The Influence of the Age of the Cow on the Yield and Quality of the Milk. *T. J. Drakeley, Ph.D., M.Sc., F.I.C., and Margaret K. White, M.Sc. Journal of Agricultural Science, London,* 1927, *Vol. XVII, part* 3.—In a previous article the writers examined the effect of the stage of lactation and the breed of the cow on the yield and quality of milk.

The results of Mackintosh and of Tocher were based largely on the analyses of milks of Ayrshire cows only, those of the writers on those of nine different breeds obtained at the shows held by the British Dairy Farmers' Association during the past 48 years.

These cows are above the average, but it is considered that the position of the curve showing the relationship between the various factors and the age would be the same as regards the age axis as that obtained in normal practice.

It was found that age had no separate effect on the evening as against the morning milk.

The average number of days in milk differed for each breed, the limits being 41 days for Ayrshire and 108 for Jersey cows.

Results.—Tables of results are given for the following breeds:—Dairy Shorthorns, Red Polls, Lincoln Reds, British Friesians, Ayrshires, Jerseys, Guernseys, Kerrys, Dexters.

Yield.—This increases rapidly for all breeds, reaches a maximum and gradually declines, the age and length of duration of the maximum varying slightly for different breeds. Thus Shorthorns attain their maximum yield in their 8th year and keep it for another year before showing a decline, while Jerseys attain it in the 7th year, the decline starting in the 9th.

Fat.—The percentage at first increases and then decreases; for all breeds the quality of milk of very young cows is richer than that of cows over 6 and 7, The highest fat content is attained in the 4th and 5th years by Shorthorns, whereas Guernseys reach their maximum at three.

The actual weight of fat yielded rises to a maximum between the 5th and 8th year. The percentage of fat in the milk solids shows little variation.

Solids-not-Fat.—The percentage decreases continuously with age, though sometimes almost imperceptibly until after the 3rd year. The actual weights increase until about the 8th year.

It is proposed in a future communication to deduce for each breed the joint relationship between the variable factors, age, period of lactation, yield and quality of milk.

Some Variations of the Heat Method for sterilising Milking Machines. *L. H. Burgwald, Journal of Agricultural Research, Washington, D.C.*, 1927, *Vol.* 34, *No.* 1.—The method of sterilising milking machines by the use of heat has been advocated only during the last few years. The chief criticism of this method has been that it is too injurious to the rubber parts of the machines. The present investigations were undertaken to find a method that would give as good results bacteriologically as the heat method but would allow a longer life to the rubber parts.

In the heat method referred to the unit, consisting of teat cups, claw and tubing, after being washed is placed in hot water at a temperature of 160° to 165° F., and allowed to remain there between milkings, the water cooling gradually.

The experiments indicate that sterilising the units at 160–167° F. for 20 to 35 minutes and placing them in a weak chlorine solution (about 1 : 20,000), or hanging them in a refrigerator or cold place (below 50° F.) protected from dust or contamination, will give excellent bacterial results, and that the life of the rubber parts will be materially longer than when the units are allowed to remain in hot water between milkings.

Sale of Cheese Order : France.—An Order of 7th October 1927 (*Journal Officiel*, No. 241, of 16th October 1927) regulates the cheese trade with a view to establishing the descriptions and particulars given to cheeses offered for sale, so as to avoid all possibility of confusion as regards the species and origin of these products. With this object the Order obliges all persons offering for sale cheeses with a geographical indication of the species on the labels or contained in inscriptions stamped on the cheeses, to add to it the department or region where these cheeses were manufactured. This statement must be drawn out as follows :—" *Manufactured in* (name of department or region)," and in letters at least equal to two-thirds the size of the letters composing the name of the species and similar in printers' type. These provisions are not, however, applicable to geographical titles of origin established by custom either by special laws or by judicial decision rendered in application of the Law of 6th May 1919 on the protection of titles of origin. It is also laid down that these provisions shall come into force six months after the date of the publication of the Order in the *Journal Officiel.*

INSECTS AND PESTS.

Thrips in relation to "Blindness" in Barley.—" Blindness " in barley is of two kinds. The first, which has been called the " Stripe blindness," is due to the fungus (*Helminthosporium gramineum*). Its presence is recognised by the discoloration of the affected ear due to the presence of minute brownish black pustules of the fungus spores. The grain is shrivelled and is sometimes entirely absent. The second type is distinguished by the transparent appearance of the affected spikelets, which in the later stages stand rigidly against the axes of the ear. There is no discoloration of the ear. This is the commoner form of blindness, and possibly accounts for 80 to 90 per cent. of the trouble.

An important series of experiments [1] dealing with the second type has recently been carried out by members of the staff of the Agricultural Department of Leeds University. Blindness or gapping, i.e. the failure of indivisional spikelets to mature, varies in different varieties, and these experiments suggest that certain varieties now commonly grown, e.g. " Standwell " and " Plumage," might in future be omitted from farm practice. While the condition apparently has a hereditary basis, in the case of one variety at least (Plumage) this is not an inherent physiological defect, but a structural one, viz. a slight gaping of the glumes, which afford an entrance for those minute insects of the Order known as Thrips. The genus and species of the destructive Thrips have not yet been

[1] Blindness in Barley, Leaflet No. 151, 1927. The University of Leeds and the Yorkshire Council for Agricultural Education.

determined, although no doubt remains as to the damage the insects may effect. This largely depends on the succulence of the ovary wall at the time of their entrance. If this is effected before fertilisation of the ovules, it seems very possible that the sucking of the juice from the ovary wall by the Thrips may suffice to prevent it, and the unfertilised ovary shrivels up in consequence. No eggs of Thrips have been found on the spikelets, but an examination of a sample of damaged grains showed 2 to 3 per cent. infested with hibernating adults. While the stubble is usually regarded as the usual place of hibernation of these insects, it is clearly possible for them to pass the winter in damaged seed. It may be noted in verification of the above results that blindness in several cereals associated with the presence of Thrips has been noted on the College Farm at Craibstone, Aberdeen.

Trouble with Mites.—*Mites infesting Hay.*—A case of this was reported from Skye in November last in which serious destruction of the stacks had taken place. The mites could be lifted in "shovelfulls." They proved to be one of the species commonly known as cheese mites, *Tyroglyphus longior*. These mites by no means confined their depredations to cheese; they attack hay and other dried vegetable substances, and even drugs. Analogous to the present case is one reported by Michael in which he says he received samples cut from hay-ricks "which weight for weight must have contained as large a quantity of the Acarus as of the hay; and the whole of the rick was stated to be in the same condition." The samples came from first class farms.

In the above instance the farmer was advised to restack the hay, separating and burning the debris and mites and to feed the hay to stock as soon as possible.

Dispersal of Mites.—In the case of the bulb mite, *Rhizoglyphus echinopus*, contamination takes place by means of infected soil or contact between bulbs in store or transport. But apart from casual contacts, nature has provided another suited to the wider dispersal of the mite. There is a phase of the mite, known as a Hypopus, with a flattened body which is equipped with small discs on the under side by means of which the mite attaches itself to another creature, frequently a beetle or other flying insect. In this way transportation over a wide area is effected and fresh generations appear. The sudden appearance of myriads of mites in hay or stored flour or meal is due to the dropping of Hypopus-mites by swarms of flies, and the resultant rapid breeding of mites in such food supplies.

Muscles of the Adult Honey Bee.—There has just been published by the North of Scotland College of Agriculture the first part of an account of the Musculature of the Hive Bee. It includes the study of the Histology and Physiology of Muscle. This work has been carried out by Mr. Guy D. Morison, Ph.D. (Lond.), research assistant in Entomology. This is the most comprehensive study of bee muscles hitherto undertaken and represents several years of work. This valuable undertaking forms part of the foundation work being done in connection with the study of the Pathology of Parasitic Diseases in Bees. The work is too technical for summarising here, but in view of the relation of muscles to respiration, a point of importance in connection with acarine disease may be mentioned. Dr. Morison finds independent reasons for believing that the flow of air is chiefly unidirectional, entering by all the spiracles, but leaving practically exclusively by the first thoracic pair during normal respiration. This is a point of considerable interest in relation to acarine disease, and may prove of value in treatment. The passage leading to these spiracles is the one primarily occupied in this disease by the infesting mites, and apparently from it there is a flow of carbon-dioxide-laden air. Dr. Rennie some time ago suggested that the mites are attracted to this site chemotactically by carbon dioxide, a hypothesis which now receives valuable physiological support.

STATISTICS.

PRICES of AGRICULTURAL PRODUCE, FEEDING STUFFS and FERTILISERS in December 1927, and January and February 1928.

LIVE STOCK: Monthly Averages of Prices at certain representative Scottish Markets.

(Compiled from Reports received from the Board's Market Reporters.)

Description.	December.			January.			February.		
	1st Quality	2nd Quality	3rd Quality	1st Quality	2nd Quality	3rd Quality	1st Quality	2nd Quality	3rd Quality
FAT STOCK:—									
*CATTLE—	per cwt. s. d.	per cwt. s. d.	per cwt. s. d.	per cwt. s. d.	per cwt. s. d.	per cwt. s. d.	per cwt. s. d.	per cwt. s. d.	per cwt. s. d.
Aberdeen-Angus ...	63 10	56 4	40 1	62 5	55 5	40 6	61 8	55 1	41 6
Cross-bred (Shorthorn)	58 1	49 11	34 4	56 3	49 4	36 1	56 2	49 3	35 2
Galloway	55 4	49 4	...	52 9	48 5	..	56 4	52 1	...
Ayrshire	54 3	44 9	36 0	51 9	42 9	36 0	51 7	42 5	35 7
Blue Grey	64 0	60 0	...	53 0	...	...	...	..	...
Highland	59 0	53 0	...	...	...	...	...	...	...
	per lb. d.	per lb. d.	per lb. d.	per lb. d.	per lb. d.	per lb. d.	per lb. d.	per lb. d.	per lb. d.
†VEAL CALVES	16	8½	5	16	8½	5	16	8½	5
†SHEEP—	Hoggs under 60 lb. per lb. d.	60 lb. and upw'ds. per lb. d.	Ewes per lb. d.	Hoggs under 60 lb. per lb. d.	60 lb. and upw'ds. per lb. d.	Ewes per lb. d.	Hoggs under 60 lb. per lb. d.	60 lb. and upw'ds. per lb. d.	Ewes per lb. d.
Cheviot	12¾	11¾	9¾	13½	12½	10	14¼	13½	10¾
Half-bred	12¾	11¼	7¾	13¼	12¼	8¼	14	13	9¼
Blackface	12¾	11¾	8¾	13	12¼	9¼	13¾	13	9¾
Greyface	13¼	12¼	8½	13½	12¾	9¼	14¼	13½	10¼
Down Cross	13	12½	6¾	13½	12¾	7	14	13½	8¼
†PIGS—	per stone. s. d.	per stone. s. d.	per stone. s. d.	per stone. s. d.	per stone. s. d.	per stone. s. d.	per stone. s. d.	per stone. s. d.	per stone. s. d.
Bacon Pigs	11 8	10 8	...	11 11	11 0	...	12 0	10 11	...
Porkers	12 5	11 4	...	12 8	11 8	...	12 8	11 8	...

* Live weight. † Estimated dressed carcase weight.

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PROVISIONS : Monthly Average Wholesale Prices at Glasgow.

(Compiled from Reports received from the Board's Market Reporter.)

Description.		Quality.	December. s. d.	January. s. d.	February. s. d.
BUTTER :					
Argentine (Unsalted) ...	per cwt.	1	...	168 0	166 8
Australian	,,	1	170 6	166 0	167 2
Danish	,,	1	191 0	180 3	185 5
,, (Unsalted) ...	,,	1	196 0	185 0	190 7
New Zealand	,,	1	173 0	167 3	169 5
,, (Unsalted) ...	,,	1	185 6	173 6	176 0
Russian	,,	1	164 0	161 6	159 4
Swedish	,,	1	188 4	173 8	180 0
CHEESE :					
Cheddar	,,	1	114 0	114 9	119 0
		2	104 6	104 3	107 8
Cheddar Loaf	,,	1	128 6	128 0	128 0
		2	126 0	126 0	126 0
Dunlop	,,	1	108 6	109 9	112 0
		2	100 6	101 9	105 5
Canadian...	,,	1	109 0	109 0	109 0
New Zealand (Coloured)	,,	1	103 9	99 9	98 2
,, (White)	,,	1	103 9	99 9	98 2
BACON :					
Ayrshire (Rolled) ...	,,	1	119 0	123 0	127 7
Irish (Green)	,,	1	114 0	115 6	118 0
,, (Dried or Smoked)	,,	1	120 0	121 6	125 7
,, (Long Clear) ...	,,	1	104 6	109 0	117 2
Wiltshire (Green) ...	,,	1	118 0	128 6	132 0
,, (Dried or Smoked)	,,	1	124 0	136 0	138 0
American, Short Clear Backs	,,	1	88 0	88 0	86 0
Canadian Sides	,,	1	86 8	84 0	84 7
Danish Sides	,,	1	89 0	89 0	90 0
Dutch, Wiltshire Style (Green)	,,	1	80 6	81 9	80 7

Description.		Quality.	December. s. d.	January. s. d.	February. s. d.
HAMS :					
Irish (Smoked)	per cwt.	1	157 0	157 0	165 0
		2	142 0	142 6	152 0
American, Long Cut (Green)	,,	1	102 6	100 3	95 5
American, Short Cut ...	,,	1	104 6	105 9	90 5
EGGS :					
Country	per doz.	1	2 10	2 8	2 3
		2	2 8	2 6	2 1
Irish	per 120.	1	27 0	24 11	17 1
		2	25 6	23 9	15 9
American	,,	1	16 10	17 0	...
Belgian	,,	1	22 6	22 3	15 8
		2	...	20 7	14 10
Chinese (Green)	,,	1	16 4	18 3	...
,, (Red)	,,	1	10 1	12 0	...
Danish	,,	1	27 6	25 8	...
		2	24 7	24 3	...
Dutch	,,	1	20 11	21 0	16 0
Egyptian	,,	1	8 9	10 2	10 11
		2	8 3	9 2	10 2
Polish	,,	1	13 3	15 8	12 6
Russian	,,	1	15 0	15 11	...
		2	13 2	13 0	...
Swedish	,,	1	26 2	26 0	...
		2	24 2	23 10	...

FRUIT AND VEGETABLES: Monthly Average Wholesale Prices at Glasgow.

(Compiled from Reports received from the Board's Market Reporter.)

Description.		Quality.	December.	January.	February.
Fruit:—					
Apples—					
Imported:			s. d.	s. d.	s. d.
Californian ...	... per case.*	1	15 0	15 8	15 0
Oregon	,,*	1	18 6	18 6	17 0
Other American ..	,,*	1	15 0	14 5	14 0
Canadian	,,*	1	14 0	...	...
Pears, *Calfornian*	... per case.*	1	23 9	24 9	24 6
Grapes, Muscat ...	... per lb.	1	4 6	...	...
,, Black Hamburgh	,,	1	1 3	...	...
Vegetables:—					
Beet	... per cwt.	1	5 11	11 0	14 0
Brussels Sprouts... ...	,,	1	19 0	22 6	24 0
Cabbage, Savoy	... per doz.	1	3 0	3 0	3 0
Carrots, *British* ...	... per cwt.	1	7 2	7 9	7 4
Cauliflowers— Broccoli, *Cornish*	... per doz.	1	4 9	5 0	...
,, *French* ...	,,	1	...	5 0	5 0
Celery	... per bunch.	1	2 9	3 0	3 0
Leeks ...	... per doz bunches.	1	5 3	5 6	5 7
Lettuce, Cabbage	... per doz.	1	2 0	...	4 0
Onions, *Dutch* ...	... per bag.**	1	...	13 9	15 7
,, *Valencia*	... per case.†	1	14 2	16 6	20 2
Parsley	... per cwt.	1	20 0	29 0	48 0
Parsnips	,,	1	8 0	10 6	12 0
Rhubarb	,,	1	...	50 0	46 5
Tomatoes, *Canary*	... per lb.	1	0 6	0 7	0 8
Turnips	... per cwt.	1	3 0	3 0	3 0

* 40 lbs. (approx.). ** 7½ stones (approx.). † 9 stones (approx.).

POTATOES: Monthly Average Wholesale Prices at Dundee, Edinburgh, and Glasgow.

(Compiled from Reports received from the Board's Market Reporters.)

Market.		Quality.	Late Varieties. Red Soils. Langworthy and Golden Wonder.	Red Soils. Other.	Other Soils. Langworthy and Golden Wonder.	Other Soils. Other.
			£ s. d.	£ s. d.	£ s. d.	£ s. d.
DECEMBER.						
Dundee	per ton.	1	...	...	...	5 0 0
Edinburgh	,,	1	...	...	...	5 11 0
Glasgow	,,	1	...	...	10 8 0	6 13 0
JANUARY.						
Dundee	,,	1	...	...	...	5 3 0
Edinburgh	,,	1	...	...	...	5 15 0
Glasgow	,,	1	12 10 0	...	10 11 0	7 1 0
FEBRUARY.						
Dundee	,,	1	...	...	...	5 10 0
Edinburgh	,,	1	...	...	...	6 0 0
Glasgow	,,	1	12 12 0	...	10 12 0	7 8 0

ROOTS, HAY, STRAW, AND MOSS LITTER: Monthly Average Prices at Dundee, Edinburgh, and Glasgow.

(Compiled from Reports received from the Board's Market Reporters.)

Market.		Quality.	Roots. Carrots.	Roots. Yellow Turnips.	Roots. Swedes.	Hay. Rye Grass and Clover.	Hay. Timothy.	Straw. Wheat.	Straw. Barley.	Straw. Oat.	Moss Litter.
			s. d.	s. d.	s. d.	s. d.	s. d.	s. d.	s. d.	s. d.	s. d.
DECEMBER.											
Dundee ...	per ton.	1	...	20 0	25 0	105 0 † 90 0 ‡	...	50 0¶	...	55 0¶	52 6*
Edinburgh	,,	1	...	...	...	105 0 † 102 6 ‡	...	55 0‡	...	55 0‡	...
‖ Glasgow	,,	1	...	...	...	75 0	80 0	45 0	...	45 0	32 6**
JANUARY.											
Dundee ...	,,	1	...	20 0	25 9	105 0 † 95 0 ‡	...	63 9†	62 6†	63 9†	52 6*
Edinburgh	,,	1	...	...	...	105 0 † 105 0 ‡	...	55 0‡	...	55 0‡	...
‖ Glasgow	,,	1	...	...	...	75 0	80 0	45 0	...	45 0	32 6**
FEBRUARY.											
Dundee ...	,,	1	...	20 0	26 0	105 0 † 96 0 ‡	...	65 0†	62 6†	65 0†	52 6*
Edinburgh	,,	1	...	...	...	105 0 † 105 0 ‡	...	55 0‡	37 6§	55 0‡	...
‖ Glasgow	,,	1	...	...	...	75 0	80 0	40 0	...	40 0	32 6**

Baled and delivered. ¶ Delivered bunched. ‡ Delivered loose.
Baled f.o.r. ‖ Baled Hay and Straw delivered. * Foreign (exquay).
** Home (in 1½ cwt. bales).

FEEDING STUFFS: Monthly Average Prices at Glasgow and Leith.

(Compiled from Reports received from the Board's Market Reporters.)

Description.	December.		January.		February.	
	Glasgow.	Leith.	Glasgow.	Leith.	Glasgow.	Leith.
	per ton. £ s. d.	per ton. £ s. d.	per ton. £ s. d.	per ton. £ s. d.	per ton. £ s. d.	per ton. £ s. d.
Linseed Cake—						
Home	12 6 3	11 13 9	12 12 6	11 15 0	12 15 0	12 0 0
Foreign	12 5 0	11 3 2	12 11 11	11 7 6	12 11 0	11 11 3
Decorticated Cotton Cake	11 15 0	11 17 6	11 16 3	11 15 0	11 18 6	...
Undecorticated Cotton Cake—						
Bombay (Home-manufactured)...	7 18 9	7 11 3	8 6 3	7 18 9	8 2 6	7 12 6
Palmnut Kernel Cake	10 6 3	9 10 0	...	9 10 0	...	9 10 0
Soya Bean Cake ...	...	11 14 5	...	11 15 0	...	11 11 0
Groundnut Cake, Undecorticated—						
37 per cent. Oil and Albuminoids	10 0 0	9 5 0	9 17 6	...	10 4 0	...
40 per cent. do.	10 5 0	9 13 4	10 8 2	9 17 6	10 10 0	9 15 0
Maize Germ Cake—						
Home	11 0 0	...	12 0 0	...	11 18 6	...
Bean Meal	12 17 6	12 11 3	13 1 3	12 10 0	13 5 6	12 5 0
Locust Bean Meal ...	9 8 4	8 6 3	9 15 0	8 5 0	...	8 13 0
Fish Meal	...	21 5 0	...	22 0 0	...	22 0 0
Maize Meal—						
Home Manufactured	10 13 9	9 15 0	11 5 0	9 15 0	11 13 9	10 7 6
South African (Yellow)	9 11 11	8 15 0	9 18 9	...	10 12 0	...
Do. (White) ...	9 14 5	...	9 16 11	...	10 3 6	...
Maize Gluten Feed (Paisley) ...	...	...	10 5 0	...	10 5 0	...
Maize—						
Plate	9 5 0	8 18 9	9 10 8	9 0 0	10 5 6	9 14 0
African (Flat) ...	9 15 8	...	10 0 10	...	10 7 6	...
Oats—						
Home	10 3 2	9 0 0	11 0 8	9 10 0	11 7 0	10 12 0
Plate	10 6 8	...	10 0 0	..	...	...
Barley	11 2 6	11 7 6	11 1 3	11 5 0	11 3 6	11 0 0
Wheat—						
Home	11 13 9	11 0 0	12 5 0	11 0 0	11 10 6	11 0 7
Foreign	12 13 2	...	11 0 0	...	10 18 6	...
Beans—						
English	11 17 6	...	12 0 10	...	11 16 3	...
China	11 16 11	..	11 16 11	...	12 0 0	...
Rangoon (White)	10 6 3	...	10 7 6	...	10 7 6	...
Pease—						
Karachi (White)...	13 2 6	...	12 18 2	...	12 3 0	...
Wheat—						
Middlings (Fine Thirds or Parings)	11 1 11	9 15 0	10 16 3	9 8 9	10 9 0	9 8 0
Sharps (Common Thirds) ...	9 9 5	8 13 9	9 8 2	8 18 9	9 0 6	8 12 6
Bran (Medium) ...	9 7 6	8 15 0	9 8 9	8 15 0	9 5 0	8 13 0
,, (Broad) ...	9 11 3	9 8 9	9 13 2	9 10 0	9 8 6	9 8 0
Distillery Mixed Grains - Dried	...	9 5 0	...	9 5 0	...	9 8 0
Brewers' Grains—						
Dried	9 3 9	8 7 6	9 5 8	8 11 3	9 6 0	8 13 6
Malt Culms... ...	7 10 0	7 6 3	7 10 0	7 10 0	7 10 0	...
Feeding Treacle ..	...	7 0 0	...	7 0 0	...	7 0 0

FERTILISERS : Monthly Average Prices at Glasgow and Leith.

(Compiled from Reports received from the Board's Market Reporters.)

Description.	Guaranteed Analysis.	December.		January.		February.	
		Glasgow.	Leith.	Glasgow.	Leith.	Glasgow.	Leith.
	%	per ton. £ s. d.	per ton. £ s. d.	per ton. £ s. d.	per ton. £ s. d.	per ton. £ s. d.	per ton. £ s. d.
Nitrate of Soda ...	N. 15½	...	11 10 0	11 12 6	11 10 0	11 12 6	11 12 0
Calcium Cyanamide	N. 19	...	8 12 0	...	8 12 0	...	8 16 0
Sulphate of Ammonia (Neutral and Granular) § ...	N. 20·6	10 8 9	10 8 0	10 11 0	10 11 0	10 12 7	10 13 0
Superphosphate ...	S.P. 30	2 7 6	2 10 0	2 7 6	2 10 0	2 7 6	2 10 0
"	S.P. 35	2 12 6	2 15 0	2 12 6	2 15 0	2 12 6	2 15 0
"	S.P. 38	...	3 0 0	2 17 6	3 0 0	2 17 6	3 0 0
Ground Mineral Phosphate † ...	I.P. 58/60	2 3 6	2 5 0	2 3 6	2 5 0	2 3 6	2 5 0
" " † ...	I.P. 74	...	3 5 0	...	3 5 0	...	3 5 0
Bone Meal—Home	N. 5, I.P. 40	...	...	9 0 0	...	9 0 0	...
" " Indian	N. 3¾, I.P. 45	...	8 15 0	..	8 15 0	...	8 15 0
Steamed Bone Flour	N. 1, I.P. 60	6 10 0	6 5 0	6 10 0	6 5 0	6 10 0	6 4 6
Basic Slag	T.P. 24	...	**2 5 6	...	**2 8 6	...	**2 8 6
" "	" 26	*2 8 0	**2 8 6	*2 8 0	**2 12 0	*2 8 0	**2 12 0
" "	" 28	*2 11 6	**2 11 6	*2 11 6	**2 15 0	*2 11 6	**2 15 0
" "	" 30	*2 16 6	**2 16 3	*2 15 6	**2 19 6	*2 15 6	**2 19 6
" "	" 40	...	‡2 18 9	...	‡2 15 0	...	‡2 15 0
Sulphate of Potash (on basis of 90 per cent. purity)	Pot. 48·6	10 15 0	10 16 3	10 17 6	10 17 6	11 1 6	11 1 6
Muriate of Potash... (on basis of 80 per cent. purity)	Pot. 50	8 16 6	8 15 0	8 16 6	8 15 6	8 19 4	8 19 1
Potash Salts ...	Pot. 20	3 8 6	3 8 3	3 8 6	3 8 6	3 9 8	3 9 8
" " ...	Pot. 30	4 15 6	4 15 0	4 15 6	4 15 6	4 17 1	4 17 1
Kainit (in bags) ...	Pot. 14	3 0 0	2 19 9	3 0 0	3 0 0	3 0 10	3 0 5

Abbreviations:—N. = nitrogen; S.P. = soluble phosphate; I.P. = insoluble phosphate; T.P. = total phosphate.

* Carriage paid to stations in Ayrshire. ** Carriage paid to stations in Lothians.

† Fine grist 80 per cent. through standard 100 mesh sieve; 80 per cent. fineness through standard 120 mesh sieve 2s. 6d. per ton dearer.

‡ Foreign slag at Leith. § Carriage paid in 6-ton lots.

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THE IMPROVEMENT OF GRASS LAND.

Professor A. E. V. RICHARDSON, M.A., D.Sc.

Major Walter Elliot, M.C., M.P., to whom we are indebted for the appearance of this article, says:—" The following notes were prepared by Professor A. E. V. Richardson, of the Waite Institute, Adelaide, South Australia, subsequent to the recent Imperial Agricultural Research Conference. In view of the importance of the subject to Scotland, it may be of interest to readers of the Journal to see how the problem presents itself to workers in Australia."

Importance of Grass Land.—The grass lands of the Empire form the main source of food for the live stock of the Empire, and therefore the basis of the wool, mutton, beef and dairy industries. To Australia the grass lands are of the greatest economic importance. Practically the entire sheep and cattle population of Australia is maintained on the natural indigenous pastures, and the grass crop must therefore be regarded as Australia's principal crop and outstanding source of wealth. Wool growing is by far the most important of the pastoral industries of Australia. During 1926 the export of wool exceeded £55,000,000 sterling.

As only about 1 per cent. of Australia is under cultivation either with crops or sown grasses, it follows that for many years —and in the arid and semi-arid regions perhaps indefinitely— the exploitation of the natural pastures must be looked to as the main source of food for the important pastoral industries. Though the scientific study of the problems of grass land production is of the highest importance, hitherto but little work has been done in this very important field.

Difficulties in investigating Grass Land Problems.—The typical pasture sward is of a highly complex nature, whether naturally or artificially established. Its composition and value from a grazing point of view vary considerably according to factors which, until recently, were regarded as uncontrollable. The extremely wide variation in types, the plasticity or susceptibility of grass land to slight changes of environment, the effect of the growth of one plant upon another, the phenomenon of succession, render grass land a particularly complex field of study. But apart from these considerations, the all-important influence of the *biotic* factor on grass land cannot be dissociated from any scientific study of its improvement. This latter point is of great scientific significance to Australia, because throughout long geological periods the Australian continent has been cut off from the great land masses of the Northern Hemisphere, and the continent has therefore remained a huge biological backwater, and has developed a characteristic fauna and flora unlike that of the Northern Hemisphere. Its indigenous fauna has had no close-grazing animals such as the herbivora of Europe and Asia. As a result, Australia has evolved a peculiar and characteristic flora which, until the advent of the sheep and cattle industry, was unused to the close grazing associated with herbivora maintained by man for purposes of profit. The effect of grazing animals on any flora is more or less harmful, but the effect of this biotic factor, accentuated by the periodic droughts which occasionally visit Australia, has been unusually severe, especially in the arid and semi-arid areas. Degenerative changes in the vegetation and the elimination of some of the more palatable species have resulted. Indeed, it is more than probable that some of the more valuable species have disappeared completely and are lost forever to the pastoralist, as a result of lack of knowledge of ecological factors influencing indigenous grass lands and the application of unscientific methods of grazing. In a new and vast country, covered with a wealth of rich indigenous pasture, it would be idle to expect the pioneer pastoralist to refrain from the exploitation of this virgin source of wealth.

The problem of maintaining and increasing the productivity of our indigenous pastures is, however, of first rate importance in view of the decrease of twenty or thirty millions in the sheep population within a few generations.

The Grass Land Problem in Australia.—The most important factors in determining the character of the grass land regions in Australia are the type of rainfall and its incidence, and the temperature during the rainy season. Broadly speaking, there are two main types of rainfall characteristic of the Northern and Southern Coast of Australia. The monsoonal type of rain, which affects the whole of Northern Australia to the tropic of Capricorn, is tropical in character, and occurs between November and April—a period of extremely high temperature. The Antarctic or winter type of rainfall affects the whole of Southern Australia and occurs between May and November—the coolest period of the year.

The grass land area of these two regions are entirely different in type, the former being characterised by rapidly growing summer grasses, e.g., the various species of Panicum, Andropogon, and Mitchell and Bluegrass, whilst in the latter the pasture consists of perennial forms, such as Danthonia, Stipa, Themeda, &c., with early ripening introduced annual species, e.g., Bromus, Festuca, Nordeum, Erodium, &c., and the small introduced annual clovers and trefoils.

Along the eastern and south-eastern portions of the continent the monsoonal and Antarctic types of rainfall overlap, giving a more or less regular and fairly heavy rainfall throughout the year. Those areas, for the most part originally covered with forest, are peculiarly well suited for the growth of European species of pasture plants—rye-grass, cocksfoot, white and red clover, and the South American paspalum.

Tasmania, though situated in the winter rainfall region, is by its insular position and its cooler climate, due to latitude, specially adapted for European herbage species.

Finally, the interior of the continent, which lies between the spheres of influence of the monsoonal and Antarctic rain areas and receives only occasional sporadic rains from either rain system, is necessarily arid. The rainfall of this region varies from 5 to 10 inches per annum, and drought-resisting forms, such as the perennial saltbushes and spinifex, with certain early maturing annual species, form the main herbage cover.

Any complete system of grass land research for Australia would necessarily consider these four grass land regions, namely —(1) the tropical northern area; (2) the temperate southern area; (3) the eastern and south-eastern region of high and regular rainfall, and (4) the arid interior. The southern grass land region, dominated by the winter rainfall, is of great economic importance, because it includes the sheep and wheat belts of New South Wales, Southern Queensland, Victoria, South Australia, Western Australia and Tasmania. The line of maximum concentration of sheep corresponds closely to the 18 to 20 inches line of rainfall south from the tropic of Capricorn. The northern grass lands, dominated by the summer or monsoonal rains, are of great economic importance to the cattle industries of Northern Queensland, the Northern Territory, and the tropical portion of Western Australia. The area of more or less uniform rainfall, extending from Sydney to Melbourne and including the highlands between those centres, and the more elevated portions of the Western District of Victoria, is specially adapted to the growth of European pasture grasses and for the support of an intensive dairying industry. The arid interior, though forming one-third of the continent, is comparatively sparsely stocked, and indeed much of it is unoccupied. The great bulk of the sheep population is maintained on the country with 12 to 22 inches of rainfall, and in the area of winter rainfall.

Scientific Problems underlying Grass Land Development.— —The scientific problems underlying grass land development in Australia fall under three heads—(1) ecology, (2) agrostology, (3) genetics. These have not been placed in order of importance, but rather in the order of national procedure.

(1) *Ecology.*—The first step in the scientific study, and therefore of the most economic and productive treatment of grass land, is the thorough examination of the natural composition, be-

haviour and succession of the vegetation. The study of the ecological conditions affecting the succession of pasture plants must be followed by a study of the influence of the biotic factor (grazing by the animal) on pastures in typical arid, semi-arid and moist regions. Ecological work on pastures is of great practical significance where large tracts of semi-arid country are affected and where the pastures will be rarely ploughed, and is a pre-requisite for the improvement of herbage plants.

(2) *Agrostology*.—The investigation of the characters, habits and qualities of the indigenous grasses and exotic herbage plants, which constitute the natural and artificially seeded pastures of Australia, is a very important and fundamental portion of the work. It is very important to determine the persistence, palatability, drought-resisting capacity, seed-setting, and other characters of the indigenous and exotic herbage plants available in any given region, and their behaviour under the normal climatic conditions of the area.

The conditions affecting the establishment of pastures and the effects of fertilisers, cultural treatments and grazing in the growth and development of individual species require to be determined.

(3) *Herbage Breeding*.—Finally, the ecological and agrostological work must be backed by plant-breeding work. At Aberystwyth it has been shown that an accurate knowledge of the characteristics and behaviour of individual grass and clover species must form the starting point from which to build up reliable information on the establishment of pastures. The direct outcome of this has been the numerous nationality and strain trials which have pointed the way to improvement of herbage plants by breeding, which in turn leads to the investigation of the best methods of seed production. The marked superiority of strains developed by careful methods of selection has been amply demonstrated. One of the most striking and important results has been the recognition of the superiority of indigenous over cultivated types of grass species. Most commercial strains of pasture plants, such as Perennial Rye Grass, Cocksfoot, Red Clover and White Clover, have been grown by seedsmen for many plant generations, and the process of artificial selection for seed to which they have been subjected has tended to isolate plants of the prolific seed-bearing type but of poor pasture value. The work at Aberystwyth has definitely shown that by going back to the old indigenous pastures it is possible to obtain by selection permanent, leafy, nutritious forms of high pasture value, though they may be of lesser seeding value. Though the indigenous seed may thus be more costly, it will undoubtedly prove of far superior value to the farmer. It is probable that in future we shall have distinct varieties and strains of each important herbage grass for the market, just as we now have individual and distinct varieties of wheat, barley, oats and maize.

In regard to herbage breeding, it would appear undesirable for many reasons for Australia to duplicate the very important and valuable breeding work in process at Aberystwyth on Cocksfoot, Rye Grass and Red and White Clover. To duplicate such work would be not only very costly, but would require a highly trained scientific staff with a specialised knowledge of these European grasses. For the immediate future, Imperial interests might be better served by providing facilities in the uniform rainfall area and in Tasmania for the thorough testing of the strains developed at Aberystwyth to determine their suitability to Australian conditions. If such tests definitely demonstrate that the strains developed at Aberystwyth are unsuited to Australian conditions, then it may be necessary to consider the best method of producing by local effort the European herbage plants required for our own special conditions. Before any such step is contemplated, however, thorough testing of Aberystwyth material should be made. On the other hand, it is highly desirable, and indeed essential in the interests of grass land development in the Empire, that work should be undertaken on those species of herbage plants which are of great value to Australia, the drier portions of New Zealand, and South Africa—work which cannot be conducted at Aberystwyth, or, indeed, in any other part of the Empire, so well as it can be done in Australia, since the main problem is that of drought resistance.

A factor of great importance in the drier areas of Australia, New Zealand, and South Africa is the liability of vegetation to crucial periods created by prolonged dry weather, high temperature, low humidity, intense light, and drying winds. In temperate Australia these periods are normally manifest from November to April. A study of the vegetation induced under such conditions gives a reliable indication of the types of pasture plant most likely to succeed. Two distinct types of pasture plants are met with under these conditions—(1) perennial types, with well developed underground root stocks, e.g., Danthonia, Themeda, Stipa; (2) annual types, with early maturing and early seeding habits, which seed on or before the approach of dry weather, e.g., Festuca, Bromus, Hordoum, Erodium, and the annual clovers (cluster, subterranean, and burr clover).

The tiding over of crucial periods common to Southern Australia and the drier parts of New Zealand is due to what may be termed their drought resistance; this, in the case of perennials, may be merely the capacity to live through a period of relatively dry weather without adding materially to the herbage until the ensuing break of the season, or to the ability, e.g. in the case of perennial saltbushes (Atriplex and Kochia), to make use of ecologically ineffective rainfall (e.g., 15 inches or less) by means of leaf absorption; and at the same time they have been shown to possess a low transpiration rate, relatively independent of environmental conditions. In other cases, again, the root stock and base of the stem is covered with a protective sheath (e.g., Themeda). Finally, the early seeding habits of certain annual grass and small clovers ensure their appearance in the pastures in the following autumn with the first break in the weather.

There are many species of grass and clovers which would amply repay intensive investigation, but of outstanding importance is the large and extraordinarily valuable group of plants included in the genus Danthonia (Wallaby grass and its allies), which is common to Australia, New Zealand and South Africa, and in which species there has already developed a considerable seed trade.

This genus forms the bulk of the perennial grass throughout the natural pastures in the sheep and wheat belt of the Commonwealth, and investigations at the Waite Institute have shown that herbage forms are to be met with in every species. The Danthonias form very attractive material for investigation because of their recognised value as sheep- and wool-producing grasses, their great drought resistant character, the extraordinary range of variation of types within each species, and the fact that they are perennial, deep rooting pasture plants of the highest nutritive value for stock. Moreover, they are found not only in Australia but in New Zealand and South Africa, and have been cultivated in California. Other genera of economic importance are Themeda, which is common to Australia and South Africa (indeed, in South Africa Themeda is the dominant grass of the high veldt), Phalaris, several species of which are cultivated in Australia, and Lolium subulatum (the so-called Wimmera). Apart from these grasses the small annual clovers are of great potential value and may prove to be of the greatest importance to the development of semi-arid lands in the Empire.

There are no indigenous members of the Trifolium family in Australia, but the introduced annual clovers have done extraordinarily well, and subterranean, cluster clover, suckling clover, and burr clover (*medicago denticulata*) have been of extraordinary value in the drier areas for pasturage in association with indigenous grasses. The great value as pasturage of subterranean clover throughout Southern Australia is an indication of the possibilities which await the exploitation of the annual clovers in the drier portions of the Southern Hemisphere.

Material should be collected from all these countries where the various genera thrive and should be critically studied at some central institution located in the winter rainfall region, where adequate staff, equipment, laboratories and testing grounds are available.

The herbage plants of the Tropical Region would need to be investigated at some suitable central institution in Tropical Australia, and indeed the proposed Tropical Research Station in Northern Queensland would be a suitable locus for such work.

As regards the arid interior, for some years past Professor Osborn of Adelaide University has been engaged on an intensive study of the effects of grazing on the indigenous pastures at Koonamore (8 inch rainfall) and on the regeneration of the indigenous flora in typically arid country. The result of this valuable ecological work will have an important bearing on the effects of overstocking in arid areas and on the growth of fodder plants under low rainfall conditions. Similar work might well be done in the drier areas of the tropical zone in association with the proposed Tropical Research Station and at some convenient centre in New South Wales. The testing of various strains of European grasses and clovers developed at Aberystwyth might be undertaken at the experimental farms of the Departments of Agriculture in New South Wales, Victoria, Tasmania or Western Australia, in those portions of the country where climatic conditions are specially favourable to these species.

The suggestions in the above section may be summarised as follows :—

1. It appears undesirable to establish in Australia at present a herbage breeding station to deal with those species of herbage plants which are receiving attention at Aberystwyth, namely, Cocksfoot, Rye Grass, Timothy, Red and White Clover. The fullest facilities should be provided, however, by the Commonwealth to test thoroughly the various strains of herbage plants developed at Aberystwyth to determine their suitability for Australian conditions.

2. It is highly desirable from an Imperial point of view to establish in the Commonwealth a station to deal primarily with native and introduced grasses and clovers of value to the semi-arid regions of the Empire. At such a station ecological, agrostological and herbage breeding work would be conducted for the temperate semi-arid region (10 to 25 inches rainfall), which supports almost the whole of the sheep and a considerable number of the cattle of Australia.

When the Tropical Research Station in Northern Queensland develops, the ecological and agrostological work for tropical areas would be undertaken.

LAND SETTLEMENT (SCOTLAND).

A LITTLE over a year ago (in May 1927) the Secretary of State for Scotland appointed as a Committee Sir John Gordon Nairne, Bart. (*a*), Mr. J. R. Campbell (*b*), Mr. Joseph F. Duncan (*c*), Mr. Norman Reid (*d*), and Mr. John Speir (*e*), " to enquire into the settlement of small holders in Scotland under the Small Landholders and Land Settlement (Scotland) Acts, with a view to reporting upon the cost incurred by the State in carrying out such settlement; the value of the results achieved,

(*a*) A Director and lately Controller of the Bank of England.
(*b*) Late Assistant Secretary, Department of Agriculture and Technical Instruction (Ireland).
(*c*) Secretary of the Scottish Farm Servants' Union.
(*d*) Late Gaelic speaking Member of the Scottish Land Court.
(*e*) A tenant farmer and President of the Scottish National Farmers' Union.

both economic and social; the defects, if any, in the procedure under the said Acts, with suggestions for such amendments as the Committee may deem expedient; the desirability of devolving upon local authorities any of the powers and duties under the said Acts; and whether any amendment of the law is desirable as regards the valuation for rating of small holdings within the meaning of said Acts."

It will be observed that the question of the cost to the State was given priority in the terms of reference. That this aspect of the enquiry was prominently in the mind of the Secretary of State is clear from the observations he made in the House of Commons when the Vote of the Board of Agriculture for Scotland was under discussion in Committee of Supply on 9th May 1927. Speaking on land settlement he said: "I desire to have an enquiry into a problem which is admittedly a very difficult and complex one. I am aware, as the House is aware, of the figures given from time to time as to the cost of land settlement. I may be less ready in following or understanding figures than some honourable members, but my own personal feeling is that in the figures which are available to me I do not see in a clear and concrete form what the real cost has been. That being so, I trust the House will see in the selection of a Chairman who, whatever other qualities he may have, has a full knowledge of finance, the possibilities of dealing with this problem without bias."

The Committee set about their task with thoroughness. They decided to visit, in the first instance, a number of typical settlements, feeling, as they say, that "in the course of these visits we could ascertain more accurately and intimately than we could by formal examination of witnesses the views of the holders themselves on their achievements and prospects and on any difficulties with which they were faced." They visited 59 schemes of settlement, inspected 158 individual holdings, and on each holding interviewed the holder or a member of his family.

Recognising that the administration by the Board of Agriculture of the Land Settlement Acts had been the subject of public criticism, the Committee sought the views of representative agricultural and other public bodies; as well as of factors on estates affected by the Board's operations, of lawyers who had been engaged in cases of land settlement and had experience of the procedure under the Land Settlement Acts, and of the small holders themselves. The public bodies who appeared before the Committee included the Board of Agriculture for Scotland itself, the Ministry of Agriculture and Fisheries (England and Wales), the Scottish Land Court, the Forestry Commission, the Scottish Land and Property Federation, the Highland and Agricultural Society, the Scottish Chamber of Agriculture, the National Farmers' Union of Scotland, the Scottish Agricultural Organisation Society, the Association of County Councils in Scotland, the Free Church of Scotland and the United Free Church of Scotland.

The first section of the Committee's Report gives an adequate short history of the growth of the legislation affecting land settlement, and in an admirable summary brings out that the powers of the Board of Agriculture are derived from two distinct groups of legislation, viz. :—

(1) The Small Landholders (Scotland) Acts, 1886–1919 (embracing the Crofters Acts, the 1911 Act, and Part II of the 1919 Act), which authorises the Board to form new holdings and enlargements of existing holdings, by agreement or by statutory process, on properties which remain in private ownership.

(2) Part I of the Land Settlement (Scotland) Act, 1919, —read in conjunction with the Congested Districts (Scotland) Act, 1897, and the Small Holding Colonies Acts of 1916 and 1918,—which authorises the Board to acquire, by agreement or compulsorily, properties for subdivision into new holdings or enlargements of existing holdings.

Holders settled by the Board, whether on properties owned by private landlords or by the Board, are registered as landholders by the Scottish Land Court and receive the benefits secured to that class of tenants. In the main these benefits are :—

(1) Fixity of tenure, subject to conditions.

(2) The right to compensation for permanent improvements suitable to the holding, executed or paid for by the tenant or his predecessors in the same family.

(3) A fair—as distinct from a competitive—rent, and the right to a periodical revision of this by the Scottish Land Court.

Assistance is given, at the Board's discretion, to holders whether on their own or other estates, in any of the following forms :—

(1) Free grants towards fencing, roadmaking, installation of water supplies, &c.

(2) Loans to enable new holders to defray the cost of buildings.

(3) Loans in exceptional cases towards the cost of internal fencing or drainage works.

(4) Loans in the case of pastoral schemes in the north and west to enable a group of holders to take over sheep stocks to be worked on a co-operative system.

The extent of the Board's operations, from 1st April 1912 to 31st December 1927, is shown in Appendix No. I, which gives particulars of the 4,915 holdings and enlargements which have been constituted by the Board under the various statutes during that period.

The claim of the Secretary of State that by his appointment of Sir Gordon Nairne to the chairmanship of the Committee he had ensured a clear and concrete analysis of the costs of land settlement is fully justified by Section II of the Report. The Committee state the reasons why the cash accounts laid before Parliament, while adequate and accurate for the purpose designed, viz., to record the amounts actually received and paid in cash by the Board of Agriculture during each financial year, cannot in themselves give a clear view of the cost incurred by the State in carrying out the work of land settlement.

They decided that the closest estimate of such cost could be obtained only by making, scheme by scheme, an actuarial valuation as at a given date of the present or immediate value of the known and estimated payments and receipts expected to accrue in respect of the scheme. The Report details the facts on which this valuation of costs was based and the rate of interest employed in the calculations, and a summary of the results of the valuation is given as an Appendix (No. II) to the Report.

It is an interesting summary. It divides the operations of the Board into three periods of time :—

(1) From April 1912 to Martinmas 1918, that is to say, the period from the constitution of the Board up to the date of the Armistice;

(2) From Martinmas 1918 to Martinmas 1922, i.e. the period embracing the settlement of the ex-service men; and

(3) From Martinmas 1922 to 31st March 1927, which the Committee call the " current " period.

In the first period, which was concluded before the passing of the Land Settlement Act of 1919, settlement was made wholly on land owned by proprietors other than the Board of Agriculture, and the average cost per holding is found to be £153 in the crofting counties and £488 in other counties, with a general average for Scotland of £219.

In the second period (the ex-service period) the average cost of holdings on " private " estates was £151 in the crofting counties and £480 in other counties, figures very closely approximating those in the pre-war period. It would seem, therefore, that increased prices for building materials, fencing, labour, &c., were to an extent counterbalanced by savings in the procedure under the Act of 1919. The costs of holdings on the Board's own estates during this period were ascertained to be £519 per holding in crofting counties and £1,105 per holding in other counties. These figures, include, of course, the purchase price of the land, and, as the Committee point out, the buildings for the new holders were erected at the period of the " peak " prices for materials and labour. The general average cost for Scotland during this period was £484.

The third period shows what is virtually the cost of a small holding at the present time, viz., on estates in private ownership £198 per holding in the crofting counties and £531 per holding in the other counties of Scotland; and on the Board's own estates £431 per holding in the crofting counties and £634 per holding in the other counties.

The Committee further conclude that holdings of the various classes will continue to be made in much the same proportion as in this period, and the average cost throughout Scotland of a holding constituted by the Board is thus expected to be £360, the average in the crofting counties being £285 and in other counties £596.

This will probably be regarded by many people as a smaller sum than they had contemplated. Perhaps the explanation is to be found to some extent in the fact that the initial expenditure on land settlement schemes is necessarily greater than the actual cost, inasmuch as the initial expenditure is subject to reduction by subsequent receipts accruing as a consequence of such expenditure; perhaps also for reasons given in a paragraph of the Report which says :—

> "It may be desirable to make reference to a point upon which there appears to be some misapprehension in the public mind. The settlement of ex-service men during the years following the war was financed almost entirely by loans from the State through the agency of the Public Works Loan Commissioners, and, in fact, a sum of £2,158,185 was borrowed by the Board of Agriculture for Scotland for this purpose. While cognisant of this fact, the public see in the published Accounts of the Board that certain sums are voted to the Board annually under the name of loss in respect of land settlement schemes, and it appears to be assumed by many that this annual loss falls to be added to the original expenditure met from borrowed moneys in order to arrive at the total cost of land settlement. This is not so. Actually the borrowings are being repaid in full to the State, through the Public Works Loan Commissioners, by annual instalments with interest at the rate ruling for Government borrowing at the time when advances were made to the Board by the Commissioners, but, as the returns or receipts from the estates are not sufficient to meet the whole of these instalments, a sum to make up the difference is required to be voted annually. The sums thus provided annually represent the amount by which the receipts fail to meet in full repayment of capital and interest in respect of amounts advanced by the State for initial expenditure. In point of fact, as the original borrowings are being so repaid, the only sum the taxpayer is out of pocket to date in respect of schemes financed *in this way* is the total of the amounts so far provided annually to make up the shortage of receipts above mentioned. The sum of the amounts so provided in respect of the period from 1st April 1919 to 31st March 1927 was £494,330, 18*s*. 2*d*."

In discussing the economic and social results achieved by land settlement operations the Committee are less conclusive in regard to the Lowland counties than to the Highland areas. In their view " there can be no difference of opinion as to the social results of the work . . . in the Highlands." . . . "The prospects of all these crofters are greatly improved as a result of the settlement policy. Since the first Crofters Act was passed there has been a complete revolution in the housing conditions of practically all the Highland areas"; and the only doubt they express is whether, if there is a change in the outlook of the younger people, the holdings may not become more and more homesteads for the older people rather than nurseries for the young.

In the Lowland areas they are less sure of the success of the policy, and generally speaking they found that the holders were satisfied if in a good year they could show a return which, after allowing for interest on capital and depreciation, equalled the wages to be earned in farm employment.

The Committee could not record any measure of increased production on small holdings where the methods employed were similar in character to those employed before the farm was broken up, though they were satisfied that increased production could be obtained on the smaller holdings where the holder devoted himself to the intensive cultivation of fruit and vegetables or to pig and poultry keeping and small dairying. Any increase in the hours of labour required from a small holder and his family they found to be readily undertaken, and set off by the feeling that they were "their own masters" and immune from any necessity of changing their home.

In regard to changes of procedure, the main recommendation involving legislation which the Committee make is that the settlement of landholders on estates in private ownership under the tenure of the Landholders Acts should cease in the Lowland counties, and that a new class of agricultural tenants should be formed on properties to be purchased by the Board of Agriculture. They advocate the settlement of new tenants on the ordinary conditions of tenancy as prescribed by the Agricultural Holdings Acts, save that these tenants should have a right to have their rents revised by the Land Court at the end of every quinquennial or septennial period of their tenancy, and also that questions of compensation for improvements at outgo and other matters which in the case of agricultural tenants are normally determined by arbitration under the Agricultural Holdings Act of 1923 should be made a matter of reference to the Land Court for settlement.

Another recommendation of some importance which would also necessitate amending legislation concerns the position of the landlord and his tenant under the Landholders Acts when holdings fall vacant through failure of succession. It was represented to the Committee in evidence that in the cases where an outgoing holder had obtained a loan from the Board of Agriculture for the purpose of executing permanent improvements (e.g. erecting buildings) it would be proper to continue such loan to the new holder other than a statutory successor who succeeded him. The Board represented, however, that this procedure is not in accordance with the regulating statutes. The claim of the outgoing tenant for compensation is a debt due by the landlord, and the balance of the loan due to the Board by the outgoing tenant is a charge on the payment due by the landlord. The Board can go no farther than allow this balance to be deemed a loan to the landlord.

The Committee feel that, in the circumstances, the present procedure may make it difficult to secure a new holder, and they recommend that, if it can be effected, without diminishing the Board's security for their loan, they should be empowered, at discretion, to lend to an incoming tenant a sum of money equivalent to the outstanding balance of their loan to the outgoing tenant.

On the question of the small holder's liability for local rates and his present exemption from assessments on his buildings and other permanent improvements, the Committee fall into line with the Report of the Dunedin Committee of 1922. In their view the holder should be required to pay rates as occupier on such buildings and other improvements on his holding as are at present exempt from rating. This recommendation will, however, fall to be considered by the Government in the light of the statement made by the Chancellor of the Exchequer in introducing his Budget, in the course of which he announced the intention of the Government to relieve agricultural lands of all rates—leaving only the dwelling-houses of agricultural occupiers subject to assessment.

The Committee do not consider it desirable that any of the powers and duties falling to the Board of Agriculture under the Landholders and Land Settlement Acts should be devolved upon local authorities in Scotland. The evidence submitted to them was almost unanimously against any such devolution. The fear that a share in the cost of land settlement might fall to the local authorities along with the responsibilities may have weighed with witnesses in coming to this opinion; but it is also apparent from the Report that administration by a central department is generally regarded as preferable to administration by local authorities in Scotland,—where land settlement is a matter of very general interest and a problem of great national importance.

THE CROFTING PROBLEM, 1780-1883.

MARGARET M. LEIGH, M.A.

IV.—THE SIZE OF THE ECONOMIC HOLDING.

It has been seen that the crofting question, reduced to its simplest terms, is the problem of too many people on too little land; and inevitably there follows the discussion of the size of the economic holding, so common in the literature of small cultivation. How much, or rather how little, land is required to support a family of average size in decent comfort, assuming that the crofter would spend his whole time upon the holding without subsidiary occupations? It is of course impossible to set any uniform theoretical limit; the amount of land required varies with the quality of the soil, the kind of crops grown and live stock raised, and the capacity and resources of the holder. Where hill ground is included the total acreage is necessarily large, and the proportion of pasture to arable very high. On hill farms it is the custom to reckon size by the amount of stock carried.

It will be interesting to take some estimates made at various periods from the middle of the eighteenth century to the present day of the amount of land required to support a crofting family throughout the year.

In 1776 the Duke of Argyll abolished runrig on his estates, and reorganised them on the basis of larger holdings. It was recommended that the minimum croft should consist of "four mail land." The size was calculated on the number of stock carried, for one mail comprised four soums, and a soum was the grass of one cow, or two two-year-olds, or five sheep, so that the stocking in cows alone would be 16, or in sheep alone 80.[1] Nothing is said about the proportion of arable.

In 1798 John Smith published his Agricultural Survey of Argyllshire, which contains an estimate of the ideal size for a small Highland farm. The figures for arable land seem on the high side, but it must be remembered that at this period large sheep-farming was attacked because it was thought to cause wholesale depopulation, rather than the overcrowding of certain limited areas. "Of sheep-farms," he says, "on lands consisting almost altogether of pasturage, perhaps the most common size should be as much as one person could well manage, which is generally supposed to be as much as would maintain 600 sheep. In determining the proper size of arable farms, that which seems to promise best for the improvement of the country and the increase of population is that the farm should be as much as the farmer, with one servant and one plough, can easily manage and properly cultivate. This cannot be much where, as with us, the lands are in such bad order, and the fields small, detached and distant. It may be in general from 30 to 45 acres of arable land, with whatever pasture may happen to be connected with it. The pasture may be sometimes more and sometimes less, but taking the average proportion of the county, one-thirteenth being arable, it will allow from 400–600, or at an average 500 acres to a farm. In most parts this much may be managed by the farmer and his family. . . . When any family is large enough to manage more, every farm has abundance of waste or improveable land to keep them sufficiently occupied" (pp. 29–30).

In 1883 the Crofters' Commission made exhaustive enquiries on this subject,[2] taking as their definition of an economic holding

[1] Crofts and Farms, p. 9.

[2] Report of Commissioners, 1883. All subsequent references to this Report are to the edition by R. H. Macdonald, The Crofter Bill and Report of the Crofter Commission (Aberdeen, 1885).

the statement of Malcolm MacInnes, a crofter of Tighary, North Uist: "The very thing we want is to live as farmers on a farm where we could make a living out of our crofts by our own labour." Evidence taken from large numbers of persons interviewed locally gave the following results:—

District.	*Cows.*	*Sheep.*	*Arable.*
Skye	4–5	50–100	Enough to supply family with food.
The Uists ...	6	40–50	Do.
Lewis ...	6–10 (cattle)	40–50	6–10 acres.

There is no material differences in these figures. Taking the usual souming, the figures, reduced to sheep units, are: Skye, 70–125; Uists, 90–100; Lewis, 70–100. The average is 92½. On the type of pasture to be found in these districts, 3–5 acres of grazing is required per sheep, or an average of 4½ over the whole. At the lowest computation this would mean 277½ acres of pasture, or, including 9–10 acres of arable, 287 acres to each croft. In 1883 the average size of the family in Skye and the Long Island was 5·02. Hence over 57 acres a head were required, whereas the actual acreage available worked out at 19·43.

The Appendix to the Report contains memoranda by individual members of the Commission in which their personal views and recommendations are expressed. Donald Cameron Lochiel, M.P., considered that the minimum holding should consist of 12 acres arable, and grazing for six cows and followers and 200 sheep; the rent should not be less than £30. Sir Kenneth Mackenzie of Gairloch thought these figures on the small side. In his view there should be enough arable to give half-time employment to a pair of ponies, while the minimum rent should be £15 in the islands and £50 on the mainland.

Coming down to recent times, the Interim Report of 1919 on the economics of small holdings (p. 36), issued by the Scottish Board of Agriculture, contains a calculation of the number of live stock to be carried by a crofter holding averaging 33 acres of enclosed land. To arrive at these figures 122 holdings were examined. They were as follows:—

Horses	2·54
Cows	3·95
Other cattle	4·88
Sheep	32·39
Sows	0·18
Other pigs	1·06

The holdings are in the statutory crofting counties—Inverness, Ross, Sutherland, Caithness, Orkney and Shetland. But in the islands very few crofts approximate to this size. Thus in

Skye,	only	16	out of	2,134	crofts are above 30 acres.
Harris,	,,	2	,,	4,185	,, ,, ,,
North Uist,	,,	32	,,	481	,, ,, ,,
South Uist with Barra and Benbecula	,,	115	,,	1,480	,, ,, ,,
Lewis,	only	9	out of	3,138	crofts are above 30 acres.
Mull and Tiree,	,,	61	,,	469	,, ,, ,,

V.—SUBSIDIARY OCCUPATIONS.

The Manufacture of Kelp.—During the short period of its prosperity the manufacture of kelp was the main source of revenue to the proprietors of coast or island estates and of wages to large numbers of small tenants. In many places the value of the kelp shores was greater than the total rental of the property. The money earned at this business exceeded any profit that a small crofter could hope to make out of his holding, and served to maintain a large class of landless cottars and squatters who, when the trade ceased, became a useless burden on the community. According to one writer, in 1828 50,000 people were thrown out of work by the failure of the industry.[1] Some figures given in the Statistical Account[2] show to what extent small tenants in the Outer Isles were dependent for a livelihood upon their earnings as kelpers. A tenant of halfpenny land has a stock of six cattle—three milk cows and three calves. Of these calves, one may be assumed to have died soon after birth for want of milk, and the second to have been killed in order to allow its mother to join the first cow in suckling the survivor. Thus there is but the third cow for sale, which may realise about £2, 8*s*. The crofter's annual income is therefore :—

From sale of cow	£2	8	0
From making kelp	6	0	0
	£8	8	0

For the carting of kelp he must keep six horses, of which one must be replaced every second year, and he probably has to buy one boll of meal at 17*s*. His expenditure may be stated thus :—

Rent	£5	4	0
Replacement of horses	1	15	0
Meal	0	17	0
Total ...	£7	16	0

The balance is only 12*s*. Without his wages as a kelper he could not have paid his rent, even if he had substituted cattle for horses and cultivated his land with the caschrom.

In Barra[3] wages of £1, 10*s*. to £2, 2*s*. a ton were paid for kelp made on the proprietor's shores; on tenant's own land, £2, 12*s*. 6*d*.

The kelp industry was introduced into Uist from Ireland in 1734. During the American War of Independence it fetched £8, 12*s*. a ton, but soon fell in price owing to the competition of foreign barilla and potash. But when the French war checked foreign imports kelp-making again became profitable, for the potash and soda it contained was largely used in the manufacture of soap and glass. In 1806 the price rose to £16 a ton, and

[1] Dalriad, The Crofter in History, p. 88. [2] XIII, p. 311 (1794).
[3] Statistical Account, xiii, p. 331 (1794).

between 1808 and 1810 to £22. It required 20 tons of wet weed to produce one ton of dried, and the annual output of the Western Isles alone in raw material was reckoned as 12,000 tons.[1] Some statistics for the earlier period of the industry are given by Dr. Walker in an essay on kelp, written in 1788.[2]

He calculated that the Western Highlands and adjacent islands produced an annual total of 4,892 tons. He gives a table of prices as follows :—

1740–1760	£2, 5*s*.
1760–1770	4, 0*s*.
1770–1780	5, 0*s*.
1780–1790	6, 0*s*.

The cost of manufacture at the time of writing (1788) was from £1 to £1, 10*s*. a ton, so that even then the profits were large. The top price was reached between 1805 and 1810. After the peace, the renewed importation of foreign potash gradually killed the industry,[3] and attempts to revive it on a large scale were doomed to failure. Nor is this a matter for regret. Kelp-burning was in many ways a curse to the islands. It created in rural districts a large class of landless wage-earners, who depended upon a work lasting at the outside three months in the year, and were otherwise unemployed. High returns blinded the kelpers to the precariousness of their occupation; they recklessly multiplied their numbers, without realising that the very existence of the industry depended upon the absence of foreign competition. Nor was kelp-making a suitable part-time occupation for a man with land; it required the whole of his attention in June, July and August, to the neglect of agriculture. Moreover, a large number of ponies were required to cart the wet seaweed in creels from the shore to the kilns. These ponies had to be maintained in idleness for the rest of the year, consuming pasture that might have kept an equal number of productive cattle. Cottars and squatters had their horses also, which must pick up a living on other people's grazing. Thus in Tiree, when large quantities of kelp were made, there were (in 1793) 1,400 horses to 1,800 cattle,[4] while in Snizort (Skye), where the industry was less important, cattle numbered 2,537 and horses only 597.[5]

The extensive conversion of seaweed into kelp interfered with its use as the chief fertiliser of crops; and Macdonald [6] notes that agriculture was much more backward in a kelping district like Lewis than in Skye and Mull, where comparatively little was made.

[1] MacCulloch, Western Isles, vol. i, p. 120.
[2] Transactions of Highland and Agricultural Society, Col. I. (1799).
[3] By 1822 the manufacture of kelp had become unprofitable; in 1837 it fetched only £2 to £3 per ton. Report of Select Committee on Emigration, 1841, Appendix I.
[4] Statistical Account, x, p. 410.
[5] Ib., xviii, p. 184.
[6] Agricultural Survey of Hebrides, p. 142.

Spinning and Weaving.—Until comparatively recent times the West Highlands and Islands, like other remote and isolated districts, was a region of local, and largely of domestic, industries. Clothing, and practically all the necessities of daily life, were produced by local craftsmen or by members of the family. Some idea of the number of local craftsmen per head of the population at the end of the eighteenth century is given by figures in the Statistical Account of the Parish of Morven (Argyll).[1] Out of the total population of 1,764 there were :—

Weavers (male)	24
,, (female)	10
Tailors	15
Shoemakers	3
Joiners	4
Wheelwrights	2
Cowans (smiths)	8
Boatbuilders	2
Coopers	2
Millers	3

We can further assume that to keep 34 looms supplied with yarn large numbers of women must have been employed in spinning. Unfortunately we do not know whether cloth made in Morven was all used locally, nor whether some of it found purchasers elsewhere; and as a whole the Statistical Account, which might have contained a wealth of information about Highland industries, is on this subject almost entirely silent. The products of the handloom were not, as in Scotland to-day, confined to rough tweeds and homespuns; they included linen cloth, which, though coarser than the imported article, was considered good enough for the shirts of a Highland gentleman. Many farmers grew quantities of flax, for which the climate was not unsuitable; and this crop was from time to time encouraged by Government bounties.

During the eighteenth century, and especially in the years following the '45, the question of fostering local industries in the Highlands received much attention, perhaps more from the political than the social point of view. In 1753 a Government grant was given for the encouragement of linen manufacture. "This," says Bremner,[2] "was regarded as a judicious act, calculated to wean the turbulent Highlanders from their feudatory propensities, and to import a spirit of industry to them." The establishment of spinning schools goes back to a much earlier date. In 1727 the Board of Trustees for Manufactures allotted of sum of £150 to the foundation of these schools. Each school was to have an endowment of £10 a year, of which £5 was to supply the teacher's salary, £4, 1*s*. 8*d*. to purchase 14 wheels, 5*s*. for maintenance and repairs, 13*s*. 4*d*. for coals and candles for the session (October to April). "The spinning schools were

[1] Statistical Account, x, p. 270.
[2] Bremner, Industries of Scotland, p. 218.

situated chiefly in the Highlands, as the trustees considered it highly desirable to create habits of industry in those regions where poverty and indolence reigned supreme."[1]

Some information about the condition of these spinning schools at the end of the eighteenth century can be gathered from the Statistical Account. In the parish of Barvas (Lewis) there were two, under the patronage of Mrs. Mackenzie of Seaforth. The teacher received a salary of £6; the girls were taught free, and were paid 10*d.* for each spindle of yarn. Wheels were supplied at a low rate, and many of the poorer pupils had them for nothing. They were allowed 2 lbs. of coarse lint for themselves to begin with.[2] There was also a school in the parish of Lochs (Lewis). Here the S.P.C.K. paid part of the teacher's salary, with a view to " directing the industry of the female inhabitants to the useful and rational occupation of spinning flax." Several Aberdeen merchants sent a quantity of flax every year to a trustee in Stornoway, who distributed it to all parts of the island.[3] About the year 1790 an attempt was made to introduce the linen manufacture into Shetland, but without success, for the people did not take kindly to it. " The fair sex were so accustomed to roam about the rocks that they could not apply themselves with diligence to the manufacturing business, and the constant sitting was said to have brought on hysterical disorders."[4] By the close of the century the schools seem to have accomplished their work, for in 1800 the Board of Manufactures refused an application from Sir John Sinclair to have them established in Caithness, on the ground that spinning was so generally known and easily acquired that no special teaching was necessary.[5]

On handloom weaving there is little information to be had. The earlier promoters of Highland industries seem not to have attempted the organisation and improvement of weaving as a domestic craft, though individual production and co-operative sale is the only economic means of encouraging industry among scattered populations remote from markets, and has since been successfully practised in Ireland under the auspices of the Congested Districts Board. In the late eighteenth and early nineteenth century the chief idea of Highland reformers was to induce the people to concentrate in towns and villages, where the manufacture of woollen and linen goods could be established. Attempts were made to start factories on the Lowland model, but the condition of the country and habits of the people were so unsuited to organised industry that the mills could not pay their way and were soon abandoned. The difficulties are sufficiently obvious. In very few places, perhaps only in Fort William, Stornoway and Oban, was the population sufficient to staff a factory large enough to make the use of machinery a paying proposition, nor was it easy at a moment's notice to turn a body of crofters living on their scattered holdings into a

[1] Bremner, Industries of Scotland, p 217. [2] Statistical Account, xix, p. 269.
[3] Ib., xix, p. 276. [4] Quoted in Bremner, p. 224. [5] Ib., p. 219.

compact gang of landless industrial workers. The Highlanders, whose traditional mode of life had brought them little of the regular industry and manual dexterity required in the factory, made poor mill-hands; it is often remarked that those who were forced to seek employment in industry were kept exclusively in unskilled work.[1]

A few details of some of these industrial experiments are given in the Statistical Account. In 1776 the Duke of Argyll founded a woollen factory at Inveraray.[2] He provided machinery and buildings and let the site at a very low rent. He himself took shares in the concern, and many gentlemen advanced money to the manufacturers at 2½ per cent. In spite of this encouragement the business was not conducted with advantage. The chief difficulty was said to be the lack of spinners, and this was attributed to the employment of women in peat stacking and carrying.

A linen factory was established by the Board of Trustees for Fisheries and Manufactures at their fishing settlement of Ullapool in Lochbroom, but it was soon given up,[3] and the same fate overtook the factory in Lochcarron called New Kelso.[4]

About 1790 a still more ambitious scheme was set on foot. Mr. Dempster, a Sutherland landowner, persuaded a group of Glasgow capitalists to form a company for the establishment of a factory on his estate. The site chosen had a harbour on the Dornoch Firth and lay in the midst of a populous district. No money or pains were spared to make the undertaking a success, and a large number of hands were employed in the spinning and weaving of cotton. But in spite of the low cost of labour it proved to be a uniformly unprofitable business. "With the utmost exertion on the part of the managers, they could never succeed in producing the amount of work which is generally expected in other manufactories from the same machinery and number of hands." By 1797 the original capital advanced was entirely exhausted, and most of the partners withdrew. The two leading spirits, Dale and Mackintosh, struggled on for another seven years, but in the end were forced to wind up the business, after having suffered considerable loss.[5] The history of "Spinningdale," as the place was called, is instructive, because not only was the capital adequate, but the managers were men of tried business ability, so that the failure can only be ascribed to the unsuitability of the Highlands for industrial development.

[1] Selkirk, Observations on the Present State of the Highlands (1806), p. 88. See also Appendix K. Mr. Dugald Bannatyne, a mill-owner of Rothesay, wrote to the Earl of Selkirk: "We have at different times, when wanting hands, recruited from the Isle of Mull, but we scarcely ever derived benefit except from the children, the grown-up people (for want of early associations, I suppose) seeming to be almost without a capacity of acquiring dexterity in the very common operations."

[2] Statistical Account, v, p. 298.

[3] Ib., x, p. 467.

[4] Ib., xiii, p. 558. By 1794 the linen factory was no more than a memory. It has now become a private house, but still bears the same name.

[5] Selkirk, Observations, Appendix K.

Fisheries.

(a) *At the end of the Eighteenth Century.*—In the seventeenth and early eighteenth centuries the Scottish fisheries had been in a flourishing condition, but later their prosperity declined, until it was thought necessary to bolster them up with Government aid. The causes of this decline were various. The unsettled state of the country, wars and political agitation, were all unfavourable to the development of industry of any kind. It was alleged that the forfeiture of small estates had removed many persons interested in the fisheries, while the profits of smuggling had tempted away the most enterprising[1] spirits. Many others had joined the Highland regiments or the Navy, while "the fever for emigration" had further reduced the numbers of potential fishermen. The salt duties made fish-curing unduly expensive and the distance of the west coast fishing grounds from markets prevented any extensive sale of fresh fish.

Cod and Ling Fisheries.—Besides these general disadvantages, there were difficulties of a more special kind. In the cod and ling fishery Scotland had lost the Spanish and Mediterranean trade to Newfoundland, whence the fish, though of inferior quality, could be put on the market more cheaply. The Scottish boats were small and undecked, and therefore unfit for deep-water fishing. There were no facilities for salting the cod on board; the day's catch had to be landed each night or the fish spoilt by being left in the bilge water. As a rule the boat was the joint property of the crew, and the catch was divided among them in equal shares. To remedy these defects it was suggested[2] that decked sloops or smacks of about 20 tons burthen, as used by the Dutch and English fishermen, should be substituted. Such boats should be the property of a man with capital, who was to engage a master and crew to run it; the owner was to claim half the catch, and the other half should go to the master and crew in proportionate shares.

Herring.—The earlier herring fisheries were mostly on the east coast, but when herring became scarcer in these seas the west coast fishing grounds increased in importance. About the middle of the eighteenth century large Government bounties were given to encourage the industry. This policy did not have quite the expected result, for only a very small proportion of the fish were caught by Highland fishermen, largely because they were unable to provide themselves with boats and tackle. Men of capital from the Clyde district fitted up heavier boats, which, like the modern steam trawlers, monopolised the best grounds and spoilt the fishing for the natives. The vessels lay at anchor, and the actual fishing was done from small rowing boats. No regard was paid to close seasons, and no care was taken not to disturb the herring; "an irregular and turbulent manner of

[1] Essay on Scottish Fisheries by Mr. Melville, of Ullapool, in Transactions of Highland and Agricultural Society, vol. ii.
[2] Ibid.

fishing," which resulted in the taking of far too many small fry and the frightening away of much valuable fish.

The want of adequate harbours was then, as a hundred years later, one of the main obstacles to the development of the fishing industry. To remedy this the Society for British Fisheries built harbours and laid out villages at Tobermory, Stein, Shieldaig and Ullapool. But none of them flourished. At the end of the century one of the Highland Society's prize essayists remarks[1] :— "It was with regret that I learnt in one of the villages erected by the Society for British Fisheries that neither boat, nor line, nor hook belonged to any person in that village, and that no individual among them either fished occasionally or made a regular business of fishing. The people lived by cultivating small patches of land in the ancient and confused mode of runrig. From all I could learn of the other villages erected by the Society, I was led to conclude that the character here given was applicable to the whole." A century later all these foundations had fallen into decay except Tobermory, which had become a tourist and yachting centre, where fishing had little importance. In 1885 Ullapool was tumbling into ruins; there was no seaworthy boat in the place, and the houses were used to accommodate 378 paupers of the parish of Lochbroom at the cost of £1,677 per annum.[2]

The failure of these villages was attributed to the fact that each house had a small plot of land, which distracted the fisherman's attention from the sea, and eventually turned him into a crofter who depended upon fishing only to supplement his living from the land. "These patches of land," says the Earl of Selkirk, "though they afford but a miserable subsistence, are yet a sufficient resource for men whose rooted habits require the stimulus of absolute necessity to bring them to a life of regular and persevering industry." The incompatibility of fishing with farming is well brought out by Melville : "No two occupations can be more incompatible than farming and fishing, as the seasons which require undivided exertion in fishing are precisely those in which the greatest attention should be devoted to agriculture. Grazing, which is less incompatible with fishing than agriculture, is even found to distract the attention and prevent success in either occupation. This is demonstrated by the very indifferent success of those who devote themselves exclusively to fishing. Indeed, the industrious fisher finds the whole season barely sufficient for the labours of his proper occupation. From the middle of spring the fishing season continues frequently till after Christmas, and the intervening space is barely sufficient for refitting nets, lines and fishing tackle. But the population of

[1] Rev. James Headrick, Improvements in Highlands, Transactions of Highland and Agricultural Society, vol. ii, p. 453. See also Selkirk, Observations, p. 103. "The villages of Tobermory and Steen, on which very large sums of money have been expended, are scarcely possessed of a fishing boat: their inhabitants are sunk in inactivity, and consist in general of the refuse of the population of the country."

[2] R. H. Macdonald, Letter to the Lord Advocate on the Emigration of Highland Crofters (1885), p. 38.

the Highlands is sufficient to admit of the professions being separated, which only injure each other when conjoined."[1]

There is little doubt that the inability of the Highland fishermen to provide themselves with proper boats and tackle, and to use them co-operatively to advantage, was a very serious difficulty, which still existed at the time of the Crofters' Commission. A few enlightened proprietors tried to solve this problem, and Selkirk gives an account of an interesting experiment made on Loch Fyne by Maclachlan. He took ten or twelve picked families and settled them on the shore, where he provided them with two substantial fishing boats with tackle, on condition that the cost should be repaid out of the profits of their industry. A season or two of successful fishing made them the owners of their boats. Land was given to them for a year or two at a low rent, which was gradually raised to its full value, so that the tenants were obliged to fish to satisfy their landlord. Other inhabitants were brought to the village and the original lots sub-divided, so that agriculture became entirely subordinate to fishing. In due time, when a market for provisions should be established, the owner hoped to deprive them of land altogether. "The success of the first fishermen has been such that they have fitted out a number of additional boats of the best construction at their own charge, and several of them have accumulated considerable sums of money."[2]

(b) *In the last half of the Nineteenth Century.*—In the course of the nineteenth century the improvement of communications and the means of transport had given much encouragement to the Scottish fisheries. Markets had become more accessible, while an improved type of boat made it possible to fish the deep-sea grounds with less risk and less dependence on the weather. In 1883 the Crofters' Commission found that by far the greater number of crofters and cottars were wholly or largely dependent for their living upon their earnings as fishermen, and gained a larger annual income from the sea than from the land.[3] But in spite of this the fishermen of the north-west suffered from many of the old disadvantages. Their boats were small and unseaworthy, existing harbours and piers were inadequate, while the West Highlands and Islands had little share in the advantages of railway and telegraphic services.

The new type of boat used on the east coast for the herring fishing was wholly decked, of 25 to 30 tons burthen, and when completely equipped cost about £200 to £250. The ownership of such boats was beyond the means of crofter fishermen. They usually worked as hired hands, first on the Stornoway and Barra grounds from the middle of May till the end of June, and then moved to the east coast, where they were employed from mid-July till mid-September. Many Lewis men still went to sea in small boats, at great risk on a harbourless and stormy coast; the chamberlain of the estate reckoned that in the 35 years preceding

[1] Transactions of Highland and Agricultural Society, vol. ii, p. 43.
[2] Selkirk, Observations, p. 105.
[3] Report, 179.

the Commission, 293 Lewis fishermen had been drowned.[1] For the cod and ling fishery smaller boats were used. They were often the property of fish-curers, who hired them out to the fishermen, generally on condition that all fish was sold to the owner and all stores and equipment bought from him. In other cases the boat and tackle remained in the owner's possession until the crew were able to pay the purchase money out of the profits of their fishing; in the meantime they paid interest to the owner and agreed to sell him their fish at a price fixed beforehand. This system had its advantages, as it enabled fishermen without capital to acquire their boat by gradual stages, but the compulsory disposal of fish was a heavy price to pay for the privilege. The Commissioners, while not altogether condemning these voluntary contracts, believed free sale to be essential, and proposed that money should be advanced to *bona fide* fishing crews under certain safeguarding conditions; the boat, fully insured, was to be considered sufficient security.

Though the west coast is as a whole well provided with natural harbours, there are long stretches of coast, especially in the islands and in the neighbourhood of good fishing grounds, where there is no place of refuge in stormy weather. In the Long Island, from Barra Head by the west to the northern end of North Uist, there is no harbour; the same is true of the northern coasts of Lewis, from Carloway in the west to Stornoway in the east. Nor was there at that time any shelter at Tiree. After the failure of the British Fishery Society's attempts in the previous century, there was some hesitation in recommending the use of public funds for the making of harbours, though it was shown that several of the older settlements had been unsuitably placed. The Commissioners proposed that public money should be spent only on works which were likely to be permanently useful to the fishing industry in general; otherwise local improvements should be made by proprietors or traders whose interests were concerned. Where harbours were constructed, provision should be made for fishermen's houses and gardens. In connection with this proposal the old question of the effect of combining fishing with farming was once more discussed. Evidence taken from outsiders was mostly in favour of separating the two callings, while those engaged in either preferred to keep them combined. The Commissioners came to the conclusion that in the past the lack of properly equipped boats and harbours had forced men who would otherwise have given their whole time to fishing to try and supplement their earnings by cultivating the land; and that conversely, crofters with inadequate holdings turned to fishing to recoup themselves for the losses of a bad season. They believed, with a rather vague optimism, that the provision of better boats and harbours, and the removal of the surplus population overseas, would produce a smaller number of more efficient fishermen.

Communications, though greatly improved, were still in-

[1] Report, 202.

adequate on the seaboard of Ross and Sutherland and in the outer islands, and remained a serious obstacle to the development of the west coast fisheries. The mail service to the outer isles went by a circuitous route across Skye to Dunvegan, and thence by sailing packet. According to evidence given by traders, letters might take up to six days and telegrams up to three days to reach their destination.[1] The terminus of the Dingwall and Skye railway was at Strome Ferry, while great tracts of country in the north-west were without railways, and many crofting settlements without roads. In some cases fish had to be carted many miles on ponies' backs. The inadequacy of the telegraphic service was a serious thing for the fisheries. Continental markets might be missed, and fish sold at a lower price; it might be impossible to deal with an unexpectedly large catch, because additional stores could not be procured in a hurry.

It will thus be seen that fishing, though largely practised by the crofters as a subsidiary and sometimes as a whole-time industry, could not be depended upon to provide a living for all those who needed a supplement to, or a substitute for, an economic holding.

AN ACIDITY SURVEY OF THE SOILS OF TWO PARISHES IN BERWICKSHIRE.

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In connection with the agricultural survey of certain parishes in the south of Scotland carried out by the Board of Agriculture during 1927, an examination of the soils of two of these parishes has been made, particularly to determine the extent of the areas having an acid reaction and the degree of this acidity.

It was thought at first that an examination in the field by means of a colour test for acidity would be sufficient, but later, on account of the interesting results and striking differences obtained, it was decided to make a more thorough investigation. Every field in both parishes was therefore sampled, and where differences were apparent in a single field more than one sample was taken. Each sample was made up of several borings taken to a depth of 9 inches by means of an auger, and in many cases the subsoil was also examined to a depth of 3 feet. The samples were tested for acidity in the laboratory, and the results are shown in the accompanying tables and diagrams. Data with regard to drainage and growth of crop—particularly the condition of pastures—were also collected.

Since a full account of the parishes has been given in the

[1] Report, 209.

agricultural report,[1] it will be sufficient here to mention merely that parish A lies in the fertile Merse of Berwick between the foothills of the Lammermoors and the River Tweed, whilst parish B extends well up the Lammermoors and is fairly typical of the upland districts of the Border Counties.

Geology and Soils.—The geological formation of parish A is the Calciferous Sandstone Series of the Lower Carboniferous, and this is covered with a thick blanket of glacial drift. Most of the drift consists of a heavy reddish boulder clay, which contains, besides sandstone fragments, numerous boulders of Silurian and other rocks. The resulting soil is decidedly heavy over most of the parish.

About half of parish B is on the Upper Old Red Sandstone and half on the Lower Silurian. The greater part of the Old Red Sandstone area is covered with glacial drift, mostly boulder clay, although there are also considerable areas of "sand and gravel." Most of the arable land and part of the uncultivated areas of the Silurian are also drift covered, but a large part of the hill land is free from drift or contains only a thin coating in the hollows.

Generally speaking the boulder clay of parish B is much more sandy than that of A, and the soils correspondingly lighter in texture. The soils of the driftless area in parish B are usually thin, stony, and covered with a layer of peat. The numerous hollows in this parish are often covered with thick peat.

Agriculture.—It is difficult to give a fair comparison of the parishes on account of the different systems of agriculture being followed, but to the most casual observer it is evident that parish A is much more fertile than B. As regards cereals and turnips, this impression is borne out by figures for normal yields per acre. A further indication of the differences between the parishes is given by a comparison of the rentals per acre and the percentage of arable land under crop.

	Parish A.	*Parish B.*
Yield of Oats per acre ...	6–8 qrs.	3–6 qrs.
Yield of Turnips per acre ...	25 tons.	18–20 tons.
Percentage of arable land under crop	75	42
Rental per acre	25*s.* to 65*s.*	12*s.* 6*d.* to 28*s.*

On account of the large area under grass in both parishes, particular attention has been paid to the condition of the pasture. Again a marked difference was at once observed between the parishes, the pasture of parish A being on the whole immensely superior to that of B. The chief differences were (1) the presence of a much greater proportion of broad-leaved grasses in parish A; (2) the frequent occurrence of bent grasses (especially *Agrostis alba*), Yorkshire Fog and Crested Dogstail in the pasture in parish B; (3) the much greater prevalence of moss and buttercups, and the apparently weaker condition of the clover in parish B.

[1] **Agricultural Survey of Four Parishes in the South of Scotland,** ***Scottish Journal of Agriculture,*** **xi, 33 (1928).**

These striking differences in pasture may to some extent be accounted for by the following :—

1. The system of farming in parish B necessitates a large area of pasture, and in consequence the farmers break up as little as possible every year, with the result that much of the pasture is five, six or more years old. In parish A, on the other hand, where more cropping is done, the pastures are not usually so old.

2. In parish B there is a tendency to over-graze the "new grass" at lambing time, and the grasses which chiefly suffer are the early broad-leaved types. Later in the season the tendency, on the other hand, is to under-graze, with the result that the less desirable bent and other grasses, which escaped the early heavy grazing, are able to seed and spread.

The above practices undoubtedly assist in bringing about the early deterioration or reversion of pastures which is so noticeable in parish B, and which, as was pointed out by local farmers, sometimes occurs two years after the pasture has been laid down. The field to field soil examination has, however, brought to light other factors—viz. acidity and bad drainage—which may have even more to do with the unsatisfactory condition of things.

Soil Acidity.—Preliminary work with a rapid field test showed that there were marked differences in acidity between the parishes, although they are only about 10 miles apart. It was decided, therefore, to measure the acidity more accurately in the laboratory.

Acidity is frequently expressed by what is called the pH notation.[1] This gives a measure of what might popularly be termed the "active" acidity. It may be regarded as a scale of acidity which ranges from about pH 3·5 for very acid soils to pH 9–10 for the most alkaline. A neutral condition is represented by pH 7, and investigations by the writers for a large number of soils from the south-east of Scotland have shown that the majority of agricultural soils in that area have a pH ranging from 5 to 6·5.

The question of the lime requirements of soils is certainly closely bound up with soil acidity, and for soils of the same type there is a fairly close correlation between pH values and lime requirements. It should be clearly understood, however, that acidity as measured by pH represents only one of several factors concerned in the lime requirement of a soil, and that although in general it may be assumed that the more acid the soil (the lower the pH) the greater will be its need for lime, fairly acid soils are frequently found which for most crops do not respond to liming. It may safely be assumed, however, that soils which are neutral or alkaline do not require lime, whilst extremely acid soils do, and that there is an intermediate group about which it is unsafe to dogmatise without further data, although their acidity

[1] The pH was determined as described by the writers in the *Journ. Agr. Science*, xviii, 131 (1928).

is a valuable clue. Additional information throwing further light on this intermediate group and useful in affording some guidance as to the amount of lime to be applied is given by estimations of what are known as the exchangeable bases[1] and by "lime requirement" methods such as that of Hutchinson and MacLennan.

The following table gives a general representation of the information given by the pH figures :—

TABLE I.

pH Value.	Description of Reaction.	Lime Requirement.[2]
7 and over	Alkaline.	None.
6·5–6·99	Slightly acid.	None for most crops.
6 –6·49	Fairly acid.	Lime necessary in some cases.
5·5–5·99	Acid.	Lime necessary in many cases.
5 –5·49	Strongly acid.	Lime necessary.
4·5–4·99	Very strongly acid.	Do.
4 –4·49	Abnormally acid.	Do.
3·5–3·99	Do.	Do.

(Amount of lime required depends to a great extent on crop to be grown.)

The acidity figures obtained for the two parishes may conveniently be arranged and compared on the above plan.

As has already been stated, the figures represent one or more samples from every field in the two parishes. The acreages were obtained from the 25-inch Ordnance Survey maps, and the results are expressed in number of acres of the various acidity groups.

In parish B only a limited number of samples were taken from the unenclosed hill land and from the bogs. It would be unfair to compare as a whole a parish of which a very large area has never been cultivated with a parish which is wholly under cultivation. Table II, therefore, compares only the land in the two parishes which is enclosed, and which has presumably at one time or another been tilled.

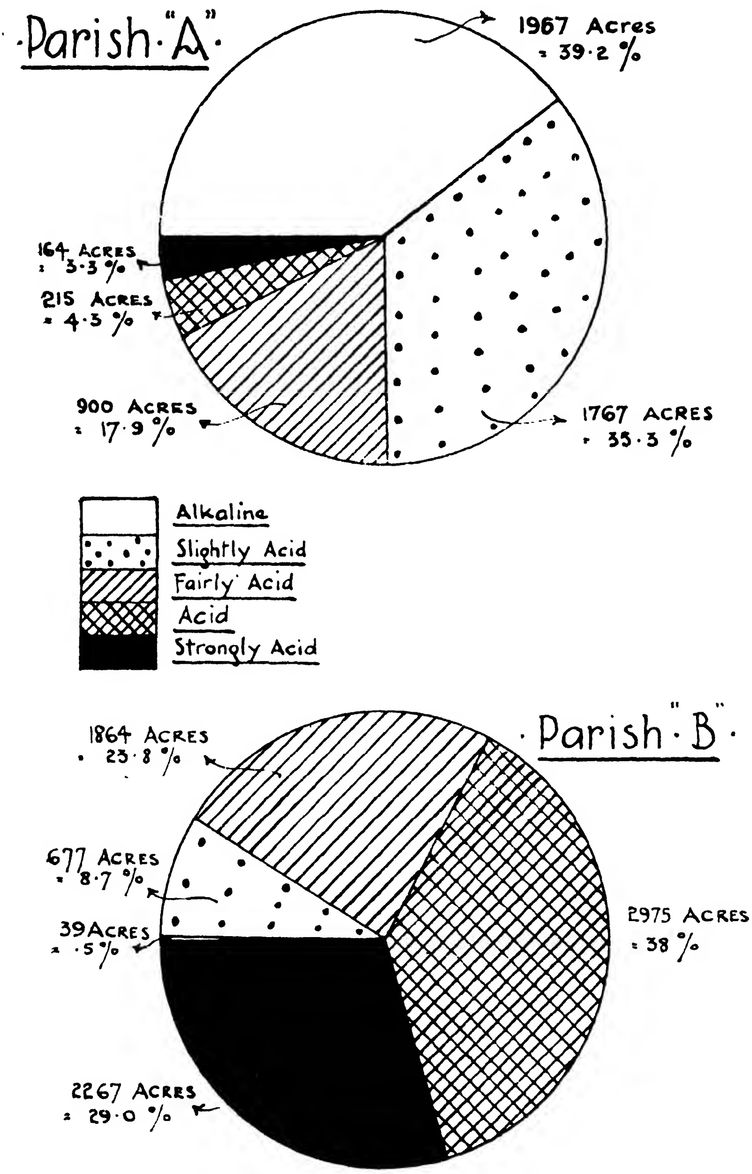
TABLE II.

pH.	Description of Reaction.	Parish A.		Parish B.	
		Acres.	Per cent. of Total.	Acres.	Per cent. of Total.
7·5 and over	Alkaline.	596	11·9	...	...
7 –7·49	Do.	1,371	27·3	39	0·5
6·5–6·99	Slightly acid.	1,767	35·3	677	8·7
6 –6·49	Fairly acid.	900	17·9	1,864	23·8
5·5–5·99	Acid.	215	4·3	2,975	38·0
5 –5·49	Strongly acid.	164	3·3	1,521	19·5
4·5–4·99	Very strongly acid.	...	...	437	5·6
4 –4·49	Abnormally acid.	...	...	235	3·0
3·5–3·99	Do.	...	...	74	0·9

The comparison is shown diagramatically in Figure I.

[1] See W. G. Ogg, *Scottish Journal of Agriculture*, ix. 20 (1926).
[2] Based on data given in *Journ. Agr. Science*, xviii, 131 (1928), and applying particularly to the S.E. of Scotland.

·Fig·1·



Comparison of enclosed land.

Of the 7,822 acres comprising the arable land and enclosed permanent pasture of parish B, only 0·5 per cent. was found to have an alkaline reaction; a further 8·7 per cent. was only slightly acid and probably does not suffer from lack of lime; another 23·8 per cent. consists of land the reaction of which might be described as fairly acid, but which is capable of supporting the crops usually grown in that district, although it is probable that in many cases liming would bring about an improvement; another large group, comprising about 38 per cent. of the total enclosed area, is still more acid than the last, but might also be classed as doubtful, although there is a strong probability that for many crops these soils would respond to liming. All the remaining soils—about 30 per cent. of the total enclosed area—are classed as very strongly acid and abnormally acid, and require lime.

In parish A, on the other hand, 39·2 per cent. of the total enclosed area is alkaline; 35 per cent. is only slightly acid, and as a rule does not require lime; 22·2 per cent. belongs to the two doubtful classes in which lime may or may not give a response; and only 3·3 per cent. is very strongly acid and definitely requires lime. More definite information on the intermediate groups (pH 5·5–6·49) will be obtained from determinations of exchangeable calcium and "lime requirement" at present being carried out.

Comparing the parishes—which are only about ten miles apart—it will be seen that there is a very marked difference. In parish A, 74·5 per cent. of the soils may be taken definitely as being sufficiently well supplied with lime for most crops, whilst in parish B only 9·2 per cent. of the soils are in that condition. At the other extreme, only 3·3 per cent. of the soils in parish A are very strongly acid and may safely be assumed to require lime, whilst in parish B there is 29 per cent. of these very strongly acid soils. The two indefinite groups amount to 22·2 per cent. in parish A and 61·8 per cent. in B.

Of the 3,000 acres of uncultivated land (chiefly hill grazings) in parish B it is estimated from the samples examined that over 95 per cent. has a pH of less than 5·5, and would consequently be grouped with the very strongly acid and abnormally acid soils. A great part of this land is in heather and covered with peat, having a pH of less than 4·5. Of twenty-four samples examined nineteen had a pH of less than 4 and the remaining five a pH of less than 5; six samples with sparse heather—probably once cultivated—had a pH ranging from 4·4 to 5·4. It is probable that some of this land would respond to very heavy liming, but at the present time it is scarcely a practical proposition and need not be considered. A few small areas of natural pasture on recent alluvium, e.g. along stream sides, are not very acid and have a much better vegetation.

It might be claimed that a comparison of the arable land and permanent pasture in the two parishes is not quite a fair one on account of the different systems of agriculture practised. In parish B the pasture remains down for a much longer time than in A, and some of the pasture has not been ploughed for well over 100 years. This old pasture requires improvement and is usually very acid, but some of it is back almost to uncultivated land.

To obtain a comparison of land which is more alike in treatment, the land which is under crop (cereals and roots but not hay) in the two parishes is shown in Table III.

TABLE III.

pH.	Description of Reaction.	Parish A.		Parish B.	
		Acres.	Per cent.	Acres.	Per cent.
7·5 and over	Alkaline.	252	11·1	...	...
7 -7·49	Do	668	29·6	2	0·1
6·5–6·99	Slightly acid.	1,095	48·3	350	19·1
6 -6·49	Fairly acid.	250	11 0	683	37·4
5·5–5·99	Acid.	...	...	665	36 4
5 -5·49	Strongly acid.	...	...	127	7·0

The results are also shown in Figure II.

There is the same marked contrast between the parishes. In parish A, 89 per cent. of these cropped soils contain sufficient lime for most crops, whilst in B only 19 per cent. fall within this class. At the other extreme none of the cropped soils of parish A definitely require lime and only 11 per cent. belong to the doubtful class, whilst in B, 7 per cent. require lime and 74 per cent. are doubtful, a considerable proportion probably requiring lime for certain crops.

In both parishes it will be seen that the percentage in the various acidity groups increases to a maximum and then falls again. The maximum in parish A is 6·5–6·99 and in parish B 5·5–5·99.

Table III and Figure II show that the land which was then (1927) under crop is much less acid than the land (arable and permanent pasture) of the parish as a whole. This is probably due partly to selection for cropping of the land which was originally more fertile, and partly to cultivation and practices such as liming associated with it.

It serves to emphasise that although a considerable area of arable land in parish B requires liming, it is the pasture land that is the more acid.

Acidity of subsoil material (at a depth of 3 feet).—An examination of the parent material of the soil is useful in throwing light on the origin of the soil, in giving some clues to the changes which have taken place, and in indicating methods of soil treatment. Pronounced weathering of the parent material often takes place to a much greater depth than 3 feet, but the material at that depth gives information of considerable practical value.

Of twelve samples examined from various parts of parish A, four were alkaline (pH 7 or over) at the surface, six were slightly acid (pH 6·5–6·99), and two were acid (pH 5·5–5·99). The material at 3 feet was, in every case, decidedly alkaline.

In parish B twenty-nine subsoils were examined to a depth of 3 feet, many of them from land which had never been cultivated. In every case the surface was acid, but in four cases the material below was alkaline, and in the majority of the remaining cases, although still acid, it was decidedly less acid than the surface.

TABLE IV.

pH.	Description of Acidity.	Parish A.				Parish B.			
		Surface.		3 ft. deep.		Surface.		3 ft. deep.	
		No. of Samples	Per cent.	No. of Samples.	Per cent.	No. of Samples.	Per cent.	No. of Samples.	Per cent.
7·5 and over	Alkaline.	...	...	9	75·0	...	...	3	10·3
7 –7·49	Do.	4	33·3	3	25·0	...	...	1	3·5
6·5–6·99	Slightly acid.	6	50·0	...	...	1	3·5	1	3·5
6 –6·49	Fairly acid.	...	...	...	...	7	24·1	2	6·9
5·5–5·99	Acid.	2	16·7	...	...	5	17·2	7	24·1
5 –5·49	Strongly acid.	...	...	...	...	3	10·3	4	13·8
4·5–4·99	Very strongly acid.	...	..	...	...	2	6·9	5	17·2
4 –4·49	Abnormally acid.	...	...	...	...	1	3·5	6	20·7
3·5–3·99	Do.	...	...	...	...	10	34·5	...	...

Comparison of the acidity of the parishes with that of the south-east of Scotland generally.—If a comparison be made between the soils of the two parishes and those of south-east Scotland as a whole, it will be found that the soils of parish B are rather more acid than would appear to be generally the case (from the results so far obtained) for the south-east of Scotland,[1] whilst the soils of parish A are very much more alkaline. There is a marked resemblance, however, between the results obtained for parish A and those for the East Saltoun district of East Lothian[1]—also apparently an abnormally alkaline district for Scotland.

Acidity results in relation to vegetation.—As already mentioned, general observations were made of the vegetation, especially the pastures, whilst the area was being sampled.

The general impression gained during the work has been stated already, viz., the greater fertility of parish A and the rapid reversion of pasture in parish B. There is a strong probability that the difference in acidity in the parishes is more than a coincidence.

An examination of the notes on the most acid soils in each parish shows some interesting features. In parish A the bulk of the most acid land (with a pH of less than 6) occurs in one place (neighbourhood of " X " House), and part of it consists of old policy fields which have not been ploughed for many years. The notes made on the pastures of these acid soils were chiefly

[1] Based on an examination of 681 samples—"The Reaction Exchangeable Calcium and Lime Requirement of Certain Scottish Soils." W. G. Ogg and W. T. Dow, *Journ. Agr. Science*, xviii, 181 (1928).

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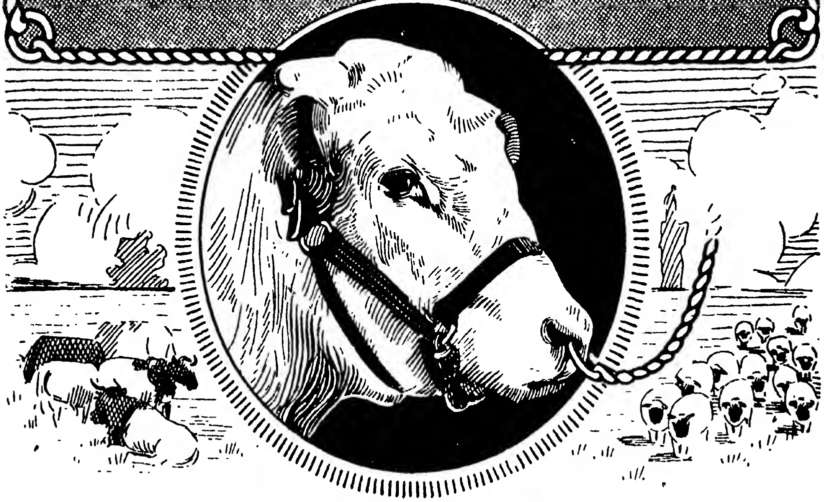

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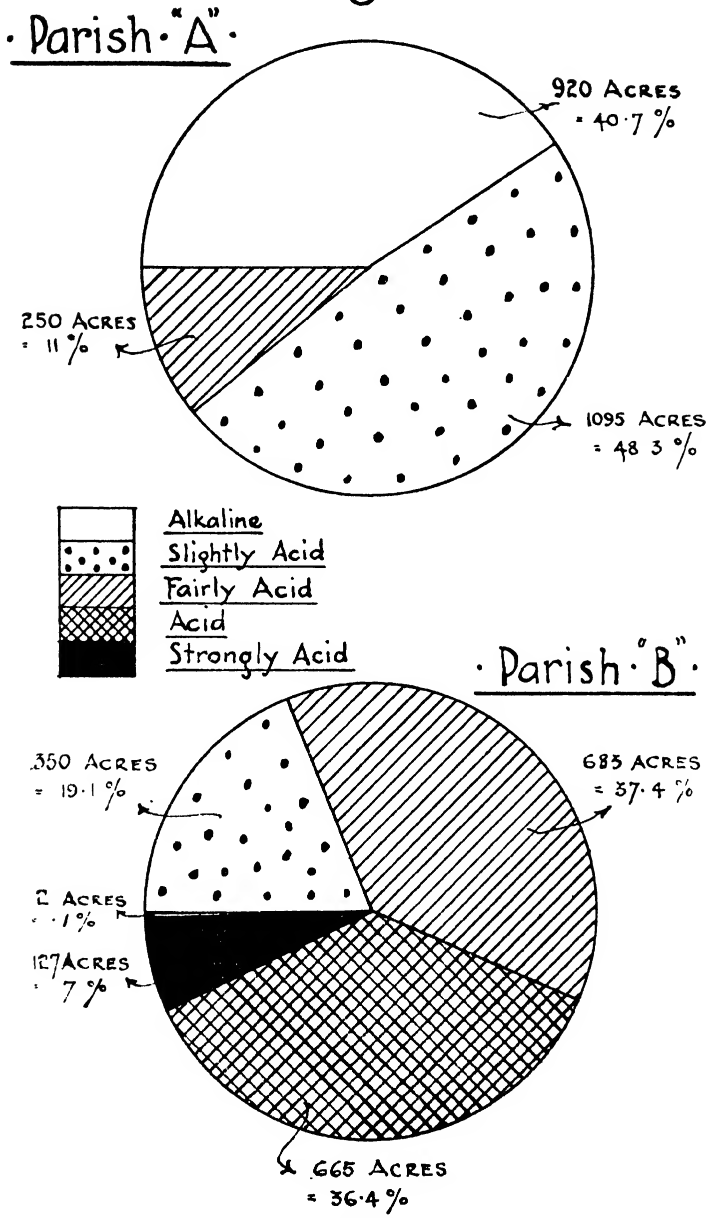
· Fig · 2 ·



Comparison of land under crop (excluding hay).

to the effect that clover was weak (though often abundant); that the pasture was rough and tufty; that in many cases the ground was wet and mossy, and that rushes, buttercups, Yorkshire Fog, Crested Dogstail and occasionally Agrostis were present. The pasture over the parish as a whole was very good, the poorer spots being usually associated with old pasture or bad drainage.

In parish B the most acid group of soils (pH below 4) usually was of a peaty character, and amongst the vegetation was noted heather (Calluna), bent and other undesirable grasses (Agrostis, Molinia, Nardus, Aira, &c.), and rushes. The next group—also abnormally acid (pH 4–4·49)—was usually peaty and the vegetation was similar to that in the last group, tufts of heather being found in some cases. Most of the land in these two groups was out of regular cultivation and had not been ploughed for many years. The next group—also abnormally acid (pH 4·5–4·99)—was slightly better, but consisted chiefly of poor pasture, often of a semi-natural type. In one or two cases the presence of clover, although very weak in growth, was noted, but many fields were without clover and were full of bent grass. The soil in some cases was dark and peaty, but in others was largely mineral, and where drainage was poor, rushes were present.

In none of these groups of soils was any cropping carried out, but in the next group (pH 5–5·49) a small area was in oats and turnips. The oats in one case were badly laid and the turnip crop was noted as "fair." In only four fields was the pasture described as good, and in over half the area it was noted as unsatisfactory on account of the absence or weakness of clover, the presence of large amounts of bent, and the occurrence of Yorkshire Fog, Crested Dogstail, moss, rushes and buttercups. Over a great part of the area the pasture had been down for many years, but several cases were observed where the deterioration had taken place within three years of the date of sowing.

The next acidity group (pH 5·5–5·99) contained a certain amount of satisfactory pasture, but also a large amount of rather poor pasture, and the condition probably was to a great extent dependent on the age of the pasture.

At the other extreme, only four samples taken on pastures were alkaline, and in every case the pasture was noted as good. In the slightly acid group most of the pasture was noted as fair to good, although in one case bent was noted as "tending to come in," and another was noted as "containing Yorkshire Fog" and being "slightly mossy."

There is undoubtedly a marked difference in the quality of the pasture between the most acid and least acid groups of soils, and there is also a great difference between the parishes as a whole as regards pasture. This difference is no doubt due to a combination of factors, but there seems to be clear evidence that soil acidity is one of these factors and that bad drainage is another.

The bulk of the unenclosed land in parish B (3,000 acres) has a peaty surface layer and an abnormally acid reaction (pH less than 4). The vegetation is chiefly heather (Calluna) with patches of bracken and grasses (Nardus, Molinia, &c.). There are occasional small areas, especially on stream sides and "flushes" from springs, where broad-leaved grasses are found and the pasture is good.

Reasons for the difference in reaction.—This detailed survey has shown a remarkable difference in the reaction of the soils in two parishes situated not far apart. The difference is such that of one parish it might be said that very little liming is required, whilst of the other it is safe to say that about 30 per cent. of the area requires lime and a further 60 per cent. might benefit by it. The economic possibilities of the question are not discussed here.

It is obvious from these results that striking differences may be encountered in districts not far apart, and that it is unwise to make generalisations—such as "that the whole country needs lime." It is interesting, however, to attempt to arrive at some understanding of the causes of this marked difference.

The most important seem to be as follows :—

(1) Geological origin.
(2) Differences in climate—especially rainfall.
(3) Differences in agricultural practice.

(1) Geological Origin.—As has already been noted, the underlying formation in parish A is the Calciferous Sandstone series of the Lower Carboniferous, and in parish B about half the parish is Old Red Sandstone and half Silurian. This difference in geological formation, however, explains very little, for in a more general acidity survey of the south-east of Scotland the writers found that over the Calciferous Sandstone the soils were usually acid, and that over the Upper Old Red Sandstone it was not unusual to find alkaline soils. It is quite understandable from the strata which occur in the Calciferous Sandstone Series that areas of alkaline soils should be found, but it would be unwise to generalise.

The whole question is complicated by the presence of glacial drift. In parish A the bulk of this drift consists of a heavy boulder clay which is alkaline in reaction—probably from the presence of limestone strata in the bed rock. At any rate, we find over the parish a parent material consisting of a tenacious, alkaline clay, and all the subsoil samples (at 3 feet) examined in the parish were decidedly alkaline.

In parish B, on the other hand, conditions are rather different. Alkaline material may occur in both the Lower Silurian and Upper Old Red Sandstone formations, but in this case again a large part of the parish is drift covered. The drift, however, appears to be much more sandy in texture, thereby facilitating the percolation of water through the soil, and hence removal of soluble material would proceed more quickly.

The examination of the parent material was carried out only to a shallow depth (3 feet), and although the material at this depth was less acid than that at the surface, it was in most of the cases examined still decidedly acid. There is, therefore, a marked difference in the nature of the parent material in the two parishes, and the fundamental reason for the striking difference in soil reaction is, in this case, probably the difference in parent material.

(2) **Climatic Conditions.**—There is considerable difference in altitude between the two parishes (parish A about 200–240 ft.; parish B 590–1,470 ft.)—parish B extending well up the Lammermoor Hills.

There is a rainfall record for a recording station in parish A but no records for B. The nearest places adjacent to parish B with rainfall records are " M " (498 ft.), which probably corresponds fairly well with the conditions in the lower ground of the parish, and " N " (1,200 ft.), which is closely adjoining the hill land.

The following are the annual records for 1923–1927 for the above places (by courtesy of Scottish Meteorological Office) :—

Location.	*1923.*	*1924.*	*1925.*	*1926.*	*1927.*	*Average.*
"X" House (parish A) (200 ft.)	24·53	25·76	30·22	30·49	33·02	28·80
"M" (near parish B) (498 ft.)	30·12	36·44	36·16	38·62	45·76	37·22
"N" (near parish B) (1,200 ft.)	41·59	36·80	40·60	41·96	50·59	42·31

It appears from these figures that the rainfall of parish B is nearly 50 per cent. greater than that of A. This, over thousands of years, must represent a very great difference in the amount of bases leached from the soil, and would also help to account for the greater acidity of parish B.

(3) **Differences in Agricultural Practice.**—The agricultural practice of the district undoubtedly influences the reaction of the soil. This may come about in various ways. Districts which can conveniently obtain supplies of lime, and especially districts which are intensively farmed, frequently receive dressings of lime. On the other hand the application of certain fertilisers in large quantities tends to deplete the supply of lime in the soil, but on the whole the more highly cultivated districts are likely to be better off as regards lime, partly because the returns from highly cultivated land allow of more expenditure on it. Again, certain crops such as barley and wheat do not grow well in very acid soil, and most soils which have been highly cultivated have either had a good supply of lime naturally, or have been limed from time to time.

Apart from liming there are indications that cultivation often brings about a decrease in acidity, partly no doubt from the turning up of the soil by tillage operations, but probably partly from the lime compounds brought up from a greater depth by the crops and left near the surface in their roots.

In parish B the land which was never cultivated is very much more acid than the cultivated soil, even in places where it is said that the cultivated soil has never been limed.

There is a difference too in the reaction of old policy parks such as those beside " X " House, compared with the adjoining cultivated land—the policy parks being considerably more acid than most of the adjoining land. The same applies to other grassland which has long been unploughed and is well seen in various parts of parish B.

From the different system of farming, therefore, the surface soil in parish A would not have the same tendency to become acid as would the surface soil in parish B.

Suggested Treatment.—So far as acidity is concerned, parish A requires very little attention, but in parish B matters are very different. The type of agriculture practised there at present is probably the one best adapted to the acid condition of the soil since pasture (of certain types), oats, potatoes, and even turnips can be grown on fairly acid soils. The system, however, tends to aggravate the condition of acidity, and after a time a point may be reached, and is being reached, when pastures suffer and cultivated land goes out of cultivation.

A considerable amount of liming appears to have been done in parish B in the past, but in recent years on only one or two farms has lime been applied and to a very small extent. Several farmers realise that their soils require lime, but are doubtful if at present-day costs they can afford to apply it.

The present detailed acidity survey has shown how the acidity may vary even in soils of one district, and how necessary it is, before undertaking extensive liming, to have the soils examined. It has also provided data for these two parishes showing where the most acid soils occur. It still remains to be shown by means of field trials (1) whether lime can be applied profitably at the present day with the existing system of agriculture; (2) whether liming would enable the existing system of agriculture to be modified.

It has already been shown that acid soils frequently give a response to phosphatic manuring, and this question is also included in the scheme of field trials.

It is, therefore, proposed to lay down on the most acid land in these parishes two kinds of experiments :—

(1) A fairly comprehensive test at one or two centres requiring nine plots, and in which lime, phosphate, potash and nitrogen are all tried.

(2) A simpler test at numerous centres, designed to test lime alone, lime and phosphate, and phosphate alone.

It is suggested that these materials should be applied :—

1. To the oat or turnip crop before laying down grass.
2. On grassland already reverted.

Observations will be made on the pasture for several years in order to see whether the treatment brings about improvement and retards the growth of less desirable grasses.

If it should be shown that liming brings about an improvement of the pasture of parish B there still remains the question of cost. The cost of transporting lime long distances may make its application to pasture land in parishes like B economically unsound. There seems to be little doubt, however, that this parish, and many others like it, would benefit greatly from systematic liming, and there is great need for the re-opening of the limestone quarries all over the country in order to supply local needs.

Summary.—1. Every field in parishes A and B has been tested for acidity, and it has been found that, although the parishes are only about 10 miles apart, there is a remarkable difference in the soil reaction.

2. In A practically 75 per cent. of the soils can be regarded as being in a thoroughly satisfactory condition as regards lime, whilst in B only 9 per cent. of the soils of the enclosed land are in that condition. Again, only about 3 per cent. of the soils of A are extremely acid compared with nearly 30 per cent. of the enclosed land of B.

3. Corresponding to this great difference in soil acidity there is a marked difference in the quality of the pasture, and it is believed that lack of lime is one of the most important factors responsible for the poorer quality pasture in B.

4. The most acid soils of B are in pasture—frequently old pasture, and it is a matter for field experiment to determine whether it is economically possible to apply dressings of lime sufficient to bring about an improvement.

5. There are in both parishes considerable areas which in addition to liming require draining, and since acid soils frequently respond to phosphatic manuring it is also desirable to carry out experiments with phosphatic manures.

6. Although much of Scotland obviously needs lime, the survey shows that even within short distances the acidity may vary greatly, and that when liming is carried out it ought not to be done indiscriminately.

DISEASE IN STRAWBERRIES.

D. G. O'Brien, M.A., B.Sc., B.Sc.(Agric.), and E. J. M'Naughton, B.Sc.(Hons.), B.Sc.(Agric.).

Within recent years a disease of strawberries, resulting in a very serious reduction in yield of fruit, has become a menace to the strawberry industry in many parts of Britain and more especially in the Clyde Valley, where the trouble is extremely acute, and where the disease is known as "The Lanarkshire Strawberry Disease." Although the problem was taken up by many competent workers in other parts of Britain, there was no agreement as to the cause and symptoms of the disease; and when in 1926 the West of Scotland Agricultural College commenced an investigation of the disease the mycological aspect of the problem was assigned to us.

The present paper contains the substance of a Bulletin [1] issued by the College which gives the results of a mycological investigation, undertaken in the years 1926 and 1927 by the authors, into the disease. The investigation was first confined to the disease as it occurs in Lanarkshire, but later was extended to include strawberry-growing districts in other parts of Great Britain, as evidence was forthcoming that the disease existed throughout the country—the symptoms showing various points in common.

The most characteristic symptom of the disease is " root weakness," indicated by the primary roots being devoid of lateral branches and fibrous rootlets. This is a symptom of the disease of the strawberry plant grown on the best of soils as well as on the worst, and therefore cannot be attributed directly to wetness, water-logging, or any other adverse soil condition. The other symptoms of the disease—the stunted appearance of the plant, the small sickly leaves, and the marked inability to produce and ripen fruit—are but the usual signs of starvation arising from the loss of the fine absorbing rootlets.

No organism capable of doing injury to the plant could be found in any part of the tissues except in the lateral and fibrous rootlets of established plants; and in all cases where a plant showed traces of the disease, a definite fungus was consistently present in the living tissues of the rootlets. This fungus was identified by us as an endotrophic mycorrhizal fungus, and we believe it to be the primary cause of " Strawberry Disease."

Reference to Previous Literature.—Reference to literature showed that this mycorrhizal fungus of the strawberry had not been made the subject of special study, although its presence had been noted by Gallaud in France, by Peyronel in Italy, and by Jones and White in America.

The Mycorrhizal Fungus of the Strawberry Plant.—An endotrophic mycorrhizal fungus is a specialised type of fungus which lives completely embedded in the root tissues of plants. In order to extract food from the host tissue (i.e. the tissue in which it lives) it develops small tree-like organs called " Arbuscules " within the host cells in the attacked region (Plate I). When the mycorrhizal fungus has fed on the host tissue for some time it begins to produce " vésicules " (Plate II). These vésicules are small oval organs densely filled with food material. They arise from the end of a fungal filament, and are generally regarded as a resting cyst or spore from which another fungus will emerge later to infect new rootlets.

Selection of material for study. — Selection of the most suitable part of the rootlet to be examined was found to be a matter of considerable difficulty, as the fungus does not occur throughout the whole length of an infected rootlet, but is con-

[1] The Endotrophic Mycorrhiza of the Strawberry and its Significance.

fined to small localised patches. With practice, however, these diseased patches could be distinguished with a fair degree of certainty, as they tend to become slightly swollen and brittle. This is especially the case in the early summer months.

Life History.—Little is known regarding the mode of life of this mycorrhizal fungus in the soil. It is apparently stimulated, however, by the proximity of strawberry roots, towards which it sends out fungal threads, which pierce the outer coat of the root and gain admission to the inner or cortical tissues (Plate III). Here, through the agency of its arbuscules, the fungus robs the host cells of their contents (Plate IV), and as it grows in size it absorbs the contents from an ever increasing number of cells which ultimately die. The great development of the fungus in the cortical cells causes the rootlet to become much swollen and often distorted when badly attacked. Further, the swollen part is extremely brittle, dies and falls away from the primary root, which is thus deprived of its means of absorbing the necessary mineral salts and water from the soil.

The production of vésicules seems to be dependent on several factors, among which are weather conditions and the variety of strawberry infected. The true function of these vésicules is unknown, but they may be regarded as resting cysts which germinate under favourable conditions and infect new rootlets.

The Parasitic Nature of this Fungus on the Strawberry.—*Historical evidence (Mycorrhizal fungi in general).*—The term "mycorrhiza" has been used in the past to signify a state of mutualism or symbiosis—a state in which both the plant and the fungus are benefited—the plant affording protection to the fungus and supplying it with such food materials as it could not otherwise obtain; and the fungus building up within its body certain products and reserve foods, which the plant finds valuable and which it secures by killing and digesting the fungus.

It is recognised now, however, chiefly owing to the work of Bernard in France, that in the case of green plants examples of true mutualism are very rare. To this outstanding worker the presence of a mycorrhizal fungus in the root tissues represented a state of disease in which the fungus alone stood to benefit; the host plant was seldom able to kill and digest the fungal tissue.

Mycological evidence.—A consideration of all the evidence bearing on the fungus as it occurs in the strawberry roots and as it affects them points to the view that this mycorrhizal fungus is of a parasitic nature. It lives in the finer roots of the host plant and depletes the cells of their contents (Plate IV). The arbuscules never become completely digested by the host tissue as is the case in true mutualism. On the contrary the host cell dies very early, and could not possibly digest the arbuscule which lies within it. Owing to the withdrawal of food and the death of the cells in the infected region, the root becomes swollen and brittle. It ruptures readily and falls off into the soil. If the rupture takes place close to the primary root, a considerable amount of absorbing rootlet is lost to the plant. The plant reacts by producing

PLATE I.

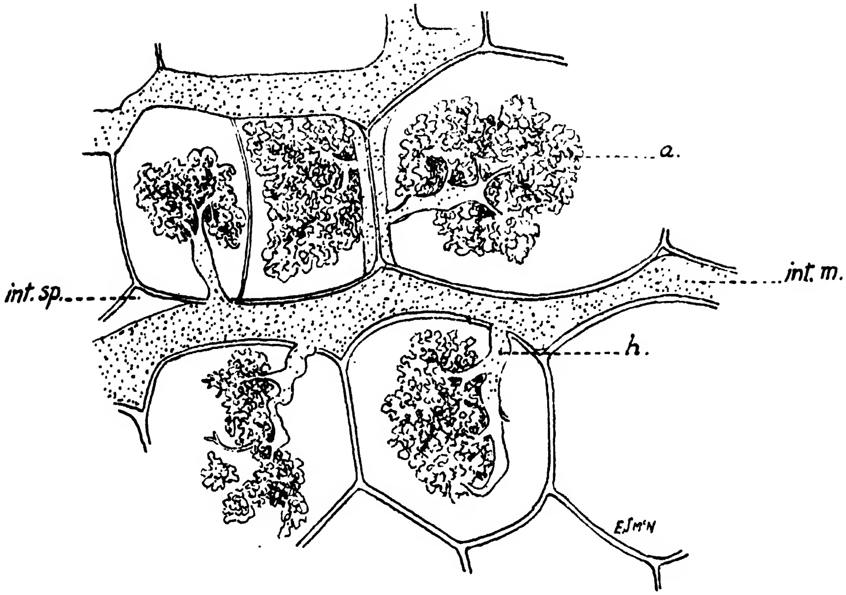


Fig. 1.

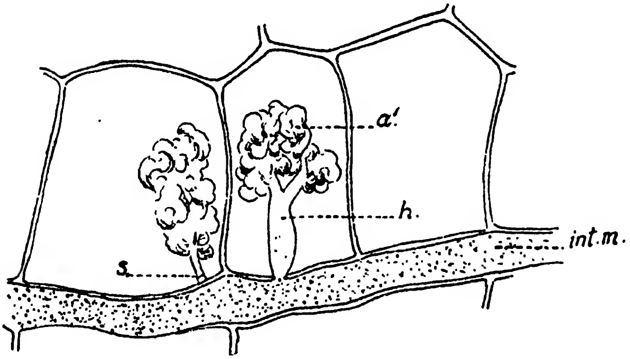


Fig. 2.

Plate I.—Arbuscules in various stages of digestion.

Fig. 1.—Fully developed arbuscules before the onset of digestion. (x400.)

Fig. 2.—Partially-digested arbuscules. (x400.)

int. sp., intercellular space; int. m., intercellular mycelium; h., hypha-bearing arbuscules; a., arbuscules; a′., partially digested arbuscules; s., septum.

PLATE II.

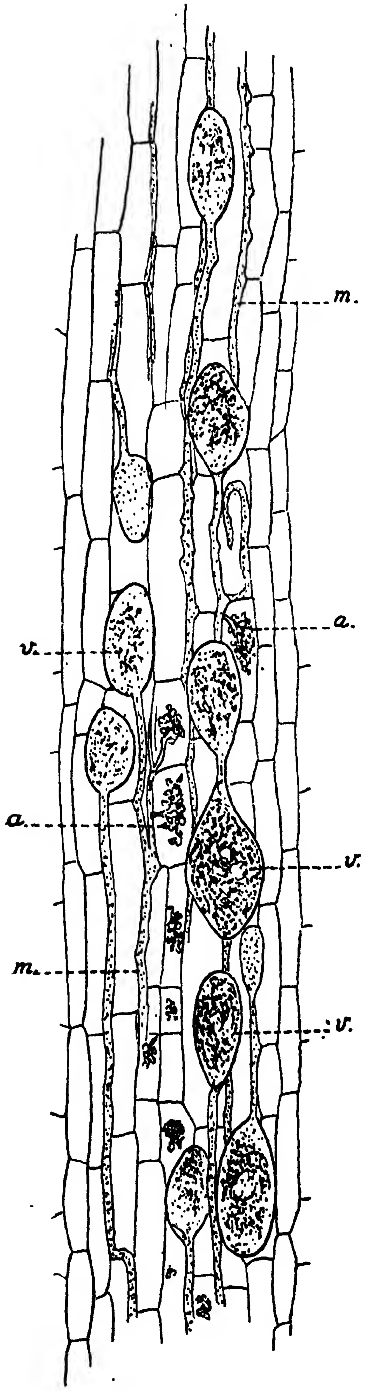


FIG. 1.

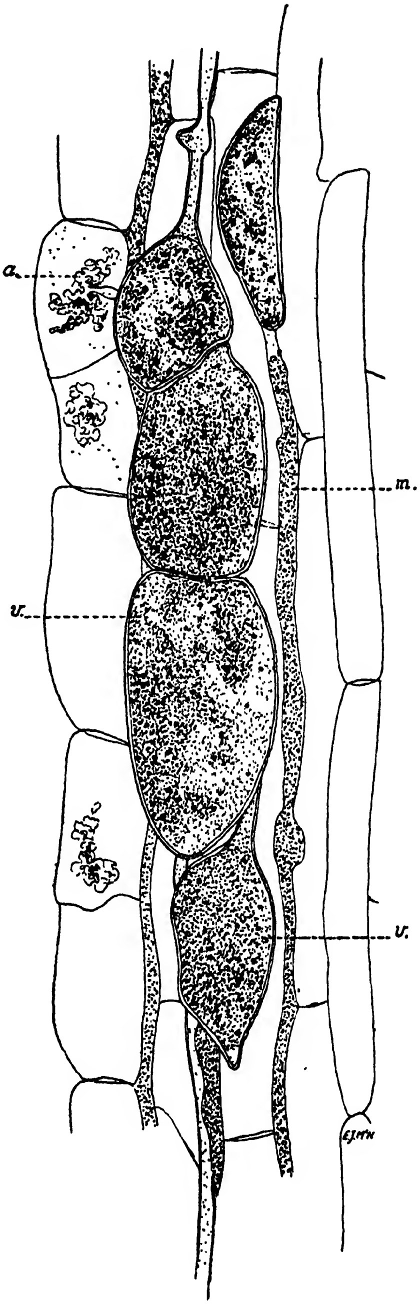


FIG. 2.

PLATE II.—Longitudinal sections of infected rootlets with vésicules.

Fig. 1.—Numerous vésicules in various stages of development are seen in the tissues. (x100.)

Fig. 2.—Chain of vésicules. (x250.)

m., mycelium; a., arbuscules; v., vésicules.

PLATE III.

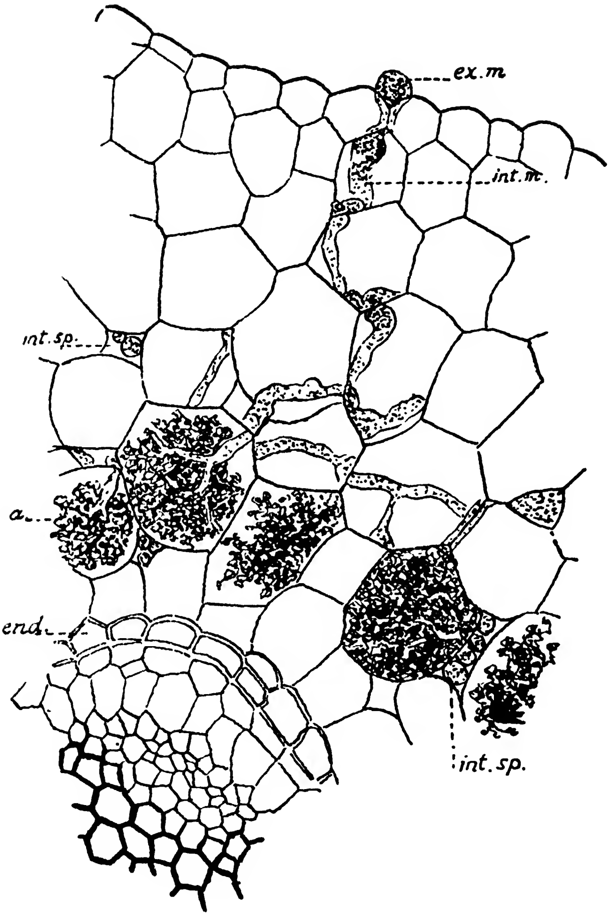


PLATE III.—Transverse section of fine absorbing rootlet of the strawberry. The section has been cut through an infected area and shows the entering hypha. (x200.)

ex. m., extraradical mycelium ; int. m., intracellular mycelium ; int. sp., intercellular space ; a., arbuscules ; end., endodermis.

PLATE IV.

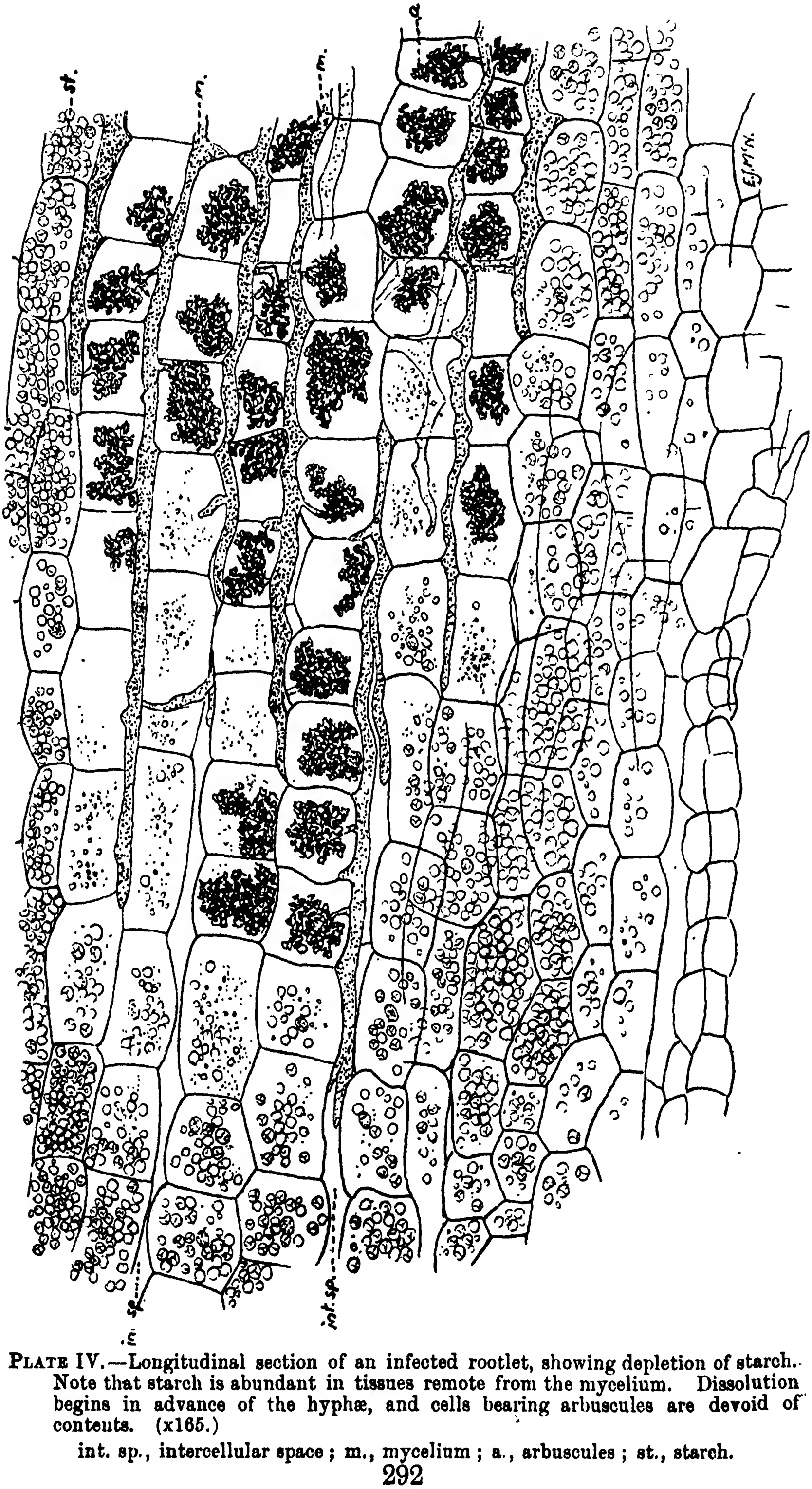


Plate IV.—Longitudinal section of an infected rootlet, showing depletion of starch. Note that starch is abundant in tissues remote from the mycelium. Dissolution begins in advance of the hyphæ, and cells bearing arbuscules are devoid of contents. (x165.)

int. sp., intercellular space; m., mycelium; a., arbuscules; st., starch.

more rootlets, but these too are attacked and soon break off; so that ultimately the plant, being deprived of its finer absorbing roots, is starved to death. It is to this fungus that we ascribe the poverty of absorbing rootlets.

Bad soil conditions such as excessive dryness, wetness, acidity, &c. affect the strawberry plant adversely, and by lowering its vitality enable the mycorrhizal fungus to gain the upper hand, with the result that the balance which obtains under good soil conditions between root formation and root destruction in the plant is upset. Moreover, such soil conditions are no doubt specially suitable to the fungus and make it more virulent. The presence of patches of intense infection in the wetter, sometimes in the drier, parts of the fields points to this conclusion. Again organisms which normally are saprophytic in the soil can parasitise such weakened plants.

Further evidence that this fungus is the cause of Strawberry Disease may be found in the fact that it is the only organism that was constantly found in the living root tissues of unhealthy plants.

Inoculation experiments.—It was not found possible to culture the mycorrhizal fungus in artificial media with a view to obtaining a pure culture for inoculation of healthy plants. Nevertheless an attempt was made to infect healthy plants growing in sterilised soil by adding to the soil portions of infected rootlets which were undamaged externally. Examination of these plants at a later date showed that those growing in the inoculated soil (1) became infected with the fungus, and (2) were deficient in absorbing rootlets when compared with the control plants grown in uninoculated soil.

Field evidence.—Late in March or early in April active growth of the strawberry plant commences, and for the next three months, coincident with the production of foliage, fine fibrous rootlets are developed from the primary roots already formed in the previous autumn. The critical period for the plant is from May to June, when flowering and subsequently fruit formation takes place. At this stage the maximum strain is put upon the resources of the plant. At this time also mycorrhizal invasion is at its height, and the plant begins to lose its rootlets in the manner already described. The consequent starvation of the plant renders it unable to produce and mature a crop of fruit. In severe cases the plant itself dies.

Ball and Mann working at Long Ashton Research Station have shown that there is a gradual decrease in the weight of the roots of strawberry plants from March until the middle of May; and that during the early stages of growth and up to flowering there is a marked disappearance of reserve food, especially starch from the root tissues. The action of the mycorrhizal fungus may very well account for both of those phenomena—the loss in weight of the roots being due to the finer rootlets dropping off, and the removal of the food from the tissues being the result of activity of the arbuscules.

Ball and Mann also investigated the effects of root trimming and obtained some very interesting results. They found that in the first year after planting the strawberry plants which had been root trimmed were much superior to those that had not been root trimmed, but that this superiority was lost by the second year. The explanation of this is that the trimming of the roots removes the majority of the finer rootlets, i.e. those that are affected with the mycorrhizal fungus, and when the plant is set out in fresh soil rootlets develop and remain fairly clear of infection during the first year. By the second year, however, they have become as heavily infected as the rootlets of the untrimmed plants and therefore as badly diseased.

Other results given by Ball and Mann on the effects of early and late planting can be readily explained by the presence of the mycorrhizal fungus. These workers found that (1) the longer runners remained with the parent plant before being planted, the less vigorous were the resulting plants; (2) progressively smaller crops were obtained from the later dates of planting, but the most marked difference was between the runners planted in August and September, the former yielding a crop three times greater than the latter; (3) runners set out in October were in no way superior to those set out in spring when both series were examined in May, but neither series was sufficiently vigorous to bear a crop.

The fact is that the longer the runners remain in the neighbourhood of their parents, the longer are they exposed to infection by the mycorrhizal fungus, and the more heavily will they be infected. Such runners cannot give rise to healthy plants. By early planting, however, the runners are removed before they become appreciably infected and produce much healthier plants. Very young runners planted in August will be almost entirely free from infection, while those planted in October will be almost as heavily infected as those which are planted in the following spring, since the mycorrhizal fungus is inactive during winter. The difference between the plants set out in August and September and the similarity of October and spring plantings is a direct result of the degree of infection of the runner.

Finally we are convinced that the severity of the disease of the strawberry crop in the Clyde Valley is due to the planting of runners in spring, and to the crowding of the plants in beds where they cannot be properly cultivated and where the roots occur in tangled masses.

Control.—In the present state of our knowledge, it is difficult to indicate effective control measures for this trouble. Since the disease is ever present and is greatly aggravated when environmental conditions are unfavourable to the strawberry plant, it is evident that any control measure must first aim at modifying the influence of any adverse local factors. The more important of these factors have already been enumerated. Anything which will promote rapid and good root development will prevent the disease from assuming a serious aspect.

As regards manuring, it is well known that phosphates encourage the development of roots, especially the fine absorbing fibres; on that account phosphates should form the chief constituent of any manurial dressing applied to strawberries. On the other hand, nitrogenous manures, which favour the development of foliage, and which, when applied in excess tend to lower the vitality of the plant, should be used with caution. In this connection the manuring of strawberries with farmyard manure, while essential for successful growth of the crop, should not be overdone, and the quantity applied should be regulated chiefly by the type of soil.

Good cultivation is essential both before and after planting of runners, since it reduces the amount of mycorrhizal fungus in the soil and at the same time encourages the development of the roots.

Wet conditions favour the development of the mycorrhizal fungus and have a weakening influence on the plant itself. Drainage, therefore, should be efficient in all cases. The growing of the plants in drills improves the soil in this respect and undoubtedly is preferable to the bed system. The crop can be horse-hoed more effectively in the critical early stages, and this, in addition to improving conditions for root growth, keeps down weeds which might harbour the mycorrhizal organism.

When planting runners, certain definite precautions should be observed. Runners for planting should be obtained only from districts where they are formed relatively early and where the soil is of a free, open nature such as promotes a vigorous root growth. The older the plant the greater will be the amount of infection around it and the greater will be the danger of the runners being heavily invaded by the fungus. For this reason runners should always be selected from young mother plants and early planting should be adopted wherever possible.

For reasons already stated, root trimming should be carried out, especially in districts where late or spring planting is necessary.

It is not advisable to attempt to secure a crop in the first year. If deflowering is practised at this time the economy to the plant will result in more prolific root formation with subsequent benefit in the second year. During this period any plants showing pronounced symptoms of the disease should be carefully removed and destroyed by burning.

The close cropping of strawberries, so widely adopted, serves to increase the amount of the mycorrhizal fungus in the soil, so that fields which have been under this crop for a long period of years become heavily infected. Where possible a system of rotation should be practised. The best fields for strawberry cultivation are those which have been constantly under the plough, and which have borne different crops in the preceding years. It is a mistake to plant runners in fields which have been freshly broken from old pasture.

Soil sterilisation, where not prohibitive on account of expense, would reduce the presence of the fungus to a minimum.

The effect of varietal resistance remains yet to be determined, but there is preliminary evidence to show that some strawberry varieties are more resistant than others.

Summary.—In view of the complex nature and widespread occurrence of the trouble, it should be understood that much research work still remains to be done before the problem is finally solved; meantime, on the evidence presented in this paper, the authors have come to the following conclusions as to the cause and nature of the disease :—

1. The disease of strawberries, best defined as "root weakness," is a general one.
2. Diseased plants are characterised by a paucity of absorbing rootlets. The other symptoms of the disease are but signs of starvation consequent upon this.
3. The only constant organism found in the living roots of unhealthy plants is an endotrophic mycorrhizal fungus of the type bearing arbuscules and vésicules.
4. This organism invades chiefly the fine absorbing roots of the strawberry plant.
5. The maximum infestation occurs at or about flowering time of the strawberry plant, this being also the time when fine fibrous roots are produced in great amount. The disease is most destructive at this critical stage.
6. Starch and other materials are removed from the root tissues by the action of the arbuscules, and there is no evidence of any return of starch to cells when once depleted of their contents. The vitality of the roots is therefore lowered.
7. The arbuscules are never completely digested by the host cells, so that the fungus benefits at the expense of the plant.
8. At the points where strong infestation occurs, the finer rootlets are ruptured and drop off into the soil. To this we ascribe the poverty of absorbing roots noted on diseased strawberry plants.
9. We regard this endotrophic mycorrhizal fungus as a parasite, and believe it to be the fundamental cause of the disease.
10. The disease tends to be slow-acting and chronic in its nature, but the fungus is capable of bringing about death of the plant if infection is severe.
11. The disease assumes really serious proportions when aggravated by conditions inimical to the growth of the strawberry plant. But according as the mycorrhizal attack is severe or slight, and as conditions are unfavourable or favourable for plant growth, so is the ultimate damage greater or less.
12. The so-called "Lanarkshire Strawberry Disease" represents this trouble in its most serious form.
13. The endotrophic mycorrhizal fungus paves the way for the entry of secondary fungi and bacteria, which under certain conditions may invade the weakened root tissues and intensify the disease.

14. The root fragments, which are broken off from diseased plants, serve to infect the surrounding soil.

15. Young runners from affected plants are free from disease until they strike root in the soil, when their roots become infected.

16. The disease is transmitted by infected runners.

17. There is evidence to show that the fungus is not specific to the strawberry, but may invade other plants such as grasses and clovers. Infection of the strawberry crop may be traced to such sources.

LIVE STOCK INSURANCE.

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The Midland Agricultural and Dairy College.

"JUDGING from the large number of policies written by insurance companies, this class of insurance is evidently very much appreciated by the community." This quotation is extracted from the chapter on Live Stock Insurance in Eke's book —"The Principles of Insurance"; but the statement appears to be unduly optimistic when all the facts of the case are taken into consideration. There are special risks such as foaling and castration which are often covered, and a number of breeders also insure their pedigree stock against death from disease or accident. These give the companies a considerable amount of business. In comparison, however, with other branches of insurance, such as fire, the premium income from live stock insurance, even including these special risks, is very small. Live stock insurance means not only the special risks mentioned above, but the insurance by the average farmer, whether large or small, of all stock against death from disease or accident. In a survey made of over two hundred farms, not one farmer was found who insured his stock other than occasionally against foaling or other special risks. From general enquiries and survey work carried on at the Agricultural Economics Institute, Oxford, it can be confidently stated that the number of farmers insuring their live stock against death from disease or accident is negligible. In a recent article Mr. Orwin stated that the great question concerning farmers' insurance is not the ordinary liability to fire or accident, or the special liability attaching to valuable live stock in certain conditions, . . . but the question of the protection of the ordinary live stock of the farm both from the ordinary diseases and from epidemics.[1] One can therefore conclude that, although this form of insurance has been undertaken by joint stock and mutual companies as long ago as the beginning of the eighteenth century, the advance made has not been commensurate with the experience gained.

From the farmers' viewpoint the conditions under which they

[1] *Journal of Ministry of Agriculture*, vol. xxxl, No. 5.

could cover their live stock risks have been such as to give very little inducement to undertake this branch of insurance. The lack of interest shown by the farming community was explained in the last article.[1] Added to this is the very important fact that, if a farmer were to insure all his cattle or all his horses against death, the total premiums paid would be out of all proportion to the risks involved. The farmer has found out that on an average of years he can better afford to stand the loss himself than to pay insurance charges at the present rates quoted by the companies. This does not hold true to the same extent in the case of a small farmer with very little stock when the loss of one cow would cripple him for years. The fact that the big companies are not keen on "soliciting live stock insurance" is explained by the comparative unprofitableness of risks peculiar to agriculture, particularly as the volume of business done is small. Again, insurance to cover all live stock would require an enormous amount of supervision to cover the moral hazard which is more possible in live stock insurance than in other forms.

The insurance of horses and cattle is not of recent development. During the seventeenth century a certain amount of business was done, particularly in connection with the insurance of horses, but owing to the great number of thefts (this risk being covered) during that period, the attempts were not successful. From 1844, when the Farmers' and Graziers' Cattle Insurance Company was formed, until to-day, a number of joint stock companies and mutual societies have undertaken to cover specified risks and the risk of death by disease or accident to which horses and cattle are subject.

Prospectuses are issued by most of the companies interested in this branch of insurance in connection with Cattle (including Foot-and-mouth), General Horse, Stallion, Foaling, Transit and Castration risks.

Cattle Insurance.—Table I, which is a brief summary of a number of prospectuses, indicates the amount which can be insured and the premiums charged by most of the insurance offices, whether tariff or non-tariff, against death from disease or accident of three different kinds of cattle.

TABLE I.

Amount Insured.	Class.		
	Dairy Cows and Heifers, including Calving Risks.	Fattening Cattle, 6 months to 8 years.	Pedigree Cows and Heifers, including Calving.
£	£ s. d.	£ s. d.	£ s. d.
15	1 2 6	0 12 0	0 18 9
20	1 10 0	0 16 0	1 5 0
25	1 17 6	1 0 0	1 11 3
30	2 5 0	1 4 0	1 17 6
100	7 10 0	4 0 0	6 5 0

[1] *Scottish Journal of Agriculture*, vol. xi, No. 2.

In the rates above quoted the risk of death from tuberculosis is not included unless the animals insured have successfully passed a tuberculin test within a specified period of time (usually three months) prior to proposal. If tuberculosis is to be included in the selected risk a further 2½ per cent. is usually charged. Added to the above risks, Castration, Transit, Anthrax, and latterly Foot-and-mouth, can be covered for additional premiums varying from 8*s*. per cent. in the case of Show Transit to 60*s*. per cent. on the sum assured, which must not be more than 20 per cent. of the total value of the herd, against Foot-and-mouth disease.

Horse Insurance.—Foaling risks are by far the most important in this class, and brood mares can be insured either for thirty days commencing with foaling or six months or more from the date of foaling. The premiums vary from £3, 15*s*. per cent. to £7 per cent. Similarly the mare and foal can be covered by insurance under as many as five classes of premiums varying from £6, 10*s*. per cent. to £11, 5*s*. per cent. Horses used for light and heavy haulage can be covered against death from disease or accidents at rates of premiums varying from £4 per cent. to £8, 15*s*. per cent.

The above briefly are the risks which can be insured and the rates of premiums charged by the companies undertaking this class of business in this country. It is well to remember, however, that, although there are facilities open to the farmer to cover the many risks attendant on the business of animal husbandry, they are not such as to make it a feasible financial proposition for his serious consideration. One can hardly expect a dairy farmer to insure a herd of thirty cows at the rates of premium prevailing at present. In this instance he would be required to pay £67, 10*s*. in premiums for an assured value of £900. If this figure is compared with the mortality rate for this class of animal, to be discussed later, it is good business on the part of the farmer to stand his own losses, which would not be nearly so onerous as the amount of premiums he would have to pay. It must not be assumed from this fact that there is not need for live stock insurance; it merely indicates that the present-day facilities for live stock insurance are too expensive for the farmer to undertake.[1]

Butchers' and Auction Mart Insurance Associations.—There are a number of these mutual associations in England. When a butcher who is a member of an association of this kind has bought an animal through an auction or otherwise, he may insure with the society to cover the risk of the carcase being

[1] Indemnifying the insured against possible losses is of course only one aspect of insurance. The other, and the more important from a certain viewpoint, is the influence of general live stock insurance in the elimination of infectious and contagious diseases such as tuberculosis (more prevalent amongst certain classes of live stock than is generally imagined). Continental experience indicates that the regulations laid down by insurance associations with regard to the more sanitary housing of cattle has resulted in a healthier type of animal being bred, and thereby has appreciably lessened the incidence of the insurable risks.

condemned as totally or partially unfit for human consumption through disease, tuberculosis in particular. One butchers' mutual insurance association formed towards the end of last century has had a very eventful career, and this society's experience alone indicates the seriousness of the problem of animal diseases rendering unfit for consumption an appreciable percentage of the cattle slaughtered. In a period of 24 years this small association paid nearly £25,000 in compensation for carcases condemned as totally or partially unfit for consumption.

This association in the first instance charged its members a flat rate of 1*s*. per head for bullocks and heifers and 1*s*. 6*d*. for cows, compensation being paid for two-thirds of the value of the animal. After a few years' experience this was found insufficient and a levy had to be made to meet the deficit. It appears that the most unprofitable class was that of cows. On this class the premium was raised to 2*s*. per head, but a further levy of 5*s*. had to be made to meet the claims. This class was eventually abandoned.

In 1910, owing to heavy losses, it was necessary to reconstruct the scale of premiums for the other classes. The new premiums indicate the varying liability of different classes of cattle to disease. The premiums range from 1*s*. 6*d*. for bullocks and clean heifers; 2*s*. 6*d*. for young bulls; 5*s*. for bulls "four broad teeth" or over, to 7*s*. 6*d*. for heifers having calved once. This charge, however, did not solve the financial difficulties, and the losses on "one-calf heifers" have been so serious that the committee have had to consider the abandonment of this class as well as the cows.

Although the butchers' association has had a rather chequered career it is not in any way due to bad management; in fact the insurance fund is run on very well-managed lines. Until the committee, however, have at their disposal more information regarding the incidence of losses in the various classes over a number of years and for a larger number of animals it will be very difficult, if not impossible, to assess equitably the premiums required to cover the various risks. If such statistical information as that included in Table II were available from more sources, the association would be in a far stronger position to gauge the risk and assess the premium which, on an average of years, would be sufficient to compensate the insured without having continual recourse to levies.

The following modified table has been extracted from the Annual Report of the Veterinary Officer of the County and City of Newcastle-upon-Tyne for 1925.

TABLE II.

Cattle, Calves and Pigs slaughtered within the city.		Number of Animals found diseased, unsound, and unfit for consumption.		Number found Tuberculous.
Year 1925.		Whole carcases condemned.	Parts or organs condemned.	
		Per cent.	Per cent.	Per cent.
Cows	795	9·3	6·2	13·2
Heifers	10,403	0·5	0·6	0·8
Bulls	304	...	2·3	2·3
Bullocks	6,984	0·5	0·8	0·7
Total	18,486	0·85	0·94	1·34
Calves	4,348	1·13	...	0·07
Pigs	51,284	0·31	0·5	0·46

A Scottish Society.—Another insurance society similar in character but involving both farmers and butchers and run in connection with an auction mart in Scotland is of special interest. Up to 1914 a premium of 1*s.* per head was levied on both buyer and seller. Since 1914, however, ½*d.* per £ is levied on both parties, and the full value of the beast is paid in the case of a confirmed claim. The manager is of the opinion that a charge of so much in the £ is a more equitable way of collecting premiums than a fixed charge per head.

Table III gives the premiums collected and compensation paid in respect of bullocks and clean heifers from 1913 to 1925. This insurance fund covers the risk of tuberculosis and does not include other diseases, as was the case in the other society mentioned, although it should be noted that the bulk of the claims in the former society were for tubercular animals.

TABLE III.

Premiums collected and compensation paid in respect of Tuberculosis in a Scottish Auction Mart Insurance Fund.

Year.	Premium Paid.	Compensation Paid.
	£ s. d.	£ s. d.
1913	216 8 0	317 10 3 −
1915	311 14 4	257 14 5 +
1917	423 14 1	337 5 1 +
1919*	...	...
1921	751 6 6	711 16 10 +
1923	639 5 9	630 0 10 +
1925	664 19 10	696 10 2 −

* Government control period.

From 1913 to 1925 the above mutual insurance association collected in premiums £5,237 and paid in compensation £4,872.

A comparison of the two insurance societies mentioned provides the following points of distinction. In the first place the Scottish society covers its members only against the risk of tuberculosis, whereas the other society insures against all contagious and infectious diseases. Secondly, the Scottish society definitely limits the insurable risk to two classes, bullocks and clean heifers. This exclusion of the other classes of cattle more subject to tuberculosis, as the experience of the butchers' association proved, has undoubtedly placed the Scottish society in a stronger financial position to meet the claims made upon them. Thirdly, in the butchers' association only one party pays the premium, and there is no attempt to place some of the burden on the seller. In the other society the premium payment is equally divided between the seller and the buyer, making it considerably easier for both to bear. Lastly, there is a very important difference in the assessment of premiums. The Scottish society collects its premiums on the basis of so much per £, a ½*d.* in this case, the other society charging a given sum per head, and in the event of claims being higher than the premiums paid a further levy is charged.

While it is not desirable to dogmatize from the limited data of the experience of two societies, these four points may tend to indicate the reasons for the more uniform success of the Scottish society.

One can definitely add, however, as far as both these associations are concerned, that not only should more statistical information regarding incidence of losses be available in all classes of stock, but some form of re-insurance should be considered so as to lessen the burden which often crushes small societies in the event of heavy losses.

Cow and Pig Clubs.—These are small local mutual insurance associations formed in most cases to cover the risk of death from disease or accident in respect of the cows and fattening pigs of small-holders and cottagers. They are well distributed over England, but are rarely found in Wales or Scotland. As experiments in mutual live stock insurance the history of the "Clubs" is interesting; but as long as they remain isolated societies without the advantages of federation, which is the feature of all continental insurance societies, one cannot expect them to contribute much to the solution of live stock insurance.

Since the war there has been a very noticeable decline in the number of these societies, due, in the first place, to the stringent sanitary regulations regarding the housing of animals; and secondly, to the failure of many of these societies to meet the claims for losses owing to the parochial distribution of the risks, which would crush even a fairly strong society in the event of heavy losses.

Table IV illustrates clearly the decline in Pig Insurance Societies during the last few years.

TABLE IV.

Percentage Membership and Pigs Insured.

(1913 taken as 100.)

Year.	Membership.	Pigs Insured.
1913	100·00	100·00
1914	100·75	105·50
1915	101·40	102·60
1916	96·00	96·20
1917	96·70	95·60
1918	98·75	100·90
1919	105·90	104·00
1920	106·60	111·20
1921	109·30	113·70
1922	97·40	103·20
1923	94·40	99·70
1924	85·90	93·25
1925	80·00	86·25
1926	74·60	79·85

The above table refers only to Pig Insurance Societies, but from information collected and the number of societies not returning statistics it would be true to say that the decline in the number of Cattle Insurance Societies is still more marked.

The growth of these local mutual insurance societies is an expression of mutual dependence and co-operation. There is no doubt that many of these small societies have been very successful, and have realised their objects in covering the live stock risks of the small holder at very low premium charges. Speaking generally, however, they have not attracted the medium and large farmers, with the result that, as at present constituted, they could not possibly tackle live stock insurance on a big scale.

A brief outline has been given in this article of the facilities open to farmers and others to insure their animals. It appears, however, that the big insurance organisations, more interested in other and more profitable branches of insurance, are satisfied that the premiums, however prohibitive they may be to the average farmer, can not be lowered. This means that commercial live stock will remain uncovered by insurance as far as the big companies are concerned. The smaller mutual societies mentioned, although they attempt to insure commercial animals at reasonable rates of premium, are too local in character, and the consequent narrow distribution of risks cripples the society when losses are heavy.

Whatever may be the steps taken in the future to make live stock insurance a more feasible financial proposition to the farmer, information of a statistical nature regarding the incidence of mortality must be available if the organisation undertaking these risks is to remain in a sound financial position during years of heavy losses. In an investigation carried out from the Agricultural Economics Research Institute, Oxford, information of the nature indicated above has been collected. This will be of considerable assistance in dealing with the various problems affecting live stock insurance.

INVESTIGATIONS on INTERVARIETAL DIFFERENCES of a CHEMICAL NATURE in the MATURE POTATO TUBER.

T. P. M'INTOSH, B.Sc.

WHILE precise identification can always be made from the growing plant during the summer months, there is great difficulty in identifying potato tubers in winter. During this season the number of visible characters is few, and not all of these have an absolute, or even relative, value. The characters used hitherto by the writer are—(1) the colour of skin; (2) the colour of flesh; (3) the location of pigment in the skin[1]; (4) sprout colour; (5) rapidity of sprouting, and (6) condition of sprout hairs. Tuber shape and depth of eyes are valuable characters, but in small samples too much importance should not be given to them. Amongst the shapes already enumerated[2] the round (spherical) type is the most constant; the deep- and fleet-eyed types are also very constant, but intermediate forms are difficult to distinguish.

This paucity of constant morphological characters renders it desirable to explore the possibilities of physiological and chemical differences.

That there are definite and marked differences in the rapidity of sprouting amongst the healthy, mature tubers of potato varieties has already been noted.[2] The reaction of varieties to wart disease may be determined in winter by laboratory tests (cf. Anon., " Wart Disease: Immunity Tests," *Scot. Journ. Agric.*, X, 3, 1927). Under favourable conditions the time involved need not exceed a month, and thus varieties may be grouped during winter into two clearly defined classes, immune and non-immune. The method, however, is laborious and not suited to extensive tests.

Chemical differences between the mature tubers of varieties have been long recognised. The commoner methods have been attempts to differentiate by moisture, dry matter, starch, proteid or ash, but these have not been successful because environment influences each constituent considerably. There are, however, other substances in tubers which do not fluctuate so much as the above. Thus Artschwager[3] has investigated differences in solanin content, but substantial variations were not found.

Some preliminary observations gave promise of a possible grouping according to " flavone " reaction and detailed investigations were made, the results of which are now presented. Complex analyses, involving the preparation of expressed juice, have been avoided, as simpler tests would have a wider value for commercial purposes. It was considered better also in this preliminary work to restrict observations to a few varieties and to

[1] i.e., whether in cortex or cork.
[2] See M'Intosh, T. P., *The Potato*, 1927.
[3] Artschwager, E., Studies on the Potato Tuber, *Journ. Agric. Res.*, March 1924.

test a large number of samples from as many districts as possible. In this way the influence of environment could be ascertained and the limitations of the methods fixed.

In the following descriptions it has not been deemed expedient to give more than a very brief and simple account of the chemistry of the various reactions.

A. The Alkali Test.—Almost universally distributed in plants are substances known as " flavones." In bulk " flavones " are yellow, but they exist in the cell-sap in such minute quantities as to be practically invisible; on the other hand, when they are treated with alkalies an intense yellow colour is developed. The tubers of potato varieties differ in the amount of " flavones " they possess, and the approximate relative quantities may be determined by a colorimetric test.

Method.—Sections of potato tubers, about one-eighth inch thick—taken from the middle of the long axis of the tuber and avoiding wounds, where the " flavones " appear to concentrate —were immersed for several seconds in a normal solution of caustic potash and then laid out on petri dishes. The yellow colour continued to develop in intensity for approximately five minutes after the removal of the slices from the solution, but thereafter the colour remained constant, or almost so, for at least twenty minutes.

The results obtained are shown in Table I.

TABLE I.

The Alkali Test.

1. Very faintly Yellow.	2. Faint Yellow.	3. Yellow.	4. Deep Yellow.
Eclipse. Edzell Blue. Puritan. Witchhill.	Bishop. British Queen. Catriona. Crusader. Duke of York. Di Vernon. Epicure.* Field Marshal. Golden Wonder. Katie Glover.* Kerr's Pink. King Edward. May Queen. Ninety-fold.* President. Rhoderick Dhu. Sharpe's Express.	Abundance. Ally. Arran Chief. Arran Comrade. Arran Consul. Arran Victory. Dargill Early. Great Scot. Immune Ashleaf. King George. Lochar. Majestic. Northern Star. Tinwald Perfection.	Champion.

* Varieties thus marked differ only very slightly from those in Group 1.

Comparisons were made between these discs of tissue and the colour obtained from the crude extract and expressed juice and similar intensity of colour was obtained. The colour of each variety fluctuates slightly about a mean, but on the whole remains relatively constant. Thus samples of Kerr's Pink derived from ten Scottish sources, one Dutch and one French source gave approximately the same results; similarly, no substantial variations were noted in samples derived from acid and alkaline soils. The tests were continued throughout the whole storage period, November to March, with constant results.

The method is thus applicable to tubers drawn from many sources and throughout the entire storage season. Moreover, from a limited number of tests it appears that the reaction holds in the case of tubers affected with virus diseases and also in the case of the two common variations, bolters and wildings. Nor does the manuring of the crop affect the result; tubers from plants manured in the following way showed no substantial deviation from the normal, viz. :—(1) no manure; (2) nitrogen and phosphates, and (3) nitrogen, phosphates and potash. That maturity at lifting time was without substantial influence was determined for the variety Golden Wonder, which gave similar reactions for tubers taken from plants treated thus : (*a*) sprouted and planted on 1st March; ripe when lifted, very mealy when boiled; and (*b*) unsprouted and planted on 16th June; foliage dead before maturity; soft and soapy when boiled.

Application of the Test.—Four groups have been made. With regard to all groups it may be stated that there is a tendency to deeper pigmentation in the tissue outside the vascular cylinder. In group 2 the tissue within the cylinder is frequently coloured to the same extent as that in group 1, but the external tissue is always darker. The range of variation of individual varieties is such that the positive variation of a variety in one group may overlap the negative variation of a variety in an adjacent group; hence, although—especially with large samples—each group may be compared with its neighbour, determinations may be made with certainty only by omitting adjacent groups, i.e. by comparing 1 with 3 and 4; 2 with 4; 3 with 1; and 4 with 1 and 2. Similarly, if in any sample a tuber gives the reaction of an alternate group, it must be regarded as a rogue.

B. The Oxidase Test.—The potato tuber contains what is known as the oxidase system. The presence of such a system may be demonstrated by the use of certain substances, known as "acceptors." All varieties, however, do not react to the same degree when treated with these substances.

Method.—The procedure finally adopted in these experiments was as follows : to the surfaces of slices cut as in the preceding test—avoiding injuries and eyes—were added, or brushed on, a few drops of a 0·5 per cent. solution of Benzidine in 50 per cent. alcohol.[1] These slices were allowed to lie in petri dishes for 60 minutes in a laboratory the average temperature of which was 40° F. The colour which develops in some varieties is a rich brown-purple, in other varieties only faint colouring is noticeable,

[1] In this and the tyrosinase test a little practice is necessary before the operation can be successfully performed : the same quantity of solution is necessary for the same area of tuber surface.

and in others again an intermediate tone is reached. Table II gives the results.

TABLE II.

The Oxidase Test.

1. Dark.	2. Intermediate.	3. Light.
Abundance.	Ally.	Eclipse.*
Bishop.	Arran Chief.	Edinburgh Castle.
British Queen.	Arran Comrade.	Epicure.*
Edzell Blue.*	Great Scot.	Dunottar Castle.
King George.	May Queen.	Harbinger.
Lochar.*	Ninety-fold.	King Edward.*
Majestic.	Rhoderick Dhu.	Puritan.
Village Blacksmith.*	Sharpe's Express.	
	Tinwald Perfection.	
	Up-to-date.	
	Witchhill.	

These tests were continued throughout January, February and March 1928. Limited tests with bolters and wildings and with tubers affected with virus diseases showed that no substantial variation of the varietal reaction appeared to be caused by these conditions.

Application of the Test.—The reaction of any variety fluctuates about a mean. Three groups have been made. All tubers of all varieties in group 1 may be compared with all tubers of all varieties in group 3, subject to the qualification that a small percentage of tubers of those varieties in group 3 denoted by asterisks show an intermediate reaction which is difficult to distinguish from the lightest variations of group 1 varieties; even so, however, the asterisked varieties of groups 1 and 3 may always be compared with certainty.

As with the previous test, a white tuber in a group 1 variety or a brown tuber in a group 3 variety may be considered a rogue. All tables in addition furnish useful information concerning the identity of any variety.

C. The Blackening of Potato Tissue and the Tyrosinase Reaction.

(1) The Blackening of Potato Tissue.—When a potato tuber is cut and allowed to lie exposed to the air for some time, the cut surface gradually reddens; later the red colour disappears and is replaced by black. These reactions are due to the oxidation of a substance, tyrosine, through the agency of an enzyme, tyrosinase. The production of the red colour requires the presence of the enzyme and takes place only in the presence of oxygen. The red substance changes spontaneously into a colourless substance, and this latter is finally oxidised to form melanin, which gives rise to the black coloration. The last two processes do not require the presence of the enzyme, but may be accelerated by it or by other oxidases present in the potato juice.

All potato varieties do not blacken to the same extent when the cut surfaces are exposed, hence varieties may be grouped according to the intensity of the colour produced.

Method.—The temperature and hydrogen-ion concentration of the medium have a marked influence on the formation of the black coloration. Potato tyrosinase acts on tyrosine between pH 5 and pH 10. In neutral and acid medium the main product is the red substance during the first few hours, but in alkaline medium the production of melanin is hastened and the black colour rapidly develops, the preliminary reddening not being very marked.

The following system was therefore adopted in these tests, viz.—

(*a*) Transverse slices were cut with a stainless steel knife from the middle of the long axis of the tubers, and the surfaces of these slices were lightly scratched with a silver fruit fork in order to expose more tissue;

(*b*) these slices were immersed in a solution of sodium carbonate (pH 8·3) for about 30 seconds; and

(*c*) the slices were placed in petri dishes and incubated at 37° C. for thirty minutes in a moist incubator, care being taken not to use up the oxygen supply by incubating too many samples at once.

It was found that the blackening continued for some time after removal of the slices from the incubator. Table III gives the results.

TABLE III.

The Blackening of Potato Tissue.

1. Dark.	2. Intermediate.	3. Faint.
British Queen.	Abundance.	Dunottar Castle.*
Katie Glover.	Ally.	Golden Wonder.
King George.	Arran Chief.	Harbinger.
	Arran Comrade.	Langworthy.
	Arran Victory.	May Queen.
	Bishop.	President.
	Eclipse.	
	Edzell Blue.	
	Field Marshal.	
	Great Scot.	
	Majestic.	
	Puritan.	
	Rhoderick Dhu.	
	Sharpe's Express.	
	Tinwald Perfection.	
	Witchhill.	

* Included in trials since February only.

All varieties were tested six times during the months December 1927 and January 1928, four tubers of each variety being used on each occasion. Thereafter only the varieties in groups 1 and 3 were compared, eight tests being made during the months of February and March 1928, five tubers of each variety being used on each occasion.

With the exception of slight differences in degree of varieties in the intermediate group, the results were consistent. Towards the end of the storage period there appeared to be a slight diminution in the amount of melanin formed, but the individual varieties still retained their relative positions.

It was found also that these differences may be correlated with the intensity of the reddening on the cut potato surface. This latter action, however, is slower and does not give such clearly defined results as that under consideration.

Application of the Test.—The blackening of potato tissue by the method described, and also the reddening of the tissues exposed to the open air, may be used in separating stocks of the varieties of group 1 from those of group 3. The method has no value for the detection of rogues, but it provides useful evidence of the identity of a variety, the information given in group 3 being especially valuable. In making such tests it is desirable to use a control of a group 1 variety.

(2) **The Tyrosinase Reaction.**—As previously noted, the red colour which forms on cut potato slices is due to the oxidation of the substance tyrosine by an enzyme. Para-cresol is similar in its chemical constitution to tyrosine, hence it was to be expected that it also would be oxidised by the enzyme. Para-cresol has therefore been used in tests on a large number of tubers.

Method.—Slices of potato tubers were cut as before and to the surfaces were applied, either by a dropper or small brush, a few drops of a 0·2 per cent. solution of para-cresol. The tests were carried out in a laboratory where the average daily temperature was 40° F. The red coloration which developed appeared in about ten minutes, and during these tests readings were taken at the end of fifteen minutes. If the slices be left longer the colour differences become less pronounced. Table IV gives the results.

TABLE IV.

The Tyrosinase Test.

1. Red.	2. Intermediate.	3. Pale Pink.
Bishop.	Abundance.	Arran Victory.
British Queen.*	Ally.	Dunottar Castle.
Crusader.	Arran Chief.	King Edward.*
Edzell Blue.	Eclipse.	
Katie Glover.	Great Scot.	
King George.*	Harbinger.	
President.	Majestic.	
	May Queen.	
	Sharpe's Express.	
	Up-to-date.	

* Almost intermediate.

These tests were begun in February and continued through March without any appreciable variation being noticed.

Application of the Test.—As in other tests, the reaction of any variety fluctuates about a mean, and varieties have been placed into three groups. Stocks of the members of groups 1 and 3 can be compared with certainty. The range of variation of the individual varieties is greater, however, in this test than in the alkali and oxidase tests, and occasional lighter-coloured tubers are found in group 1. Deep red tubers, however, have not been found in any group 3 variety, hence the occurrence of such a tuber in a variety of that group may be taken as evidence of an impurity. Here again all tables provide useful information concerning the identity of varieties.

The Nicotine Test. — Advantage has been taken of the destructive effects of alkaloids on vegetable tissue. When sections, cut as in the previous experiments, are steeped for two minutes in a 20 per cent. solution of nicotine and then exposed to the air, the results are not always the same; the cortex, or band of tissue next the skin, in some varieties turns gradually brown and in about thirty minutes black, while that of other varieties appears to be quite unaffected. The blackening may be regarded as due to the action of the liberated enzymes, and in those varieties where no colouring appears it may be assumed that the destruction of tissue has been slight. Further investigations, however, will be necessary before the full details of the reaction can be elucidated.

Unfortunately the fact that different reactions existed was only found late in April when the writer's stocks were almost exhausted. Nevertheless sufficient observations are believed to have been made to determine that some varieties may be differentiated by this method.

Further trials will be necessary to ascertain whether or not the results are constant throughout the storage season.

Negative Results.—The following tests have failed to reveal substantial intervarietal differences :—

1. For tyrosine. (Millon's reagent.)
2. The reducing power of tissues. (Methylene blue.)
3. Oxidising agents.
4. Reducing agents.
5. Common acids in various degrees of concentration.
6. Hydrogen-ion concentration of the cell-sap.

With regard to the last mentioned (6), it is interesting to note that (*a*) the heel ends of tubers are generally less acid than the remaining tissue; (*b*) the majority of potato varieties give acid reactions, but some, e.g. King George, are outstanding because they contain a high percentage of neutral, or nearly neutral, tubers; and (*c*) the reaction of the tuber appears to depend to some extent on the environment in which the tubers were grown.

Conclusion.—The tests enumerated afford useful and simple means for differentiating the tubers of many potato varieties, but the investigations described may be regarded as preliminary in nature, and the reactions to the various chemicals of many more varieties will require to be determined. On the other hand, sufficient information has been obtained to warrant the assumption that perhaps more might be done in differentiating varieties by chemical means. In consequence it is proposed to continue and extend these investigations.

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THE BIOLOGIST on the FARM.—No. XXX.

Prof. J. Arthur Thomson, M.A., LL.D.,
University of Aberdeen.

Carrier Pigeons.—There are many remarkable features in the familiar achievements of carrier pigeons. Thus everyone knows that the homer is a domesticated variety of the wild Rock Dove (*Columbia livia*), which is still common on some parts of the west coast of Scotland and also in Yorkshire. But the remarkable feature is that this wild pigeon is a resident in Britain, and is not much of a migrant in Europe. Thus man has educed a noteworthy homing capacity in a bird which is on the whole a stay-at-home except for short distances. Educationists need not despair even when their material is not what would be called " promising."

There is, no doubt, considerable variability in the hereditary endowment of carrier pigeons, but the essential feature seems to be whether they are able to learn. The all-important quality is educability. The important part of the training is the graduated series of lessons in the topography of the region round the home. As our knowledge increases, the need for postulating a mysterious " sense of direction " is receding for the carrier pigeon, as it has receded for ants and bees. There is probably some enregistration of movements, which is often called " muscle memory " ; but the main factor in finding the way home seems to be the previous thorough learning of the geography lessons. A third fact of importance is that when the return journey presents some difficulty, e.g. in traversing new country, the carrier pigeons usually take a surprisingly long time for the distance. In other words, there are probably many tentatives and mistakes that are unknown save to the birds themselves.

Taste in Bees.—Thanks to the very careful work of men like Prof. K. von Frisch of Munich, we are gradually reaching some certainty in regard to the various senses of hive bees. Recently he has been studying their taste, which varies greatly from bee to bee, just as it does from man to man. Some bees are indifferent to a cane-sugar solution of about 17 per cent., while others are attracted by a 4 per cent. solution. Moreover an individual bee's " sweet tooth " varies from time to time in its sensitivity, even within the short duration of its summer life in and out of the hive. Professor von Frisch never saw a span of more than four weeks outdoor activity.

The observer kept bees without food, but with plenty of water, for a day or so, and then tried them with sugar solution. All took an 8 per cent. solution; some condescended to 4 per cent., but none would stoop to 2 per cent. It follows that the limit or threshold of the bee's taste-sensitiveness is a little under the 4 per cent. strength. But this limit may be extended by mixing with the sugar solution some other substance of another taste which does not increase the actual sweetness. As always happens in these precise inquiries, the state of affairs turns out to be much more subtle than it seemed at first sight. Thus such non-sugary substances as saccharin and dulcin, which taste sweet to ourselves, are not approved of by bees. Moreover there are several sugars, such as xylose, sorbose and cellobiose, which are not sweet to bees, while mannose, also not sweet, acts as a poison. It seems that slight changes in the chemical architecture of a sugar may make a great difference in its taste; and it is certain that sweetness does not necessarily spell sugariness.

Plant Communities.—When a flattish stone is dredged from the floor of the sea, in the Firth of Clyde let us say, it is often seen to be the home of a dozen different kinds of animals, such as sponges, zoophytes, moss-animals or Bryozoa, tube-inhabiting worms like Serpula, flat bivalves like the False Oyster, small sea-squirts and so forth. In the same locality the same dozen animals may be found on a dozen different stones, though every now and then there is something quite novel in the little group. Now, so far as we know, the sameness in these successive associations is mainly due to the fact that the same kind of stone and surface suits the same types of animal, whether actually fixed or creeping sluggishly among the crevices. But there is rarely any evidence that the members of the little group are helped by one another in a definite way. There is no community bond.

But it is far otherwise among plants, for one of the ideas that seems to have come to stay in modern botany is that of " communities." There are frequently recurring plant-associations where the members work to some extent into one another's hands, where the bonds are so real that the group is sometimes

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compared to an organism. Thus there are communities in a grass land and in a homogeneous forest which make for success, as is seen in their competition with other communities, in their powers of spreading, and in their treatment of intruders. The point is that the members of the plant association are often bound together to their mutual advantage, forming not a crowd, but a community.

Monkey Glands.—The whole aspect of physiology was changed soon after the beginning of this century when Bayliss and Starling defined the idea, and demonstrated the fact, of chemical messengers or hormones which are secreted by ductless or endocrine glands, and, being swept through the body by the blood, regulate the harmonious working of other organs. No doubt, as is usually the case, there were anticipations of this idea of chemical messengers by the genius of Claude Bernard (say 1859), and by the daring experiments of Brown-Sequard (say 1889) and of Berthold in 1849; but the credit of realising the important controlling and harmonising function of the ductless glands is to the credit of Bayliss and Starling.

It must be understood, to begin with, that ordinary glands such as the pancreas or sweetbread, which makes three digestive ferments, have ducts which carry away the secretion they manufacture. But the secretion of the ductless or endocrine glands can be carried away only by the blood-vessels. These break up into fine branches in such endocrine organs as the thyroid, the parathyroid, the supra-renals, and the pituitary body, and they carry away the hormone secretions. As a gland with a duct the pancreas makes digestive juices which pass into the duodenum (the beginning of the small intestine); but the islands of Langerhans in the pancreas secrete the hormone insulin which is carried away by the blood, and regulates the treatment of the sugar.

Another introductory point must be made clear. Two generations ago it was usual to speak of the essential reproductive organs (the ovaries and the testes) as the reproductive glands. To this it was objected that since the ovary is the seat of the production of egg-cells, and the testis of sperm-cells, they should not be called glands, since glands make secretions. Thus those who cared for precision dropped the term reproductive glands and spoke of reproductive organs or gonads. But now we know the old term was more correct than those who used it were aware. For the ovaries and the testes of backboned animals include or may include interstitial glandular tissue which produces hormones. These are distributed through the body by the blood, and they serve to activate the appearance of secondary sex-characters, or to inhibit their expression, as the case may be. Thus the male frog's swollen first finger, the decorations of male birds, the antlers of stags do not develop unless the tissue concerned receives a stimulus from a masculine hormone proceeding from the testes. The hormone is not in any way formative; it is an activator or trigger-puller.

Similarly the milk-glands of a female mammal are activated by a reproductive hormone, and in many cases an ovarian hormone acts as an inhibitant of masculine features which may normally lie latent in the female's inheritance. Thus a duck that has lost its ovary may put on a drake's plumage at the next moult. A hen whose ovary is diseased or abnormal may begin to crow and to exhibit other characteristics of the cock.

Dr. Voronoff was impressed by the flabbiness, inferior intelligence, early senility, and relatively short life of Egyptian eunuchs, and attributed these features to the absence of the normal testicular hormones. Similarly he was impressed by the tendency to early decreptitude and the like in castrated mammals. So just as thyroid deficiency in man is counteracted by treatment with preparations made from the thyroid glands of mammals (or nowadays from synthetised thyroxin), Voronoff suggested that the experiment should be made of grafting reproductive glands into the ageing organism. The transference of a reproductive organ from one individual to another of the same species is no novelty; thus it was successfully effected twenty-five years ago by Dr. F. H. A. Marshall, Reader in Agricultural Physiology at Cambridge, and it has been repeatedly successful since. But Voronoff was able to effect the transference of chimpanzee or of baboon testes into man, and apparently with very good results,—as regards memory as well as muscles, as regards will-power as well as blood-pressure.

But most of Voronoff's successes (we know too little of the failures) have been between animals of the same species. Thus a decrepit ram, grafted at twelve years, renewed its youth in three months and was vigorous till it was twenty. Dr. Marshall vouches for the re-invigoration of an enfeebled Algerian bull, which was in good fettle four years after the graft. In the case of immature male sheep, whose reproductive hormones have not begun to tell, Voronoff claims that a testicular graft hastens growth and increases general vigour, affecting for instance the quality and length of the wool. But there are many possible snags in these investigations, and while the Austrian experimenter's work is of great interest, there is need for scientific caution. Let us hasten slowly.

Parthenogenesis.—This is one of Nature's shortcuts. It means the development of an egg-cell without being fertilised by a sperm-cell. It is not a primitive state of affairs, but has arisen secondarily among animals, and more rarely among plants, in types whose ancestors presumably showed, as their relatives certainly show, the ordinary mode of development from fertilised egg-cells. It was first proved, we believe, by the Swiss naturalist Bonnet, who showed in 1762 that the summer generations of green-flies or Aphids are all females, no males occurring for months. It is possible to have at least four years of continuous virgin birth without any male being present. In the beehive it is well known that the drones have a mother but no father. Yet they have a grandfather, namely the father of the queen.

There are three classes of animals in which parthenogenesis is very common, namely—(*a*) among the Lower Crustaceans or water-fleas; (*b*) among rotifers, where it is the rule; and (*c*) among such insects as gall-flies, saw-flies and green-flies. To prove its occurrence it is not sufficient to say that males are absent, for some males are minute and elusive pigmies that readily escape detection. The convincing proof is when isolated females produce eggs that develop normally. Even then great care must be taken, for a pigmy male sometimes lurks inside the female! There are two or three oceanic angler-fish where the female carries the minute male about with her,—under her gill-cover for instance. But there is no uncertainty as to the occurrence of parthenogenesis in the groups we have mentioned.

On the other hand, parthenogenesis is often in evidence although males are present. Among the minute Rotifers or wheel-animalcules the pigmy and rather degenerate males sometimes effect insemination, and yet the eggs are not fertilised. In some members of the rotifer class the males have never been found. In many gall-flies there is an alternation of ordinary and parthenogenetic reproduction; in many water-fleas fertilisation occurs at intervals in a series of parthenogenetic generations.

Parthenogenesis occurs in isolated species here and there. Thus it is known in Solenobia, a wingless relative of the clothes-moths, and in Bacillus rossii, one of the quaint stick-insects that thrives well in greenhouses in this country. Among the threadworms or Nematodes there are many instances of parthenogenesis; and one gets the general impression that, as an alternative, egg-cells of many different kinds can fall back on aspermic development, either occasionally, or periodically, or habitually. Parthenogenesis does not occur naturally among backboned animals, but it can be readily induced by artificial stimulus in frogs' eggs. The fatherless froglings are not obviously different from those that develop from fertilised ova. It would be rash to say that artificial parthenogenesis—by chemical or physical stimulation—cannot occur in organisms higher than frogs; but there are as yet only whispers of this among the experimenters. It must be remembered that the discovery of artificial parthenogenesis does not go further back than about the beginning of this century, when it was proved for sea-urchins and the like by Delage and by Loeb.

There is something puzzling in the cropping up of parthenogenesis in so many different corners of the animal kingdom. It has not been discovered that any peculiarity characterises those ova that are normally able to develop without being fertilised. There is no necessary degeneration associated with a long-continued or even perpetual parthenogenesis. Rotifers are minute, but the females are certainly not degenerate. Some instances of variability have been recorded in the course of parthenogenetic generations, which shows that dispensing with fertilisation need not imply a full stop to further evolution. It may be that parthenogenesis, being a shortcut, favours rapid multiplication, so that in conditions of abundant food the variants exhibiting parthenogenesis would automatically tend to survive. It may also be that parthenogenesis is a distinct advantage in species where, for some obscure reason, the males are few and far between. But it must be confessed that in many, if not most, cases it is impossible at present to find a utilitarian justification of the parthenogenetic departure from the typical course of sexual reproduction.

But if the question be asked why there should be males at all if it is possible for so many different kinds of females to continue the race single-handed, part of the answer would be that having two parents is on the whole better than having only one, since there is a pooling of two inheritances, so that the father may compensate for some deficiency in the maternal contribution. Another part of the answer is that cross-fertilisation is one of the conditions of new departures or variations—the raw materials for further evolution. Another larger reason for the ordinary process of sexual reproduction may be found in the fact that the egg's usual need for fertilisation is wrapped up in most cases with the occurrence of dimorphic sexes, with reproductive division of labour, and that great consequences—psychical as well as physical—have followed from this primeval dichotomy. Sex has been a powerful factor in organic evolution.

Parthenogenesis in Plants. — Many plants multiply by asexual propagation. Thus some of the liverworts give off minute buds which are washed away by the rain, and start for themselves when they are landed on a suitable place. Even some of the duckweeds, which are the smallest of flowering plants, may multiply asexually in the pool. But this is not what is meant by parthenogenesis; it is merely a relapse into asexuality.

Many Algæ and Fungi, besides liverworts and mosses, ferns and horsetails, produce asexual spores which develop without being fertilised. In liverworts and mosses (*Bryophytes*), in ferns and horsetails (*Pteridophytes*), these spores typically produce a sexual generation with egg-cells and sperm-cells. The fertilised egg-cell develops into the asexual spore-producing generation, such as we ordinarily call fern-plants and horsetails. This is the interesting phenomenon known as alternation of generations, and comparable to the alternation between fixed asexual hydroids and free sexual medusoids among animals. Now it is difficult to separate off these spore-cells from parthenogenetic ova. This difficulty is well illustrated by the intricate life-history of the liver-fluke, so important to sheep farmers, for the larvæ living in the freshwater snail multiply precociously by means of spore-cells, which are practically indistinguishable from parthenogenetic egg-cells.

But, as we have seen, the established usage is to keep the term parthenogenesis for cases where an egg-cell develops without being fertilised, although males are represented in the species or in nearly related species, or although ordinary development from fertilised ova may sometimes occur in the same species. Parthenogenesis is a shortcut; it is the aspermic development of an egg-cell. Our question is whether this true parthenogenesis ever occurs in plants, and the answer is that it does, but very rarely. The development of an egg-cell without fertilisation is seen in *Chara crinita*, one of the water stoneworts, which is represented in Northern Europe by female plants only. But it is a surprising fact that parthenogenesis has come to be the rule in the common dandelion and in some of its relatives, the hawkweeds, belonging to the genus *Hieracium*. It also occurs in a few other types, e.g. species of Lady's Mantle (*Alchemilla*) and *Antennaria*. No one can say that dandelions don't thrive on their parthenogenetic regime!

Man as Conqueror.—We are such strange mixtures of inertia and initiative that it is often necessary to stress one aspect of a practical problem in order to excite endeavour. As Tennyson said: "Reversion is ever dragging Evolution in the mud"; and therefore we must be always sounding the danger-signal. It is easier to drift than to swim, so we broadcast warnings. Thus it is often that the Biologist on the Farm has spoken of the cloud that is so apt to gather in man's sky when insects get the upper hand. These rapidly reproducing creatures are a menace to the whole world, and there can be no relaxation in man's efforts to conserve the natural balance that keeps them in check. In an interesting paper on insect immigrants, Professor G. W. Herrick tells us that more than a hundred different species have come to America from other countries. On his return voyage from a visit to Europe he was interested to see on the breakfast table one morning a lively female of the clover-leaf weevil, which had taken her passage from Cherbourg or Southampton, and, had not the entomologist intervened, would probably have settled in the States like previous members of her species. How difficult it is nowadays to exclude these unobtrusive aliens, and how much harm they can do when they settle down. We need only mention the gipsy moth, the San Jose scale, the brown-tail moth, and the Mexican cotton-boll weevil. The immigration continues, and Professor Herrick speaks of the recent American worries due to the appearance of the European corn borer, the Oriental peach moth, the Japanese beetle, the Asiatic beetle, and the twilight beetle. Of course, the immigration is not all in one direction, for one recalls the Colorado beetle and the Grape Phylloxera, both of which passed from America to France and proved exceedingly destructive. In view of these and a hundred similar facts, one realises the folly of relaxing carefulness. It is not foolish to be afraid lest insects get the upper hand.

On the other side, however, account must be taken of man's conquests, and Professor Herrick closes his paper on a cheerful note.

From 1860 to 1870 there was great anxiety because of the spread of the Colorado potato beetle from the Rocky Mountains to the Atlantic Coast. "Fifty years after, we are still growing potatoes more abundantly than ever, and the beetle is rarely a subject of inquiry on the part of the growers." From 1890 to 1902 the San Jose scale threatened to ruin certain fruit crops. "Twenty-five years after, we are not greatly concerned about the San Jose scale in New York State, and nowhere in the country does the insect seriously curtail the production of good fruit." From 1900 to 1920 it was feared that the Mexican cotton-boll weevil was going to ruin cotton growing in America. "Yet in 1926 the United States produced by far the greatest cotton crop in all its history." These are useful and encouraging statements, for while the three insects named are still causing enormous losses, man is gaining and keeping the upper hand. By putting brains into the business he is proving himself a conqueror. And to this everyone, except the Father of Flies, will say Amen.

PIG TESTING.

The Results of Preliminary Work on Bacon Type.

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While faulty methods of marketing and lack of standardisation of the finished product contribute greatly to the depressed condition of our bacon industry, an equal, if not more serious weakness, is the unsuitability for the production of first class bacon of the large majority of the pigs we put upon the bacon market. Yet it cannot be disputed that we possess stocks of breeding pigs of the finest bacon type. What we need is some standard of merit in conformity with bacon requirements, so that the best bacon strains may become more generally sought after for breeding stock. Our show standards have served, and are still serving, a useful purpose in maintaining the breed characters and impressiveness of our breeds, but bacon type is not receiving the attention merited by its economic importance.

The Testing Station is undoubtedly the most effective means of co-ordinating all information concerning the economies of bacon production. With regard to our need to improve the average quality of our home-produced bacon, it should be especially valuable in demonstrating which breeds, breed crosses and strains within breeds are the most suitable material for the production of the best class of bacon. The principal function of Testing Stations, as in operation in other countries, is not only to determine suitability for bacon purposes, but also to measure economy of live weight gain and prolificacy, and to discover strains with the best combinations of these three all important economic factors. The Board of Agriculture in conjunction with the Animal Breeding Research Department have established the first Pig Testing Station in this country at West Mains, Edinburgh, and this station is now ready to commence testing operations.

For the past two years the Animal Breeding Research Department has maintained at West Mains a herd of pedigreed pigs, mainly Large Whites and Middle Whites. In order to get experience of the working of the Pig Testing Scheme, and especially for the purpose of getting the method of the slaughter records properly adjusted before the Scheme came into operation, two litters from our farm stock were put on test. One litter consisted of pure-bred Large Whites and the other of pure-bred Middle Whites, both litters being typical of their respective breeds. While it was fully realised that the Middle Whites were not likely to conform to bacon requirements, the choice of litters from these two breeds was made so as to represent as closely as possible the range of type of pigs marketed for bacon purposes. Eight pigs were farrowed in each of the two litters; there were no deaths either at the time of farrowing or afterwards, and there were no crits. We were particularly fortunate in having such uniform conditions to commence with. The Middle Whites were farrowed on July 5th and the large Whites on August 19th of last year, and, although there was an interval of six and a half weeks between the two farrowings, both lots reached the desired bacon weight at the same time. Each litter was divided into two lots, and the four pens of sixteen pigs were reared under the same conditions of housing, feeding and general management. The composition of the rations fed was varied in accordance with live weight and each pen of pigs received as much food as they could clean up. A ration of simple composition was used, the constituents being barley meal, parings and fish meal. The fish meal was discontinued for each lot after the average weight reached 120 lbs. By the middle of February of this year both lots averaged approximately 190 lbs. live weight, at which stage, mainly because of the apparent tendency towards the slowing down of growth and the excessive laying on of fat in the Middle Whites, it was decided that they should be sent to slaughter. Through the kindness of Messrs. Cavaghan & Gray, Ltd., of Carlisle, we were offered every facility and assistance for the carrying out of the slaughter tests at their bacon factory.

Rate of Development and Economy of Live Weight Gain.—Although these pigs were reared and brought to market weight during the winter months their development was not impeded by colds, cramp or any other ailment. All the pigs were fed up to their full consuming capacity, and consequently a fair comparison can be made of the two lots as regards their relative rate of development and economy of live weight gain. On 21st February, the date when the pigs were despatched to the factory, the Large Whites, then 26 weeks 4 days old, averaged 190 lbs. live weight, while the Middle Whites, then 33 weeks old, averaged 192 lbs. The average live weight increase per day in the Middle Whites was 0·83 lbs., while in the Large Whites it was 1·02 lbs., or, in other words, the Large Whites put on weight approximately 20 per cent. more rapidly than did the Middle Whites. Of course it must be remembered that we were dealing with a single, though representative, litter from each of two breeds, and while we refrain from dogmatising as to the relative merits of the breeds, it is interesting to observe how much more rapidly the Large Whites gained in weight than did the Middle Whites.

As regards financial return to the producer, no matter whether pigs are being kept for bacon or pork purposes, ability to make live weight gain economically is the most important qualification for the keeping of any breed or strain within a breed. This necessitates recording the consumption and the composition of the rations fed. In addition to the record of the food consumed by these two test lots, allowance was made for the productive ration fed to the sows during the suckling period, and this was fixed at 1 lb. of meal per pigling per day up to the time of weaning. The accompanying table shows the relative economy of live weight gain of the two litters.

TABLE I.

Average Economy of Live Weight Gain.

Breed.	Live weight at time of slaughter in lbs.	Weight of food consumed in lbs.	Lbs. of meal consumed per lb. of live weight increase.	Cost of food consumed per capitum, at 1¼*d.* per lb.
Middle Whites ...	192	785	4·09	£4, 1*s.* 9*d.*
Large Whites ...	190	676	3·56	£3, 10*s.* 5*d.*

From this it will be observed that the Large Whites consumed approximately 14 per cent. less meal per lb. of live weight gain than did the Middle Whites, and consequently there was a corresponding difference in the cost of feeding in favour of the Large Whites. During times such as the present, when it is difficult to realise prices for commercial pigs that will cover the cost of production, a difference of 11*s.* 4*d.* per head in the cost of feeding different litters to the same weight and under the same system of feeding and general management is an economic point worthy of careful consideration when further selection of breeding stock takes place. In cases such as that under discussion, the labour involved in recording food consumed and live weight increase would be well repaid if the breeder used the information obtained along with accurate knowledge of other economic points, such as prolificacy, as a guide to how he may best work upon a utility basis of selection.

Preliminaries to Slaughter.—In order that the loss in weight due to transit and the slaughter tests might be strictly comparable for the two groups, it was necessary to select so as to get the average weight in the two lots sent for slaughter as nearly

PLATE No. 1.

Typical Pigs sent to Carlisle. On the right Large White, in centre Middle White.

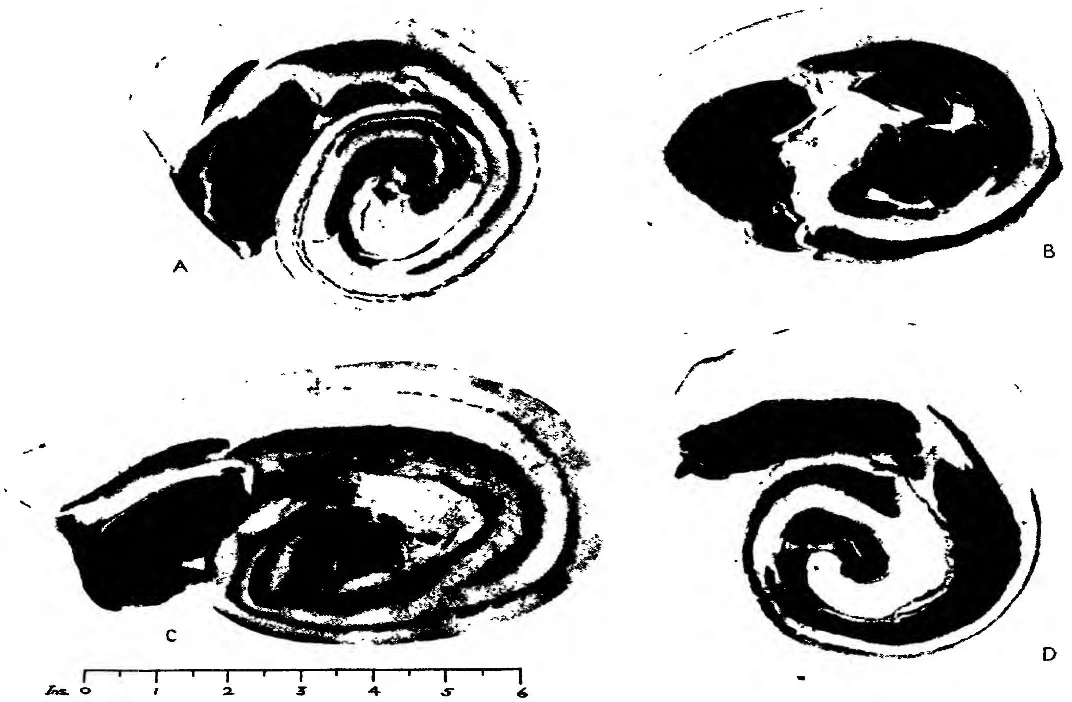

PLATE No. 2.

Above—(A) Large White Shoulder Roll. (B) Large White Ham Roll.

Below—(C) Middle White Shoulder Roll. (D) Middle White Ham Roll.

Note the small amount of fat in the Large White, superiority of streak in the Middle White, better marbling in the Large White.

equal as possible. Consequently the selection for slaughter consisted of six Large Whites averaging 190 lbs. live weight and six Middle Whites averaging 190·5 lbs. live weight. The pigs were weighed about one hour before being loaded on the railway lorry, this being about four hours after the pigs received their last feed. They were railed at Edinburgh on the afternoon of February 21st and reached Messrs. Cavaghan & Gray's bacon factory during the early forenoon of February 22nd, when individual weights of the pigs were again taken.

Table II shows the weight lost in transit and the slaughtering percentages.

TABLE II.

Weight lost in Transit and Slaughtering Percentage.

Average for each lot of six.

	Middle Whites.	*Large Whites.*
Weight lost in transit	12·5 lbs.	10·66 lbs.
Percentage loss live and dead weight ...	21·5 per cent.	24·83 per cent.
Percentage loss dead weight to fresh bacon	33·96 per cent.	34·54 per cent.

It will thus be observed that the Middle Whites lost during transit almost 2 lbs. per head more than the Large Whites. The greater loss in the Middle Whites may have been due to the fact that they were in higher condition than the Large Whites, and that they were less strong in the legs and consequently may have been more knocked about. As regards both percentage loss live to dead weight and percentage loss dead weight to fresh bacon the Middle Whites scored over the Large Whites; in the first case probably because at the weight of 190 lbs. the Middle Whites were the more mature, seeing that the percentage of offal which, according to Smithfield records, decreases with maturity; and in the second case mainly because of the finer bones of the Middle Whites, as will be shown in the table of carcase analysis.

Observations on the Carcases.—After the carcases were halved a careful examination of the sides was made. The most striking difference between the sides from the two lots of pigs was observed in the thickness of the back fat. Measurements of the back fat were taken (*a*) at the shoulder, (*b*) above the last rib, and (*c*) at the loin. The average thickness of the back fat in the Middle Whites was approximately 2 inches and in the Large Whites only 1¼ inches. The back fat of the Middle Whites was much too thick for the bacon trade, and Messrs. Cavaghan & Gray had to pare an average of approximately ¾ inch of back fat from these sides so that the bacon would be of a more saleable quality. The proportion of fat to lean in the sides of the Large Whites was ideal, but the fat appeared to be not quite so firm as that of the Middle Whites, due, probably, to the fact that at this light live weight of 190 lbs. the Large Whites were rather immature. While the streak in both lots was good, that of the Middle Whites appeared to be slightly superior. Measurements of the lengths of sides were taken from the front of the aitch-bone to the top of the first rib. The average length of sides in the Large Whites was approximately 30 inches and in the Middle Whites 28 inches, thus indicating that a greater proportion of the bacon in the Large Whites fell within the range of the dear cuts than in the case of the Middle Whites. The hams were equally good in both lots, but at the low priced shoulder end the Large Whites carried a much smaller proportion of meat than did the Middle Whites.

TABLE III.

Carcase Analysis and Costs of Fresh Bacon.

Per lots of 6 pigs: Totals for each lot.

Received by Breeder.	*Middle Whites.*						*Large Whites.*					
6 pigs—live weight ...	1.144 lbs.						1,140 lbs.					
,, dead weight ...	64 st. 2 lbs. at 9*s.* 6*d.* = £30 9 4						61 st. 3 lbs. at 9*s.* 6*d.* = £29 1 7					
Valued by Curer.	*Cwts.*	*qrs.*	*lbs.*	*£*	*s.*	*d.*	*Cwts.*	*qrs.*	*lbs.*	*£*	*s.*	*d.*
Heads at 2*d.* per lb. ...	0	1	16	0	7	4	0	1	19	0	7	10
Skins at 3*s.* 6*d.* each ...	0	3	7	1	1	0	0	3	10	1	1	0
Ribs at 2*d.* per lb. ...	0	1	23	0	8	6	0	2	10	0	11	0
Knuckles at 2½*d.* per lb.	0	1	3½	0	6	7	0	1	11	0	8	2
Bones at ½*d.* per lb. ...	0	0	15	0	0	7	0	0	20	0	0	10
Trimmings at 5*d.* per lb.	0	0	10	0	4	2	0	0	10	0	4	2
Kidneys at 8*d.* per lb.	0	0	3½	0	2	4	0	0	3½	0	2	4
Lard at 5*d.* per lb. ...	0	0	26	0	10	10	0	0	17½	0	7	3
				£3	1	4				£3	2	7
Cost of Fresh Bacon to Curer.												
24 quarters— (*a*) Middle Whites cost 97*s.* 8½*d.* per cwt. (*b*) Large Whites cost 103*s.* 7½*d.* per cwt.	5	2	12	27	8	0	5	0	1	25	19	0
				£30	9	4				£29	1	7
Untrimmed fresh bacon costs	97*s.* 8½*d.* per cwt.						103*s.* 7½*d.* per cwt.					
Fat trimmings at 5*d.* per lb.	0	1	7	£0	14	7	Nil.					
Trimmed bacon costs 100*s.* 9*d.* per cwt. ...	5	1	5	26	13	5						
				£27	8	0						
Net cost of fresh bacon	100*s.* 9*d.* per cwt.						103*s.* 7½*d.* per cwt.					

From the carcase analysis it will be observed that in dressing the sides to the stage of untrimmed fresh bacon the Middle Whites gave a smaller proportion of all the items of secondary offal except lard. Yet the aggregate value of the secondary offal from the Large Whites is only 1*s.* 3*d.* greater than that from the Middle Whites, because the Large Whites were least economical in the lowest priced items of secondary offal, viz., the ribs and the knuckles; the lard—the only item of secondary offal in which the Middle Whites yielded the greater proportion—was of more than double the value of ribs and knuckles per unit of weight. The superiority of the Middle Whites in respect of value, and especially of weight of secondary offal, resulted in the bacon costing less than that from the Large Whites; the Middle White untrimmed fresh bacon cost 97*s.* 8½*d.* per cwt. as against the Large White 103*s.* 7½*d.* However, the fat trimmings which it was necessary to remove from the back portion of the Middle White sides increased the cost of the bacon to 100*s*. 9*d*. per cwt., while the cost of the bacon from the Large Whites remained at 103*s*. 7½*d*. per cwt., no fat trimmings being necessary. As against this difference in cost of 2*s*. 10½*d*. per cwt. it was estimated, as will be explained later, that the Large White bacon was of more value to the retailer than the Middle White bacon by at least 1*d*. per lb. in the cheap cuts and 2*d*. per lb. in the dear cuts. Further, when it is taken into consideration that the Large Whites cost 11*s*. 4*d*. per head less to feed and that they came to market weight in 6½ weeks less time than the Middle Whites, with a consequent reduction in labour, housing, and bedding expenses, it will be obvious that, of the two litters under test for bacon production, the Large Whites gave much the better returns to the producer.

Testing the Bacon.—The bacon was put through the Ayrshire cure and was not specially processed in any way. Through the kindness of Mr. Watt, of J. Laing, Provision Merchant, 57 Clerk Street, Edinburgh, and the Atholl Crescent School of Domestic Science, we were enabled to test out the relative cooking qualities and palatability of the bacon from the two lots of pigs. A shoulder roll and a ham roll from a representative carcase of each breed—four rolls in all—were purchased by Mr. Watt. In order to estimate the proportion of cheap to dear cuts the following measurements of the rolls were taken : (1) length; (2) circumference at 6 inches from the back end of the shoulder roll and at 6 inches from the front end of the ham roll in each case, this giving the relative sizes of the middle cuts, and (3) the circumference at 9 inches from the front end of the shoulder roll and at 9 inches from the back end of the ham roll in each case, this indicating the relative proportion of shoulder and ham bacon. The most striking difference between the two sets of rolls was in respect of the much greater amount of shoulder bacon in the Middle Whites than in the Large Whites. The hams were of about the same dimensions in both cases, but there were about 2½ inches more of middle cuts in the Large Whites than in the Middle Whites. Although about ¾ inch of fat trimmings had been pared off the back portion of the Middle White sides, the Large White bacon was much leaner and better mixed. Plate No. 1 shows a representative cut from each of the four rolls. Two lbs. of representative cuts from each roll—8 lbs. in all—were sent to the Atholl Crescent School of domestic Science, where expert judgment was given as to the relative cooking qualities and palatability of the samples of bacon from the two breeds.

It was stated that the Large White bacon was best both in the shoulder and ham rolls, and that its superiority was largely due to the fact that the rind of fat almost entirely melted out in the cooking, whereas the fat of the Middle Whites, although more in quantity, did not melt out to the same extent, thus giving a much more fatty bacon. The Large White bacon was much more crisp, broke across easily and required very careful cooking. As would be expected, the ham bacon in each case was of much better quality than the shoulder bacon. The ham bacon, however, was slightly salter than the shoulder bacon. Twelve households co-operated with us in testing the quality of the bacon and in ten instances preference was shown for the Large White bacon, while in the other two instances, a fatty class of bacon being preferred, the decision was given in favour of the Middle White.

Economic Aspects of the Cooking Tests.—In the first place it should be again emphasised that the following comments do not allude to the Large White and Middle White breeds in general as regards their respective suitability for bacon purposes, but only to the relative bacon qualities of the litters chosen as apparently representative of these two breeds. While the Large White bacon was reckoned to be of the better quality, it must be recognised that this was mainly consequent upon the heavy loss of fat in the cooking. This raises the question of economy to the consumer. Each ½ lb. of the Large White bacon lost 4 ozs. in the cooking, whereas the Middle White bacon lost only 2½ ozs. It would appear that for those who in general prefer a lean type of bacon irrespective of any heavy loss that may take place in cooking, the bacon produced by these Large Whites supplied the desired article; on the other hand the Middle White bacon would seem to be well suited to the requirements of those who favour a fatty type of bacon, which (1) is much more economical in the cooking, (2) is more sustaining and supplies more energy than the lean kind, and (3) costs less owing to its greater fatness and consequent lesser demand. Thus it might be deduced that for those who prefer a fatty type of bacon the bacon from these Middle Whites met such a requirement economically. This deduction, however, requires to be qualified by taking into account the fact that about ¾ inch of back fat was trimmed from the sides of the Middle Whites before curing. If no back fat had been trimmed off there is little doubt that this bacon would have been too fatty even for the majority of those who have a preference for fat.

Conclusion and Acknowledgments.—These preliminary tests have been made (*a*) to enable us to discover in what respect the proposed scheme of recording may be improved and to have the recording system finally adjusted before any official tests are carried through, and (*b*) to demonstrate to pig breeders the working principle of the Pig Testing Scheme. While these two tests are not in any way claimed to show the relative potential values for bacon purposes of the Large White and Middle White breeds, they nevertheless provide a good indication of the possibilities of the scheme as a means of discovering differences between breeds, strains within breeds and breed crosses as regards (1) suitability for bacon and (2) economic bacon production.

Finally, we have much pleasure in acknowledging our indebtedness to Messrs. Cavaghan & Gray, Ltd., Harraby, Carlisle, for the splendid facilities they afforded us for the carrying out of the slaughter tests and for giving us the benefit of their expert judgment in all matters relating to the slaughter tests. We also express our thanks to Mr. Watt, of J. Laing, Provision Merchant, 57 Clerk Street, Edinburgh, and to Miss de la Cour, Principal of the Edinburgh School of Domestic Economy.

INSECT PESTS.—No. II.

R. STEWART MACDOUGALL, M.A., D.Sc.

INSECTS INJURIOUS TO FARM ANIMALS (*continued*).

IN the last issue of the JOURNAL the family *Oestridæ*, the bot and warble flies, had been reached, some description being given of the horse bot fly and the sheep-nostril fly. There remain for special notice two species of the genus Hypoderma, viz. *H. lineatum* and *H. bovis*, the warble flies of cattle. Before describing these it should be stated that in the Highlands and in Aberdeenshire there is a handsome black-brown and yellow Oestrid species whose larvae are found in the nostrils and pharynx of the red deer. This is the Deer nostril or throat fly (*Cephenomyia auribarbis* var. *rufibarbis*). The deer show alarm in the presence of these flies, whose females lay their maggots in the deer's nostril. The maggots become full grown in the back of the deer's throat, from which, on attaining full growth, they are coughed out.

The Ox Warble Flies.—*H. bovis* measures just over half an inch in length and suggests by its hairiness and its colour a small humble-bee (there are only two wings, however). The mouthparts are rudimentary and the flies are unable to wound or to feed. The other species, *H. lineatum*, is a shade smaller. In *H. bovis* the forebody has whitish or yellow and black hairs, and the end of the abdomen is orange yellow or lemon yellow. In *H. lineatum* the forebody is not so hairy and has dark lines running down it; the tip of the abdomen is reddish orange. Both species are found in Scotland and are also well known in England and Ireland. The larvae or maggots are internal parasites of cattle, and the buying and introduction of store cattle from other places may serve, should such cattle be parasitised, to keep up or add to the numbers of the parasite. Examination of cattle from Canada at the port of arrival and also when distributed, on sale, over farms, has proved the presence of the larvae of both *H. lineatum* and *H. bovis* ready to fall away for pupation. Of the two flies *H. lineatum* is found on the wing three weeks or a month earlier than *H. bovis*. Roughly speaking, *H. lineatum* is in flight and busy with egg-laying in the early part of the summer, and *H. bovis* in the later summer with intermediate overlapping. The flies do not give out a loud buzzing note as do the larger Tabanids (see back), but a distinct low hum is characteristic, and this, with the come and go of the flies as they lay their eggs on the beast, alarms the cattle and sends them careering over the field or paddock. Hadwen has told us that animals that chance to be confined in a rather limited area get so pestered by the flies that, tired out, they lie down, stubbornly behaving as cattle do that "are reluctant to be driven."[1] Cattle visited by or chased by the Hypoderma flies intent on laying their eggs on the hairs of the animals seek water into which they wade, and may stand in the water—quite shallow

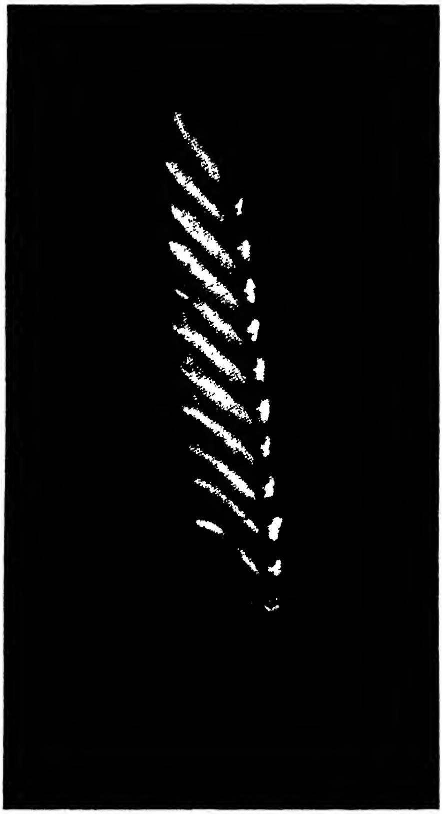

FIG. 1.
Eggs of *H. lineatum* attached to a hair. (After Carpenter.)

water—for hours. Hypoderma does not follow the cattle over water. The small oval eggs have at one end an appendage or stalk which is grooved on one side; the groove fits neatly over the hair, the egg being further fastened by a sticky secretion given out by the female at the time of laying of the eggs; the sticky matter dries and glues the egg to the hair. A female Hypoderma in the course of her life—a week or fortnight, or perhaps more if conditions be favourable—lays a large number of eggs. The eggs of *H. bovis* are attached one egg to a hair and low down on the hair; *H. lineatum* lays a series of eggs—seven to twelve

[1] Warble Flies, by Dr. Seymour Hadwen in *Parasitology*, March, 1915.

or fourteen or so—close together about the middle of the hair.[1] The eggs are very small and are difficult to see and to find, as they tend to be concealed by the overlapping hair. The eggs are laid on the hairs of the leg, well down (hence the name heel fly), but sometimes higher up, and it may be on the lower part of the body. Hadwen[2] has observed *H. lineatum* laying her eggs on an animal lying down :—" The insect ran backwards like a crab, reached upwards from the ground and oviposited about six inches below the point of the ischium, where the cow's body touched the ground. From this point it laid eggs at intervals all along the side touching the ground as far forward as the elbow." The eggs hatch in six or seven days. The larva or maggot, by means of a sharp spine projecting in the centre between its mouth-hooks, makes a rent in the end of the eggshell and creeps out. What happens next has been much debated, but Carpenter's experiments in Ireland and the observation of American and Central European workers prove that the larva, crawling down the hair, directly enters the skin, and then for nine to ten months, out of the twelve months taken for the life-cycle, the larva lives internally in the animal affected; for about seven months the larvae are quite lost to view. Tiny entrance holes indicate the places invaded by larvae; a slight exudate follows, and the lesions may be for a short time painful and the cause of irritation, as indicated by the kicking and impatience of the infected animal, and the constant licking of the places where the larvae have entered. Soon the slight scab that results dries and scales off.

From the place of entry the little maggot, by aid of its cutting mouth-hooks and spiny armature, makes its way from the leg upwards and forwards until the gullet is reached. From September onwards till January and February the maggots may be found in numbers in the submucosa of the gullet, in the loose tissue of which they move about. After some months' residence in the gullet wall the maggots continue their wanderings, in the course of which various regions of the animal are visited. From January onwards through the spring the larvae reach the tissues under the skin of the back by various routes. Swellings appear on the back along each side of the middle line, with sometimes considerable inflammation. At each swelling a larva is present which makes an opening through the skin to the outside. At first the opening is very small, but it becomes larger by pressure from the larva, whose hind or hard spiracular end is pushed against the opening. Up till now the larva in its two or perhaps three different stages has been provided with cutting mouth-hooks, but soon after reaching the back a moult takes place resulting in a larva with greatly reduced mouth-parts, the hooks being mere rudiments. There is no more cutting and moving about by the larva, and the tissues form an encystment sac under cover

[1] The Biology of Insects, by George H. Carpenter (Sidgwick & Jackson).
[2] A further contribution on the Biology of *H. lineatum*. Dep. of Agric., Canada, Scientific Series, Bull. No. 21.

of which the larvae rapidly increase in size, nourished on the products of the ulceration produced by their irritating presence; the larvae lie horizontally in this cell or cyst with the hind spiracular or breathing end close to the outside opening. In this position still another moult takes place and the larva attains the final form so well-known to the farmer. On the completion of the last moult the now barrel-shaped larva is pale in colour with dark spiracles, but as the days pass the outside cuticle darkens and the spiracles become quite black. During the last two stages organisms from the outside may enter and a pus-like matter may accumulate, which, exuding from the external opening, mats

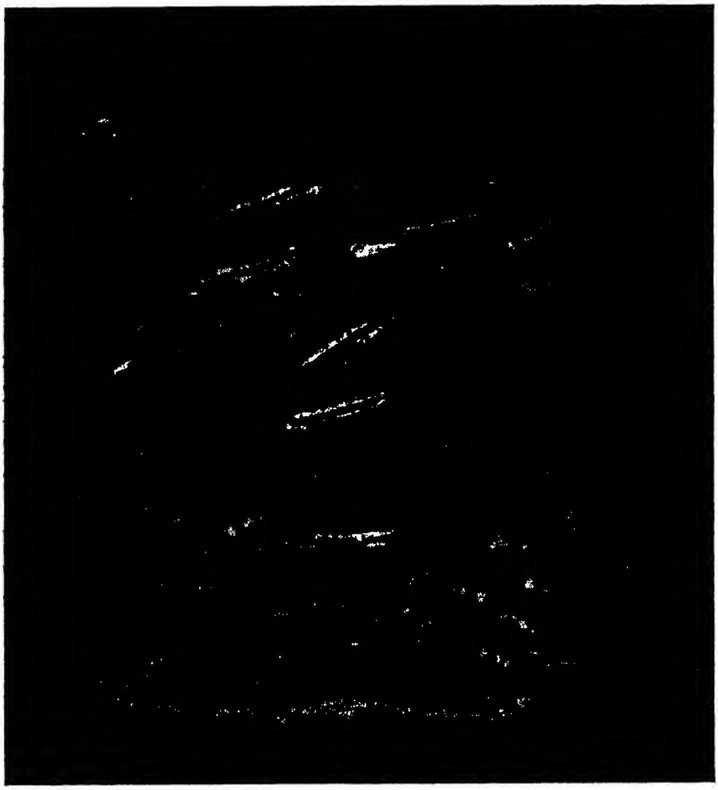

FIG. 2.
Gullet of Ox showing early stage larva of *H. lineatum*.
Natural size. From nature.

together the surrounding hairs and dries into a small scab. In our experiments against the larva this scab or plug sometimes prevented, and often interfered with, the entrance of the experimental washes. From the chamber or encystment sac in the back I have in April found on two occasions the larva in the third last stage. Numerous second last stage larvae of both species of fly have been obtained, and the final stage in all ages. Larvae in the final stage are seen in Fig. 3, and those of the two species may be contrasted thus :—

H. bovis.

Larva not so spiny.

The second last joint has no spines either on upper or lower surface.

The third last joint has spines on the under (the rounded) surface but none on the upper (the flatter) surface.

The hind or spiracle-bearing joint has the spiracles somewhat cup-like or depressed.

H. lineatum.

Larva with stronger armature.

The second last joint has spines both on upper and lower surface.

The third last joint has spines both on under and upper surface.

The spiracles tend to jut out so that the end of the larva has a somewhat more pointed appearance.

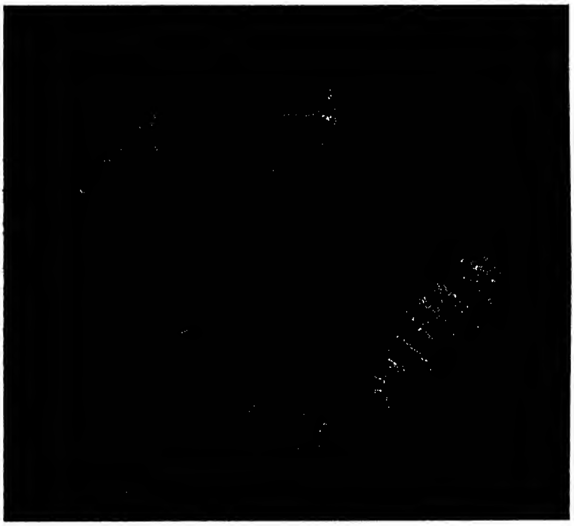

FIG. 3.
Larvae of *H. bovis* in last stage.
From nature.

In time the full-fed larva presses itself, with muscular effort, out of the hole in the skin, hind end first, and having fallen to the ground moves to a place of shelter, say under cover of soil litter or into loose soil, where the outermost spiny skin contracts, becoming hard and dark, to form a puparium or pupal case under cover of which the fly is perfected. The length of the pupal stage is a month to six weeks. When the fly is ready it pushes off the front end of the puparium and walks out; soon its wings expand and it takes flight. The boundary of the lid which is pushed off by the issuing fly is marked by a seam or line easily seen by aid of a hand lens.

The life-cycle just detailed is most probably the same for *H. bovis* and *H. lineatum*. The early stage bovis larvae, however, may not take up their residence in the gullet, as the larvae of lineatum do, but may wander elsewhere. We have taken numbers of lineatum larvae from gullets without ever finding a bovis larva. There is considerable mortality in both species in the larval stage before reaching the back, on reaching the back, and on leaving the cell in the back.

Harm done and loss due to Warble Flies.—1. The cattle alarmed by the fly run wildly about instead of grazing peacefully, and the excitement has a bad effect.

2. Where milk cows are excited and gallop about the milk suffers in quality and quantity.

FIG. 4.
Under side of warbled skin. The cysts are shown in each of which a larva lies. From nature.

3. Badly infested animals do not thrive. As tested experimentally, removal of the larvae has resulted in the animals' better progress.

4. When warbled animals are slaughtered and the carcases dressed there is loss. The inflammation due to the presence of the larvae in the warbles extends to the connective tissues and to the flesh. The inflamed tissue has a straw-coloured jelly-like appearance which after exposure to the air turns a dirty-green colour, and all this has to be scraped away.

5. There is great annual loss from hides spoiled or ruined for tanning purposes.

6. There is considerable pain and discomfort to a badly attacked beast, first, during the cutting of the larvae from the eggs into the skin, as evidenced by the irritation of the affected beast, and later from the presence of the larvae in their different stages.

Treatment.—Natural Control.—In Britain few or no direct observations have been made regarding our insectivorous birds and mammals in relation to the full-grown larvae and pupae of the warble flies, nor is there any proof that the pupae are parasitised. In the United States, where these warble flies have been studied very thoroughly, certain birds are known to take the larvae and pupae.[1] Continued wet weather during the flight period of the flies is unfavourable to them. In the spring of 1923 we had no difficulty in getting experimental material, but warble fly damage was much less marked in 1924, and the observations in the open agreed with examination of the hides passing through the abattoir in Edinburgh. The lessened infestation was due, at least in part, to the unfavourable weather conditions in summer 1923, unfavourable that is to the warble flies and their egg-laying.

In byres and cattle courts there must be a high mortality among the larvae after these have fallen away from the animal owing to such larvae being trampled on, or killed by being covered with dung.

Artificial Control.—Little or no success can be chronicled as to attempts to repel the flies and prevent their egg-laying by means of oils or evil-smelling applications. The Departmental Committee on the Warble Fly Pest[2] tested some sprays and dressings but nothing practicable can be recommended. A great disadvantage was the cost in labour for dressing, because repeated treatment was necessary and over a long period of time, as some flies might be in flight, first lineatum and then bovis, throughout the summer. One of the substances which had some success was birch-tar oil, but it took a long time to apply and was disfiguring to the cattle. In the United States experimental cattle have been made to wade frequently through a vat containing an arsenical or other insecticide, the aim being to destroy the percentage of eggs laid low down on the legs, but so far this has not proved a satisfactory method of control.

Destruction of Larvae in the backs of Cattle.—This is the best and most practicable way of combating the warble flies. The larvae are reachable through the hole that leads to the cell or cyst in which they lie; they are confined to a definite area on the back and they can be fought there during a definite season, March or April to June. Most advantageous would be the squeezing out, through the hole in the skin, of the last stage larvae and their destruction. If this were regularly and generally practised there

[1] The Cattle Grubs or Ox Warbles, their Biologies and Suggestions for Control, by F. C. Bishopp, E. W. Laake, H. M. Brundrett, R. W. Wells. U.S. Dep. of Agriculture, Bull. No. 1369.

[2] Report of the Departmental Committee on Warble Fly Pest. Ministry of Agriculture and Fisheries, His Majesty's Stationery Office, 1926.

would quickly result a very great diminution of the pest, and where there was no constant introduction of new warbled cattle from elsewhere the warble flies would cease to be a problem. The practice of this measure would be onerous at first owing to the number of cases and the period, April to June at least, over which the last stage larvae can be found. The predominantly arable farmer of, say, East Lothian or Fife, not rearing his own stock, having no land to spare for grazing in the summer, and buying cattle in autumn to feed off his own turnips and straw, may object that the dressing of his bought-in cattle in order to destroy the warble larvae will not result in a progressive diminution of the fly, because the cattle bought in the next autumn may come from a badly infected warble area. A reply to this is that attempted annihilation must be a general undertaking. Where, however, the farming is not predominantly arable and where cattle are reared to a considerable extent, and grazed where reared, it is sure that warble larvae destruction, regularly practised, must result in the diminution of the fly.

In Ireland and in Scotland and England[1] a great deal of experimental work has been done with substances applied to the backs of infested cattle in order to kill the larvae, and mention is here made of those that proved successful.

(*a*) Tobacco-powder and Lime, viz. :—4 lb. tobacco-powder, 1 lb. lime, 1 gallon water.

Mix the fresh lime in a gallon of water and to this add the 4 lb. of tobacco-powder and allow to stand for 24 hours. Strain the liquid through coarse muslin or sacking and apply by means of a brush, or a sponge, or a syringe with strong nozzle. A high percentage of larvae were killed and there were no ill-effects on the cattle either to health or hide. This dressing should be used soon after preparation as it deteriorates on keeping.

(*b*) Derris (Kurmange).

The powder was used in the strength 1 oz. to a quart of water and 1 oz. to a pint of water. Derris is a leguminous plant of the East, where preparations of the roots have long been in use as a poisonous insecticide. The experimental work in this case was done by a skilled veterinarian, a stout syringe being used and application made individually to each warble, any scab or matted hair being first removed so as to leave the opening in the skin clear. The larvae were squeezed out for examination some days after treatment, 378 out of 440 being killed by the weaker strength of Derris and 581 out of 614 treated larvae by the stronger.

(*c*) Nicotine Sulphate 2 fluid ozs.; Calcium Hydrate 1 lb.; Water 1 gallon.

Measure out the nicotine in a glass or celluloid measure.

[1] **Report of the Departmental Committee on Warble Fly Pest. Ministry of Agriculture and Fisheries, His Majesty's Stationery Office, 1926.**

Place the lime in a receptacle, add the water gradually, stirring thoroughly, and then add the nicotine sulphate. It should be prepared only when required, as it does not keep.

Iodoform Ointment.—In the United States this ointment—1 part iodoform to 5 parts vaseline—is in use for application to the openings in the skin under which the larvae lie. During the spring and early summer of 1927 this ointment was tested on a small scale in some Scottish counties and gave satisfactory results.

In other tests in the United States[1] very successful results attended the following different dressings :—benzol and carbon tetrachloride injected into the cysts; derris in dry form and as an ointment with petrolatum; derris in suspension in water injected into the cysts; derris applied as a wash; pyrethrum and petrolatum as an ointment; very fine tobacco dust and nicotine dust used in powder form.

We had opportunity of testing, in spring and early summer of 1927, Hypoderma Oil, a dressing in great favour in Denmark. This can be recommended. It was more successful against the younger larvae than against the last stage larva near the end of its larval life. Where more than five larvae on an animal were treated, the animal evidenced a slight irritation by tossing its head and by attempting to lick the dressing, by lifting its forelegs, and sometimes by lying down. In five or seven minutes all signs of irritation had passed and there were no after-effects such as falling out of hair.

Treatment for destroying larvae in the cysts would require to take place at least four times in the season.

The Brodersen suction pump, patented in Denmark, for extracting the larvae was tested by us, but could not be described as successful.

One is often asked whether the holes in the skin heal up after the larvae have left the back naturally, and what happens when the larvae are killed in the cysts by any of the ointments or washes. With the live animal in good condition the contents of the warble are absorbed after the larva has left and the holes heal over. In observations made as regards this in the United States,[2] " the time required for healing of holes where the grubs emerged normally ranged from about 13 to 76 days." Any plug of foreign matter naturally retards healing. If the larvae die under the skin after treatment by washes then they are gradually absorbed, especially if they are in a sufficiently early stage before their external cuticle has become markedly chitinised. Killed larvae are often expelled from the skin. In our experimental work, in a day or two after treatment the dead larvae were often seen standing up out of the holes previous to their falling away altogether; the hardened skin of a full-grown larva may not be thrown or washed off and so plugging the hole may prevent healing.

[1] United States Dep. of Agriculture, Bull. No. 1369 (previously cited).
[2] Ibid.

Sometimes the opening at the cyst becomes plugged up by scab-exuded pus and matted hair, in which case very marked abscesses appear and the closed-in larva dies. In our experimental work we found considerable mortality from this cause.

Anaphylaxis and Rose Fever.—In 1917 Hadwen and Bruce[1] described experiments showing how the experimental injection into cattle of extracts of warble fly larvae resulted in toxic symptoms that sometimes proved fatal. Hadwen also describes cases where such anaphylactic shock resulted from the breaking of larvae in the skin. In 1919 Brodersen[2] described somewhat similar symptoms in sick cattle as the result of breaking the larvae in attempting to squeeze them out of the back. Brodersen

FIG. 5.
Under side of hide of Red Deer showing the cysts in each of which lies a larva of *H. diana*.
From nature.

termed the ailment, which soon passes, Rose Fever. In all our experiments against the larvae no complaint has ever been made of Rose Fever. In several cases larvae up to 20 in separate animals were deliberately broken and the animals kept under observation by the veterinary surgeon. No ill effects were noticed, and in the case of two cows there was no falling off in milk.

Our warble flies are well known on the Continent and in America, and the question of the elimination of the pest has been taken up seriously in Denmark, Belgium, Germany and Switzerland. In Britain the matter is being urged by the butcher and the tanner. In Denmark and Switzerland legislative action has

[1] Anaphylaxis in Cattle and Sheep produced by the Larvæ of *H. bovis* and *H. lineatum* and *Œstrus ovis*. *Journal of American Veterinary Medical Association*, vol. li.; n.s., vol. 4, No. 1, April 1917.

[2] Om Rosenfeber hos Kvaeg. In *Mannedsskr Dyriasger*, Part 31.

been taken. The conditions are more favourable, for example in Denmark, for application of remedial treatment, and this practised regularly and for some years has resulted in considerable reduction of the pest.

The Deer Warble or Bot Fly (*Hypoderma diana*).—This is a smaller grey-brown species with yellow hairs on the abdomen; the larvae are found in spring in swellings under the skin of the back of the red deer and the roe deer; the infested pelts are spoiled for commercial purposes, e.g. glove-making.

The Family Hippoboscidæ (from the Greek *hippos* a horse, and *boskein*, to feed).—The flies of this family have become adapted to an external parasitic life; they are blood-suckers in the adult stage on mammals and birds. The larvae are nourished in the body of the mother and are put to the outside ready for pupation. Examples are the forest fly of the horse, which is winged and a fairly good flier; the ked of the deer,

Fig. 6.
Sheep Ked from nature, greatly magnified.

which is winged on issuing from the pupal case but, after finding a host, the female at any rate, loses her wings, which break off near their base, mere stumps remaining; and the sheep ked, which is wingless.

The Sheep Ked or Kade (*Melophagus ovinus*).—This insect is parasitic on sheep and goat. The colour is red-brown, and the body shows the usual insect division into head, thorax, abdomen. The head is small and fits into the thorax; it carries two compound eyes, a pair of sharp antennæ sunk in cup-like pits, and the mouth-parts. The proboscis is concealed by the two palps. The wound is made by two armed lobes or labellæ at the tip of the gutter-like labium or lower lip; the labium, grooved on the upper surface holds the other mouth-parts, namely a delicate labrum-epipharynx and a tubular threadlike hypopharynx which come close together and lock to form a tube up which the blood is sucked; the hypopharynx allows saliva to pass down. The thorax has the usual three divisions, each carrying a pair of strong hairy legs; the legs end in claws and a plume-like projection, specialisations for clinging to the wool. The abdomen is large, sac-like and flattened, narrowed in front and widened behind; down each side of the abdomen are breathing pores. The keds live among the wool and pass their whole life on the sheep, migrating from one sheep to another when such happen to be in contact, or passing to lambs with their longer wool at shearing time. They soon—in a week or less—die if removed from the host, on which they depend for warmth and feeding. The females do not put their eggs to the outside, but the egg hatches internally into a legless unsegmented maggot, which is nourished in the body of the mother. The full-fed larva is then put to the outside ready for pupation; the puparia or pupal-cases are chestnut-brown and are glued to the wool by a gummy secretion from the female, which dries and hardens. In a month, or a little less or more, according to the environment, the mature ked pushes its way out from the front end of the puparium. The number of larvae produced by a ked in the course of its life may reach twelve.

How Keds affect their Hosts?—When present in numbers on a sheep the keds are a cause of great irritation, and this with loss of blood makes sheep and lambs fall away in condition and become weak, emaciated and unthrifty. Further, the wool is soiled and is partly spoiled by the sheep rubbing and scratching themselves.

Control.—Keep clean sheep apart from ked-infested sheep. Remember how at shearing time keds come away with the wool, to which lambs should not have access.

The best remedial measure is dipping. Any of the ordinary proprietary dips are satisfactory. As a rule the dips that contain arsenic are the most preferable. Puparia, however, are not destroyed, and therefore a second dip at three weeks' interval should follow the first so as to destroy keds that have issued from puparia that survived the first dipping, and to destroy them before they have had time to produce in their turn larvae ready for pupation. Abroad sometimes three dippings take place at intervals of 14 days.

The Forest Fly (*Hippobosca equina*).—This is another Hippoboscid of the fly sub-order *Pupipara* (preparers or bearers of pupae). These flies are very troublesome in the New Forest, other parts of the South of England, and in some districts in Wales, partly from their blood-sucking habit and partly by the way that horses and ponies are irritated and restless owing to the forest fly's grip and curious mode of movement over the hairs.

Fleas: Order Siphonaptera.—Fleas are external parasites of warm-blooded animals, viz. the birds and mammals. Some confine themselves to one host and others may be found on hosts of different kinds, but even these have their favourite host animal. The fleas of birds do not willingly take mammalian blood, while fleas frequenting mammal hosts neglect birds. The females of one section of fleas when preparing to lay their eggs fix themselves to the skin of the host and proceed to enter the skin, giving rise to an ulcer through which the tip of the abdomen is extruded for the laying of the eggs; for example the Jigger or Chigoe of South America, but now carried into various parts of the tropical Old World where it is a pest of human beings and also of the pig.

Structure of Flea.—The body is flattened laterally; there is a small head, a thorax with the three joints free, and a 10-segmented abdomen. The head has two simple eyes, a pair of antennæ protected in pits, and the mouth-parts; the mouth-parts are fitted for piercing the skin of the host; the parts forming the piercer lie in a gutter-like underlip; the parts of the piercer fit together to enclose a tube up which the blood from the wound is pumped by a muscular pharynx; this blood is passed down the gullet and through the gizzard to the stomach; provision is also made for the carrying of saliva to the wound. The thorax carries three pairs of legs of which the uppermost joint is characteristically enlarged; the legs are fitted for leaping. The student of medicine sometimes wonders why it may be important to know that in experiment certain fleas have been known to jump 13 inches in length and 7 inches high (these are record distances), but some fleas act as the carriers of parasites that cause dire or troublesome diseases, and it is well that beds and patients be out of reach of the lively flea. Each leg ends in two claws. Fleas are wingless. On the upper surface of the second last joint of the abdomen is a plate-like or cushion-like sense organ. All over the flea one finds, under the microscope, bristles and spines, and these—sometimes arranged in rows to form a comb—are used in distinguishing flea from flea.

There are nearly fifty different kinds of flea in Britain. Here we shall only notice the flea of human beings, the flea of the dog and the flea of the cat. Under the microscope these three fleas can be distinguished thus :—

A. No comb-like spines on each side of head and no comb on joint behind head. *Pulex irritans*, the flea of human beings.

B. A comb on each side of head, and a comb on joint behind the head. The genus *Ctenocephalus* (= comb-headed).

a. The Dog Flea (*Ctenocephalus canis*), with a shorter head, viz. the head less than twice as long as high.

b. The Cat Flea (*C. felis*) with the head longer, viz. head twice as long as high.

Life History.—The female, after pairing and a meal of blood, lays her eggs among the hairs of the host; the small, oval, translucent eggs are not cemented to the hair or fur and fall away easily. The sleeping-mat of a dog may harbour many eggs. From the egg, in four days or longer according to the temperature, there hatches an elongated wormlike legless larva, which escapes from the egg by breaking the shell by means of a spine on its forehead (this egg-breaker disappears after the first moult); the larva has jaws by which it feeds on organic debris which it finds in its hatching place or in any collections of refuse, and also nourishes itself, it may be, on half-digested blood voided by the parent; the body of the larva bears a series of hairs and spines, and by means of these, wriggling active movement is possible; when resting, the larva or maggot assumes a coiled position. The larvae avoid the light and so are found in such shelter places as seams in the floor, in rubbish, under carpets, in the bedding of kennels. Two moults take place in the course of the larval life, which may be completed in a week or just over in very favourable temperature conditions, but may be lengthened out to a month or more in unfavourable conditions. The full-grown larva spins a cocoon of silk—generally covered by dust and debris—under cover of which pupation takes place. The adult when ready—in a week or more—issues from the cocoon. Probably a month represents on the average the life-cycle of a flea.

Economic importance.—Fleas are blood-suckers and when in numbers are a source of considerable irritation to the host. The flea of the dog acts as the intermediate host of a troublesome and not uncommon tapeworm of dogs (*Dipylidium caninum*) and accidentally also of human beings, especially children (the flea of the cat may also carry the young stage of this tapeworm).

One of the rat fleas in the East (*Xenopsylla cheopis*) is the common carrier of the parasite of plague. Plague—the Black Death of the fourteenth century and the Plague of London in 1665—is due to a bacterium known as *Bacillus pestis*. Normally this bacillus lives in the blood of the rat and infected rats die in numbers. The rat flea becomes infective by feeding on plague-stricken rats, and, reaching man for a feed of blood, is able to infect him with the bacillus of bubonic plague. *Pulex irritans* and the dog flea are also capable of acting as carriers of the plague bacillus. There is constant oversight in Britain of any plague cases that may come from the East, and a careful watch of rats on vessels in case they may harbour the plague bacillus. This is one of the sanitary problems of our great ports. Elaborate precautions are taken to prevent the introduction of plague to London, Liverpool and other ports. Any vessel which may have called at an infected port is visited on arrival at a home port by a sanitary inspector and a medical officer. Rats are taken and their blood examined by a bacteriologist for the presence of the plague bacillus. Rat guards are placed on the hawsers that moor the lines and other precautions are taken.

Pulex irritans does not confine itself to man but sucks the blood of the dog and other animals, while the dog and cat flea also feed on man.

Control of Fleas.—Fleas are not likely to prove troublesome when there is constant disturbance of eggs and larvæ by regular cleaning :

> Where chamber is sweeped and pyrethrum is strown
> Not a flea for its life doth abide to be known.

It will be clear that sleeping-mats and beds of dogs and cats are likely places for flea eggs and larvae, and so are tacked down carpets, which afford good shelter. There should be regular and repeated sweeping, with the burning of the sweepings. Infested domestic animals should not have free access indoors. Dogs and cats so infested should be dusted with fresh pyrethrum powder or be bathed in a slightly warm 2 per cent. solution of creolin (the eyes of the treated animal should be protected). An emulsion of paraffin and soft soap is a good cleanser of a flea-infested kennel. Flake or powdered naphthalene is an excellent insecticide; it should be spread on the floor where fleas are active or suspected, and the room kept closed for a day.

Note.—Figs. 2, 3, 4, 5 and 6 are Dr. Stewart MacDougall's figures, by courtesy of the Highland and Agricultural Society.

Quality in Potatoes.

THE following article has been contributed by Mr. Wm. M. Findlay, N.D.A., North of Scotland College of Agriculture.

Of all the foods used in this country, none is so cheap as potatoes. It is, moreover, the only crop that is produced in sufficient quantity to meet the requirements of the population. Every year, however, complaints are made by housewives regarding the poor cooking quality of many lots and the difficulty of getting supplies of uniformly good quality.

There may be differences of opinion as to what is meant by quality. In England, in most cases, kinds that are soft and soapy seem to be preferred, but this may be due to some extent to the suitability of such kinds for their diverse methods of cooking. On the other hand, most people in Scotland generally prefer a nice mealy, well flavoured potato, and we shall consider this point of view.

Possibly the chief reason for poor quality nowadays is that growers usually pay comparatively little attention to it, but concentrate their energies in getting a good yield. This is a mistake, as there is no doubt that poor quality limits consumption. If the quality were uniformly good, many people would eat more and hence increase the demand.

During the last year or two in connection with the potato trials carried out at Craibstone a considerable number of boiling tests have been made, and the following are the conclusions that have been arrived at from these and from general observation.

Good or poor quality, as a rule, is not the effect of any one cause, but is generally due to a number of conditions. Some of the conditions favour good quality while other conditions favour poor quality, and the result will vary accordingly.

The following are the chief factors that affect the quality :—

1. Variety.
2. Kind of soil and season.
3. Maturity—
   (a) Time of planting,
   (b) Sprouting the seed.
4. Manuring.

Variety.—While certain varieties are generally regarded as being of better cooking quality and some of poorer quality than others, it should be kept in mind that the conditions may be such that even what are considered the best may be of poor quality, while on the other hand a combination of good conditions may, in some cases at least, make what are usually considered poor ones quite fair. Very often an opinion regarding the quality of a variety may be formed by the growing of that particular variety under a particular set of conditions. Another person may have quite a different opinion of the same variety when it had been grown under another set of conditions.

We often hear elderly people refer to the fine quality of potatoes in their young days, such varieties as Old Long Blue, Pink Eye, Fortyfold, Rocks, Cups, &c., and complain that they never get the same quality nowadays. While these were good, we now have varieties that are quite as good and of higher cropping capacity.

In considering the relative quality of different varieties, it should be assumed that they are all grown under the same conditions, that the conditions for quality are fairly good and that the tubers are ripe when lifted.

The following list gives what the cooking tests have generally shown when all varieties were grown under the same conditions.

EARLY :—

Good.—Duke of York, Di Vernon, Harbinger, Mein's Early Round, Edzell Blue, Witchhill, Early Pink Champion.

Fairly good.—America, Immune Ashleaf, Sharpe's Express, Early Eclipse, Dargill Early, Arran Rose, Herald.

Fair.—Puritan, May Queen, Epicure, Katie Glover.

Poor.—Ninetyfold.

SECOND EARLY :—

Good.—British Queen, Arran Comrade, Abundance, Great Scot, Nithsdale, Tinwald Perfection.

Fairly good.—Queen Mary, Crusader, St. Malo.
Fair.—Giant Marvel, King Edward, Ally, Majestic.
Poor.—Evergood, King George.

MAINCROP AND LATE :—

Good.—Arran Victory, Irish Queen, Arran Chief, Arran Consul, Champion, Kerr's Pink, Golden Wonder, Langworthy, Early Market.

Fairly good.—Bishop, Up-to-Date, Field Marshal, Roderick Dhu, President, Templar.

Fair.—Achievement, Lochar.

Poor.—Irish Chieftain, Northern Star.

Certain varieties are favourites in different districts. For example, the preference for King Edward in England is well known. In Ireland for many years Champion was the favourite, but its place is now largely taken by Arran Victory. In several parts in the East of Scotland the fisher people must still have Champion. During the last year or two Kerr's Pink has been almost the only variety exposed for sale in shops, and taking its cropping power into consideration, this is possibly the safest maincrop variety to plant for the production of ware in this part of the country at the present time.

The high price of Golden Wonder compared with other varieties indicates the favour in which it is held in many quarters. No doubt if this variety were a heavier cropper and could be produced more cheaply it would be more largely consumed. Trials have shown that heavier yields could be obtained without affecting the quality, if well sprouted seed of a mosaic-free stock were planted about the beginning of April and a heavy dressing of artificial manure applied. It is well known that, owing to its slow sprouting characteristic, Golden Wonder is pre-eminently useful for late summer consumption.

Several little known, comparatively poor cropping varieties of good quality, like Kepplestone Kidney, are grown locally for the grower's own use.

Kind of Soil and Season.—A few years ago sufficient clay, peat and sand were procured to make up plots alongside each other, so that crops of potatoes could be grown under these different soil conditions, the other factors of climate, cultivation and manuring being the same. The primary object of the trial was to test the effect of the different soils for " seed " production, but the opportunity was taken of testing the cooking quality. The varieties grown were Di Vernon, Great Scot, Kerr's Pink and Golden Wonder. Every season the tubers of all these varieties grown on the sandy soil were of better quality than those grown on either the peat or clay. In 1925 and 1926 there was not much difference between the clay and peat, but in 1927, when the rainfall was high, the quality of the tubers grown on the clay was distinctly poorer than of those grown on the peat.

Generally, the fine quality of potatoes grown on sandy soil is well known. Certain farms have got a name for producing potatoes of good quality while, on the other hand, other farms have a name for poor quality.

It is a well known fact that potatoes are of better quality in a dry season than when the rainfall, especially during the period before maturity, is high. In the same way, in districts where the rainfall is generally low, such as in the East Coast of Scotland and along the coast of the Moray Firth, the quality is better that it is in inland districts where the rainfall is generally higher. For example, the high reputation that the red soil potatoes from the Dunbar district of East Lothian have for quality is due to the combination of the sandy nature of the soil and the low rainfall (round about 24 in. per annum). *Dry conditions favour good quality and wet conditions poor quality.*

Maturity.—No potato is at its best until it is fully matured. Immature tubers contain a larger amount of water than mature tubers. Everything should therefore be done to ensure that the tubers reach maturity before they are lifted. In many cases, however, maturity is never reached. In the case of early varieties, tubers are lifted and sold as soon as they are considered large enough, in order to get the high price obtaining then, and at the beginning of the season they are usually in a very watery condition. At this time, however, those who buy early lifted tubers—chiefly Epicure—are not at all fastidious regarding the quality. In fact, many say they like the characteristic flavour of a new potato. However, when home-grown Duke of York, which are usually better in quality, come into the market a higher price is obtained (locally at least) for them, indicating that they are considered of better quality.

In the case of late varieties, which are always liable to be frosted down or to have the leaves destroyed by blight when they are at the height of their growth, long before they reach maturity, it is essential that the seed should be planted fairly early in the season, and also that they should be well sprouted. This is more particularly essential in late districts.

Time of Planting.—Trials have been carried out during the past seven seasons with Great Scot and Golden Wonder planted at fortnightly intervals commencing at the beginning of March. Every season, whether wet or dry, the tubers of both varieties planted early were much drier than those planted late, there being a gradual deterioration in quality from the earliest to the latest planting. So far as the weight of the crop is concerned, there was generally little difference between those planted from the middle of April to middle of May, except in 1927, when the April plantings were best. Possibly the best time to plant, keeping both crop and quality in mind, would be about the beginning of April if unsprouted and the middle of April if sprouted, and if the soil is in a suitable condition.

Sprouting.—Most potato growers are satisfied that sprouting is an advantage with early varieties, as not only is the crop ready for lifting much earlier, but the yield is also considerably increased. Notwithstanding the large number of experiments that have been carried out, and which have invariably showed increases in yield, the value of sprouting late varieties does not seem to be fully appreciated.

In the above trial with Great Scot and Golden Wonder half of each were sprouted, the other half being unsprouted. While with the early plantings sprouting did not make much difference, in the case of the medium and late plantings the quality was considerably improved. In fact, even with Golden Wonder, those that were unsprouted and planted late were of very poor quality. Golden Wonder naturally sprouts so slowly in spring that if it is planted late without previous sprouting in boxes it very rarely reaches maturity, hence the complaints sometimes made regarding its quality. *Early planted sprouted seed gave extremely dry mealy potatoes, while late planted unsprouted seed of the same varieties gave wet soapy tubers.*

Some varieties have the valuable characteristic of being of good quality before they are fully ripe. For example, British Queen is often lifted when the shaws are quite green, but if the weather previously has been comparatively dry the tubers are likely to be of excellent quality.

Among late varieties, Kerr's Pink and Arran Victory are varieties which appear usually to be of good quality even although the shaws are down before they are mature. It is undoubtedly for this reason that these varieties have become so popular of late years. In seasons when blight is prevalent spraying, by prolonging the period of growth, also helps to improve the quality, especially of maincrop and late varieties.

Manuring.—Many people are of opinion that artificial manures have an adverse effect on the quality of potatoes. This general statement is not altogether correct. What the tests have shown is that the excessive use of nitrogenous manures and the use of badly balanced mixtures have a detrimental effect.

In trials where different amounts of a complete, well balanced mixture were used, the tubers from plots with no artificials were distinctly inferior and soon turned black after cooking, while where up to 9 cwt. per acre were used, the quality was much improved and the tubers remained white for a considerable time.

Of the nitrogenous manures, sulphate of ammonia has been found to produce the best quality. When not more than 1 to 1½ cwt. is used, depending on the variety of the potato and the amount of phosphate and potash included, there has been little effect on quality. Varieties that are naturally good in quality stand more nitrogen without appreciably affecting the quality than poor varieties.

When nitrate of soda and nitrate of lime were used there was a greater detrimental effect on the quality, unless where comparatively small amounts were used.

Possibly one reason why the Ayrshire Epicures are generally of such a wet and soapy nature is that large quantities (up to 3 or 4 cwt.) of a nitrogenous manure are usually applied.

Of the different phosphates that have been tried, superphosphate has practically always proved to be the best for quality. The omission of phosphates from the manure mixture had a distinctly adverse effect on the quality.

A large number of tests have been made in several different seasons with the different kinds of potashes, and the results showed great differences. Every season where no potash was used the tubers in the case of many varieties turned black even during the process of cooking. In dry seasons there was not much difference between the sulphate and muriate of potash, but in seasons of greater rainfall the sulphate was distinctly superior and the colour of the potatoes when boiled was better.

The low grade potashes were distinctly poorest, and a large number of the tubers turned black, especially in wet seasons.

Where applications of lime were made the quality was distinctly affected, the tubers being best and driest when no lime was used.

It often happens that in gardens dung is the only manure used year after year. In such cases the soil gets into a poor physical condition, with the result that no variety is of good quality. In such cases it would possibly be well to grow other crops for a season or two and to use artificials.

Boiling tests were also made with tubers affected with mosaic and leaf roll. In the case of mosaic there was practically no difference in quality, but where leaf roll was present the quality was much poorer than in unaffected tubers.

Good quality potatoes of maincrop or late types were got when well sprouted seed of a suitable variety was planted in April on comparatively light soil which was dressed with a complete manure (sulphate of ammonia, superphosphate and sulphate of potash), in seasons where the weather conditions were such that the tubers had reached full maturity.

THE following article has been contributed by Mr. J. N. Pickard, Animal Breeding Research Department, University of Edinburgh.

The Influence of Certain Foods on the Wool Growth of Angora Rabbits.

It has been suggested that the growth of wool in Angora rabbits might be varied by the feeding of certain substances. With a view to ascertaining whether this was correct some preliminary tests have been undertaken which it is hoped to repeat on a larger scale in the near future.

The rabbits were typical Angoras, weighing about 5½ lbs. each, and the wool produced by them was of the same type. No change in quality was observed during the period of the test. The rabbits were all fed on a normal diet, consisting in the morning of a rather moist mash made up of equal parts broad bran and flaked maize to which hot water was added, and in the first and third experiments meadow hay

of inferior quality and turnips in the evening. The rabbits in the second experiment received grass in the evening in place of the hay and roots. On Sundays the mash was replaced by whole oats.

In the last experiment the rabbits were housed in an open shed in wire pens on straw and sawdust. In the two other experiments they were kept in a wooden building in wooden hutches fitted with open wire floors. These were cleaned out once a week.

The rabbits were clipped prior to the commencement of the experiments and were divided into groups which had previously produced approximately similar total yields of wool. In all cases they were clipped by the writer as closely as possible with scissors over the entire body.

The tests were undertaken in three separate experiments, of which the following is a summary.

First Experiment.—In the first experiment there were 28 rabbits, divided into four groups of seven rabbits in each. The period of the test between the two clips was 83 days.

> Group A were controls, and produced an average yield of 46·86 grams of wool.
>
> Group B were fed similarly to those in A, but had a few drops of cod liver oil added to their mash. These gave a yield of 51·71 grams of wool, an increase of 4·85 grams or 10·4 per cent. as compared with Group A.
>
> Group C had the same diet as A, with the addition of 0·5 grams of calcium lactate to the mash of each rabbit. These only produced an average yield of 34 grams of wool, a decrease of 12·86 grams on Group A and 17·71 grams on those fed on cod liver oil.
>
> Group D had the addition of both cod liver oil and calcium lactate to their food and produced an average yield of 46·14 grams of wool.

This experiment pointed to the fact that whilst the addition of calcium lactate to the diet decreased the production of wool, if cod liver oil were also added the yield was practically the same as the controls.

Second Experiment.—There were four groups of six rabbits each in the second test. The period between the two clips was one day longer than in the previous experiment.

> Group A were controls and gave an average yield of 41·33 grams of wool.
>
> Group B, as in the first experiment, received the addition of cod liver oil to their mash. These produced an average yield of 44·33 grams, an increase of 3 grams or 7·3 per cent. as compared with the controls.
>
> Groups C and D had the same food as the controls, to which were added two proprietary mineral mixtures in the amounts recommended by the manufacturers. These groups

both showed decreases when compared with either the controls or those which had the addition of cod liver oil. Group C produced an average yield of 34·33 grams, whilst those in D yielded an average clip of 36·67 grams.

These figures again suggest that the addition of minerals to the diet is liable to decrease the yield of wool, whilst cod liver oil tends to increase it.

Third Experiment.—This experiment was planned to increase the data available with regard to the effect on the wool yield by the addition of cod liver oil to the diet. In it there were 30 rabbits, divided into two groups of 15 rabbits in each. The duration of the experiment was 87 days. Whilst the controls produced an average yield of only 52·53 grams, those which had cod liver oil added gave 58·53 grams of wool, showing again an increase, this time of 11·4 per cent.

Discussion.—In all these experiments the addition of cod liver oil produced an increase when compared with the controls. The 28 rabbits which acted as controls yielded 1,364 grams of wool, whilst the same number which were also given cod liver oil produced 1,506 grams of wool, an increase of 142 grams or 10·5 per cent.

Although the number of rabbits which underwent these experiments is insufficient to give truly significant results, the observations made point to the deductions that the addition of minerals to the normal diet of Angora rabbits has no beneficial results with regard to wool production. On the other hand cod liver oil tends to increase the yield, and might well be added to the mash fed to rabbits of this variety. It is the writer's intention to repeat this experiment on a larger scale in the near future, but it is thought advisable to publish the results of these preliminary tests in order to draw expressions of opinion from breeders.

The writer desires to express his thanks to Dr. F. A. E. Crew and Dr. J. E. Nichols, both of the Animal Breeding Research Department, for their valuable assistance and advice.

Review.

Farm Economics Reports issued from the University of Cambridge.—There have appeared since 1925 five Reports giving "An Economic and Financial Analysis" of East Anglian farms, prepared by the Farm Economics branch of the School of Agriculture, Cambridge University, and covering the period 1923 to 1926. In these Reports the accounts of eleven farms for three consecutive years, and for other farms for shorter periods, are presented, and it is proposed to publish a comprehensive summary of the results when these have been obtained for a period of four years, covering a rotation of crops on the normal four course shift.

The farms are grouped according to whether the soil is

" light," " medium," or " heavy," and within these groups the holdings are arranged in order of size. In each group they show considerable variations in the proportions of arable and grass. For each holding data classed as " statistical " and " economic " are given for the farms as units, followed by detailed costs per acre and per unit of produce of the various crops and of milk; in the case of live stock, percentage returns are calculated on the capital invested in cattle, sheep, and poultry respectively. Care has been taken to state the basis upon which the figures have been compiled, and the results leading from the premises laid down are clearly and comprehensively stated in tabular form.

The adequate presentation of the salient facts relating to the economic position of the industry is perhaps one of the most important tasks to which agricultural economists can address themselves at the moment. Important as the detailed analysis of farm accounts may be to the farmers concerned, the economic position of the great variety of farms in wide areas must remain uncertain until surveys on more comprehensive lines and with perhaps more limited objectives can be made. It is to be hoped that Cambridge may yet find such wider enquiries to be both practicable and worth while.

Guide to Current Official Statistics, Volume VI.

The sixth volume of the *Guide*, dealing with statistical publications issued during the year 1927 by Government Departments in Great Britain and Northern Ireland, was issued in May, this being the earliest date yet achieved. The scope of the *Guide* has been described on previous occasions, and it is sufficient to bring the new volume to the attention of all who wish to make effective use of the large quantity of official statistical material that is published annually. Copies may be obtained from H.M. Stationery Office, 120 George Street, Edinburgh, either directly or through any bookseller, price 1*s*. or by post 1*s*. 4*d*.

Farm Wages in Scotland.

The Board have as usual issued with their Monthly Reports for 1st January and 1st July supplements giving the wages of various classes of workers as at Martinmas 1927 and Whitsunday 1928. This article summarises these statements, and gives a comparison with the wages current at Whitsunday 1927; a similar article appeared in the issue of the Journal for July 1927.

The money values of the allowances given in addition to the cash wage, as reckoned at each of the three terms mentioned above, are as follows :—

	Whitsunday, 1927.	Martinmas, 1927.	Whitsunday, 1928.
Meal, per cwt.	16*s*.	18*s*.	24*s*.
Milk, per gallon	1*s*.	1*s*.	1*s*.
Potatoes, per ton	£5	£4, 10*s*.	£4, 10*s*.
House, per annum	£6	£6	£6
Coal, per ton	£1, 15*s*.	£1, 15*s*.	£1, 15*s*.
Board and lodging for single men, per week	14*s*.	14*s*.	14*s*.
Bothy accommodation, with attendance, per annum	£9	£9	£9
Bothy accommodation, without attendance, per annum	£6	£6	£6
Keep of cow and followers, per cow, per annum	£12	£12	£12

The rise of 8*s*. in the estimated value of a hundredweight of oatmeal would mean, for men getting 65 stone per annum, about 1*s*. 3*d*. a week, while the fall in the value of potatoes would mean, for men getting a ton a year, about 2*d*. a week. The other items show no change throughout the period.

The arithmetical averages of the Board's figures for the wages of married men are as follows :—

Average Weekly Earnings of Married Men.

	Summer, 1927.						Winter, 1927-28.						Summer, 1928.					
	Cash.		Allowances.		Total.		Cash.		Allowances.		Total.		Cash.		Allowances.		Total.	
	s.	*d.*	*s.*	*d.*	*s.*	*d.*	*s.*	*d.*	*s.*	*d.*	*s.*	*d.*	*s.*	*d.*	*s.*	*d.*	*s.*	*d.*
Ploughmen ...	30	0	8	2	38	2	29	8	8	2	37	10	29	1	8	9	37	10
Cattlemen ...	31	1	8	6	39	7	30	11	8	5	39	4	30	9	9	1	39	10
Shepherds ...	29	8	10	8	40	4	28	7	11	1	39	8	28	9	11	8	40	5

These averages show a slight fall in ploughmen's wages during the past year, the cash wage having been reduced by 11*d*. while the value of the allowances has increased by 7*d*. Shepherds' cash wages have fallen by the same amount, but this is balanced by a rise of 1*s*. in the value of the allowances, while the cash wages of cattlemen show a fall of 4*d*. and the allowances a rise of 7*d*., the total being thus increased by 3*d*.

The following table gives in round figures the weekly earnings of ordinary married ploughmen in summer 1927 and summer 1928 in 38 out of the total number of 52 counties and parts of counties included in the Board's statement.

County or District.	Summer, 1927. Cash.	Summer, 1927. Allowances.	Summer, 1927. Total.	Summer, 1928. Cash.	Summer, 1928. Allowances.	Summer, 1928. Total.
	s.	s.	s.	s.	s.	s.
Wigtown	24	14	38	24	16	40
Kirkcudbright	34	4	38	33	5	38
Dumfries	33	5	38	33	5½	38½
Selkirk	30	6	36	30	6	36
Roxburgh	30	6	36	30	6	36
Berwick	34	6	40	34	6	40
Peebles	34	6	40	34	6	40
East Lothian	34	8	42	34	8	42
Midlothian	34	7½	41½	34	7½	41½
West Lothian	34	7½	41½	34	7½	41½
Stirling	40	3	43	40	3	43
Dumbarton (Lower Clyde Valley)	39	4	43	39	4	43
Lanark (N.W.) (Lower Clyde Valley)	36	4	40	36	4½	40½
Renfrew (Lower Clyde Valley)	38	4	42	38	4	42
Ayr (N.)	36	5	41	36	5	41
Ayr (S.)	35	4	39	35	4½	39½
Lanark (S.E.)	35	4	39	35	4½	39½
Clackmannan	38	1	39	38	1	39
Fife (S.W.)	38	1	39	38	1	39
Fife (N.E.)	28	12	40	28	13	41
Kinross	28½	11	39½	28½	12	40½
Perth (S.E.)	29	10	39	29	11	40
Perth (Central)	27	10	37	28	11	39
Forfar (S.W.)	31	10	41	31	11½	42½
Forfar (N.E.)	29	10	39	28½	11	39½
Kincardine	30	11	41	28	12	40
Aberdeen (E.)	25½	11	36½	24½	12½	37
Aberdeen (N.E.)	24	11	35	23½	12	35½
Aberdeen (Central)	22	10	32	23	11	34
Aberdeen (S.W.)	24	10½	34½	25	12	37
Aberdeen (N.W.)	24	10½	34½	24	11½	35½
Banff (N.E.)	24	10½	34½	25	11½	36½
Moray	26	9	35	25½	10½	36
Nairn	22	12	34	21½	13½	35
Inverness (E.)	22	12	34	21½	13½	35
Ross and Cromarty (E.)	24	12½	36½	23½	13½	37
Sutherland (E.)	17½	13	30½	18	14	32
Caithness	16	15	31	16½	16	32½
	s. d.	s. d.	s. d.	s. d.	s. d.	s. d.
Average	29 9	8 2	37 11	29 8	8 11	38 7

The arithmetical average for this summer for these 38 counties or parts of counties, which is slightly higher than the average for Scotland as a whole, is higher than that of the summer of 1927 by 8*d*., which is almost wholly accounted for by the value placed upon allowances, the cash wage being practically unaltered.

Most of the districts show no change in the cash wage, but an increase of 1*s*. is recorded in Central Perth, Central and South-West Aberdeen and Banff, and one of 6*d*. in Caithness and Sutherland, while a decrease of 2*s*. has taken place in Kincardine, one of 1*s*. in Kirkcudbright and East Aberdeen, and one of 6*d*. in North-East Forfar, North-East Aberdeen, Moray, Nairn, Inverness, and Ross and Cromarty.

Including cash and allowances, the average weekly earnings of a married ploughman in the southern counties range from 38*s*. to 40*s*.; in the south-eastern counties from 36*s*. to 42*s*.; in the

Lower Clyde Valley from 40*s*. 6*d*. to 43*s*.; in the rest of the central area from 39*s*. to 43*s*.; and in the north-eastern counties from 32*s*. to 37*s*.

Single ploughmen.—The average wage of single ploughmen in the south-eastern counties is 33*s*. a week, the same as in 1927. In the Lower Clyde Valley and North Ayr the cash wage averages 19*s*. 8*d*. (as compared with 20*s*. last year), with board and lodging valued at 14*s*. In Forfar, North and East Perth and Fife the average cash wage is 29*s*., or 1*s*. less than in 1927, while the allowances are valued on the average at 7*s*. 4*d*. In the north-eastern counties the average cash wage is 21*s*. 4*d*., about the same as last year, with board and lodging at 14*s*. In Inverness, Sutherland, Caithness and Orkney the cash wage ranges from 13*s*. 10*d*. to 19*s*. 3*d*., with the addition of board and lodging at 14*s*. In Scotland as a whole a single ploughman's earnings average about 33*s*. (cash 22*s*. 7*d*., allowances 10*s*. 5*d*.), the same as at this time last year; the average weekly remuneration of married ploughmen is stated above as 37*s*. 10*d*.

Women Workers.—In the case of women workers wages paid weekly generally range from 20*s*. to 22*s*. 6*d*.; for longer engagements when board and lodging are provided the total weekly earnings range from about 23*s*. in Caithness to about 31*s*. in South-West Aberdeen. In most districts women paid by the day get from 3*s*. to 4*s*., and occasionally 4*s*. 6*d*. or even 5*s*.

Boys.—The wages paid to boys vary considerably according to age and experience. Where the engagements are made for a period of six months and where allowances are given the total weekly earnings range from 21*s*. to 27*s*. 6*d*.; when paid in cash the weekly rates vary from 15*s*. to 24*s*.

Girls.—In the south-eastern counties, where the wages are paid in cash, girls earn from 15*s*. to 18*s*. a week; where board and lodging are provided the estimated weekly earnings are considerably higher in many cases; where paid by the hour the usual rate is from 3*d*. to 4*d*.

Casual Workers.—Male casual workers get from 5*s*. to 6*s*. a day in most districts, while skilled workers can earn up to 8*s*. in some parts of the country; with a weekly engagement the wages vary from 30*s*. to 40*s*.; for casual labour employed by the hour the usual rate is 9*d*.

Agricultural Conditions.

THE weather during March was generally cold and dry in the northern districts and good progress was made with ploughing. In the western and south-western areas the first half of the month was fine and dry and much of the arrears of spring work was overtaken, but during the last two weeks cold and wet weather was general, with the result that the planting of potatoes and other outdoor work was delayed. In the eastern and south-eastern counties the weather was variable throughout the whole of March and seasonal work was retarded. The first half of April was dull and unsettled generally; night frosts were frequent and snow fell in exposed districts. During the last ten days of the month, however, bright dry conditions prevailed and satisfactory progress was made with cultivation, potato-planting and the sowing of seeds. Growth, however, was slow owing to the low temperatures that prevailed in all districts. The weather conditions during May were favourable for farming operations, and in most areas any arrears of work were overtaken. The first three weeks of the month were dry, with night frosts occurring in most parts of the country. During this period turnips were sown under favourable conditions but the growth of crops and pastures was checked. Towards the end of May the weather was bright and warmer, and some rain fell in all districts with beneficial effects on all crops. Live stock made little progress until the last week of the month when grass became more plentiful.

The growth of wheat was checked by the cold weather in April and May, but the crop is generally healthy, and there are few indications of damage by pests. At the end of May the plants were reported to be fairly vigorous, although in most districts there are some fields where the crop is patchy and thin on the ground. According to the estimates furnished by the Board's Crop Reporters, the area under the crop will probably prove to be somewhat smaller than last year.

Barley was sown rather later than usual in some districts, but is generally reported to have brairded well and to be vigorous and healthy. In South-West Forfar the crop is said to be the most promising of the cereals. The estimates of the acreage sown indicate that on the whole the area will be rather less than last year.

The reports on the oat crop are not quite so satisfactory as those for wheat and barley. The crop has brairded fairly well in the northern and western areas, but in Perth and some eastern districts germination and growth have been unsatisfactory, the plants being thin on the ground and lacking in vigour. Damage by grub or wire-worm is reported from almost every part of the country, more especially from the eastern counties. The area under oats is estimated to be greater by about 5 per cent. in Forfar, the Lothians and Peebles, while in Central Perth, Berwick and Stirling the estimated increase is about 10 per cent.; slight decreases in acreage are reported from several areas, while in Central Aberdeen the area sown is estimated to be less by about 12½ per cent.

The sowing of beans was delayed and the crop was accordingly rather backward in appearance at the end of May, but the plants are generally reported to be healthy and vigorous. Ryegrass and clover seeds were checked by cold winds and the want of rain, but the plants are recovering from the set-back, and in many districts at the beginning of June the crop was reported to be strong and healthy. It is anticipated, however, that in some areas the yield of hay this season may be lighter than usual.

The planting of potatoes was completed in April in some districts, and throughout the country as a whole the work was practically finished at the end of May. In some cases the soil was heavy and difficult to prepare, but, speaking generally, the work was carried out under favourable conditions. Where the crop was showing above the ground at the beginning of June it was reported to be strong and promising. In a few districts the area planted is estimated to be less than last year, but in several eastern counties and in Dumbarton small increases in the acreage are reported. The sowing of root crops was well advanced generally at the end of May, and in most areas where grown the sowing of swedes and mangolds was completed at that period; the sowing of yellow turnips was completed in the south-western counties at the end of May, while elsewhere at least half of the work had been accomplished. The braird generally is rather irregular owing to the dry conditions prevailing during May. The reports received regarding sugar beet indicate that the area sown is considerably smaller than last year, more especially in Forfar, Berwick, Kincardine and North-East Fife. Where sown early the crop was just showing above the ground at the end of May and had a fairly satisfactory appearance.

Fruit trees made a good show of blossom in most of the districts where they are widely grown and, should there be no late frosts or high winds, there are prospects of satisfactory crops. Small fruit now require warmth and moisture, but the prospects are much better than last year. In South Lanark disease is prevalent among the strawberry plants.

Pastures are generally backward, but with the improved weather conditions during the last week or ten days of May the grass made considerable progress. Grazing cattle are rather lean but dairy cows are in good average condition; the milk yield, which in some districts fell slightly below the normal for a few weeks, increased satisfactorily with the recovery of the pastures.

Sheep on arable farms have thriven fairly well. The reports on hill sheep are, however, not so uniformly good; in several districts the flocks made fairly good progress, but in the Lothians, Peebles, Lewis and Dumfries they are said to be rather backward in condition. The fall of lambs has been about the normal on both arable and hill farms, except in some of the more exposed parts of Aberdeen and Perth, where the numbers are estimated to be slightly below the average. The lambs are healthy, but in several districts they have not developed quite so well as usual. Considerable losses among ewes and lambs are reported from North and East Perth, Berwick, Central Argyll, Dumfries and Wigtown.

The supply of regular and casual labour is sufficient for requirements, except in Dumbarton, Renfrew and South Ayr, where there is a shortage of experienced women dairy workers, while in Skye there is a general scarcity of agricultural labour.

SCIENCE AND PRACTICE.

The following extracts and summaries are supplied by members of the staffs of Scottish agricultural colleges and scientific institutions or are taken from recent bulletins of the International Institute of Agriculture. Full references to the original publications may be obtained on application to the Secretary, Board of Agriculture, York Buildings, Edinburgh.

CROPS AND SEEDS.

The Improvement of Poor Pasture in Yorkshire. (*Bulletin* 150. *The University of Leeds and the Yorkshire Council for Agricultural Education.*)—This bulletin gives a report of a series of trials carried out by Messrs. Hunter and Milliard with lime and phosphates on Yorkshire pastures, and describes the resultant changes in the botanical composition of the pasture. The pastures that most readily respond to dressings of lime are those described as " matted "; the " mat " is composed of the dead leaves and stems of grasses and other plants and may be two or three inches thick, with a hard upper layer. Lime may produce a slightly adverse effect on the herbage in the first year, but later, as the " mat " decays, it leads to a marked improvement. There is no evidence of a marked change in the grass species, but the relative proportion of the species may alter. Dressing with lime increased the drought resistance of these pastures. Basic slag has been found on the " matted " pastures to be almost, if not quite, useless.

The pastures responding to phosphatic manures show little or no " mat," and the number of species of plants in much greater than in the " matted " pastures. The response to phosphates on these pastures is much the same as the response to lime on the " matted " pastures—a decrease in dead material, a great improvement in freshness, and a remarkably rapid increase of wild white clover. There are considerable differences in the rapidity of action of the different phosphatic manures, high-grade slag and low-grade slag of high citric solubility being the most rapid, while low-grade slag of low citric solubility produces little effect until the second year. Mineral phosphates are shown to be still slower in action.

The report concludes with useful notes on the identification of plants occurring commonly in poor pastures.

The Maximum Profitable Manuring of Potatoes, *by H. G. Robinson.* (*Bulletin No. 17. Midland Agricultural and Dairy College.*)—Mr. Robinson reports in this bulletin on two series of trials carried out with a view to ascertaining the maximum profitable use of artificial fertilisers on the potato crop. Twelve tons of farmyard manure were applied per acre, and the artificial mixture employed in the first series was in the following proportion :—

1 part by weight of sulphate of ammonia,
3 parts by weight of superphosphate,
1 part by weight of sulphate of potash.

The mixture was applied at the rate of 2, , 6, 8, 10, 12, 14 and 16 cwt. per acre, and the greatest total yield was got with the 12 cwt. per acre dressing. It is noteworthy, however, that the 10 cwt. per acre of artificial manure gave an equal weight of ware to that given by the 12 cwt. dressing, and, when the results were expressed in money, the 10 cwt. per acre of artificial manure proved more economical under the soil and climatic conditions at the Midland College Farm.

In the second series of trials the plots were manured with a standard dressing of 3 cwt. per acre of superphosphate, while the amounts of sulphate of ammonia and sulphate of potash were the same as applied to the equivalent plots in the first series, and farmyard manure was again applied at the rate of 12 tons per acre. The returns in this series were not equal to those in the first series, and this would suggest that quantities in excess of 3 cwt. per acre of superphosphate along with sulphate of ammonia and sulphate of potash may be applied quite profitably to potato crops on the soils where the trials were carried out. In respect of the influence of manuring on maximum yields, the results were similar in both sets of trials.

Beets and Carrots: A Guide to Seed-Growers. *By T. F. Ritchie, B.S.A., Division of Horticulture. Dominion of Canada Agricultural Bulletin, No. 82, New Series.*—The main purpose of this bulletin is to place in the hands of the grower the type that has been decided upon as ideal, or as close to the ideal as is possible. Many varieties of beets and carrots are described and illustrated, and they are arranged according to the "Official List of Standard Variety Names." Notes are also given concerning the utility of each variety.

Do Potato Varieties degenerate in Warm Climates? *John Bushnell, Ohio Agricultural Experiment Station, U.S.A. Abstract from the Journal of Heredity, March* 1928, *Volume* 19, *No.* 3.—In the United States of America degeneration of potato varieties is prevalent. Loss of vigour is generally attributed to virus diseases, but the view is still held by some people that unfavourable high summer temperatures, entirely apart from infectious diseases, are to some extent responsible for the degeneration. In comparative tests of local seed potatoes, with certified seed from Northern Michigan, tests carried out during four years have shown that the disease-free Ohio seed yielded as well as the northern seed. There was no indication in the comparative tests of degeneration directly due to high summer temperature.

An old variety known as "Long John" has been grown in Ohio for ninety years. A sample of this variety was grown at the Experiment Station in 1926 and compared with the "Russet Rural." The "Long John" variety showed no symptom of any virus disease.

A prominent grower in South-Central Ohio has maintained one of the "Rural" varieties in a high degree of vigour for fifteen years. In recent seasons his yields had been more than 200 bushels per acre above the state average. The high yields obtained were in part due to the practice of applying a straw-mulch.

As a means of reducing the spread of virus diseases, a potato specialist in Northern Ohio in 1906 adopted the policy of planting the tubers late in June. The results from this method have been very satisfactory, and, so far, his stock shows no sign of degeneration.

It is concluded that degeneration of potatoes is entirely due to disease rather than to any effect of high temperature upon the hereditary constitution of the plant.

FERTILISERS.

"Nitrochalk," a new Nitrogenous Fertiliser. *J. Carbonel. L'Engrais, Lille*, 1927, *t.* 42, *No.* 18.—"Nitrochalk" is a mixture of nitrate of ammonia and of limestone, yielding on analysis only 10 per cent. of nitrogen. The limestone comes from the manufacture of sulphate of ammonia from gypsum instead of from sulphuric acid. The small amount of nitrogen is considered advantageous owing to the difficulty of spreading small amounts of very powerful fertiliser. Thus the use of a rather weaker fertiliser is much more convenient than that of nitrate of ammonia, urea, &c.

SOILS.

The Crop-producing Power of Limited Quantities of "Essential" Plant Nutrient. *Charles Hartman, Jr., and Wilbur L. Powers, Oregon Agricultural Experiment Station. Soil Science, XXV*, 371 (1928).—In this paper experiments are described which are designed to study the effect on the plant of the total absence of one of the "essential" plant nutrients—nitrogen, calcium, magnesium, potassium, phosphorus and sulphur, each being left out in turn.

The effect of the addition of various increments of the missing elements on the nutrition and growth of the crop was also studied.

Throughout the experiments the plants were grown in culture solutions contained in jars which were wrapped with brown paper to exclude light from the roots. The jars were kept in greenhouses.

It was shown that little growth could be expected where nitrogen was deficient, and that lack of nitrogen led to the development of an extensive fibrous root system and also caused chlorotic, sickly looking plants.

Calcium deficiency was found to hinder the root development of alfalfa plants, and there were indications that large quantities of magnesium in proportion to calcium were harmful. Where there was total lack of magnesium the leaves became chlorotic, wilted, and dropped off.

Potassium deficiency impaired growth, caused a dull colour of the leaves, weak stems, small shrivelled seeds, and a liability to disease.

Total absence of phosphorus led to an entire growth of tops and the roots grew but little.

The presence of phosphorus increased the development of the roots, which became large and fibrous.

Nitrogen effected by far the highest yield of dry matter, whilst magnesium had a comparatively small effect.

ANIMAL BREEDING.

Cattle.

The Improvement of Cattle in Ireland. *(A) Northern Ireland, by J. S. Gordon; (B) The Irish Free State, by Daniel Twomy.* 1927. *The Journal of the Royal Agricultural Society of England, v, 88, pp.* 50–65.—The appearance of these two accounts of how Ireland is eliminating the Scrub bull appear timeously in view of the agitation in this country which has been apparent in many quarters during the past few months. The main provisions in the Act of 1924 for Northern Ireland have already been the subject of an article by Dr. Gordon in this JOURNAL, Vol. IX, No. 3.

Mr. Twomy, dealing with the Free State, writes :—

" All bulls accepted as suitable for licensing must have good shapes, size and substance, and be correct in colour and type for their particular breed. Subject to the foregoing the following classes of bulls may be licensed :—

" (*a*) Pedigree bulls of all breeds.
" (*b*) Non-pedigree bulls of good Shorthorn type and character.
" (*c*) Non-pedigree bulls of good Kerry type and character in the Kerry cattle area only.

" Non-pedigree bulls of any other type or breed are rejected. The fact that outside the Kerry cattle area, where Kerries only are bred, and Connemara, where Galloways are mostly bred, more than 95 per cent. of the commercial breeding cows are of Shorthorn type, renders the problem of licensing comparatively easy, since the majority of the non-pedigree bull calves retained for breeding purposes are the progeny of such cows and Shorthorn bulls.

" At the first inspection a relatively easy standard was adopted in passing bulls for licenses, but the standard has been raised gradually at each half-yearly inspection, and this policy will be continued until ultimately licences will be issued in respect of none but bulls of high quality. Already, in the year 1927, what might be regarded as a very fair standard has been reached.

" As a matter of fact the practice of retaining the best older bulls for longer periods has now become so general that the number of young bulls required for replacements is less than in the former years. The total number of licensed bulls in the Irish Free State averages about 25,000 each year, and this number is ample, having regard to the number of breeding cows, since it means that there is one bull for every 54 cows.

" On the whole it must be stated that the Act is working very smoothly. This is mainly due to the fact that it has the general support of farmers, and for this reason also little difficulty has been experienced in detecting evasions. Since the Act came into operation prosecutions have been instituted in 230 cases, principally against persons who failed to apply for licenses in respect of bulls of the prescribed age. The number dealt with in the Courts to date is 199, and fines varying from £1 to £5 have been imposed in 181 cases.

" It is not anticipated that the results of the operations of the Act will be apparent immediately, but it is confidently expected that in time the class of cattle produced throughout the country will be materially altered, and that a high and uniform standard in the breeding stock will be established. Once that point has been reached there certainly will be a marked improvement in the quality of the cattle available for export purposes."

Better Dairy Cattle in the United States. *By C. W. Larson.* 1927. *Report of the Chief of the Bureau of Dairy Industry, U.S. Dept Agriculture.*— This is an interesting report which deals with the numerous investigations conducted by the Federal Government in connection with dairy cows. An account of the more practical cases from a breeding standpoint follow.

As indicated in a previous report, it is believed that the most important need in the dairy industry to-day is to increase the efficiency of the average cow. The studies of this Bureau have shown that the quantity of production per cow is the most important factor in economy of production.

On January 1, 1927, there were in this country 837 groups of about 25 farmers each in dairy herd improvement associations. Since that time the number has increased to about 900 associations. Each of these groups employs a trained man to make the necessary tests and weighings every month in order to determine accurately the profitableness of each animal in each herd. Of the 22,000,000 dairy cows in the United States, nearly 400,000 are now in these associations, and the average production of these cows is about 7,500 lbs. of milk a year. The records of these cows are available for study, and provide an excellent basis from which the production situation in the country and the possibilities and opportunities for improvement can be determined.

The 360,000 cows in these associations during 1926 produced as much milk as 584,000 average cows, and returned as much income over cost of feed as 640,000 average cows.

High producing cows are economical in the use of feed. A tabulation of more than 100,000 individual cow records shows that cows producing 9,000 lbs. of milk per year did not eat twice as much as cows producing 4,500 lbs., which is the average production of the cows of the United States. Instead, they ate approximately 40 per cent. more in dollars' worth of feed per cow to produce twice as much milk and butterfat.

At the Federal Dairy Farm at Beltsville, Maryland, bull experiments are being conducted to determine the effect of certain nutritional régimes, exercises, and amount or frequency of service on the activity of the spermatozoa, their longevity, numbers, form and structure. The herd sires at the farm are examined each month. A stained specimen of the semen is preserved from each examination. A number of bulls are being used in this investigation.

One bull has been used in a series of experiments to determine the effect of sprouted oats in the ration, the effect of exercise, the effect of exercise and sprouted oats, and the effect of lack of exercise on the initial activity of the spermatozoa and their activity five hours later. The bull was kept under each phase of the experiment for a period of 90 days. At the end of each period he was allowed one service a day for six consecutive days and the semen for each service was examined.

The inbreeding experiment with grade cattle started in 1913 has been continued in spite of serious setbacks due to the disposal of a considerable number of the breeding females in 1918 and to the inroads of abortion disease. Twenty-five females of all ages are now being used in this work. Production records are being made and photographs taken to show the effects of inbreeding. When the original bull became impotent, he was replaced by one of his sons and the experiment continued. Data up to the present show no decrease in vigour or bad results of any kind among the inbred animals.

Dentition of Friesian Cattle. *A. M. Hilma, Tijdscrift voor Diergeneeskunde, Utrecht,* 15 *Jan.* 1928, 55*e deel, aflevering,* 2, *bladz.* 65–83. *Abstract in German, English and French.*—The writer in his investigations on the second dentition of Friesians came to the following conclusions :—(*a*) An animal with 2 permanent incisors is more than 1 year and 9 months but less than 2 years and 9 months old; it will usually be from 2 to 2½ years. (*b*) An animal with 4 permanent incisors may be 2 years old or again 3½, being usually 2½ to 3 years. (*c*) An animal with 6 permanent incisors may be 3 years or 4 years and 4 months. (*d*) An animal showing 8 permanent incisors is more than 3, and is usually even more than 3½ years old.

Measures adopted by the Animal Husbandry Service of the United States for Controlling Tuberculosis in Cattle. — The Federal North American Legislations are devoting special attention to the question of the effective control of tuberculosis in cattle. Grants of 6 million dollars have already been made, to which a further sum of 18½ million dollars will now be added, for the active development of the anti-tuberculosis campaign. New legislation will shortly be promulgated which will amend the provisions previously in force and intensify the practical control methods. During the financial year 30th June 1926 to 30th June 1927 very satisfactory results were obtained. According to information supplied by the "Bureau of Animal Industry," 347 counties have already carried out official diagnosis work and have determined the areas which are free from infection. This number represents more than 11 per cent. of the total of the counties of the United States, and it is reported that at the beginning of the present financial year 945 additional counties have begun to take an active part in the campaign.—(*Science,* Vol. LXVI, No. 1710. 7th October 1927.)

Horses.

The Horse in the States. *Dr. Church. Report of A.V.M.A. Representative of the Board of Managers of the Horse Association of America. Journal of A.V.M.A., New Series, V,* 25, *pp.* 193–196.—The constant investigations by the Horse Association carry its agents into every field where it is possible to make comparisons of horse power against motive power, and thus the work of previous years has been continued. Data representing facts from actual experience are still being accumulated, which demonstrate where horses should be used.

A seven-months' exhaustive survey of milk delivery in New York City, with co-operation of all leading companies, shows that the horse constitutes the only motive power in delivering house-to-house milk in Greater New York. Delivery of $1,000,000 worth of milk by horse and wagon, instead of by electric truck, in Chicago saves $94,100; by horse and wagon, instead of gasoline truck, $112,000 is saved. The average weekly cost of operating a horse-wagon milk delivery unit in Chicago, salesmen's compensation included, is $66·82; for an electric truck it is $84·82, and for a gasoline truck it is $97·23.

The horse-power unit, where the haul is less than five miles, can more economically deliver wholesale groceries and other sundry heavy goods than motor-power units. One report indicated that while it costs six cents a minute to keep a five-ton motor truck on the streets of New York, a horse-drawn truck doing similar work could be kept on the streets for two cents per minute, that is, $28·80 for an 8-hour day in the case of the motor truck, as against $9·60 per 8-hour day for the horse truck.

The United States had, on January 1, 1927, 15,279,000 horses and 5,734,000 mules on farms, and it is believed that there were approximately 1,750,000 head of horses and mules still engaged in non-agricultural work.

In spite of all the discouraging news, there is a belief that breeding is increasing, that more mares were bred and more colts foaled during the year 1926 than for several years previously. There were more importations of Belgian, Shire and Percheron stallions during 1926 than in any year since the war.

ANIMAL NUTRITION.

Calf Meal Studies: I. Laboratory Experiments in Improving the Physical Condition; II. Feeding Experiments with Cooked and Uncooked Meal. *J. G. Archibald. J. Dairy Sci., XI, March* 1928.—One of the reasons for the excellence of milk as a food is its physical condition. It is one of the best examples of an almost perfect natural emulsion, its solids (fat excepted) being in either colloidal or molecular dispersion. It was considered possible to improve the physical condition of a calf meal and hence of the gruel made from it by one of three ways: (1) increase in fineness of division of the solids; (2) addition of a protective colloid; (3) partial cooking of the mixture.

Laboratory experiments showed that grinding increased somewhat the ability of the meal to remain in dispersion, but reducing the meal to such a degree of fineness was found to be impracticable, while the fine meal had a tendency to "lump" when wetted. Gelatin, taken as a type of protective colloid, was found to be without effect on calf meal gruels as ordinarily prepared. Moderate heating seemed to be the most efficacious way of improving the physical condition of the gruels. It accomplishes the same end as does fine grinding or adding gelatin and is much more practicable. Practical feeding experiments showed that the cooking of reasonably fine calf meal does not appear to exert any favourable effect on growth, the calves receiving the raw meal putting on 1·05 lbs. per day as compared with 0·95 lb. per day for the calves receiving cooked meal. The digestibility of a calf meal is not significantly affected by cooking.

Nutritive Value of Pasture: I. Seasonal Variations in the Productivity, Botanical and Chemical Composition and Nutritive Value of Medium Pasturage on a Light Sandy Soil. *H. E. Woodman, D. L. Blunt, and J. Stewart. J. Agric. Sci., XVI,* 1926, *p.* 205.—An account is given of an investigation, carried out at Cambridge in 1925, into the seasonal changes in the productivity, botanical and chemical composition and nutritive value of pasture grass. The experimental plot, which was on light, sandy soil, was divided into seven sub-plots and grazing was imitated by the use of a mowing machine. Each plot was cut once a week, and the produce was weighed, analysed and used for digestibility trials. The plot results were compared with results from adjacent plots allowed to grow for hay and aftermath.

During the growing season it was found that the botanical composition altered greatly, but the most interesting finding was the influence of frequent and close cutting on the wild white clover. It spread in an extraordinary manner, the improvement being equal to that which might be effected by the use of basic slag. The whole season's bulk of produce per acre from the hay and aftermath plots was more than twice that obtained by frequent cutting from the pasture plots. The latter, however, were characterised by a very high percentage of protein and a low percentage of fibre. In respect of digestibility, well-grazed pasture grass was found to compare favourably with concentrates like linseed cake and was far superior to meadow hay. The nutritive value of the pasture grass was highest in the early part of the season, diminished during the dry mid-season, but with the coming of rain recovered, so that in early autumn the grass was but little inferior to that available in spring. Although the hay plots gave a higher yield (5,943 lbs.) of dry matter per acre as compared with the pasture plots (3,065 lbs.), the latter gave a production starch equivalent of 2,124 lbs. of starch and 614 lbs. of digestible protein as against 2,092 lbs. starch and 406 lbs. digestible protein from the hay. The nutritive ratio of the pasture ranged from 1 : 2 to 1 : 3 except in two periods, and it is therefore comparable with linseed cake. The maintenance requirements of fully grown sheep have been calculated from the results as 1·29 lbs. of starch equivalent per day. The amount of lime and phosphorus in the pasture grass showed a seasonal variation, the lime increasing to a maximum in the dry mid-season, falling off later in the season. The phosphate percentage showed an opposite tendency. The ratio of lime to phosphoric acid rose from 1·08 in April to 2·09 in July and fell to 1·23 in October, and this offers one reason for any supplementary feeding to be done with cereals and their by-products, partly because they are rich in carbohydrate and partly because they contain an excess of phosphate over lime.

II. Seasonal Variation in the Productivity and Chemical Composition and Nutritive Value of Pasturage on a Heavy Clay Soil. *H. E. Woodman, D. L. Blunt, and J. Stewart. J. Agric. Sci., XVII*, 1927, *p.* 208.—This investigation, carried out in 1926, was similar to the above, but the soil was heavy clay with a different botanical character of pasturage. The experimental plot was again divided into seven sub-plots, each plot being mown once a week. The produce was analysed and fed to sheep in digestibility trials. The weather conditions during the 1925 and 1926 experiments differed considerably, being on the whole warm and dry in 1925 and cold and wet in 1926. The 1926 results showed an increase of creeping bent up to 90 per cent. of the herbage at the end of the season, but the growth of wild white clover was never luxurious. The curve of productivity differed from that of 1925 due to different soil and weather conditions, the clay pasture being more productive than the light sandy pasture. It is concluded that irrespective of botanical composition or the presence of little or much wild white clover a pasture will yield a herbage whose dry matter will be exceedingly rich in protein. Further, under a system of close grazing, the high protein content will be maintained throughout the season. Nutritive value results confirmed those of 1925, except that with the better soil and weather conditions there was no mid-season falling off. A narrow nutritive ratio was again found, showing that supplementary feeding should be carbohydrate-rich. The maintenance requirement for sheep weighing 100 lbs. is given as 1·24 lbs. starch. The 1926 herbage was distinctly lower in lime and slightly higher in phosphorus than the 1925 herbage, and the range of seasonal variation was much more restricted. The ratio of lime to phosphoric acid attained a maximum in mid-season and did not vary so much as in 1925. For very young animals a ration of 9 parts by weight of fresh closely-grazed pasture and 1 part of maize will give an albuminoid ratio of 1 : 4·2 and a lime to phosphoric acid ratio of 0·88, a close approximation to that of ewe's milk.

III. The Influence of the Intensity of Grazing on the Composition and Nutritive Value of Pasture Herbage (Part I). *H. E. Woodman, D. B. Norman, and J. W. Bee. J. Agric Sci., XVIII*, 1928, *p.* 266.—The object of this investigation was to ascertain the effect of cutting at fortnightly instead of weekly intervals on the yield, composition, digestibility and nutritive value of the herbage. The main plot on the light, sandy soil of the 1925 experiment was divided into 14 sub-plots, and one sub-plot was mown per day, the whole plot being mown over once per fortnight. A second trial was also carried out on two of the sub-plots of the 1926 heavy land pasture. The results were compared with the results of the 1925 experiment under a system of weekly cuts.

From the results of both trials, the authors concluded that there are no marked differences in the chemical composition, organic and inorganic, between pasture grass cut at weekly and fortnightly intervals. The dry matter of the grass cut at fortnightly intervals is extremely rich in crude protein, and contains in comparison with grass cut at the hay stage a low percentage of crude fibre. These characteristics are retained by systematic cutting at fortnightly intervals over the entire season. Digestion trials show that the dry matter of the herbage is a protein concentrate equal in digestibility and nutritive value to that obtained by weekly cuttings. There is a slight widening of the nutritive ratio in the fortnightly as compared with the weekly cut herbage, but the value is still lower than the nutritive ratio of milk. The light land pasture produced 26 per cent. more dry matter, 29 per cent. more starch equivalent, and 21 per cent. more digestible protein with the fortnightly cutting than during the weekly cuts of 1925. The results obtained from the heavy land portion, however, indicate that the big improvement in productivity is not wholly ascribable to the use of the more lenient system of cutting, but was partly due to the different weather conditions of the two seasons. It is probable that when meteorological conditions are favourable to active growth, productivity under the two systems of cutting will not differ by more than 10 per cent.

Effect of Cooking on Nutritive Value of Foodstuffs. *E. Friedberger. Die Volksernährung, Berlin,* 1927, *Jahrg.* 2, *Heft* 15.—The author carried out feeding experiments on rats with a view to determining the effect of cooking on the nutritive value of foodstuffs. Of the two series under observation the one was fed with a normal well-cooked ration, while the ration of the second was cooked for hours longer. On similar feeds the animals of the first group grew more rapidly, although a smaller quantity was accepted. When animals of the second group were allowed to take as much of the feed as they liked they devoured five times as much as the first group, and were, all the same, backward in growth.

These experiments therefore show that a good foodstuff if cooked too long deteriorates. Trials with raw foodstuffs gave results even more favourable as regards increase in weight.

Influence of Salted Feeds on Milk Production. *E. Marre. Comptes rendus des Séances de l'Académie d'Agriculture de France, Paris,* 1927, *v. XIII, No.* 11.—The writer's work has been carried out by noting in two byres and one sheep-fold the daily product of the milking of animals to whose ration salt has alternately, for periods of two weeks, been added or taken away in the proportion of 10 to 15 gm. per 100 kg. live weight per day. It should be remarked that the tests have not covered a very long period, and that, owing to labour difficulties, it was not possible to constitute lots of animals homogeneous or comparable from all points of veiw.

The following are the conclusions of the tests :—

(1) Taking into account the decrease of daily yield inherent in the lactation, it is observed that in cows and ewes the decrease of the milk was considerably modified by the addition of salt to the rations.

(2) As regards the influence of the salt on the quality of the milk, the fear expressed in certain quarters that the increased yield in the ewes would be prejudicial to the richness of the milk does not appear to be justified. It has in fact been possible to ascertain, by an analysis of the samples of milk taken, some in the period of salted feeds and others in the period of normal feeding, that the addition of salt had not diminished the richness in solids and in fats and had even slightly increased it in some cases.

DAIRYING.

The Relation between the Vitamin B Content of the Feed eaten and of the Milk produced. *S. I. Bechdel and H. E. Honeywell. Jour. Agr. Res.,* 35–3–283.—The milk from three cows which had been fed for over two years on a ration deficient in vitamin B was given to rats, and it was found to be equal in vitamin B potency to milk from a herd fed a normal winter ration. It was concluded that vitamin B in the milk is not dependent on the presence of the vitamin in the ration. Cows may possess the power to synthesise vitamin B, and this possibility is being tested so as to determine whether this synthesis is due to micro-organisms normally present in the rumen.

Making Camembert Cheese from Pasteurized Milk. *W. Hochstrasser. Milchwirtschaftliche Forschungen, Berlin,* 1927, *V. Bd.,* 1 *und* 2, *Heft.*—The writer's experiments have proved that milk which has been warmed and kept at a temperature of 62 to 63° C. for half an hour produces a Camembert cheese of better quality, taste and uniformity than that produced from the same milk untreated. The difference in quality is most conspicuous when poor quality milk is used. Pasteurizing does not affect output. When milk is pasteurized, more starter is necessary.

MACHINES AND IMPLEMENTS.

A new Charlock Sprayer. *Dir. Soller. Illustrierte landwirtschaftliche Zeitung, Berlin,* 1927, *Jahrg.* 47, *Nr.* 20.—Charlock control is to-day carried out with substances which combine the capacity for killing charlock with that of nourishing crops. Calcium cyanamide is one of such substances. In using it the greatest care must be taken that it is finely divided before use, so as to ensure the complete covering of the charlock and the smallest possible effect on the crop, which then has the calcium cyanamide as a top dressing. With this aim the Bruninghaus steel works are making the "Radikal-Zerstauber." It is not a fertiliser spreader proper, but consists of a fast revolving blower, which can be erected on any ordinary spreader. The blower is in the middle of the machine on the front of the frame and is compressed and expanded off the left wheel by a shaft and two chains. The compressed air resulting from the blowing apparatus is carried into a tube which runs under the cart, corresponding with the length of the distributing slit, and provided with numerous holes at the back of the distributor. The air emerges from them with considerable force carrying with it a narrow band of sprayed fertiliser. In calm weather this forms a cloud which slowly sinks to the ground.

A new Ditch Cleaner. *Dr. L. Engelbrecht. Die Technik in der Landwirtschaft, Berlin,* 1927, *Jahrg. VIII. Nr.* 8.—A new ditch cleaning machine was lately demonstrated by the inventor, Heumann-Jtzehoe, to a company of experts. A lateral articulated screw is carried at the side of the traction unit and set in motion by a bevelled wheel drive. The tractor travels at the side of the ditch, while the screw rotated by the engine cleans with its sharp edges the side of the ditch. A metal sheet is spread over the far side to prevent the clearings from falling into the ditch, the main rubbish being carried up in the turns of the screw and deposited on the side of the ditch. Most of the water escapes before the process is completed. Naturally the machine is unsuitable for stony soils, but it is specially intended for marshy moor soils where the ditches need considerable attention annually. The machine is easily manufactured and the running expenses are low; it can also be used in connection with a small tractor. This is a great advantage over the large bucket dredging machines, which do good work but are very heavy and are therefore costly to run.

The Disc Plough and its Advantages. *L. G. Samsel, Farm Implement News, Chicago,* 1927, *Vol.* 48, *No.* 38.—This short illustrated note describes the advantages to be gained by the use of a disc plough whereby the soil is rapidly broken up to a considerable depth.

The machine, which is tractor driven, makes it possible to plough from over 20 to nearly 40 acres a day to a depth of 4 to 6 inches. The general use of these machines will assist in increasing production and reducing cultivation costs.

INSECTS AND PESTS.

Magpies attack Farm Stock.—For some years complaints have been received from several of the Western States of America that farm stock, sheep, cattle and horses were being killed in numbers by magpies. It was an American story and on the face of it almost incredible, but it happens to be a very reasonable statement of a curious feeding habit of recent origin. The matter has been investigated by E. R. Kalmbach of the U.S. Department of Agriculture (*Tech. Bull.*, Oct. 1927). He discovered that in certain areas of the States of Utah, Colorado, Wyoming and Montana farmers had come to regard the magpie as their most serious enemy. Hundreds of cattle are killed in one region each winter, as well as many sheep and horses. The magpies attack fresh sores, such as the brand marks of newly branded cattle, saddle-sores of horses, or cuts caused by shearing on sheep. They dig with their powerful beaks into the flesh, so that they sometimes penetrate the body cavity, and sometimes they tear out and devour the kidneys. The habit, learned first by a few magpies, is picked up by imitation, for it has spread in ten years over a considerable expanse of country, and the birds soon learn to attack the farm animals even where no sore is present to induce an attack. Nevertheless the investigator considers that only a relatively small number of magpies are involved in this nefarious practice, and that the steady killing out of these marauders will free each district from what at present is a very serious menace.

Beetles injurious to Timber. *Bulletin No* 9, *Forestry Commission*, 1928. —In a pamphlet of 29 pages, with many excellent illustrations of the beetles themselves and of characteristic examples of their damage, Dr. J. W. Munro describes an important section of insect pests. The timber-destroying beetles are separated by their habits into two groups. The true forest pests attack timber just after it has been felled and while it is still green, and they abandon the wood as soon as it becomes dry and seasoned; these are longicorn or pin-hole borers. The second group, on the other hand, will not touch green wood and frequent seasoned timber. As a result the powder-pest and furniture beetles are found most abundantly in timber yards, and in old furniture and the wooden roof-trees and rafters of ancient buildings. Dr. Munro describes shortly the appearance and habits of each of these beetle pests and the damage it causes. He also suggests the methods which are best fitted to prevent infestation and to control an attack which has been launched.

Losses caused by Insect Pests.—The damage done by individual insects is so small, and that accomplished by a specific group of insects is so wide-spread and diffuse, that except in a few cases where plague conditions force the destruction upon man's notice, he seldom realises how much intrinsic loss is due in the course of a year to insect attacks. A few examples, collected by Schröder in his *Handbuch Entomol.*, 1926, illustrates the losses which may be caused, and indicate how well worth the labour and the cost would be scientific investigations which might lead to the control of the pests. The Colorado beetle reduces the potato harvest of North America by £500,000 a year; the vine Phylloxera cost Germany about £50,000 a year, and in half a century cost France £1,200,000,000. In Italy the olive fly causes a yearly loss of £600,000; France loses each year some ten to forty million pounds through her cockchafers; France and Germany together suffered to the extent of £5,500,000 through the ravages of the moth *Clysia*; and the total annual loss caused to farm crops and forests in Germany is put at £100,000,000, and in the United States of America at £250,000,000.

The Treatment of Liver Fluke.—Much research has recently been carried out with a view to mitigating the loss caused by this troublesome and serious pest, and not least important are the investigations undertaken under the supervision of the Council of Scientific and Industrial Research of Australia. A preliminary report by the veterinary pathologist, I. Clunes Ross (in *The Chemical News*, 4th May 1928), discusses the cause and fluctuations of the disease, and describes the remedies which have been found to be most effective. The outstanding drug for the treatment of infected sheep is undoubtedly carbon tetrachloride, which in very small doses of 16 drops has been found to be completely effective. Further, it can be given with safety in such quantities, since some sheep will tolerate a dose 30 times as large. Since the dose is so small, however, it is imperative that none should be lost in the administration, and the author consequently recommends the administration of the drug either mixed with liquid paraffin, by the mouth, by means of a syringe, or enclosed in gelatine capsules, a soft variety of which may be obtained ready prepared and filled, while a hard form is also available which may be filled and used as required.

MISCELLANEOUS.

Trade in Agricultural Products, Fertilisers and Live Stock. *South Australia.*—An Act, No. 1819, of 21st December 1927, entitled "Potato and Onion (Grading) Act, 1927," provides for the inspection and grading of potatoes and onions. In pursuance of this Act no person may sell any potatoes or onions unless the products in question are packed and graded in the manner prescribed. Powers are given to the proper inspectors to enter and inspect any premises, and open, or call upon the owner to open, any packets, and where justified mark the packets as "Falsely packed" or "Falsely marked," as well as seize or take samples of any potatoes or onions, and detain such products for inspection purposes. Penalties are imposed for breaches of this Act and for any alteration of marks on packages by unauthorised persons. The Governor is authorised to make comprehensive Regulations as regards the packing, grading, stacking and marking of potatoes and onions, as regards fees due to and powers of inspectors, and generally for the carrying out of the provisions of this Act.

A new Process of Foodstuff Preservation. *Trenkle. Praktische Blätter für Pflanzenbau und Pflanzenschutz, München*, 1927, 5, *Jg.*, *Heft IV*, *S.* 85–87.—Following on a journey through Holland for purposes of study, which gave to the author the opportunity of being present at observation trials carried on in the works of the N.V. Conservator Maatschappij, an account is given of the Company's plant and of the experiments undertaken according to a new method.

This method is based on the discovery that the rapid deterioration of foodstuffs under thunderstorm conditions is not to be ascribed, as has been assumed till now, to the presence of ozone, but to the high electric tension, and that in store rooms free from electric tension foodstuffs are preserved for a long period against deterioration.

The store rooms constructed by the above company are iron tanks in which special mechanisms provide for the cutting off or, at least, for the reduction to a minimum of the electric tension. The author describes in detail these devices and the plant as a whole.

It has been established that with this method eggs can be preserved quite fresh for 1½ years, margarine for three months and cauliflowers for four weeks. On the contrary less satisfactory results have so far been obtained with apples and pears; this, however, may be attributed to the fact that the fruits were already over-ripe at the moment of storage.

The main advantage of the new preservation method consists in its cheapness in comparison with cold storage.

Planting of Strawberry Plants in Clusters. *J. Vercier. Revue Horticole, Paris,* 1927, *a.* 99, *No.* 21.—Without enlarging on the various modes of planting generally adopted, including isolated lines, twin lines, beds 1m. wide, &c., the writer describes the method employed in the Valley of the Saône, at Villers-les-Pots.

Planting is done early, in July or August, following a crop of early potatoes, heavily manured before planting with approximately 9½ tons of farmyard manure, 9½ cwt. slag and 3½ cwt. K_2SO_4 per acre, the whole dug in at the middle of March. Planting is done in lines 80 cm. (31·4″) apart, in clusters formed of three plants placed in a triangle with sides 15 cm. long. These clusters are 70 cm. apart in the line. In the following spring, after the first crop, the whole of the foliage is simply cut away and the soil is then very easily cleaned. The subsequent vigour of the plants is remarkable. These plantations are destroyed after three crops.

STATISTICS.

PRICES of AGRICULTURAL PRODUCE, FEEDING STUFFS and FERTILISERS in March, April and May 1928.

LIVE STOCK : Monthly Averages of Prices at certain representative Scottish Markets.

(Compiled from Reports received from the Board's Market Reporters.)

Description.	March.			April.			May.		
	1st Quality	2nd Quality	3rd Quality	1st Quality	2nd Quality	3rd Quality	1st Quality	2nd Quality	3rd Quality
FAT STOCK:—									
*CATTLE—	per cwt. s. d.	per cwt. s. d.	per cwt. s. d.	per cwt. s. d.	per cwt. s. d.	per cwt. s. d.	per cwt. s. d.	per cwt. s. d.	per cwt. s. d.
Aberdeen-Angus ...	62 1	56 2	42 3	65 0	59 2	43 11	70 0	63 7	47 5
Cross-bred (Shorthorn)	57 6	51 5	36 8	61 0	54 7	39 7	66 1	59 2	43 0
Galloway	57 6	53 2	...	61 5	55 3	...	65 2	68 7	...
Ayrshire	53 0	44 0	38 0	55 6	46 0	40 3	63 0	52 10	43 0
Blue Grey	57 0	...	...	60 6	...	...	66 9	...	...
Highland	...	...	...	...	...	...	...	...	...
	per lb. d.	per lb. d.	per lb. d.	per lb. d.	per lb. d.	per lb. d.	per lb. d.	per lb. d.	per lb. d.
†VEAL CALVES	15¾	8¼	5	15	8½	5	15	8½	5
†SHEEP—	Hoggs under 60 lb. per lb. d.	60 lb. and upw'ds. per lb. d.	Ewes per lb. d.	Hoggs under 60 lb. per lb. d.	60 lb. and upw'ds. per lb. d.	Ewes per lb. d.	Hoggs under 60 lb. per lb. d.	60 lb. and upw'ds. per lb. d.	Ewes per lb. d.
Cheviot	16	15¼	12	16¾	16	12½	18	17	12½
Half-bred	15¼	14¾	11	16½	15¾	11½	17	16¾	11½
Blackface	15½	15	11	16½	16¼	11¾	17¼	17	12
Greyface	15½	15	12¼	16¼	15¾	12¾	17	16¾	13
Down Cross	15¼	15	10	16¼	15¾	10¼	17¼	16½	10
†PIGS—	per stone. s. d.	per stone. s. d.	per stone. s. d.	per stone. s. d.	per stone. s. d.	per stone. s. d.	per stone. s. d.	per stone. s. d.	per stone. s. d.
Bacon Pigs	12 2	11 2	...	11 10	11 0	...	11 8	10 6	...
Porkers	12 8	11 9	..	12 6	11 7	...	12 0	11 0	...

* Live weight. † Estimated dressed carcase weight.

LIVE STOCK : Monthly Averages of Prices at certain representative Scottish Markets—*continued.*

Description.	March. 1st Quality	March. 2nd Quality	March. 3rd Quality	April. 1st Quality	April. 2nd Quality	April. 3rd Quality	May. 1st Quality	May. 2nd Quality	May. 3rd Quality
STORE STOCK :—									
CATTLE—	Per head.	Per head.	Per head.	Per head.	Per head.	Per head.	Per head.	Per head.	Per head.
Aberdeen-Angus :	£ s.	£ s.	£ s.	£ s.	£ s.	£ s.	£ s.	£ s.	£ s.
Yearlings	17 17	14 4	12 14	19 4	15 19	13 12	18 19	15 14	12 14
Two-year-olds ...	23 15	19 3	...	25 1	20 16	17 11	26 16	21 8	16 16
Cross-bred (Shorthorn):									
Yearlings	16 8	13 7	11 10	17 19	14 18	12 19	17 5	14 10	11 17
Two-year-olds ...	22 13	18 10	...	23 3	19 16	16 11	25 11	19 18	16 16
Galloway :									
Yearlings	16 8	12 10	...	17 5	...	...	15 13	...	...
Two-year-olds ...	...	...	...	23 3	20 0	...	31 8	19 12	...
Ayrshire :									
Yearlings	...	...	...	13 8	...	...	11 5	...	...
Two-year-olds ...	...	...	...	...	...	...	15 10	13 0	...
Blue Grey :									
Yearlings	...	...	..	18 0	...	...	...	...	...
Two-year-olds ...	...	...	...	...	...	...	17 10	14 10	...
Highland :									
Yearlings	...	...	...	...	...	...	11 3	9 17	7 15
Two-year-olds ...	...	..	...	...	15 5	13 0	16 2	13 15	12 8
Three-year-olds ...	...	...	...	...	17 0	15 15	22 5	18 15	16 4
DAIRY COWS—									
Ayrshire :									
In Milk	28 19	21 0	11 5	28 6	20 16	11 8	29 3	19 11	11 15
Calvers	27 14	20 13	13 10	28 1	21 4	13 13	28 0	20 3	13 18
Shorthorn Cross :									
In Milk	31 18	23 7	...	30 18	22 11	...	31 8	22 5	...
Calvers	28 5	20 4	14 8	28 4	20 8	14 10	28 5	20 9	15 13
SHEEP—	s. d.	s. d.	s. d.	s. d.	s. d.	s. d.	s. d.	s. d.	s. d.
Cheviot Hoggs ...	50 8	38 11	30 10	48 8	37 2	30 3	52 6	41 9	36 9
Half-bred Hoggs ...	69 6	54 9	38 0	63 5	52 4	49 1	66 1	48 4	38 0
Blackface Hoggs ...	35 7	26 2	19 10	32 11	26 10	20 9	41 7	30 0	23 8
Greyface Hoggs ...	52 3	42 5	34 10	56 0	44 7	36 10	58 7	46 5	36 3
Down Cross Hoggs	...	57 0	47 3	..	59 11	46 9	...	47 9	...
PIGS—									
(6 to 10 weeks old)	27 6	17 6	...	24 10	15 4	...	24 1	14 10	...

DEAD MEAT: Monthly Average Prices at Dundee, Edinburgh, and Glasgow.

(Compiled from Reports received from the Board's Market Reporters.)

Description.	Quality.	March. Dundee.	March. Edinburgh.	March. Glasgow.	April. Dundee.	April. Edinburgh.	April. Glasgow.	May. Dundee.	May. Edinburgh.	May. Glasgow.
		per lb. d.	per lb. d.	per lb. d.	per lb. d.	per lb. d.	per lb. d.	per lb. d.	per lb. d.	per lb. d.
BEEF:—										
Home-fed—										
Bullock or Heifer ...	1	8⅞	9¼	10¾	9½	9⅞	11	10½	10¾	11¾
	2	8⅜	...	10¼	9⅛	..	10½	10⅛	...	11¼
Bull	1	6⅞	7⅜	7¼	7¼	7¾	7¾	7¾	8½	8⅝
	2	6⅜	6	6¾	6⅞	6¾	7¼	7⅜	6¾	8⅛
Cow	1	5¾	5¾	6⅞	6¼	6⅜	7½	6⅞	6½	8¼
	2	5⅛	...	6⅜	5⅛	5½	7	6⅜	...	7¾
Irish—										
Bullock or Heifer ...	1	...	...	8¾	...	...	9⅜	...	...	10⅛
	2	...	...	8⅜	...	...	9⅛	...	...	9⅞
Argentine Frozen—										
Hind Quarters ...	1	6	6⅛	6⅛	6⅛	6¼	6⅛	...	6¾	6½
	2	..	5⅜	5⅝	...	5½	5⅝	...	5⅝	6
Fore ,, ...	1	4⅜	4½	4¼	4½	4⅜	4¼	...	4½	4¼
	2	...	4¼	4	...	4¼	4	...	4¼	4
Argentine Chilled—										
Hind Quarters ...	1	6⅞	6½	6⅝	7⅝	7½	7⅜	7¾	7½	8¼
	2	...	6⅛	6⅛	...	7⅛	6⅞	...	7¼	7¾
Fore ,, ...	1	4⅝	4½	4½	4⅞	4⅝	4¾	5	4½	4⅞
	2	...	4⅛	4¼	...	4⅜	4½	...	4⅜	4⅝
Australian Frozen—										
Hind Quarters ...	1	...	...	5½	...	...	5½	...	...	5½
	2	...	...	5	...	...	5	...	...	5
Crops	1	...	...	4	...	...	4	...	...	4
New Zealand Frozen—										
Hind Quarters ...	1	...	...	6	...	...	6	...	...	6
	2	..	...	5½	...	...	5½	...	...	5½
Fore ,, ...	1	...	...	4	...	...	4	...	...	4
MUTTON:—										
Hoggs, Blackface ...	under 60 lb.	13½	13⅝	14¼	14½	15	15½	15¾	16½	17
	60 lb. & over	...	...	13¾	...	...	15	...	...	16½
,, Cross	under 60 lb.	13½	13⅝	14¼	14½	15	15½	15¾	16½	17
	60 lb. & over	...	...	13¾	...	...	15	...	...	16½
Ewes, Cheviot	1	...	10⅜	11⅛	...	11¼	12⅞	...	10⅛	12⅝
	2	...	...	10⅝	...	...	12⅜	...	...	12⅛
,, Blackface ...	1	10½	10⅜	11⅛	11½	11¼	12⅞	12	10⅛	12⅝
	2	...	...	10⅝	...	...	12⅜	...	...	12⅛
,, Cross	1	8	10⅜	9⅛	9½	11¼	10⅜	9¾	10⅛	10⅛
	2	...	...	8⅝	...	...	9⅞	...	...	9⅝
Argentine Frozen ...	1	...	...	6¼	..	...	6½	...	...	6½
	2	...	...	5⅜	...	...	5½	...	...	5½
Australian ,, ...	1	...	6⅜	6	...	6⅛	6	...	6⅝	6
	2	...	5⅝	5½	...	5⅞	5½	...	5⅝	5½
New Zealand ,, ...	1	...	..	6½	...	...	7	...	...	7
	2	...	...	5⅝	...	...	6	...	...	6
LAMB:—										
Home-fed	1	...	...	...	...	...	...	...	18⅝	19
	2	...	...	...	...	...	...	...	...	18½
New Zealand Frozen ...	1	...	10⅞	10½	...	10¼	9⅜	...	10¾	10⅛
	2	...	10¼	10	...	9⅞	9⅛	...	10	9⅝
Australian ,, ...	1	...	...	9	...	...	8¾	...	...	8¾
	2	...	...	8¾	...	...	8½	...	...	8½

PROVISIONS : Monthly Average Wholesale Prices at Glasgow.

(Compiled from Reports received from the Board's Market Reporter.)

Description.		Quality.	March. s. d.	April. s. d.	May. s. d.
BUTTER :					
Irish Creamery ...	... per cwt.	1	...	169 0	169 6
Australian ...	... ,,	1	176 0	169 0	162 7
Danish	... ,,	1	200 6	188 3	181 5
,, (Unsalted)	... ,,	1	205 6	193 3	186 2
New Zealand ...	... ,,	1	181 9	176 0	173 10
,, (Unsalted) ...	,,	1	183 0	178 9	176 0
Siberian	.. ,,	1	...	165 0	164 7
Swedish	... ,,	1	195 6	184 3	179 8
CHEESE :					
Cheddar (Old) ...	... ,,	1	119 6	122 6	123 10
		2	109 0	111 6	...
,, (New) ...	... ,,	1	...	109 6	97 0
Cheddar Loaf ...	... ,,	1	128 0	129 0	131 0
		2	126 0	...	...
Dunlop (Old) ...	... ,,	1	117 0	124 0	128 0
		2	111 0	...	...
,, (New) ...	... ,,	1	...	109 6	98 0
Canadian... ...	... ,,	1	110 6	112 8	...
New Zealand (Coloured)	,,	1	103 6	105 3	104 2
,, (White)	,,	1	104 3	105 6	104 2
BACON :					
Ayrshire (Rolled) ...	,,	1	130 0	128 6	128 0
Irish (Green) ...	.. ,,	1	122 0	125 0	127 7
,, (Dried or Smoked)	,,	1	128 0	131 0	134 0
,, (Long Clear) ...	,,	1	119 6	121 6	123 7
Wiltshire (Green) ...	,,	1	130 0	125 0	127 10
,, (Dried or Smoked)	,,	1	137 9	133 0	134 10
American, Short Clear Backs	,,	1	86 0	85 6	87 10
BACON—*continued.*					
Canadian Sides ...	... per cwt.	1	85 6	83 3	86 5
Danish Sides ...	... ,,	1	90 6	92 0	98 0
Dutch, Wiltshire Style (Green)	,,	1	78 6	76 6	88 5
HAMS :					
Irish (Smoked) ...	... ,,	1	169 6	177 0	187 0
		2	156 6	163 6	172 0
American, Long Cut (Green)	,,	1	87 3	88 3	89 2
American, Short Cut ...	,,	1	82 0	84 9	86 7
EGGS :					
Country	... per doz.	1	1 6	1 4	1 5
		2	1 4	1 3	1 4
Irish	... per 120.	1	12 2	12 6	12 4
		2	11 2	11 3	11 7
,, (Duck)	,,	1	13 1	12 1	10 9
Belgian	,,	1	11 2	11 6	11 9
		2	10 10	...	...
Dutch	,,	1	11 6	11 6	11 6
,, (Duck)	,,	1	11 9	11 2	...
Polish	,,	1	9 7	9 7	8 11
		2	8 6	...	8 0
Russian	,,	1	...	10 2	10 3

FRUIT AND VEGETABLES: Monthly Average Wholesale Prices at Glasgow.

(Compiled from Reports received from the Board's Market Reporter.)

Description.	Quality.	March.	April.	May.
FRUIT:—				
Apples—		*s. d.*	*s. d.*	*s. d.*
Imported:				
Oregon ... ... per case.*	1	17 9	18 0	17 6
Other American ... ,,*	1	14 8	15 0	15 0
Australian ... ... ,,*	1	...	16 0	17 0
Pears, *Californian* ... ,,*	1	24 6	...	...
,, *South African* per box of 25.	1	...	...	4 8
VEGETABLES:—				
Beet ... ... per cwt.	1	14 0	17 0	18 0
Cabbage, Coleworts ... per doz.	1	2 0	1 11	1 6
,, Savoy ... ,,	1	3 6	...	...
Carrots, *British* ... ... per cwt.	1	14 4	17 6	28 8
Cauliflowers, *French* ... per doz.	1	6 8	6 9	7 0
Celery ... ... per bunch.	1	3 0	3 0	...
Cucumbers ... ... per doz.	1	8 0	8 0	8 0
Greens ... ... ,,	1	1 6	1 6	...
Leeks ... ... per doz bunches.	1	9 9	10 3	9 0
Lettuce, Cabbage ... per doz.	1	4 3	2 11	3 0
Onions, *Dutch* ... ... per bag.**	1	16 3	...	...
,, *Egyptian* ... ,,†	1	20 3	19 9	10 8
,, *Spring* ... ... per bunch.	1	...	0 6¼	0 7¾
Parsley ... ... per cwt.	1	52 0	48 0	26 0
Parsnips ... . ,,	1	11 6	11 0	12 0
Rhubarb ... ... ,,	1	38 0	27 0	6 5
Tomatoes, *Channel Islands* per lb.	1	...	1 10	1 2
,, *Canary* ... ,,	1	0 8	0 8	0 8
Turnips ... ... per cwt.	1	3 2	3 3	4 2

* 40 lbs. (approx.). ** 7½ stones (approx.). † 8 stones (approx.).

Potatoes: Monthly Average Wholesale Prices at Dundee, Edinburgh, and Glasgow.

(Compiled from Reports received from the Board's Market Reporters.)

Market.		Quality.	Late Varieties. Red Soils. Golden Wonder.	Red Soils. Other.	Other Soils. Golden Wonder.	Other Soils. Other.
			£ s.	£ s.	£ s.	£ s.
March.						
Dundee	per ton.	1	...	...	...	7 5
Edinburgh	,,	1	...	...	...	7 17
Glasgow	,,	1	13 15	10 13	11 12	8 12
April.						
Dundee	,,	1	...	...	...	9 0
Edinburgh	,,	1	...	...	...	9 8
Glasgow	,,	1	16 0	12 0	13 7	10 13
May.						
Dundee	,,	1	...	...	...	8 8
Edinburgh	,,	1	...	...	...	10 2
Glasgow	,,	1	16 0	12 0	13 7	10 13

Roots, Hay, Straw, and Moss Litter: Monthly Average Prices at Dundee, Edinburgh, and Glasgow.

(Compiled from Reports received from the Board's Market Reporters.)

Market.		Quality.	Roots. Carrots.	Roots. Yellow Turnips.	Roots. Swedes.	Hay. Rye Grass and Clover.	Hay. Timothy.	Straw. Wheat.	Straw. Barley.	Straw. Oat.	Moss Litter.
			s. d.	s. d.	s. d.	s. d.	s. d.	s. d.	s. d.	s. d.	s. d.
March.											
‖ Dundee ...	per ton.	1	...	...	30 0	107 6 † 100 0 ‡	...	65 0	62 6	65 0	52 6*
Edinburgh	,,	1	...	...	...	105 0 † 105 0 ‡	...	55 0‡	37 6§	55 0‡	...
‖ Glasgow	,,	1	...	...	...	75 0 †	80 0†	40 0	...	40 0	32 6**
April.											
‖ Dundee ...	,,	1	...	...	32 6	110 0 † 102 6 ‡	...	60 0	...	60 0	52 6*
Edinburgh	,,	1	...	...	...	105 0 † 105 0 ‡	...	55 0‡	37 6§	55 0‡	...
‖ Glasgow	,,	1	...	...	...	76 3 †	81 3†	41 3	...	41 3	32 6**
May.											
‖ Dundee ...	,,	1	...	...	38 0	115 0 † 108 0 ‡	...	56 6	57 6	56 6	52 6*
Edinburgh	,,	1	...	...	...	105 0 † 105 0 ‡	...	50 0‡	37 6§	50 0‡	...
‖ Glasgow	,,	1	...	...	...	80 0 †	85 0†	45 0	...	45 0	31 7**

† Baled and delivered.
** Home (in 1½ cwt. bales).
* Foreign (ex quay).
§ Baled on rail at Musselburgh.
‡ Delivered loose.
‖ Baled Straw delivered.

Feeding Stuffs: Monthly Average Prices at Glasgow and Leith.

(Compiled from Reports received from the Board's Market Reporters.)

Description.	March.		April.		May.	
	Glasgow.	Leith.	Glasgow.	Leith.	Glasgow.	Leith.
	per ton. £ s. d.	per ton. £ s. d.	per ton. £ s. d.	per ton. £ s. d.	per ton. £ s. d.	per ton. £ s. d.
Linseed Cake—						
Home	12 14 5	12 5 0	12 15 0	12 6 3	12 12 0	12 4 0
Foreign	12 14 5	11 16 3	12 13 2	...	12 6 0	...
Decorticated Cotton Cake	11 15 0	...	11 11 8	11 15 0	11 19 0	12 0 0
Undecorticated Cotton Cake— Bombay (Home-manufactured)...	7 10 0	7 5 0	7 17 6	7 10 0	8 4 0	7 15 0
Palmnut Kernel Cake	11 0 0	9 10 0	11 3 4	9 10 0	11 5 6	...
Soya Bean Cake ...	13 10 0	11 5 0	13 15 0	11 5 0	13 10 0	11 15 0
Groundnut Cake, Undecorticated—40 per cent. Oil and Albuminoids	10 0 0	9 17 6	10 5 0	9 17 6	10 6 6	...
Maize Germ Cake—						
Home	11 15 0	...	11 0 0	...	11 15 0	...
Foreign	11 0 0	..	11 2 6	...	11 10 0	...
Maize Germ Meal ...	...	..	11 5 0	...	10 15 0	...
Bean Meal	13 5 8	12 5 0	13 15 8	12 5 0	13 15 6	12 8 0
Rice Meal	9 0 0	...	8 13 9	...	8 18 0	...
Locust Bean Meal ...	9 15 0	8 15 0	10 0 0	9 1 3	10 1 0	9 9 0
Fish Meal	20 0 0	22 0 0	20 0 0	21 2 6	20 10 0	21 18 0
Maize Meal—						
Home Manufactured	12 3 2	11 5 0	12 11 3	11 15 0	12 8 0	11 15 0
S. African (Yellow)	11 3 9	...	11 5 8	...	11 2 0	12 0 0
Do. (White)	10 15 0	...	10 18 2	11 10 0	10 3 6	...
Maize Gluten Feed (Paisley) ...	10 10 0	...	10 5 0	...	10 2 0	...
Maize—Plate ...	10 16 11	10 13 2	11 2 6	11 0 0	10 18 0	11 2 0
Do. African (Flat)	11 5 0	...	11 5 0	...	11 5 0	...
Oats—Home ...	11 15 0	11 17 6	12 17 6	13 1 3	13 13 6	13 17 2
Do. Plate ...	10 10 0	...	11 17 6	12 5 0	12 9 5	12 5 8
Do. Canadian No. 2	10 10 0	...	13 10 0	...	13 1 3	...
Barley	11 1 3	10 17 6	11 7 6	11 0 0	11 10 0	11 18 0
Do. Bran ...	10 10 0	...	10 15 0	...	10 13 9	...
Do. Meal ...	12 0 0	12 0 0	11 15 0	12 1 8	12 8 0	12 10 0
Wheat—Home ...	11 13 9	10 16 3	12 0 10	11 5 0	13 2 0	12 7 2
Do. Foreign ...	11 3 9	...	11 10 0	...	11 19 0	...
Beans—English ...	11 13 2	...	12 6 8	...	12 17 6	...
Do. China ...	11 16 11	...	12 6 11	...	12 8 6	...
Do. Rangoon (White)	10 3 9	...	10 8 2	10 5 0	10 9 6	...
Do. ,, (Red)	9 18 9	...	10 0 0	...	10 5 0	...
Locust Beans, Kibbled & Stoned	9 5 0	8 10 0	9 5 0	8 11 3	9 5 0	8 18 9
Pease—						
Karachi (White)...	12 1 3	...	12 3 9	13 0 0	12 6 8	...
China (,,)...	11 17 6	...	11 15 0	..	13 5 0	...
Wheat—						
Middlings (Fine Thirds or Parings)	10 3 2	9 5 0	10 3 9	9 16 3	10 8 6	10 2 0
Sharps (Common Thirds) ...	8 12 6	8 11 3	8 16 3	8 13 9	8 15 6	8 18 6
Bran (Medium) ...	9 0 0	8 9 5	9 2 6	8 12 6	8 16 6	8 14 6
,, (Broad) ...	9 3 9	9 3 9	9 5 8	9 6 11	8 19 0	9 6 0
Distillery Mixed Grains Dried	9 0 0	9 13 9	9 2 6	10 0 0	9 4 5	10 0 0
Do., Malt Grains—do.	9 0 0	...	9 0 10	...	9 1 6	...
Brewers' Grains—do.	9 2 6	8 16 11	9 2 6	8 17 6	9 1 6	9 8 9
Malt Culms... ...	7 10 0	...	7 16 3	...	8 0 0	...
Feeding Treacle ..	7 0 0	7 0 0	7 0 0	7 0 0	6 17 6	7 0 0
Crushed Linseed ...	20 10 0	...	21 10 0	...	21 0 0	...

FERTILISERS: Monthly Average Prices at Glasgow and Leith.

(Compiled from Reports received from the Board's Market Reporters.)

Description.	Guaranteed Analysis.	MARCH.		APRIL.		MAY.	
		Glasgow.	Leith.	Glasgow.	Leith.	Glasgow.	Leith.
	%	per ton. £ s. d.	per ton. £ s. d.	per ton. £ s. d.	per ton. £ s. d.	per ton. £ s. d.	per ton. £ s. d.
Nitrate of Soda ...	N. 15½	11 12 6	11 15 0	11 0 0	11 11 3	11 0 0	11 8 0
Nitrate of Lime ...	N. 15½	...	11 4 0	...	11 4 0	...	11 4 0
Calcium Cyanamide	N. 19	.	9 0 0	...	..	...	9 0 0
Sulphate of Ammonia (Neutral and Granular) § ...	N. 20·6	10 13 0	10 13 0	10 13 0	10 13 0	10 13 0	10 13 0
Superphosphate ...	S.P. 30	2 7 6	2 10 0	2 7 6	2 10 0	2 7 6	2 10 0
"	S.P. 35	2 12 6	2 15 0	2 12 6	2 15 0	2 12 6	2 15 0
"	S.P. 38	2 17 6	3 0 0	2 17 6	3 0 0	.	3 0 0
Ground Mineral Phosphate † ...	I.P. 58/60	2 3 6	2 5 0	2 3 6	2 5 0	2 3 6	2 5 0
" " † ...	I.P. 74	...	3 5 0	..	3 6 11	...	3 5 0
Bone Meal—Home	N. 5 I.P. 40	9 0 0	...	9 0 0	...	9 0 0	...
" " Indian	N. 3¾ I.P. 45	8 15 0	8 15 0	8 15 0	8 15 0	9 0 0	8 15 0
Steamed Bone Flour	N. 1 I.P. 60	6 10 0	6 5 0	6 10 0	6 5 0	6 10 0	6 5 0
Basic Slag	T.P. 26	*2 8 0	..	*2 8 0	...	*2 8 0	.
" "	" 28	*2 11 6	..	*2 11 6	...	*2 11 6	...
" "	" 30	*2 15 2	...	*2 15 6	..	*2 15 6	...
" "	" 40	..	‡2 15 0	...	‡2 15 0	...	‡2 15 0
Sulphate of Potash (on basis of 90 per cent. purity)	Pot. 48·6	11 2 6	11 2 6	11 2 6	11 2 6	11 2 6	11 2 6
Muriate of Potash... (on basis of 80 per cent. purity)	Pot. 50	9 0 0	9 0 0	9 0 0	9 0 0	9 0 0	9 0 0
Potash Salts ...	Pot. 20	3 10 0	3 10 0	3 10 0	3 10 0	3 10 0	3 10 0
" " ...	Pot. 30	4 17 6	4 17 6	4 17 6	4 17 6	4 17 6	4 17 6
Kainit (in bags) ...	Pot. 14	3 1 0	3 0 0	3 1 0	3 0 9	3 1 0	3 0 2

Abbreviations:—N. = nitrogen; S.P. = soluble phosphate; I.P. = insoluble phosphate; T.P. = total phosphate.

* Carriage paid to stations in Ayrshire.

† Fine grist 80 per cent. through standard 100 mesh sieve; 80 per cent. fineness through 120 mesh sieve 2s. 6d. per ton dearer.

‡ Foreign slag at Leith.

§ Carriage paid in 6-ton lots.

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THE AGRICULTURAL OUTPUT OF SCOTLAND.

IT is sixty years since official statistics of agriculture were first obtained in Great Britain, covering the acreage of crops and grass and the numbers of live stock. These statistics were taken by various Departments successively, and since 1912 the responsibility for them, so far as Scotland is concerned, has rested on the Board of Agriculture for Scotland. Their basis is the "4th of June" returns, well known to all Scottish farmers, which have since 1926 been compulsory. In 1885 annual estimates of the produce of the principal crops were inaugurated. These rest, not on individual returns, but on estimates made by Crop Reporters for their various districts. The prices of grain, meat and wool were included in the Agricultural Statistics from an early date, so far as they were available, and this service was greatly extended and improved in 1904 by the appointment of Market Reporters for a large number of markets, including ten in Scotland.

The three classes of statistics mentioned above illustrate three different statistical methods. Those of acreage and live stock are based on complete statements by all occupiers of agricultural holdings exceeding one acre in extent, which are then tabulated so as to give the actual total of each item. The figures for the produce of crops are based on estimates made by skilled men appointed for the purpose. The statistics of prices are based on reports from selected markets, which are believed to represent fairly the prices current from week to week throughout the country.

Censuses of Production.—In order, however, to arrive at an estimate of the total amount and value of the agricultural output, further particulars are required. These were obtained, on the occasion of each Census of Production, by adding to the schedule for the 4th of June returns a supplementary schedule dealing with sales of fat stock, births and deaths of live stock, output of milk and milk products, poultry and egg production, and motive power used on farms. In the earlier Censuses mentioned below special inquiry was made regarding labour employed on farms, but this now forms part of the regular annual returns. Special schedules were also issued to agricultural occupiers producing wool, fruit, vegetables, crops under glass, and honey, and to live stock auctioneers and market authorities for the purpose of ascertaining the dead weight of animals slaughtered.

In accordance with the provisions of the Census of Production Act, 1906, a general Census of Industrial Production was taken by the Board of Trade in 1907, and at the request of that Department a Census of Agricultural Production was taken by the (then) Board of Agriculture and Fisheries in 1908, the inquiry covering the whole of Great Britain. The Report [1] was issued in 1912. The second Census of Industrial Production was taken in 1912, and the corresponding Census of Agricultural Production in Scotland was undertaken in 1913 by the Board of Agriculture for Scotland. The work was, however, interrupted by the war, and the results were not published.[2]

The general Census of Production was intended to be quinquennial, but all such arrangements lapsed during the war, and for various reasons it was thought advisable to postpone the inquiry for several years after the conclusion of peace. It was not until 1924 that the Board of Trade took the third Census of Production, and the Census of Agricultural Production in Scotland was taken by the Board of Agriculture for Scotland in 1925. The Report, which has now been published,[3] is the first Census Report dealing exclusively with Scotland. It is in nine parts, dealing respectively with the agricultural area, the production of crops, the number of live stock, the distribution of land and live stock in 1913 and 1925, the output of live stock products, the value of the agricultural output, the number and size of holdings, employment in agriculture, and motive power on farms. The principal tables, 28 in number, are placed in an Appendix, while over 50 tables are supplied in the text to illustrate special points. The Appendix tables are mainly on the basis of (1) agricultural divisions, and (2) groups of holdings, illustrating respectively geographical distribution and distribution according to size of holdings.

Like the corresponding Report for England and Wales,[4] the Report includes a summary of the changes in agriculture that took place between 1871 and 1925. This part of the Report is dealt with in the present article, the agricultural output of 1925, which is the main subject, being reserved for later treatment.

Distribution of Land.—Reference may first, however, be made to the tables in Part I of the Report showing the distribution of land in Scotland in 1925. As has often been pointed

[1] The Agricultural Output of Great Britain (Cd. 6277), price 6*d.*

[2] The tables were printed, and occasional public use has been made of some of the figures.

[3] The Agricultural Output of Scotland (Cmd. 3191), pp. 94; to be obtained from H.M. Stationery Office, 120 George Street, Edinburgh; price 2*s.*

[4] The Agricultural Output of England and Wales (Cmd. 2815), pp. xv, 152; price 3*s.* 6*d.*

out, the farm land of Scotland is about one-fourth of the whole area, while rough grazings cover one-half, and the remaining quarter is put to various non-agricultural uses. The actual figures are :—

	Acres.	Per cent.
Crops and permanent grass ...	4,700,000	24·6
Rough grazings	9,250,000	48·5
Deer forests	3,430,000	18·0
Woodlands	850,000	4·5
Remainder	840,000	4·4
Total ...	19,070,000	100·0

A juster view is, however, obtained by dividing the country into two regions of nearly equal size, one consisting of the counties of Argyll, Inverness, Sutherland and Caithness, most of Ross and Cromarty, and the mountainous parts of Aberdeen and Perth, and the other comprising the remaining counties and parts of counties. The distribution of land in the Highland region is as follows :—

	Acres.	Per cent.
Crops and permanent grass ...	570,000	6·2
Rough grazings	5,000,000	54·7
Deer forests	3,270,000	35·7
Woodlands	310,000	3·4
Total ...	9,150,000	100·0

In the Lowland region the distribution is as follows :—

	Acres.	Per cent.
Crops and permanent grass ...	4,130,000	41·6
Rough grazings	4,250,000	42·8
Deer forests	160,000	1·6
Woodlands	540,000	5·5
Remainder	840,000	8·5
Total ...	9,920,000	100·0

Thus more than two-fifths of the Lowland region consists of ordinary farm land, and a list is given of 18 counties and county districts, almost all on the east coast, in which the proportion exceeds two-thirds.

Arable and Grass Land.—The tables showing the changes in the acreage of crops and grass and the number of live stock are arranged so as to show the average number for each five-year period from 1871–75 to 1921–25. Thus the annual fluctuations are smoothed out, and the general tendencies are more clearly shown.

The total area of land under crops and grass in 1921–25 was actually greater than that in 1871–75, the averages for the two periods being 4,720,000 acres and 4,561,000 acres respectively. This area reached its maximum in 1891, and remained fairly steady until 1902, after which it declined by about 200,000 acres, or 4 per cent. The distribution between arable land and permanent grass shows a marked change. The arable area was at its greatest in 1888. There was a rapid fall between that year and 1895, when 26,000 acres were lost annually on the average, and a more gradual fall until 1915, the average annual loss being 11,000 acres. The gain achieved during the war was quickly lost, and the area of arable land in 1925 was the smallest then on record, while each year since that date has shown a further decline. Permanent grass shows a corresponding increase, and now accounts for 30 per cent. of the whole area of farm land, as compared with 24 per cent. fifty years ago.

Arable land is divided between land under crop or bare fallow and that under rotation grasses and clover. For the former the term " tillage " is used in the Report. The tillage area shows an unbroken fall from 1871 to 1915, amounting to 306,000 acres, or 14 per cent. It was greatly increased during the war years, the average for the period 1916–20 being equal to that for 1891–95. In the period 1921–25, however, the average acreage was the smallest on record. The area under rotation grasses and clover increased rapidly up to the period 1886–90, after which it fell correspondingly with the total area of arable land. The change in the rotation of arable land is shown by an increase in the percentage under rotation grasses and clover from 38·5 in 1871–75 to 45·1 in 1886–90. This figure remained fairly steady until the war years, when it was reduced to 42·4; since then it has been restored to the pre-war figure, and in 1925 it was as high as 46·5. The proportion of 45 per cent. indicates an equal division between the five-course and the six-course rotations, with two and three years' grass respectively, but this broad average covers many local variations.

Acreage of Crops.—Within the tillage area a distinction is drawn between grain crops, which cover about two-thirds of the total area, and other crops and bare fallow, which occupy the remaining third. The simplicity of Scottish cropping, considered broadly, is shown by the fact that the five crops—wheat, barley, oats, potatoes, and turnips and swedes—account for 96·5 per cent. of the tillage area. Within the group of grain crops, oats have remained steadier than wheat and barley. Wheat was at its maximum in 1872 and at its minimum in 1895, when the acreage was only one-fourth of that in the former year. In recent years it has varied from 50,000 to 60,000 acres, which is less than half the acreage fifty years ago. Barley shows a more gradual fall than wheat, with considerable fluctuations. Its area was never under 200,000 acres until 1908, and since that date it has risen above that figure only in 1920. Oats covered over a million acres until 1895, but afterwards that figure was reached only in the war and post-war years, the actual maximum being 1,244,000 acres in 1918. The average acreage for the period 1921–25 was only 7 per cent. less than that for 1871–75, while wheat and barley show decreases of 53 and 41 per cent. respectively.

Turnips and swedes show an unbroken decline in area, amounting in all to about 100,000 acres, or nearly 20 per cent. The proportion of the tillage area they occupy has shown little change. On the other hand, the acreage per 100 cattle has decreased from 44·7 to 34·6; and that per 100 sheep from 7 to less than 6; this decrease has, however, been to a certain extent counterbalanced by the increase in the yield of turnips per acre. Potatoes show a different line. Beginning with about 170,000 acres, they fell in the period 1896–1900 to about three-fourths of that area, and then steadily increased until the war period, when they reached an average of 155,000 acres. Since 1921, however, this has been reduced by about 5 per cent.

Among "other crops" the most striking points are the decrease in the area under beans, peas, vetches, tares, &c., and the increase in that under cabbage and rape. Bare fallow, which averaged 20,000 acres fifty years ago, now ranges from 5,000 to 9,000 acres according to the season. It accounts for only ½ per cent. of the tillage area, as compared with 5½ per cent. in England and Wales.

Particulars of the area of rough grazings have been obtained only since 1892. It shows a decline up to the period 1911–15, and a large increase since that time, which appears, however, to involve some overlapping with the deer forest area.

Production of Crops.—A table in the Appendix shows the estimated total produce and the yield per acre of each of the principal crops for each quinquennial period since 1886. All the crops show increases in the yield per acre, amounting to 17½ per cent. for potatoes, 11½ per cent. for wheat, 10½ per cent. for oats, and 9 per cent. for turnips and swedes, while barley and hay show smaller advances. This increase in the yield of Scottish crops may be attributed in a large measure to the improvements resulting from agricultural education and research.

The annual fluctuations in the yield per acre are concealed in these quinquennial averages, but a table in the text gives the highest and lowest yields of each crop. The widest range is shown by potatoes and the narrowest by barley. All the highest yields, except that of barley, occur in the twentieth century, and all the lowest, except those of barley and potatoes, in the nineteenth.

Live Stock.—The total number of horses on farms in the year 1925 was about the same as in the years 1871–75. The maximum was reached in the period 1916–20; since then a rapid fall in horse-breeding has taken place, stallions having diminished by 32 per cent., unbroken horses over a year old by 42 per cent., and those under a year by no less than 60 per cent. The number of horses used for agricultural purposes, however, remains comparatively steady, as the annual replacement is a small proportion of the total.

Cattle show an increase of about 50,000 at the end of the period as compared with the beginning, which is altogether due to an increase in the number of dairy cattle; other cattle were considerably more numerous from 1896 to 1905 than they are now. When set against the acreage of crops and grass, cattle show a slight advance, the ratio of dairy cattle per 1,000 acres having increased by about 10 per cent., while that of other cattle has diminished by 5 per cent. Another comparison shows that the cattle population has by no means kept pace with the growth of the human population. There are now 92 dairy cattle per 1,000 persons, as compared with 114 in 1871–75, and 147 other cattle as compared with 213, the total diminution being 88, or 27 per cent., i.e. there are only three-fourths of the cattle in relation to the human population that there were fifty years ago. The actual maximum number of cattle is 1,247,000, which was reached in 1903 and again in 1913.

Sheep reached their maximum in the period 1896–1900, when the yearly average was nearly 7½ million. Seven million remained the normal total until 1916, when a serious decrease began, the minimum number, 6,360,000, being reached in 1920; this loss had not been fully made up in the period 1921–25. The maximum number was recorded in 1891, viz. 7,624,000.

Pigs were practically the same in 1921–25 as in 1871–75, after being well below this level in the intervening periods. The yearly variations in the number of pigs are much greater than those of other classes of stock. The maximum number recorded was in 1924, viz. 199,000, which exceeded the minimum, 112,000 (recorded in 1891), by 77·5 per cent. The corresponding percentage for cattle is 16·5, and for sheep 19·9.

Numbers of Agricultural Holdings.—Another subject dealt with in the Census Report is the numbers of agricultural holdings of various sizes. Unlike the figures of acreage and live stock, however, these numbers were not tabulated annually in the earlier years, nor has the same classification been used throughout. It appears that little change took place in the number of holdings in Scotland between 1870 and 1895. Since then there has been a reduction of about 3,500, or over 100 a year. This is almost wholly accounted for by a decrease in the number of holdings not exceeding 5 acres. At the other end of the scale, farms above 300 acres have also decreased in number, and figures are given showing that this decrease has taken place among the very largest farms, while those between 300 and 500 acres have slightly increased in number.

Detailed statistics are not available for the whole period of fifty years, but from 1913 to 1925 holdings between 15 and 75 acres increased in number by 715, while those from 75 to 150 acres remained almost stationary; on the other hand, holdings up to 15 acres and those over 150 acres were considerably reduced in number. Another table shows that holdings between 15 and 150 acres increased their proportion of the diminishing total area of farm land, while the smallest holdings just maintained their proportion, as did holdings between 150 and 300 acres, and the largest holdings suffered a substantial loss.

A statement is given showing that since 1914 the number of holdings returned as owned by the occupiers had in 1925 increased by 3,398, or 57 per cent., and it is remarked that this is probably an understatement of the actual number.

Employment in Agriculture.—Here again it is difficult to get completely comparable figures covering the whole period of fifty years. It appears, however, from the Reports on the successive Censuses of Population that male workers, including farmers and crofters and their relatives assisting them, declined between 1871 and 1921 from 178,200 to 140,250, the loss being about 38,000, or 21 per cent. The average annual decrease was 760. This was not, however, uniform. The largest diminution was in the decade 1891 to 1901, when the loss averaged 1,210 per annum. This is clearly associated with the rapid decline in the area of arable land that is mentioned above. The decade 1901–11 showed a very small loss, amounting only to 280 per annum, while in the last decade, which included the war years, the diminution was over 800 per annum.

The figures for women are less satisfactory, owing to changes in classification. If, however, the figures for 1871 and those for 1921 are comparable, the total number of women fell from 48,000 to 22,250, a decline of 54 per cent. Thus the total number of agricultural workers was reduced from about 226,000 to 162,500.

A comparison of the figures for labour obtained in connection with the Agricultural Censuses of 1908 and 1913 and the Agricultural Returns of 1921 with the figures given in the Reports on the Population Censuses of 1911 and 1921 shows the difficulty of arriving at an accurate statement of the number of persons, and especially the number of women, engaged in agricultural work. Reference is made in this connection to an article that appeared in this Journal in July 1924.

RECENT PASTURE RESEARCH AND ITS PRACTICAL SIGNIFICANCE.

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Introduction.—The application of scientific principles to the summer feeding of farm animals is only possible if information is available concerning the composition and nutritive value of grass as consumed by grazing animals. No attempt, however, appears to have been made by the earlier workers on grassland to secure such information, their efforts in this direction having been confined to the investigation of the feeding value of grass after it had attained to the relatively mature stage of growth suitable for hay-making. The results obtained in this manner had little or no significance in relation to the problems of the grazing animal, and it was with a view to filling in this gap in nutritional knowledge that the Cambridge grassland investigations were undertaken. During the last four or five years the writer and his co-workers have been engaged in a systematic study of the composition, digestibility and nutritive value of pasture herbage in its different stages of growth, and although at the present time the investigations are by no means complete, much useful information has been accumulated, especially in regard to the question of close-grazing. It is the purpose of this article to outline very briefly the discoveries which have been made in the course of these investigations and, in particular, to indicate their bearing on the practical problems of grassland husbandry.

The problem of securing information concerning the feeding value of pasture herbage under conditions resembling those of grazing was attacked in the following manner. At the beginning of the 1925 season a large plot was marked out on one of the pastures of the University Farm. This main plot was further divided into seven equal sub-plots, and on every day throughout the grazing season one sub-plot was cut over by means of a 16-inch motor lawn mower. In this way the whole plot was cut over once per week throughout the season. After cutting, the grass was left as short as it might be left after being grazed by sheep under conditions of heavy stocking.

It should be noted, therefore, that in this initial trial the system of cutting was frequent and severe. The conditions were so designed as to bring out the results which would be obtained in respect of composition and nutritive value of pasture herbage under a system of close and uniform grazing. In subsequent trials the interval between successive cuttings was lengthened to a fortnight, three weeks, and so on, and the influence of these more lenient systems of cutting on the yield, ccmposition and feeding value of the herbage was investigated.

After the cutting of a daily sub-plot, the produce therefrom was weighed and sampled for chemical analysis. A suitable bulk was transported forthwith to the metabolism room of the School of Agriculture and spread out overnight in a thin layer on a stone floor, to prevent heating, and on the following morning was well mixed and weighed out for feeding to two experimental sheep on which digestion trials were being carried out. In this first trial the ration received by each sheep was 4,400 gm. per day. The whole season was divided into ten periods, each period corresponding with the duration of a digestion trial.

Composition and Nutritive Value of closely-grazed Pasturage.—The results of the 1925 investigation may briefly be summarised as follows. Pasture grass kept short by efficient grazing contains a very high percentage of protein. Roughly one-quarter of the dry substance in such herbage consists of protein, an amount two and a half times as great as that found in grass which had been allowed to grow unchecked to the hay stage of maturity. Under a system of close-grazing, moreover, this high content of protein is maintained throughout the entire season. No falling-off occurs during the second half of the season, such as would be noted on poorly-grazed pasture, where the grasses are permitted to advance in maturity.

The amount of fibre in such young pasture herbage is very much smaller than that in meadow hay. Thus, while the dry matter of the weekly-mown pasture grass contained, during May, from 13 to 14 per cent. of fibre, the percentage of this constituent in the dry matter of grass grown, in the same field, to the stage of maturity suitable for hay, was as high as 30 per cent. The pasturage also contained, on the basis of dry matter, a higher percentage of crude oil than the hay. This distinct contrast between hay and young pasture grass in respect of organic composition extended also to the mineral composition, the dry matter of the pasture samples containing approximately twice as much lime and phosphate as was contained in the dry matter of the hay.

Very striking results were obtained in the digestion trials which were carried out on the young pasture herbage. It was demonstrated that the digestibility of such grass compares very favourably with that of linseed cake, being superior to that of a concentrate like palm kernel cake, and very much superior to that of the very best quality of meadow hay. The food material in the grass obtained during the spring of the 1925 investigation was digested and utilised by the sheep to the extent of about 84 per cent. The corresponding figure for linseed cake is 80·1 per cent. and for palm kernel cake 70·8 per cent. Even the fibrous constituent, which in hay is often woody and of low digestibility, is in young pasture grass digested to an extent almost equal to that of the carbohydrate constituent. The constant cutting or grazing of a pasture keeps the grasses immature and prevents the fibrous cell walls from undergoing thickening or lignification. For that reason the fibre in closely-grazed pasturage is present mainly in the form of the simple and highly digestible cellulose, unmixed with any significant amount of the more carbonaceous and entirely indigestible lignocellulose. Since the cellulose coatings of the plant cells in young pasture grass are capable of being easily dissolved by bacterial action in the rumen of the animal, it follows that the nutrients, like protein and carbohydrate, contained within the cells are readily liberated and become easily accessible to the digestive ferments in the alimentary tract. To this circumstance must be attributed the extremely high digestibility of the protein and carbohydrate in young pasturage. With hay, on the other hand, the cell walls have become lignified, and for that reason the protein and carbohydrate in hay, although not essentially different in a chemical sense from the corresponding constituents of pasture grass, are of low digestibility. They are enclosed within cell walls which cannot readily be digested, and are therefore relatively inaccessible to the action of the digestive ferments.

Since Kellner has shown that digestible fibre has a value equal to that of starch in the fattening of ruminant animals, it is clear that the fibre of young pasture grass must not be regarded as a useless constituent, as it substantially is in the case of mature coarse fodders, but as a nutrient of high digestibility and nutritive value when consumed by sheep, bullocks and dairy cows.

It became clear, during the course of the first year's investigations, that the dry matter in the produce of closely-grazed pastures partakes of the character of a protein concentrate of high digestibility and nutritive value, and that young pasture grass is essentially a feeding stuff designed for production rather than for maintenance purposes. The dry matter of the spring grass in the 1925 investigation contained 22·5 per cent. of digestible protein, 75·2 per cent. of digestible organic matter, and about 73 per cent. of starch equivalent. This high feeding value, under a system of intensive grazing, may be maintained substantially throughout the entire season, especially when rainfall distribution serves to keep up the level of productivity during the summer and autumn months. The prevalence of droughty conditions during mid-season leads to a temporary slight falling-off in the protein content and nutritive value of the herbage, but, with the coming of rain, a progressive improvement takes place until values obtained in the later stages of the season are equal to those which characterised the spring grass. It has since been demonstrated that on pastures where soil conditions, rainfall distribution and botanical composition conduce to active growth throughout the entire season, the mid-seasonal depression in respect of nutritive value becomes insignificant.

Inadequate grazing of pastures leads to a running-off in feeding value during the summer months; under such conditions the grasses are enabled to grow long and fibrous and of diminished digestibility. For this reason the occasional use of the mower is to be recommended when it is found impossible by grazing alone to keep the pasture herbage short and leafy.

It is further of interest to note that the protein concentrated food produced from closely-grazed pastures possesses advantages which are not shared by many of the ordinary farm protein concentrates, in that it is an excellent source of all the important vitamins, and is also capable of supplying the requirements of farm animals for bone and milk-forming minerals like lime and phosphate. A dairy cow yielding four gallons of milk per day, for instance, requires 3½ oz. of lime and 3⅓ oz. of phosphoric acid in its daily ration. If such an animal consumes 30 lb. of dry matter per day on young pasturage, this amount of herbage, on the basis of the 1925 Cambridge data, will contain about 7·4 oz. of lime and 5 oz. of phosphoric acid; these amounts are more than sufficient to meet the maintenance and production requirements of the animal. It is therefore scarcely an exaggeration to claim that the farmer's cheapest, and possibly his best, protein concentrate is to be found growing within easy reach of the homestead.

Influence of Botanical Composition on the Nutritive Value of closely-grazed Pasturage.—The results summarised in the preceding paragraph were obtained on a pasture plot in which the characteristic herbage consisted of perennial rye grass and wild white clover, together with rough-stalked meadow grass. Although the plot contained too big a proportion of weeds (which were, of course, included in the herbage fed to the sheep) to be regarded as really first class pasture, yet its botanical characteristics were such as would be associated with a good type of grassland. It was thought that the conclusions which had been drawn from the 1925 experiments were sufficiently striking and fundamental to warrant further work, in order to ascertain whether they would still hold good with grassland of a different type. Accordingly, the 1925 trial was repeated during the season of 1926 on a pasture in which the soil and botanical conditions were essentially different from those which characterised the 1925 pasture. The botanical composition of the 1926 plot was such as would be associated with inferior pasturage. Rye grass and wild white clover were only of minor importance in this plot; rough-stalked meadow grass figured prominently in the early part of the season, but this species diminished very considerably in importance as the season advanced, due partly to the effect of close-cutting, which left this grass fully exposed to light, and partly to the competition of creeping bent. The latter species flourished, under the system of cutting, to quite an extraordinary extent and was easily the dominant grass in the sward. Indeed, it was estimated that creeping bent during the later stages of the experiment constituted as much as 90 per cent. of the total herbage of the plot.

It is not necessary at this point to summarise in detail the results which were obtained on this second pasture plot. The data secured demonstrated very clearly that equally good results in respect of composition, digestibility and nutritive value had been obtained in two different seasons on two widely differing pastures, one of which, on the basis of theories connecting good nutritive properties of pastures with the presence in abundance of certain esteemed species of grasses, would have been expected to yield much better results than the other. It would appear that richness in respect of protein and starch equivalent is, under a system of close-grazing, independent of the botanical character of the herbage or of the presence of little or much wild white clover in the pasture.

In view of these facts it is difficult to resist the conclusion that the botanical composition of a pasture is of secondary importance, and that management, involving not only efficient stocking and close-cropping (as under a system of rotational grazing) but also adequate manuring to ensure density of herbage and vigour of growth, is the primary factor determining the nutritive value of pastures. Botanically, it is desirable that a pasture should contain a number of different species of grasses of different seasons of luxuriance, in order to ensure a continuous succession of growths from early spring to late autumn. In addition to this, however, it is necessary, in order to ensure the best results from the nutritional standpoint, to concentrate on preventing the grasses from flowering and seeding. Should the herbage be permitted to grow long and mature, as on poorly grazed pasture or under meadow conditions, there can be little doubt that the different species would display different feeding values, and under such conditions the nutritive value would be likely to be conditioned by botanical composition. Under pasture conditions, however, it should be possible in large measure to overcome handicaps from the botanical standpoint by combining a system of close-grazing with an intelligent system of fertilising.

What constitute, then, the actual differences between the so-called inferior and superior pastures? Two suggestions may be put forward in answer, or partial answer, to this question. (1) The superior pasture is characterised by the density and luxuriance of its herbage, this circumstance enabling the grazing animal to gather its daily ration of grass with a minimum expenditure of muscular energy. (2) The inferior pasture not only grows a scantier supply of herbage, but its characteristic grasses are of such a type that, if the vigilance of the grazier be relaxed, they more readily become coarse and less digestible than the grasses on the better types of grassland. In other words, management, in respect of stocking, is more difficult on such inferior pastures if the spring-time feeding value of the herbage is to be maintained throughout the season. It is on such pastures that the mowing machine should prove a useful adjunct to the efforts of the grazing animal. Further, where it can be done economically on pasturage of this type, fertilisers might be used with a view to increasing the density and growth-vigour of the herbage. Such treatment might also lead to a more *uniform* growth of grass throughout the season, since usually the efficient stocking of such pastures is rendered difficult by the fact that the bulk of the season's growth is produced during the short spring "flush" period, and later in the season the grazier is confronted with anxious problems arising from shortage of pasturage. The first class pasture, on the other hand, is characterised not only by dense herbage, but also by a reasonably uniform rate of growth over the whole season. Management on such pastures is obviously a comparatively simple matter.

Supplementary Feeding on closely-grazed Pastures.—Under conditions of intensive grazing, pasture grass is extremely rich in protein and possesses a nutritive ratio comparable in narrowness with that of linseed cake. It will be advisable to consider the significance of this fact in relation to the nutrition of the grazing animal, since, if it would be considered unsound practice to feed an animal on linseed cake alone, then it would appear justifiable to assert, on the basis of the Cambridge results, that closely-grazed pasture grass constitutes an unbalanced food for all farm animals. One or two examples will serve to make this point clear.

A ration of young spring grass containing 30 lb. of dry matter (that is, the amount of dry matter usually assumed to be the measure of the appetite of a 12-cwt. dairy cow) will supply, according to the Cambridge data, sufficient digestible protein (but not, of course, sufficient starch equivalent) to satisfy the requirements of a dairy animal yielding as much as nine gallons of milk per day. The extra starch equivalent necessary to bring up the energy content of this ration to the standard amount should not of course be given in the form of protein-rich food, but in the form of a carbohydrate concentrate.

It may be assumed that the ideal ration for a young animal going out on to pasture will be one which approximates most closely to milk in respect of nutritive ratio and lime : phosphate ratio. The Cambridge results show that such a ration is obtained when nine parts of fresh young pasture herbage are supplemented by one part by weight of maize meal.

A fattening sheep of about 120 lb. live-weight requires no more than ¼ lb. of digestible protein in its daily ration. Such an animal, when grazing freely on young spring pasturage, will consume rather less than 4 lb. of dry matter per day, including, according to the Cambridge figures, about ⅘ lb. of digestible protein. In other words, the animal is receiving more than three times the amount of digestible protein requisite for its maintenance and production purposes.

If it be admitted that it is desirable to feed balanced rations to farm animals in summer as well as in winter, then it follows that the traditional practice of using linseed cake, cotton cake and other protein concentrates as supplementary foods for pasturing animals is not in accord with the results which have been obtained in the Cambridge investigations. On well-grazed pastures animals should receive, as supplementary food, feeding stuffs which are rich in carbohydrate and poor in protein, such as maize meal, flaked maize, maize germ cubes, barley meal, locust bean meal, dried sugar beet pulp, meadow hay, &c. Indeed, it appears justifiable to assert that the optimum results are not possible on closely-grazed pasturage with any class of stock, young grazing stock, dairy cattle and fattening animals alike, unless such animals are receiving at all stages of the season some supplementary food which is richer in carbohydrate.

It has further been suggested that the use of carbohydrate supplements might materially help to mitigate the evils which often arise when farm animals, especially young beasts, are first led out on to young rich pasturage in early spring, such evils possibly being due to the tendency displayed by such animals to consume an excessive amount of digestible protein. This may be so, but the evidence on the subject is decidedly conflicting. In the writer's opinion, "scouring" on pasture may arise from a variety of causes, among which the consumption of excessive amounts of protein may sometimes, but not always, be the main factor. It is high time that this vexed and complex question of "scouring" on spring grass was submitted to systematic investigation.

What constitutes the correct form of supplement for animals on less severely grazed pastures must for the present remain uncertain. Might it not be possible, by a somewhat less drastic system of grazing, to secure the herbage at a slightly more advanced stage of maturity, in which condition, whilst retaining the high digestibility and nutritive value of a concentrate, it will at the same time be better balanced in its content of protein and carbohydrate and be more adapted to meeting, in itself, the requirements of young stock and dairy animals? Investigations are being carried out at the present time at Cambridge to determine the influence of the intensity of grazing on the yield, composition and nutritive value of pasture herbage. During the 1927 season, experiments were made to ascertain the effect of cutting at fortnightly instead of weekly intervals. It was found that the dry matter of the pasture herbage grown under a system of fortnightly cutting is a protein concentrate equal in digestibility and nutritive value to that obtained by weekly cutting. There is no significant running-off in respect of composition and feeding value during the second week of growth. At the end of a fortnight the herbage still consists of the same immature, non-lignified tissue as it was at the end of a week's growth. Despite the slight widening of the nutritive ratio in the fortnightly-cut grass as compared with the weekly-cut herbage, the value is still significantly lower than the nutritive ratio of milk, and the conclusions arrived at under the system of weekly cuts respecting the desirability of employing carbohydrate concentrates instead of protein-rich foods for the purpose of supplementary feeding on closely-grazed pastures still holds good under a somewhat more lenient system of grazing. During the past season a further step has been taken by repeating the work under a system of cutting every three weeks. The results obtained throw further light on the whole question, and an account of this work will be published shortly in the *Journal of Agricultural Science*.

Wider Aspects of the Close-grazing Question.—Under the title of "The Farmer's Sheet Anchor," a review of the live-stock branches of agriculture appeared from the pen of Professor T. B. Wood in *The Nineteenth Century and After* for August 1927. In this publication the author deals with the factors which are relative to the modern tendency in the direction of intensive production in farm animals. The conclusion is drawn that in order to attain an all-round standard of high productivity, such for instance as that of the 1000-gallon cow, the 200-egg hen, the pig which is ready for the factory in six months, and the steer which makes "baby beef" at eighteen months, the national bill of fare of our live stock must include concentrated foods (in which is included the dry substance of root crops) and coarse fodders in equal proportions.

Going into figures, however, Professor Wood shows that the annual supply of concentrated foods available for animals in the British Isles amounts to about 16 million tons, whereas the grand total of coarse fodder is about 48 million tons, that is to say, a ratio of coarse fodder to concentrated food of 3 : 1. An all-round standard of high productivity is therefore not possible under the present conditions. Further, such a state of affairs leads to a scramble for the short supply of concentrated foods, and prices rise to uneconomic levels.

The central problem of to-day in animal husbandry is to bring about a material increase in the supply of concentrated foods. How is this problem to be solved? The results of the Cambridge pasture investigations point the way to a simple solution. The dry matter of young grass possesses the character of a superior protein concentrate; this productive character is, moreover, under a system of close grazing, retained throughout the season. By the better utilisation, along the lines of closer grazing, of our continually expanding area of grassland, the available supplies of concentrated food can be increased considerably at the expense of the coarse fodder, and many of the difficult problems associated with intensive production in farm animals will be capable of solution.

Conservation of the Produce of Pastures.—The well-managed pasture provides the farmer with a cheap means for converting inorganic nitrogen into digestible protein. It is now recognised that the use of nitrogenous fertilisers on grassland leads to a more abundant and luxuriant growth of young grass. By such means the cheap nitrogen of sulphate of ammonia is built up into the form of valuable and highly digestible protein. It is of interest in this connection to consider the proposals which have emanated from Cambridge for the conservation of this ideal pasture protein concentrate for purposes of winter feeding, along with balancing home-produced foods like roots, cereals, meadow hay, sugar beet pulp, &c.

During the season of 1927 Messrs Nitram, Ltd., undertook the systematic cutting of some acres of grassland in the neighbourhood of Billingham. The young herbage, after cutting, was dried artificially in steam-heated troughs, and the dried grass was pressed into the form of cakes by means of a hydraulic press. The dried grass cakes measured 6 in. × 5 in. × 1 in., and were of such a density that 40 cub. ft. weighed about one ton. They had retained the green colour of the fresh grass and possessed a most fragrant and appetising smell. When placed in water they swelled up considerably and disintegrated, the resultant material being indistinguishable from newly-mown pasture grass in appearance and smell. They contained about 8 per cent. of moisture and 25 per cent. of protein, and were consumed eagerly by farm stock both in the dry and the soaked condition.

Digestion trials carried out at Cambridge on these grass cakes showed clearly that the drying process had not in any way impaired the high digestibility and nutritive properties of the fresh grass. In feeding trials on the University Farm it was further demonstrated that such conserved pasture grass could replace successfully the oil cake allowance in the rations of fattening bullocks and of dairy cows. It is by no means improbable, therefore, that dried young pasture herbage will at some future date become a familiar item in the winter bill of fare of the farm animals in this country. Such a concentrate supplies not only an abundance of digestible protein, but also constitutes a source of lime, phosphate, vitamins and green pigment, the presence of the last-named constituent being of importance in relation to the problem of keeping up the colour of winter milk and butter. Many points, including the engineering and the economic aspects of the question, require to be settled, however, before it will be possible to incorporate this suggested side-line of grassland husbandry into large-scale practice.

Promising results are also being obtained in regard to the conservation of young pasture grass by means of ensilage. During the past season very satisfactory samples of silage have been made in small experimental silos by filling in the cuttings from sports fields, alone or in admixture with absorbent materials like oat chaff or dried sugar beet pulp.

Other aspects of the Cambridge investigations which cannot be dealt with in the space of this article are :—(1) The influence of close-grazing on the yield of pastures and on the growth of wild white clover. (2) The influence of meteorological conditions on the rate of growth of pasture grass. (3) The rate of exhaustion of the soil in respect of manurial constituents under meadow and pasture conditions. (4) The comparative production of nutrient matter from meadow and pasture. (5) The composition and feeding value of meadow aftermath. Readers who may be interested in these further issues are referred to the accompanying bibliography.

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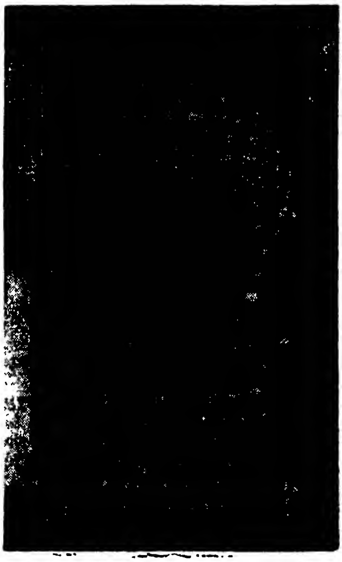

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CERTAIN SOIL PROPERTIES IN RELATION TO SUGAR BEET GROWING.

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CERTAIN soil conditions favourable for the growing of sugar beet are generally recognised, including sufficient depth of soil, with absence of hard-pan; not too heavy texture, with freedom from stones in soil and subsoil; good drainage, and freedom from sourness.

Attention has already been drawn in this JOURNAL to such points as these, and farmers have been advised to approach the county organisers and advisory officers to have their soils examined as to suitability for sugar beet growing. Unfortunately, in some instances, assistance is not sought until it is too late to remedy any mistake that may have been made, and in the course of advisory work in north-east Scotland several cases of failure of the crop, either wholly or in part, have occurred. In such cases, all that can be done is to investigate the circumstances of failure with a view to drawing a lesson which may be of future use. The soils concerned have therefore been examined with regard to certain of their properties, and, in addition. other soils, carrying more or less successful crops, have been studied for purposes of comparison.

Examination of the soils was made with regard to depth, presence of pan or hard subsoil, drainage conditions, &c. These are points the importance of which the sugar beet grower usually appreciates readily, and it was found that while the soils varied in depth, this was seldom below 8 or 9 inches, with free subsoil and good drainage. None of the soils appeared to be too heavy in texture, and the resuts of the mechanical analyses,[2] given in Table I, bear this out.

Experience has proved that sugar beet can be grown successfully on various grades of soils with the exception of very heavy clays. It will be seen from the table that none of the soils included can be classed as very heavy in texture, and in no case was crop failure found to be due to this. The figures for N1, 2, 3 and 4, for example, confirm this. These relate to samples drawn from one field, and the texture is very similar in all four. Yet at N1 and 2 the crop failed, while at 3 and 4 good growth was obtained. This was one of the heaviest soils, and one of the lightest, at Ga and Gb, shows the same thing, failure and good growth on soil where there is little difference in texture.

[1] Since the above paper was written the author, Mr. Newlands, has died. He was awarded a Development Commission Travelling Fellowship in order to undertake a three months' study of Continental methods of Soil Investigation, and he had partly accomplished this when he was taken ill in Berlin, where he died on 23rd July last. He was an able and enthusiastic student of Soil Chemistry with an excellent record of achievement, and his early death is greatly regretted.

[2] Mechanical analysis was performed according to the official method (1926) of the Agricultural Education Association. For present purposes the two sand grades have been taken together, and, similarly, the two silt grades.

TABLE I.

Mechanical Analyses—Results as percentages of air-dried "fine earth."

Soil	E.	N 1.	N 2.	N 3.	N 4.	M.H.	M.	B.	G 1.	G 3.	W.	Ga.	Gb.	H.
Sand	45·41	45·45	45·39	46·64	46·82	55·08	60·17	60·52	58·89	58·50	67·25	68·12	72·66	63·74
Silt	27·10	29·62	28·47	29·74	28·62	21·19	18·20	21·25	19·91	21·55	18·30	14·37	11·16	20·85
Clay	15·84	14·06	13·71	13·87	13 02	10·45	10·44	8·51	7·86	7·44	7·11	6·39	6·08	5·10
Loss on Ignition	9·20	8·73	9·72	7·93	9·36	9·23	8·69	6·50	9·58	9·88	6·20	9·73	8·65	7·23
Moisture	3·20	3·00	3·80	2·70	2·90	3·70	2·80	2·85	4·30	2·80	2·00	2·27	2·00	2·88
TOTAL	100·75	100·86	101·09	100·88	100·72	99·65	100·30	99·63	100·54	100·17	100·86	100·88	100·50	99·80
Crop Growth	Good.	Very poor.	Very poor.	Fairly good.	Good.	Good.	Good.	Failure.	Fairly good.	Failure in places.	Good.	Failed badly.	Good.	Poor, irregular.

Again good yields were obtained equally on a light type such as W, with 7·11 per cent. clay and 67 per cent. sand, and on a much heavier type such as E, with nearly 16 per cent. clay and 45·5 per cent. sand.

In the laboratory the soils were also examined for readily "extractable calcium," "lime requirement" and "pH value." Brief explanations of these terms may be given before the results are discussed. To obtain some idea of the availability of calcium to the plant the soils were leached with a very dilute solution of hydrochloric acid, the amount of calcium extracted was determined and the results expressed as percentages of the air-dried soil.

The "lime requirement" is the amount of lime which the soil will neutralise and absorb from a solution of lime in carbonated water, the solution being a standard one of agreed concentration, the lime taken up by the soil being expressed here in the carbonate form and the amounts as percentages of the air-dried soil. A "lime requirement" of 0·1 per cent. in terms of calcium carbonate means that roughly one ton of carbonate of lime per acre must be added to the soil to neutralise the acidity and satisfy the capacity of the soil to absorb calcium.

The "pH value" is a term used by chemists to express the degree or intensity of acidity, i.e. the degree of concentration of ions of hydrogen, in a solution. In dealing with soils it is determined by making a suspension of the soil in pure water and testing this by a special method. A neutral solution has a pH value of approximately 7, while a figure less than this indicates acidity, and the smaller the number, the greater the degree of acidity.

TABLE II.

Soil.	Percentage Extractable Calcium.	pH value.	Percentage Lime requirement as $Ca.Co._3$	Remarks on Crop.
B	0·064	4·95	0·24	Complete failure.
N 1 ...	0·080	4·85	0·38	Very poor.
N 2 ...	0·084	4·90	0·40	Very poor.
Ga ...	0·108	5·15	0·36	Failed badly.
H... ...	0·116	5·20	0·22	Poor, irregular.
N 3 ...	0·121	5·30	0·27	Fairly good.
W ...	0·148	5·20	0·23	Good, 11 tons per acre unwashed beet.
G 3 ...	0·150	5·25	0·42	Failure in places.
N 4 ...	0·161	5·40	0·26	Good, better than at N 3.
M.H. ...	0·186	5·70	0·21	Good, 10 tons per acre unwashed beet.
G 1 ...	0·188	5·40	0·34	Fairly good.
E	0·196	5·45	0·29	Good, 10½ tons per acre unwashed beet.
M... ...	0·204	5·95	0·25	Good, 10½ tons per acre unwashed beet.
Gb ...	0·256	6·10	0·16	Good.

In the remarks on growth of crop in Tables I and II, the term "good" must be taken in a relative sense only. Where it was possible to get figures for crop yield these have been included in Table II, and it will be seen that the best is only 11 tons per acre of unwashed beet. It is quite possible that the yields obtained would have been greater had the conditions of the soils been rendered less acid, for, generally speaking, experience has shown that sugar beet grows best on neutral or even somewhat alkaline soils. A pH value of at least 6·5 is required, and none of these soils reaches this figure.

In Table II the soils have been arranged according to increasing percentages of extractable calcium, and it will be seen that, in a general way, poor growth of beet is associated with low calcium content and low pH value, i.e. high acidity. With regard to lime requirement there is not the same correspondence, and this point will be discussed later. Meanwhile it will be noticed that when the extractable calcium falls below 0·12 per cent. growth is poor, with the exception of G3, which showed failure at a slightly higher figure, namely 0·15 per cent. Again, when the pH value is below 5·3 growth is poor, with the exception of W at 5·2. Such exceptions show that undue stress must not be laid on any single soil factor when crop yield is being considered. This indeed depends on several factors, the sum total of the soil conditions, together with those of climate and cultivation. Thus the soil W was a free-working, sandy loam with a deep, free subsoil in which the tap root could easily develop. The season was suitable for a lighter textured soil and cultivation received careful attention.

With regard to lime requirement, it was found that, when the figure is above 0·3 per cent., good growth is unlikely, but, on the other hand, a figure as low as 0·22 per cent. (soil H) is no guarantee of good growth—other conditions present may be unfavourable. Lime requirement depends to a large extent on the capacity of the clay and humus, not only to neutralise the lime added to the soil, but also to absorb calcium. Thus the degree of the requirement will largely depend on the amount of clay and humus present that is deficient in calcium, and therefore ready to take up more. A small lime requirement may be a favourable indication or not, according to circumstances. In one case there may be a relatively *large* amount of clay and humus present which is already supplied with practically all the calcium it requires, and is therefore able to take up only a small amount more, while in a second case there may be a relatively *small* amount of clay and humus present which is poorly supplied with calcium. The small requirement in the first case might be regarded as favourable, while in the second case it would not.

In comparing results for soils from widely separated areas it is necessary to determine to what extent they are related in character before conclusions can be drawn as to the reasons for any difference in cropping that may occur. In dealing with soil from within the limits of an acre or two, it is easier to discover whether one soil type is being dealt with or not. So when differences in crop growth arise within a field an examination of samples from the good and poor areas is likely to reveal agreement in certain properties and differences in certain others. If these soil differences can be correlated with differences in crop, then they may be regarded as of significance and considered to be factors in causing the crop differences. Such a case of good and poor growth of sugar beet within one field occurred where the samples N1, 2, 3 and 4 were drawn. These were all of one soil type, as far as field examination and laboratory analysis showed. A reference to Table I will show that there is no essential difference in mechanical composition. Chemical analyses, however, revealed differences which have been given in Table II, but are repeated again for convenience.

Sample.	Percentage Extractable Calcium.	Percentage Lime requirement.	pH value.	Crop.
N 1	0 08	0·38	4·85	Poor.
N 2	0·084	0·40	4 90	Poor.
N 3	0·121	0·27	5·30	Fairly good.
N 4	0·161	0·26	5·40	Good.

The samples N1 and 2 from the poor areas agree closely in extractable calcium, lime requirement and acidity, and differ from N3 and 4, from the good areas, which again agree well, except perhaps in extractable calcium, which is somewhat higher in N4, and as a matter of fact the area at N4 had a better growth than at N3.

That poor yield was due to lack of lime, with associated high lime requirement and high acidity, is quite clear in such a case.

Another instance occurred in the field from which samples Ga and Gb were taken. These were drawn from within a small area, part of a large uniform field on a piece of river alluvium, furnishing a deep, well-drained, free-working, sandy loam. Mechanical analysis (see Table I) shows that at Gb the soil was somewhat lighter in texture than at Ga. The chemical tests resulted as follows, the results for lime requirement and pH value of an adjoining unlimed part of the field also being given for comparison.

Sample.	Percentage Extractable Calcium.	Percentage Lime requirement.	pH value.	Crop.
Adjoining Soil ...	...	0·39	5·10	...
Ga	0·108	0·36	5·15	Failed.
Gb	0·256	0·16	6·10	Good.

In this case the area under beet had been limed, but the figures show that the distribution had been very unequal. When Ga, where the crop failed, is compared with the unlimed area adjoining it is seen that the lime requirement and acidity had been little affected by the liming, while the portions at Gb, where growth was relatively good, got a greater amount of lime, as is shown by the higher extractable calcium, lower lime requirement and reduced acidity.

Taking the results for these soils as a whole, the adverse effect of acid conditions and lime deficiency on the sugar beet is well shown, apart from other conditions of soil, climate and cultivation, which must also be taken into account. Nevertheless, the necessity of adequate liming in connection with the growing of this crop is demonstrated. Of the soils here discussed, even the least acid has still a lime requirement of about 1½ tons of calcium carbonate per acre.

STRAW HOUSES FOR POULTRY.

DAVID PATRICK WRIGHT, Agric. Dip. U.C.W.

THE general farmer is being increasingly urged, in view of the low prices obtained for grain and other arable crops, to go in for some form of poultry farming as an adjunct to the various branches which he already practices. Many farmers are quite persuaded as to the desirability of this course, but are deterred from making a start on account of the considerable amount of capital required to house the laying stock. This may constitute an even more serious difficulty for smallholders, who may be deterred by insufficiency of capital from keeping poultry in numbers proportionate to the size of their holdings.

We do not intend in this article to enter into the question of the general farmer adopting the colony house in preference to the semi-intensive type. Suffice it to say that to obtain a steady winter output of eggs during all weathers, it is essential to adopt the latter, which although more expensive soon pays for the extra outlay. The straw house described here is of the semi-intensive type, and it is well to remember this in comparing the costs with that of houses constructed of wood.

The cost of housing birds in a semi-intensive wooden house of the ridge type is about 8*s*. to 10*s*. per bird, allowing 4 square feet per bird; with the same floor space the cost in the straw house should not be more than 3*s*. 8*d*. per bird. In addition to this practically the whole house can be erected with the aid of reasonably intelligent farm hands. The labour, although included in the costings given in this article, does not involve any actual cash expenditure, but rather the employment of the men in their spare time, when other work is not so pressing. The general farmer can easily erect several houses every year, and thus increase his stock gradually, as he thinks advisable, without incurring the expense of employing extra labour.

We have also found these houses excellent for rearing chickens intensively for the first few weeks. For this purpose a few alterations should be made, e.g. windolite or a similar substitute should be used instead of glass, the walls should be doubly lined to ensure no variations in temperature, and wire divisions should be fitted in place of perches, dropping boards and nest boxes.

All the materials on this farm were purchased, but many farmers can obtain poles much more cheaply on their own land. The house described here is of the ridge type and measures 32 ft. long × 13 ft. broad. This gives accommodation for 104 birds, allowing 4 sq. ft. per bird, and on this basis costs about £19 for the whole house, which is equal to 3*s*. 8*d*. per bird.

The original idea of the straw houses erected by us at the Bass Rock Dairy and Poultry Farm, North Berwick, was obtained from Mr. L. G. Price, poultry instructor in Gloucestershire, who designed and erected such houses a few years ago. These appeared to suit the weather conditions of the south of England quite well, but required some alterations to stand the rigour of our Scottish climate. This instructor estimated the cost of a house 30 ft. × 13 ft. at £15, while our estimate is about £19 for a slightly larger house. The extra cost of our houses is due to:—

(1) The use of smaller meshed wire netting to keep out rats.

(2) The cutting of a deeper trench round the houses, along which the small meshed netting is placed to keep rats from burrowing under the floor.

(3) The insertion of windows along the front.

(4) A larger size of house, giving more space per bird.

Briefly, the straw house consists of posts sunk into the ground (thinnings from plantations or old beech hedges are excellent) to a depth varying from 1½ ft. to 3 ft. Over these posts wire netting is stretched taut and the whole structure thatched with wheat straw to a depth of 9 ins. to 1 ft. on the roof and 6 ins. to 9 ins. on the sides, using thin wire (gauge 16) to lace the straw to the netting. Other thatching material may be used such as rye straw, reeds, &c. We have used wheat straw only, but probably rye straw might be even more suitable, although we have had no experience with it.

Objections to the straw houses may naturally occur to the readers of this article, and we propose to refer briefly to the most common.

Temperature.—The straw thatching keeps the house exceptionally even in temperature as compared with wooden houses, and in hot sultry weather especially, the difference in temperature is greatly in favour of the straw house.

Stability.—Straw houses are steadier in gales and storms than wooden houses, unless the latter are very carefully wired down. Our houses stood the severest gales of last winter without any damage to the thatching.

Rats.—Provided the house is erected as described there is no fear of rats finding an entrance. This may be inferred from the fact that we have reared thousands of chicks in our straw houses.

Durability.—It is difficult to say how long straw thatching will last; we have seen straw shelters five years old in perfect condition. The fact that cottages with thatched roofs require re-thatching so seldom is a guarantee of the length of life of thatching materials.

Red Mite.—Fears are commonly expressed about the liability of straw houses to become infested with red mite. All we can say is that we have never seen them in our houses, and we see no reason why they should be found, provided reasonable precautions are taken. The chief safeguard necessary is to paint the perches and perch sockets frequently with creosote or paraffin.

Ventilation.—Straw houses are distinctly superior to other types in this respect. The air is pure and fresh, which cannot always be said of houses made of wood. No special provision is made for ventilation, as a slow but constant filtration of pure air seems to take place through the straw.

It should be noted that when a house is built on ground where cattle, sheep, or other live stock are grazing, a wire fence must be put round the house to protect the thatch.

Method of erecting Straw Poultry House.—First peg out on as level ground as possible four corner and five centre holes, so that the house faces S.S.E. Both the corner and the centre holes require to be dug 3 ft. deep. When this is completed fix the four corner posts in place and ram the earth in hard. This fixes the position of the house, and all other measurements directly or indirectly are taken from these posts.

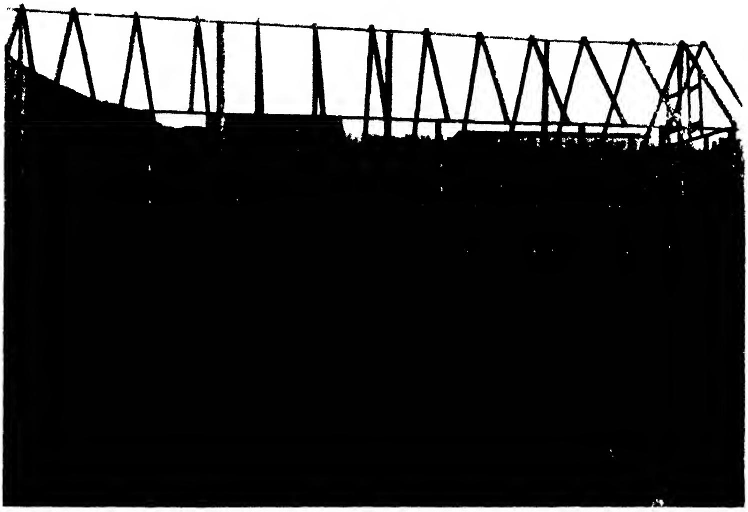
Now fix the centre posts in position, taking care to keep the top of each post in line to ensure a straight ridge. The back and front come next: stretch a line from one back corner post to the other and mark out six equidistant holes along the line to receive the posts. This is best done by means of a crowbar. Sharpen the ends of the posts and drive in to a depth of 1½ ft. approximately.

Repeat with the front of the house, marking out five equidistant holes as before. The straightest posts should be used for the front, as this greatly facilitates the fixing of the windows. Nail on the battens (2½ ins. × 1½ ins.) along the top of the posts, allowing them to project 1 ft. beyond the ends of the house to form the eaves. Then nail on the rafters.

The house is now ready for the trench. Dig this 1 ft. deep and about 1½ ft. broad. This allows the 6 in. sarking boards to be nailed in place. Fix the bottom board so that the top edge is level with the ground. Do this right round the house and then nail another breadth of board on top of this, forming in all a depth of 1 ft. of boards.

The windows extend along the whole front of the house.

Photograph showing complete house with door in front. A door in the gable is however preferable.



Photograph showing framework before thatching.

Run 2 in. × 1 in. battens between each post about 1½ ft. above the sarking boards. Cut grooves in the sides of the posts so that the battens fit in tightly and nail in position. Repeat this 20 in. above the lower batten and join the two together with 2 in. × 1 in. strips every 2 ft. or so. The actual window frames themselves fit into this outside framework and are also made of 2 in. × 1 in. wood. They can, however, be constructed conveniently during wet weather after the house has been thatched.

The construction of window frames constitutes, perhaps, the most difficult part of the house, and any who do not care to attempt to fit glass windows can use canvas screens instead. If these are hinged they can be closed or opened according to the weather conditions.

The fixing of the wire netting is the next operation. Commence with a roll (3 ft. broad, 1 in. mesh) at the door and staple it right round the house. This should reach to the bottom of the trench. Then put a second breadth above this, covering the whole house up to the eaves. Also put a small piece of netting on the boards just beneath the door.

It is necessary to put another breadth of netting along the bottom of the trench, fixing one edge to the lowest board. The trench can then be filled in to a depth of 6 ins. and rammed hard.

All that now remains to be done is to put the wire netting on the roof. Use 3 in. mesh netting for this purpose; five breadths are required.

The house is now ready for thatching : thatch with 16 gauge wire, using wheat straw, reeds or other suitable material. When finished trim the straw to the bottom edge of the lowest sarking board. This is important, because if the straw is cut above this the floor is apt to be drafty. The straw round the eaves has also to be trimmed, and the straw covering the windows to be cut away.

Note.—Where the house is on a slope it is necessary to level the floor, otherwise the litter will work to one side of the house. Where levelling is necessary it is advisable to fix the sarking boards with a spirit level to show exactly how much earth to add or cut away, as the case may be.

We have allowed £1 for interior fittings in the costings of this house. This figure, however, will vary considerably according to individual requirements. In our houses we have fitted trap-nests and other extras, which would not normally be used by the average farmer, and so have made an estimate of what would generally be the cost where no additional fittings are used.

Our houses are fitted as follows :—Nest boxes are placed along the east end about 1½ ft. above the floor, and on top of these arrangements are made for broody hens. Two perches 1 ft. apart are run almost the full length of the house, and the dropping boards are placed underneath. These are 3 ft. above the floor, and 1 ft. below the perches and 3 ft. wide.

The cleaning of dropping boards represents one of the most costly jobs on a poultry farm. This we have reduced to a matter of a few minutes' work for each house by an ingenious but simple device.

Briefly this consists of a heavy piece of wood (an oak fencing post cut to size is excellent) placed at one end of the dropping boards. Along each side of the dropping boards 2 in. × 1 in. battens are nailed to form a guide within which the oak post travels. A thin rope or flexible wire cable is attached to the oak post and passed round a pulley fixed at one end of the dropping boards. It is then once or twice wound round the roller underneath and finally led over another pulley at the opposite end of the dropping boards to the back of the oak post. When the roller is turned the oak post moves forward and sweeps the droppings into a box fixed at the end to receive them. To replace the post in its original position the roller is turned in the opposite direction.

Cost of Erecting House. (32 ft. × 13 ft.)

Posts.

	£	s.	d.
5 centre posts, 12 ft. 6 in. long (4 in. to 5 in. dia.), at 3*s*.	£0	15	0
4 corner posts, 8 ft. long (3 in. to 4 in. dia.), at 1*s*.	0	4	0
11 side posts, 6 ft. 6 in. long (2 in. to 3 in. dia.), at 10*d*.	0	9	2
1 door post, 2½ in. × 2½ in.	0	1	0
	£1	9	2

Rafters, Ridge, &c.

	£	s.	d.
30 rafters (2½ in. × 1½ in.), 8 ft. 6 in. = 255 ft., at ⅞*d*.	£0	18	7
128 ft. (2½ in. × 1½ in.) along ridge, sides, and gable ends, at ⅞*d*.	0	9	4
180 ft. (6 in. × ⅝ in.) sarking boards = 10 sq. yds., at 1*s*. 3*d*.	0	12	6
	£2	0	5

Netting.

	£	s.	d.
1 roll (50 yds.) 3 in. mesh 19 gauge, at 6*s*. 6*d*. for roof	£0	6	6
1 roll 1 in. mesh 3 ft. wide for sides	0	17	6
½ roll (approx.) 1 in. mesh 1½ ft. wide (to sink into ground)	0	5	0
	£1	9	0

	£	s.	d.
Labour	£7	17	6

Sundries.

Glass	£1	5	0
1 ton wheat straw	2	10	0
Window frames, door, hinges, thatching wire, nails, &c.	1	9	0
Interior fittings	1	0	0
	£6	4	0

Summary.

Sundries	£6	4	0
Labour	7	17	6
Netting	1	9	0
Rafters, ridge, &c.	2	0	5
Posts	1	9	2
	£19	0	1

A Summary of the First Year's Veterinary Work under the Milk and Dairies (Scotland) Act, 1914.

W. A. DAVIDSON,

Scottish Board of Health.

1. Introductory.—The Milk and Dairies (Scotland) Act, 1914, which came into operation on 1st September 1925, inaugurated a system of regular inspection of all dairy cows in Scotland. Systematic inspection of cows was, however, already in operation in most of the burghs, and had been carried on under the limited powers contained in the Burgh Police (Scotland) Act, 1903. The number of cows in burghs is of course only a fraction of the 460,000 cows in Scotland.

In future all cows supplying milk for sale, and all cows, the milk of which is made into butter or cheese, will be regularly inspected by a veterinary inspector. The sole possible exceptions are where milk is supplied only to employees or to neighbours, but in most of these cases instructions for the regular veterinary inspection of the cows have been given to the veterinary inspectors by the local authorities concerned.

Veterinary inspectors have now been appointed in almost all the counties and burghs of Scotland, and within a short time all the appointments are expected to be made. In twelve counties, which include all the principal dairying areas, the veterinary inspector is a whole-time officer, and in every case acts for some burghs as well as for the county area. In the case of many part-time appointments in burghs the inspectors do not practise among the owners of dairy cows.

2. Features of the work of whole-time Inspectors.—The reports of the veterinary inspectors on the first complete year in which the Act was in operation have now been examined. They supply much valuable information in regard to the condition of herds and the conditions under which milk is produced. In areas where the veterinary inspectors are charged with the duty of inspecting premises additional facts are available. In some instances the reports cover only part of the year, but though future reports may be fuller this brief survey has a special value as illustrating the problems encountered at the inception of the veterinary work under the Act and the progress achieved in the first year. A minimum of one inspection a year has been prescribed by the Act, but in some county areas with a large cow population this appears to be difficult of achievement with the present staff. The routine inspection of so many herds and so many cattle presents to an energetic inspector little or no difficulty from the administrative point of view, and the reports are unanimous in testifying to the fact that no obstacles are placed in the way by farmers or dairymen. Nor is the physical burden of travelling many thousands of miles, though by no means negligible, one of the main difficulties. The principal factors are (1) the enforced limitation of inspection to the winter months during which the herds are housed in the byres, as inspection at milking times during the remainder of the year has in practice been found to be uneconomical, and (2) the amount of work that falls to be performed under the Diseases of Animals Acts and the Tuberculosis Order. A partial solution of the first difficulty may be found in the provision of additional veterinary assistance during the winter months in order to carry out inspection of the great majority of herds during that period, especially of those situated at a considerable distance from the administrative centre. This would leave a limited number only, and those that could be reached most easily, for summer inspections. But the work of routine inspection will always be complicated by the necessity of attending to work under the Tuberculosis Order and Diseases of Animals Acts. Calls to dairy herds under the Order may conveniently, and indeed ought to, be made, if possible, the occasion for routine inspection of the rest of the herd under the 1914 Act; but the work under the Diseases of Animals Acts must of necessity receive the prior attention of the veterinary inspector and may completely interrupt the routine inspection of dairy herds.

In illustration of this the actual circumstances of an important dairying county with a cow population of about 29,000 may be instanced. The period covered by the appointment was 15th June to 31st December, and during that time the veterinary inspector was able to inspect only 3,668 cows under the Act. In the same period seven outbreaks of anthrax occurred on six farms, while 88 reports of unexplained deaths in cattle and two in horses required to be investigated for anthrax. One case of suspected parasitic mange was investigated, and eight outbreaks of sheep scab occurring on eight farms required investigation. These enquiries involved 121 visits and contributed considerably to the 11,421 miles travelled during the period. In another county with a cow population of 23,000 the veterinary inspector during the period 17th May to 31st December was able to inspect only 1,987 cows under the Act. Investigations were required in one case of suspected foot and mouth disease, 59 cases of suspected anthrax, six outbreaks of sheep scab involving inspection of 3,211 animals on 24 farms, and one case of suspected parasitic mange. The necessary inspection of auction marts is also a factor in the limitation of time for routine inspection of dairy herds.

The system of routine inspection of cows under the Act has made possible the framing of approximate estimates of the incidence of tubercular disease in the herds. The percentage of affected animals in some areas is reported as very high, and when it is coupled with a low standard of hygienic conditions in regard to premises, methods, and the condition in which animals are kept, must give cause for grave concern. Much can be done, however, and is being done by frequent examinations and by educative talks with individual producers to secure improvement. The results of the examinations and the detections of disease found on clinical examination are demonstrated by the increasing figures for slaughter under the Tuberculosis Order of 1925 for the years 1926 and 1927, in which 1,852 and 2,240 bovine animals were slaughtered. There can be little doubt that this increase is in large measure due to the cases discovered at routine inspections under the Act. The elimination of doubtfully sound animals by the producer as a precautionary measure in his own interests cannot be stated in such terms, but it is believed to represent a considerable factor in securing a higher standard of health in the herds, as owners come to recognise that the suspicious animal, especially when it has a chronic cough and is growing old, is a doubtful asset and a potential source of danger to the rest of the herd. The development of tuberculosis from the merely suspicious stage to the presence of definite clinical signs is often so rapid that the owner is well advised in his own financial interest to run no risks by delaying the removal of the animal until the clinical signs enumerated in the Tuberculosis Order are fully in evidence.

While the elimination of tuberculous animals must necessarily, under the existing powers, be a process of years, improvement in the sanitary conditions of byres and of the methods of production is capable of rapid achievement, and it is gratifying to observe from many reports that the response from producers has been immediate, and that much improvement is apparent even on the second visit of the inspecting officer. Confident in the knowledge that pure milk can be produced in premises that are not structurally ideal, provided that the essentials of adequate air space, light, and ventilation are present, officers are in a position to emphasise the observance of clean methods and sanitary conditions as the producer's first and most obvious contribution to the successful administration of the Act.

In many instances it is hard to secure improvement in the traditional methods of dealing with cows and milk, so often associated with much that is dirty and insanitary, but throughout the reports there are clear indications that, on the whole, producers are gradually improving their methods of production.

In some cases difficulty has been experienced in securing the isolation of sick animals from the rest of the herd. In old byres, especially during winter, isolation is often impossible owing to the fact that all the stalls are full and no other accommodation is available for the purpose. The danger of contamination from such animals, and from newly-calved cows during retention of the afterbirth, is not sufficiently appreciated by some cowkeepers, but it is a danger which should in the future assume a higher degree of importance in their eyes. While in some instances the difficulty of accommodation may be insuperable, it should, as in one important dairying area, generally be possible to secure improvement as the necessity for such a measure is impressed on dairymen.

Under the Dairy Byelaws some local authorities have required separate accommodation for sick animals at dairies. In one county a byelaw has been adopted requiring the provision of at least one loose-box for purposes of isolation. This, however, applies to new premises only, and is subject to relaxation at the discretion of the local authority. A similar provision has been adopted in a small burgh. Another group of local authorities, including several district committees and at least one town council, who have adopted uniform byelaws, have included a specific requirement in regard to the isolation of all cows suffering from any disease likely to affect milk. Along with this they require the provision of " a suitable loose-box, sick-box or other cowshed which can be disinfected, if necessary " at every dairy.

As a preliminary to registration and to requiring improvements in premises, a classification or grading showing a comparison with premises satisfactory in every respect has been made in some areas. This practice has much to commend it, as it provides a record from which the local authority and their officers may work to secure a measure of compliance with the dairy byelaws, and by dealing first with unsatisfactory cases it will be possible to obtain a general levelling-up of conditions over the whole area. Such a method goes far to obviate the criticism that the desired improvements are above the general level of dairying practice in the area. Closely allied with this procedure is the utilisation of the score-card method of assessing the value of dairying practice and premises. There is evidence that the score-card system is becoming more and more appreciated and used.

From time to time the local authorities of towns and cities, and of the county districts which consign milk to them, have occasion to submit to laboratory tests samples of the milk consigned. As a rule the results of the tests agree, but instances occur when one result may show infection with tuberculosis and the other may not. In such instances it appears that, even though more than one sample is shown to be negative, the positive result, where the laboratory method is admittedly sound, should determine the action to be taken. It is not unlikely that the presence of tubercle bacilli in the milk is intermittent, and positive samples may be preceded or followed by negative samples.

3. Details of whole-time Inspectors' Work in Counties.—(a) *Aberdeen County.*—The report covers the period from June, when the veterinary inspector commenced work, to December, and all the herds had not been visited. By the end of the year, however, 4,782 cows had been examined. Where an abnormality presented features resembling tuberculous mastitis the suspected cow was segregated and the milk was discarded until it was proved to be free from tubercle bacilli. When acid-fast bacilli are found microscopically, it is presumed that the cow is suffering from tuberculous mastitis, and it is slaughtered immediately under the Tuberculosis Order. Generally the herds examined have been found to be healthy and singularly free from clinical evidence of tuberculosis.

The general condition and cleanliness of the cows have been found very good, even in cases where the cowsheds are not nearly up to the standard laid down in the byelaws. The milk produced is also of remarkable purity, over 50 per cent. of the samples being found on bacteriological examination within the standard laid down for Grade A milk. This result speaks well for the methods adopted by the dairymen and their workers, but a system of marking by score card is contemplated, and it is hoped that even better results may be obtained. The majority of cows used for dairy purposes are cross-bred Irish of very good quality.

On most of the farms visited the major portion of the diet was straw, turnips, draff and small quantities of some composite dairy cake or meal, and in the opinion of the veterinary inspector the quantity, and to a certain extent the quality, of the milk could certainly be improved if a more carefully-balanced ration was given. In only a very few cases was the dairy farmer aware of the modern methods of rationing dairy cows in order that they might produce their maximum yield of milk at a minimum cost, but it is hoped that something may be done in the future to secure a proper method of rationing.

In some cases the methods of handling milk left much to be desired, both in the milking of the cows and after removal from the cowshed, but instructions will in future be given on these points.

(b) *Ayr County.*—Only the Ayr, Kilmarnock, and Carrick Districts are included in the report, as the Northern District Committee had not yet given instructions for the inspection of herds in their area. The number of herds inspected once during the year was as follows :—

	Herds.	Cows in Milk.	Other Cows.
Ayr	547	8,559	6,010
Kilmarnock ...	683	13,406	6,629
Carrick	258	4,765	1,534

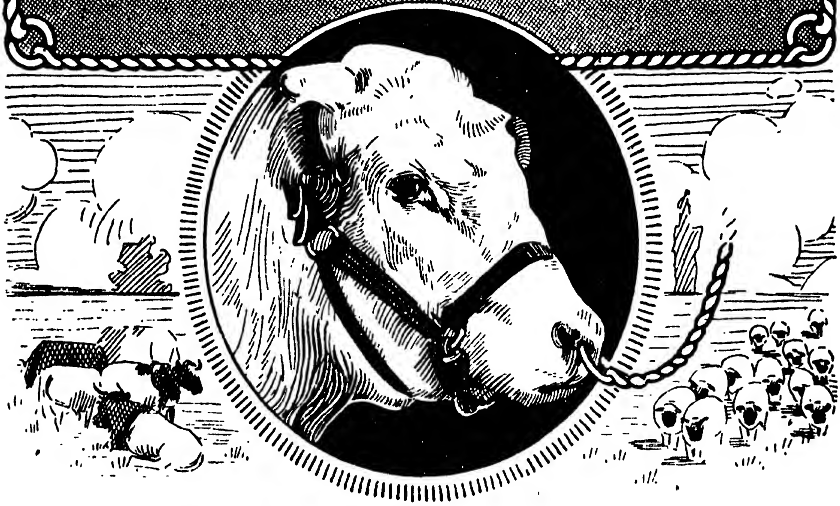
Except in a few cases, the general condition of the herds has been found satisfactory. There is need for more consideration of a proper system of feeding than has been the practice hitherto, particularly from the points of view of economy and food value of the milk.

In order that the summer inspections might have a definite object, eight mixed samples of milk were obtained at various creameries and were tested biologically for tubercle bacilli. These samples were made up by taking a representative sample from each producer's supply on delivery at the creamery, and each test sample represented 20 to 22 herds. Two of the samples were found to contain tubercle bacilli; on inspecting the herds represented in these samples, no cases of tuberculosis of the udder were found; the positive results were, however, accounted for in a rather interesting way. Two weeks after the samples had been collected, a farmer, whose supply was represented in the first positive sample, reported, under the Tuberculosis Order, a positive case of tuberculosis of the udder; this cow's milk contained large numbers of tubercle bacilli and was practically certain to have been the origin of infection in the first guinea-pig. As to the second case, the veterinary inspector for the burgh of Ayr found a cow in Ayr Market suffering from tuberculosis of the udder, and the owner sent it to the slaughterhouse; on post-mortem examination the udder was found tuberculous, and the carcase was extensively affected. This cow had been exposed in Ayr by a dealer, but it was subsequently ascertained that the cow had been in possession of a farmer whose supply was represented in the second sample, and that it had been sold on account of the udder having " gone wrong."

It is proposed to repeat such tests on a more extensive scale. Besides giving a definite object for summer inspections, they act, in a degree, as a control on the efficiency of the winter inspections, though the rapidity with which tuberculosis develops in some cases has been surprising. On quite a number of occasions a doubtful cow has been noted for reinspection three or four weeks later, and before the reinspection was made the owner has reported that the formerly doubtful cow was now showing very definite evidence of disease; while at one farm after the herd had been inspected, when a reported case of tuberculosis was dealt with, a second case was reported within a month, and a third three weeks later.

Such cases indicate the desirability of regular inspection more frequently than once a year.

Cleanliness of the cows cannot be considered satisfactory. The system employed in dealing with cleanliness on inspection has been to give points, the maximum being ten. Only 60 per



cent. of the herds gained over half marks, while 10 per cent. gained two marks or less; these may be taken as herds where no grooming worth speaking about was done. During the summer the score for cleanliness averaged about eight, and, as proportionately more of the Carrick District herds were inspected during the summer, this fact accounts for the apparently higher standard of cleanliness among the Carrick herds. It may be noted in passing that the higher ratio of summer inspections in Carrick also accounts for the larger proportion of cows in milk than in the other districts. The 30 per cent. of the herds which gave from three to five points for cleanliness fall into two classes, those in which grooming is done but not often enough, and those in poor premises, where it is much more difficult to keep cows clean. One herd which was inspected in the spring and again in December scored no points at both inspections.

During the year under review 53 unreported cases of tuberculosis within the scope of the Tuberculosis Order were found on inspection of the herds. It is hoped that in future there will be a much smaller proportion of unreported cases, as owners can rarely have any reasonable excuse for failure to notify "udder" or "emaciation" cases.

There has been a complete absence of notifications by dairymen, under section 14, of cows suffering from any disease liable to contaminate the milk. The veterinary inspector suggests that it would have been useful if a list of such diseases had been included in the Act as, in the event of prosecutions for selling milk from, or failure to notify, such a cow, proof will require to be given in every instance that the disease from which the cow was suffering was liable to infect or contaminate the milk. The control of the exclusion of milk from diseased cows appears to be one of the administrative difficulties of the Act, particularly in conditions where the dairyman perceives no obvious change in the milk.

It has been found possible to get an increasing number of sick cows removed temporarily from herds, but unfortunately at some farms this is not practicable owing to lack of suitable accommodation.

In a few cases milk from the apparently healthy quarters of a cow which had recently suffered from mastitis was being mixed with the rest of the supply, and a microscopical examination of such milk has shown that, at times, it contains considerable numbers of streptococci. When this has been found, the owners have dried off the cows and fattened them for slaughter.

Discussing the question of section 22 of the Act (power to apply the tuberculin test with consent) the veterinary inspector says :—

> "I do not consider that, unless a definite eradication scheme were built up from this power to test, the section will prove of much value. Simply testing a herd once, without control over the reactors, would lead nowhere and might entail considerable expense. With a reasonably

drafted eradication scheme administered by the local authority considerable progress could be made in clearing a greater proportion of our herds than is now being done by private enterprise."

(c) *Dumfries County.*—There are 701 registered dairies and 1,274 inspections were made in the course of the year. The majority of the larger dairies were reported on, but a number of small byres, registered solely on account of a small amount of butter being made and sold, remained to be inspected. The 730 premises reported on in regard to suitability for registration fell into the following classification :—

I. Premises which conformed, in all material respects, to the requirements of the byelaws—49.

II. Premises which fell short of the requirements, in greater or less degree, but which appeared suitable for registration if brought up to standard as soon as practicable—334.

III. Premises from which only a small quantity of surplus butter is sold—206.

IV. Premises which fell short of the requirements of the byelaws in a serious degree, and which were recommended for individual consideration by the District Committee—131.

V. Premises in respect of which registration appeared to be unnecessary—10.

Among the principal structural defects found, insufficient lighting was probably the commonest, as about 50 per cent. of the existing byres had a lighting area of less than half a square foot per cow instead of one and three-quarters square feet required by the byelaws. Ventilation was generally found reasonably adequate, although in many byres, especially the older ones, the openings for inlet ventilation were too high. Among the smaller byres the absence of steam sterilisers for cleansing utensils is a common defect. Hot water carried from the dwelling-house to the dairy is not sufficient to destroy the more resistant organisms found in milk utensils. In some instances where there was neither a steriliser nor a domestic hot water supply it was suggested that a boiler should be fitted up in the dairy and a pipe carried to the kitchen to provide hot water there. The practice of wearing overalls while milking is increasing, and grooming of cows is now more commonly carried out than formerly. One source of pollution is the retention of newly-calved cows in the dairy byre. It is very undesirable that a cow which has retained the afterbirth should be in a byre from which milk is being produced for human consumption.

Fifteen cows suffering from tuberculosis were detected during the year.

(d) *Dunbarton County.*—All the 254 registered dairies, containing 5,601 cows, were inspected once during the year. It is expected that more than one inspection will be carried out in future, as much time was spent in giving information to dairymen in regard to the details of the Act. The condition and cleanliness of the animals were on an average good in the Eastern District, but cleanliness was only fair in the Western District. Three hundred and thirty-one cows were found suffering from abnormal udder conditions, and in each case the owner was advised to remove the diseased animal from the herd and to notify the local authority how it was disposed of. A satisfactory improvement in the general cleanliness of the byres was observed in the course of the second year's inspections.

On clinical examination four cows were found to be suffering from tuberculosis, and samples of milk were drawn from 19 udders suspected to be affected with tuberculosis. Two were found to contain tubercle bacilli, seven streptococci, and two staphlycocci.

Cattle were inspected in eight premises which were not registered dairies. A list of such premises is being compiled.

(e) *Fife County.*—Registered dairies number 318, and during the six months covered by the report 245 dairies and 4,430 cows were inspected.

The general health of the cattle is good; cleanliness where it has received any attention is also of a high standard; in the majority of cases it is neglected, but a marked improvement is looked for.

The necessary precautions for securing cleanliness of animals and cowsheds do not readily appeal to a proportion of producers, but the actual milking process, so far as milkers' hands and attention to teats and udders are concerned, usually receives intelligent and careful attention. The danger of contamination from accumulation of dust, hay seeds, &c., on the floor of the standing and from fodder stored in the cowshed is generally disregarded.

Comparatively few cases of tuberculosis in cattle are reported by owners until the animal is at the stage of being an economic loss. Discovery and elimination at an early stage are thus dependent on veterinary inspection.

There is no occasional or routine manipulation of the udder by owners or attendants, whereby alone they may become aware of abnormal conditions. Instruction on the necessity and usefulness of the practice of manipulation is being given. In a great many cases there is a total lack of provision for the isolation of sick animals.

Milk samples submitted for bacteriological examination have in all cases proved negative.

A few inspections have been made of non-registered premises, when cases of tuberculosis have been notified.

(f) *Forfar County.*—There are approximately 250 registered dairymen in the county, with about 3,500 cows, all of which were examined at least once during the quarter ending 31st December, which is the period covered by the report. Eleven cows were found tubercular and slaughtered.

While a great many byres are kept too close, and it is difficult to convince some dairymen that adequate ventilation and fresh air are essential to the health of the animals, both owners and employees are endeavouring to comply with the requirements of the byelaws. The most marked improvement found is in the condition in which the cows are kept.

(g) *Kirkcudbright County.*—The period covered by the report is from 17th May to the end of December. Seventy-seven premises and 1,987 cows were inspected, the premises being graded as follows (100 per cent. representing entirely satisfactory premises and methods) :—

No. of Premises.	*Standard.*
1	94 per cent.
1	90 ,,
17	75 ,,
26	50 ,,
19	35 ,,
13	under 35 ,,

Five cows were seized during inspection and dealt with under the Tuberculosis Order. More attention might be paid to the cleanliness of byres, milk stores, and cows, as well as to the personal cleanliness of dairymen and their clothing.

Samples of milk were taken from two cows suspected to be suffering from tuberculosis of the udder. In both cases tubercle bacilli were present in the milk.

At four farms the cows are subjected to the tuberculin test, but only in one case has a licence for the sale of higher-grade milk been granted.

(h) *Lanark County.*—The number of herds inspected and reported on for the year is somewhat short of the total of a complete normal year, as veterinary inspection under the Dairies, Cowsheds, and Milkshops Order was carried on until the completion of the full year in May, and inspection during the remaining seven months was greatly curtailed because of a serious outbreak of foot and mouth disease.

The numbers of herds inspected and cows examined during the year were 1,806 and 34,632 respectively, but a point is made of inspecting every milk cow whose existence can be detected, whether milk is sold or not and whatever the class of owner, for on occasion it has been found that a diseased animal was acting as the only source of supply to a family.

The amount of veterinary inspection of dairy herds that can be done during the six months from May to November when the cows are only in for an hour or so at milking time (which varies considerably in different farms) is very limited and in some of its aspects unsatisfactory, and past experience has shown that this period is sometimes extended through the advent of an early spring or an open back-end of the year. In practice, therefore, the veterinary inspection of cows during the grazing period is chiefly confined to important dairy herds near at hand, which in many cases are re-inspected during winter. It is only during an average period of 24 winter weeks that full routine inspection of herds is possible.

The intensive campaign which has been conducted within the county for several years under the Special Designations Order has had a wonderful effect in stimulating all milk producers to a higher sense of their responsibilities, and the demand for and the sale of tubercle-free milk are steadily increasing.

It is estimated that more tuberculin has been used for this purpose in the past three years than in two decades before. For several years no milk but that of graded tubercle-free herds has been in use in all the hospitals and institutions within the county, while city local authorities drawing milk supplies from the county area are increasingly demanding the highest grades.

Six hundred and seventy-nine samples of milk were taken for examination and 70 were found to contain tubercle bacilli, while 165 contained other infectious organisms.

Out of a total of 296 animals slaughtered under the Tuberculosis Order, 91 were detected during inspection of the herds.

(i) *Stirling County*.—There are 458 registered herds with 8,092 cows, and each herd was inspected once during the year. Three hundred and one cows were found with abnormal udders; 12 were found on bacteriological examination to be tubercular and were slaughtered. In addition 10 cows were found suffering from tuberculous emaciation and were also slaughtered. The general condition and cleanliness of the cows were good.

Thirty unregistered herds with 177 cows were examined, but in one district the list of such premises has not yet been compiled.

Milk recording was carried out in 17 dairy herds during the year. Attempts were made by some farmers to feed their cows according to production, but little effort was made to balance the ration and to take advantage of the present-day knowledge of dietetics.

(j) *Wigtown County*.—During the period 15th May to 31st December, 3,668 dairy cows on 76 farms were inspected, mainly when the inspector was at the farms on other duties, e.g., investigating suspected anthrax or suspected tuberculosis in the stock. The general condition and cleanliness of the cows were on the whole satisfactory. Inspection in summer is possible only during milking periods, and the bulk of inspection must be done after the cows are housed in October.

On clinical examination 65 cows were found suffering from tuberculosis, while three samples of milk from suspicious udders were found negative on bacteriological examination. The incidence of tuberculosis among the dairy cows in the county is said to be high.

4. Details of whole time Inspectors' Work in Burghs.—*Aberdeen Burgh*.—The number of dairy herds is 18 and the average number of cows is 197. These were inspected once a month. Ninety samples of market milk were examined for the presence of tubercle bacilli, and seven were found infected. The sanitary condition of the premises was, on the whole, satisfactory.

Dundee Burgh.—During the year 311 visits of inspection were made to dairies. A certain number of samples were taken for bacteriological examination. Twenty-five cows were slaughtered under the Tuberculosis Order and all were found tuberculous.

Glasgow Burgh.—There are 62 registered cowsheds in the city, containing 1,198 cows, to which visits of inspection were paid throughout the year. Out of 244 samples of milk drawn from these cows and submitted to bacteriological examination, three were found after biological examination to be infected with tuberculosis and the animals were dealt with under the Tuberculosis Order.

As a whole the cows are kept fairly clean.

Edinburgh Burgh.—There were 105 registered dairies, containing 3,977 cows in 195 cowsheds; to these 1,233 visits were paid in the course of the year; 166 visits were paid to 38 exempted premises, and the cattle therein, numbering 85, were inspected.

On the whole, a fairly high standard of cleanliness of the cattle in the city has been maintained. In recent years proceedings have been instituted and penalties imposed in several cases in which difficulty has been experienced in securing a reasonable standard of general cleanliness.

The cattle are maintained in good condition. Apart from tuberculosis, 205 diseased cows were detected in course of inspecting the cattle in registered or exempt premises.

During the year 29 cows found to be tuberculous on clinical examination of the cows on registered premises were dealt with under the Tuberculosis Order. In five cases tuberculosis of the udder was diagnosed by microscopical examination of the milk, and in three cases microscopical examination was negative and diagnosis was arrived at by means of the biological test. Nineteen of the emaciated and clinical cases were diagnosed by microscopical examination of the sputum or urine (or both). In the remaining two, pathological material could not be obtained for laboratory examination and, though the clinical symptoms were sufficiently definite, it was considered desirable to confirm diagnosis by the application of the tuberculin test. In each case the intradermal method was employed.

In addition to the 29 animals referred to, seven cows came under suspicion in the course of clinical inspections and were proved tuberculous by the examination of pathological material obtained from them. By methods of persuasion the owners were induced in their own interests to dispose of them for slaughter. The total number of milk cows removed from registered herds and Gorgie Markets during the year, on account of tuberculosis, was 41.

Generally speaking, the structure, condition and arrangements of the cowsheds in the city are of a high average standard, and will compare favourably with the conditions which prevail in many rural districts. Some of the older premises which have been in use as dairies for a great number of years fall below the general average. On the whole the general management of the dairies is good, though in individual cases good premises which could be maintained in excellent order are not so well run as they might be.

The exempted premises are all licensed under the Cattlesheds in Burghs (Scotland) Act, 1866. In very few cases is milk sold from these premises. They are well equipped, well maintained, and in good order. On most of the farms the accommodation is good and compares favourably with the standard of the registered dairy byre. Generally, the air space, light, and ventilation are ample for the number of cows kept. Where adverse criticism can be made it is usually in respect of the floors and passages. On the other hand, there is the compensating feature that grazing is available in all but a few cases and, except during the colder winter months, the cows are for the most part out at grass.

A sample of country milk taken on delivery in Edinburgh was subjected to the biological test for tuberculosis and found positive. The herd producing the milk was inspected jointly with the officers of the local authority concerned. A cow was segregated and the use of her milk was temporarily prohibited. Her milk was subjected to the biological test in the city and gave a positive tuberculous result, but, at the other end, the same test was reported negative. The officers of the district in which the cow was located were instructed by their legal advisers that they could take no action since they had failed to demonstrate the existence of disease, and that the cow must be released from the restrictions temporarily imposed on the sale of her milk. Since the power to make an order prohibiting the sale of milk from the premises concerned is vested solely in the local authority of the district in which they are situated, it is inconceivable that an order would be made in view of the advice which would be tendered by their officers. Under these circumstances, the local authority of a receiving district, unless it is fortunate in the possession of local powers to meet the situation, may be obliged to accept milk which has been proved to be tuberculous, pending an appeal to the Board as provided by the Act, a somewhat slow process. The position of the dairyman is also anomalous. He is required by the Act to give written notice to his local authority that he has in his dairy a "cow which to his knowledge is giving tuberculous milk."

So far as the city is concerned, the powers contained in the Edinburgh Municipal and Police (Amendment) Act, 1891, have been utilised to deal with the cases of this kind which have arisen. Section 29 of the Act empowers the local authority, through its officers, to require an owner to remove from his premises any cow which "suffers from tuberculosis or any disease which may render the use of her milk for human consumption dangerous or injurious to health," and he is presumed to have used and sold her milk if he retains her in his possession. After service of the statutory notices, the cows have been slaughtered by the owners at their own risk, and post-mortem examinations have verified the positive biological tests.

"In making the foregoing statement, no reflection is implied on the care and skill with which the biological tests have been carried out by the local authorities concerned. It is suggested, however, that a positive result of a biological test should be held to override one or more negative results. Refusal to accept a positive result creates a situation which is very undesirable, no matter from what angle it is viewed. The situation need never arise provided the material on which diagnosis is based is retained and the officers responsible for carrying out the tests meet in consultation."

Two hundred and fifteen samples were submitted to bacteriological examination during the year. Whenever "graded" milk samples failing to conform to the required standard are detected the producer is notified, and it is the rule to re-sample the same milk supplied a few days later. It is the experience, almost without exception, that, when second samples are examined, they are found up to standard; thus indicating that former defects or errors in handling have been rectified.

With regard to the pasteurised milk samples examined, it is the custom in Edinburgh, when submitting milk to bacteriological analysis, to apply to all samples two distinct tests: (1) a general bacterial enumeration, and (2) a test for the presence of coliform organisms; although, as a matter of fact, the last-mentioned test is not required by the regulations applicable to pasteurised milk under the Milk (Special Designations) Order.

"While it is admitted that certain strains of the bacillus coli (but only a small percentage) have been found capable of withstanding the *minimum* temperature ordinarily employed in commercial pasteurisation (145° F.), it is clear that the percentage of such organisms able to withstand the ***higher*** temperature enjoined for milk pasteurisation (150° F.) is negligible, being, according to available records, only approximately one half of one per cent. (0·5 per cent.). This figure is so small that for all practical purposes it can be ignored in the routine bacteriological tests of milk. In the opinion of the writer, tests for the presence of coliform organisms in pasteurised milk furnish a good and useful indication as to the efficiency of a pasteurising process."

Milk for testing is purchased from retailers' shops in the ordinary course, and is thus received in the bottles supplied by the vendors. It is the custom, however, in the laboratory to withdraw the required amount of milk from the bottle by means of sterilised pipettes—never by pouring from the bottle. The object of this precaution is to eliminate the possibility of contaminating the milk, as would occur if it were allowed to come in contact with the soiled rim of the container, &c. In this connection there is one other point worthy of mention in relation to pasteurised milk, namely, the manner of sealing the containers in which it is supplied to the public. The bottles in which pasteurised milk is sold are closed as a rule with a cardboard disc which is merely inserted in the mouth of the bottle, while the rim, over which the milk must necessarily pass when poured from the bottle, is ordinarily left quite bare and unprotected, and liable to be contaminated by flies, dust, &c., and by the hands of the vendor and others who may handle the bottles prior to the utilisation of their contents.

5. The work of part-time Inspectors.—With few exceptions the part-time inspectors have only a district of a county, or even part of a district, in their jurisdiction, and moving about in their area of practice they are able to inspect the cows more frequently. This fact is reflected in the arrangements made in many districts, where the part-time veterinary inspector is to inspect the cows at least twice and in some cases four times a year.

The reports of the part-time inspectors show that they have generally been able to overtake the examination of cattle in their appointed areas. Much educative work is being done by them in securing greater cleanliness of animals and improved conditions in the byres, and already improvement can be noted as a direct result.

Berwick County, Middle District.—In this district (and possibly elsewhere) there are local cow clubs for the insurance of cows owned by farm servants. By the payment of a few shillings yearly cows may be insured against death for a sum varying from £15 to £20.

Clackmannan County.—There are 50 registered dairies containing an average of 880 cows, and 38 unregistered dairies containing 92 cows.

The general condition and cleanliness of the cows is extremely good, and a distinct improvement in cleanliness in regard to animals, premises, and utensils is noticeable. A very few of the producers have had to be warned on various points connected with a cleaner milk supply, and a marked improvement has resulted.

Seventeen animals were taken from the registered herds, showing tuberculosis of an advanced or dangerous type. Seven of these were seized in the course of the veterinary inspector's inspections, and five were reported by the sanitary inspector, three of which were dealt with under the Tuberculosis Order.

It has been found possible to visit only 15 of the unregistered dairies during the period. All the 35 cows inspected were found to be healthy.

Only one sample of milk out of 20 taken for bacteriological examination was found to contain tubercle bacilli, and the animal was slaughtered under the Tuberculosis Order.

A number of the larger milk producers installed drinking bowls during the year, and all were emphatic as to the benefit derived—more healthy animals, udder troubles reduced, a larger yield of milk, and a great reduction in manual labour.

The use of ensilage for feeding purposes is increasing, and the veterinary inspector found the animals in a large pedigree shorthorn herd, as in two other herds, in much better condition owing to its use, and was informed that the cows were giving appreciably more milk of a richer quality than before.

Perth County, Western District.—The veterinary inspector notes that the cleanliness of animals varied with byre conditions, and that well-lighted byres usually contained the cleaner cattle.

Zetland County, Mainland District.—There are 91 registered premises containing 403 cows, which were twice inspected in the course of the year; 136 cattle in 50 unregistered premises were inspected, but when the list is completed there will be considerably more.

Considering the climatic conditions under which the animals live, disease among dairy cows is uncommon. Only one case of clinical tuberculosis was found, which was dealt with under the Tuberculosis Order, but in this case no tubercle bacilli were found in the milk sample examined. Thirty-four samples of milk were drawn from cows in both registered and unregistered premises and submitted to microscopical examination. All results were negative.

In November 1925 the veterinary inspector brought forward a scheme for having all dairy cows supplying milk to Lerwick and Scalloway tuberculin-tested at a flat rate per head. With the voluntary co-operation of all dairymen, without exception, he was enabled to carry this through, and his first test, which was completed in March 1926, showed as tuberculin-positive 10·8 per cent. of the 435 cows tested. The second test was completed in June 1926, when, out of 93 cattle, he found only one tuberculin-positive.

On 1st July 1926 the milk supply to Lerwick and Scalloway was tuberculin-negative, and on that date there were 81 owners of 91 registered premises, containing 403 cows.

At the first test 4·2 per cent. of the reactors (tuberculin-positive) were imported cattle, introduced into the county the previous year. Eliminating three byres, owners of which had been in the habit of importing Orcadian and Mainland cows, the percentage falls a further 4·7 per cent., leaving among native Shetland cows the percentage of reactors at 1·9. The second test was carried out on premises where reactors were present at the first test.

At the same flat rate per head, he tuberculin-tested in the country districts 315 cows in calf or in milk, with the result that 1·5 per cent. were reactors. Over 90 per cent. of the cows tested were native Shetland cattle.

In reviewing the results of the tuberculin-testing, after an experience of fourteen years among native Shetland cattle and finding only a very few cases of tuberculosis, he considered that the importation of Orcadian and Mainland cattle was in some measure accounting for an increase in the incidence of bovine tuberculosis in the dairy byres. He felt that something ought to be done to prevent the further introduction of bovine tuberculosis into the county, and, with that object in view, approached the local authority on the matter. After due consideration had been given to this proposal for an importation order, the local authority gave it their unanimous support and laid the matter before the Ministry of Agriculture. Up to the present, however, all dairy cows which have been imported into any of the registered premises have been accompanied by a tuberculin-negative chart.

The diet of the cows, in many cases, does not contain enough succulent ingredients, and as a result the milk supply is diminished in quantity, but only where the lactation period has exceeded eight or nine months does the quality suffer.

The lack of an abundant supply of pure water is a serious drawback, only about 14 per cent. having anything approaching what is required for the cleansing of premises and dairy utensils.

In general, the existing registered cowsheds were in good repair, but many required more light and ventilation, and a few still have earthen floors. In a few, stall partitions and feeding troughs were absent, but there is every sign of a determination to attain cleanliness, though the lack of a sufficient water supply is manifest. At the first inspection many of the smaller crofter-dairymen had no outside milk store, the morning milk being sent direct from the byre to the consumers, the evening milk kept for the household. Dairymen and their employees are improving their methods of milking and handling the milk. The dry method of milking is slowly being adopted, but the handling of the milk is, in many cases, still unsatisfactory.

On the second round of inspection it was found that a large number of the minor faults had been remedied, e.g. there were more light and ventilation, new floors, new separate milk stores; limewashing had been carried out, and altogether the premises showed marked improvement.

The registered premises have been graded into three classes, viz. :—

Grade I.—Cowsheds conforming with the byelaws—27.

Grade II.—Cowsheds requiring minor alterations and repair—53.

Grade III.—Cowsheds requiring extensive alterations and repairs—11.

It is hoped to introduce the score-card system among registered dairymen, and by this means to encourage producers to give more attention to cleanliness in handling the milk and milk utensils, and to the grooming and feeding of the dairy cows.

Burgh of Kilmarnock.—It is curious and worthy of comment that in this burgh, with a population of 35,700, there is not one registered cowshed, but there is one small byre with three cows. These are kept by a lady for her own use and that of her workers, and are regularly tuberculin-tested.

6. Advertisements of Milk.—Although the matter is not raised in the reports of veterinary inspectors it may be useful to refer here to the practice that has grown in recent years, namely, the advertisement of milk, from unlicensed herds, in terms calculated to lead the public to believe that such milk is graded, or is the equivalent of higher-grade milk. Section 3 of the Milk and Dairies (Amendment) Act, 1922, prohibits any person who is not in possession of a licence from describing or even referring to his milk by the words Certified, Tuberculin Tested, or Grade A, or by any form of words containing these. This applies to notices on a cart, handbills, bottles, &c., as well as to advertisements in the press. The veterinary inspector and other officers of the local authority should report any infringement of this requirement.

LIVE STOCK INSURANCE.

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THE probable expectation of life is the important factor insurance companies have to consider in live stock insurance as in human life insurance.

Without statistical evidence of the percentage number of deaths in one year and over a series of years it is impossible to assess the risks at their proper value. In France, Germany, Belgium, and most of the other continental countries, information of the kind has been collected either by the State or from the experience of the companies undertaking this class of insurance. In this country, however, very little statistical knowledge of farm stock mortality is available, and it is, therefore, very difficult (if not impossible) to gauge with any measure of accuracy the extent of losses suffered by the average farmer. Societies of the type of the Livestock Association have, of course, available the collated experience of their members, regarding the number of animals insured and the number of deaths among these insured animals. The probability is, however, that the information refers more to pedigree animals than to ordinary farm stock and to special risks such as foaling than to the normal risks by accident and disease.

The absence of such statistical information has made it very difficult to estimate the risks which the farmers undertake in the production of commercial live stock or to compare the situation in this country with other countries. The following tables are based on information collected in this country over a period of two years. Some two hundred farmers (the majority in Wales) undertook to keep over this period quarterly records of the total stock on their farms and the number of losses. It is not claimed that the sample is big nor the records infallible in every instance, but it is felt that the figures give a fair and general idea of the incidence of mortality amongst live stock in this country. The figures shown in Tables V to X do not include any losses from foot and mouth disease, and one is justified in looking at these figures as the normal losses sustained on the farm.

In the following tables, losses over the period are shown in percentage only. From these the position in this country can be compared with that of Belgium, which is shown in the adjoining tables.

Mortality of Horses.—

TABLE V.

Percentage Mortality of Horses under various classes on Farms included in survey, with comparative figures for Belgium.

Class.	Percentage Mortality.		Percentage Mortality Belgium,[1] 1910.
	1925.	1926.	
Brood mares	1·51	1·72	2·15
Working horses	2·54	2·91	1·92
Unbroken (under 3 years)	3·74	3·09	3·91
Foals	8·49	6·06	...
All horses, excluding foals	2·60	2·57	2·66

It will be immediately noticed that contrary to general expectation the mortality amongst brood mares is lower than in any other class shown in Table V. Too much emphasis cannot, however, be laid upon this since there was not a large number of brood mares on the farms where records were kept. Prices for horses from shortly after the war until recently have been poor, with the result that there has been no inducement for these farmers to keep mares for breeding purposes. Had the records been kept on a larger number of farms or over a wider area to include more brood mares, this figure might, judging from observations in this country and abroad, be somewhat higher.

It is, however, interesting to observe that there is very little difference between the Belgian figures of losses and ours, taking into consideration all horses excluding foals.

Cattle Mortality.—This country has for many years been recognised as the best live stock producing country in the world, particularly as regards cattle. The capital invested in the latter department is enormous, yet it is true to say that only a negligible amount of that capital is insured. The individual farmer engaged either in cattle rearing, milk producing, or fattening carries all the risks himself, and, in some instances, is

[1] All the statistics relating to Belgium have been taken from "Statistique de la Belgique Agriculture Reconcement General de 1910."

financially crippled by continuous losses through death and disease among his stock. These losses when spread over a number of farms are comparatively low (as illustrated in Table VI). Very often, however, an individual farmer is in the unfortunate position of suffering from a series of minor losses or from one or two years' really heavy losses. Unless the risks are covered, these losses make it extremely difficult for him to maintain production at an economical level with the depleted capital. The economic aspect of the problem of live stock losses has been given prominence in the Final Report of the Agricultural Tribunal, which stated that the matter is important, particularly for the smaller farmers, where the loss of a horse or a cow may be a very serious matter, whilst among farmers both small and large the incidence of an epidemic may cripple his resources for years.

On the other hand, there are farmers who find that, over a series of years, their losses are such that under existing conditions it pays them better to carry their own risks rather than to pay insurance. They estimate that they would probably pay more in premiums than the money value of actual stock lost.

Table VI gives the percentage losses under the various heads of cattle during 1925 and 1926 and in Belgium during 1910. From a careful study of these figures it appears that on an average there is much justification for the farmers' reluctance to insure his cattle for premium payments varying from £4 to £7, 10*s*. per £100 insured value, which is the amount he must pay under existing insurance facilities in order to be adequately protected.

TABLE VI.

Showing percentage losses of Cattle under various classes on Farms included in survey and comparative figures for Belgium.

Class.	Percentage Mortality.		Percentage Mortality Belgium, 1910.
	1925.	1926.	
Cows in milk	3·23	1·27	1·82
Heifers in milk or in calf	1·14	1·12	1·14
Fattening cattle	1·98	2·32	0·70
Stores	3·12	3·22	1·36
Bulls	1·27	...	1·70
All cattle	2·15	1·98	1·34

It is probably safe to assume that the higher percentage of losses in this country as compared with Belgium is, in some measure, due to the more unequable climatic conditions prevailing on the farms which kept records.

TABLE VII.

Showing percentage losses on three individual Farms, compared with average percentage losses on all Farms.

Class.	Percentage Mortality all farms recorded, 1925.	Percentage Mortality on		
		Farm 1.	Farm 2.	Farm 3.
Cows in milk	3·23	33·33	3·70	10·00
Heifers in milk or in calf	1·14	...	6·25	...
Fattening cattle	1·98	...	...	...
Stores	3·12	...	...	4·35
Bulls	1·27	...	...	...

In the above table the percentage of losses on three farms are shown against the average losses for all farms. It is important to note how crushing the losses can be in one or two classes and below the average in others. The size of the farm is, of course, the most significant factor in determining the relative seriousness of the loss. Farm 1 is a mixed farm of 60 acres, and the loss of one cow in this case was felt very heavily as compared with Farm 2 of 460 acres, milking nearly ten times the number of cows. Farm 3 is another mixed farm of 200 acres, which felt the loss of one cow far less than Farm 1 but considerably more than Farm 2.

One would hardly be justified in drawing very rigid and dogmatic conclusions from statistics collected over a period of two years. They merely show the trend or the approximate losses a farmer must be prepared to stand. In one year, or as many as ten years, a farmer might be comparatively fortunate, but in another year or a series of years he may lose stock heavily, thereby counteracting the years of immunity. Statistical information should, therefore, be available indicating losses not for a year or two but over a period of five, ten or more years. Unfortunately this is not available for this country over a wide area.

In Table VII the experience of two mutual insurance societies is given, one in England and the other in Belgium. The English society is a small local mutual insurance association established as far back as 1838, and has always been extraordinarily successful. During the period under review this small society insured from 560 to 650 cows per annum, and the percentage losses are shown in the following table. The Belgian society is the well known Borenbond Belge, reinsuring during the period shown in the table about 11,500 head of cattle per year.

It should be stated that the English Mutual Insurance Society insures calves and heifers as well as cows. The losses of the former are included in Table VIII, which tends to raise the mortality level of the whole class insured. The percentage mortality in both England and Belgium is fairly low and constant throughout the period, and even from the limited statistical information shown in Tables VII and VIII it is difficult to find a sound reason for the slow growth of live stock insurance in this country.

TABLE VIII.

Showing percentage losses of Cattle in two Mutual Insurance Societies.

Year.	English Society.	Belgian Society.
	Percentage losses.	Percentage losses.
1919	2·13	2·96
1920	1·75	2·45
1921	2·92	2·77
1922	2·24	4·13
1923	3·24	3·04
1924	3·10	2·72

Sheep and Pigs.—The losses amongst sheep are far more difficult to check than in the case of the other classes. That is particularly true of Wales, where the sheep run on hundreds of acres of hill land. The figures in Table IX should, therefore, be regarded as approximations. Insurance of sheep would, in any case, be a very difficult problem to solve, and the percentage mortality of breeding ewes shown in Table IX is recorded more from a general interest viewpoint than as a possible basis for premium tables.

The part of Table IX showing losses in sows is of interest to those farmers who have within the last decade gone in for pig farming on a large scale. The experience of small mutual insurance societies insuring chiefly small-holders' pigs is shown in Table X.

TABLE IX.

Percentage losses amongst Sheep and Pigs.

Class.	Percentage Mortality.		Percentage Mortality Belgium, 1910.
	1925.	1926.	
Breeding Ewes	4·72	3·82	...
Breeding Sows	4·73	3·32	3·07

TABLE X.

Percentage Mortality in Store and Fat Pigs.

Year.	Percentage Mortality.	Year.	Percentage Mortality.
1913	3·20	1920	4·29
1914	4·70	1921	4·19
1915	4·35	1922	5·08
1916	4·92	1923	3·80
1917	4·34	1924	4·54
1918	3·24	1925	3·48
1919	4·36	1926	3·54

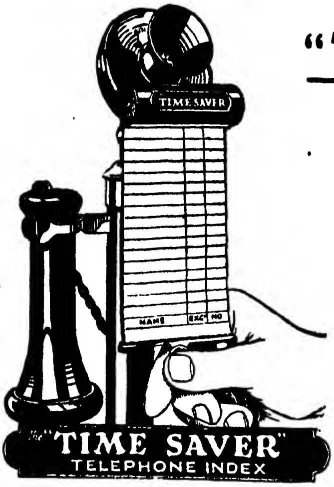

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Table X is based on information received from nearly a hundred small mutual insurance societies. The number of pigs insured during the period varies from 5,095 to 6,687 per annum, and the average losses for the same period were 4·41 per cent.

Diseases.—The information collected concerning the various diseases which occasioned the losses shown in the above table has not yet been analysed completely enough to build up tables showing distribution of diseases over the losses. It was clear, however, from a general analysis of the records that tuberculosis accounts for a considerable percentage of the losses suffered.

The following table from the report of "La Caisse Nationale de Reassurance des Caisses mutuelles contre la mortalite" is very interesting and instructive as indicating the kind of information from which we in this country should obtain reference to the distribution of diseases in the various classes of farm live stock.

TABLE XI.

Causes of death in 354 Horses and 1,386 Cattle.

Diseases.	Horses.	Cattle.
	Percentage.	Percentage.
Digestive organs	44·9	29·3
Circulatory organs	5·6	5·9
Respiratory organs...	11·1	1·2
Nervous organs	12·8	4·4
Contagious	1·9	35·5
Miscellaneous	11·6	17·5
Accidents	12·1	6·2

Nearly 50 per cent. of the losses in horses due to diseases of the digestive system were the result of colic. In the cattle the 35·5 per cent. of losses due to contagious diseases includes 57·80 per cent. due to foot and mouth disease, 14·04 to tuberculosis, 12·41 to anthrax.

Is there a case for special live stock insurance schemes in this country? The question naturally arises out of this and the previous articles. Comparing the mortality figures given for this country with those of Belgium one can justifiably say that there is. In all the continental countries where, judging from statistical evidence, the percentage of mortality in farm live stock is something similar to our own, this branch of insurance is very well and widely developed. Live stock insurance in this country, however, is never given serious consideration by the farmer. The farmer prefers to bear his own risks.

There are cases when it is good business on the part of the farmer to stand his own losses. These, however, are rare, because it is very doubtful if the distribution of risks is such, even on our biggest farms, as to warrant self-insurance. It can be said, however, without the slightest hesitation, that while the existing facilities fulfil the fundamental principle of insurance, namely safety, the premiums charged are too high to attract the farmer. Under these conditions it is undoubtedly the case that many of our bigger and even our medium farmers can more profitably stand their own losses.

Many continental writers on live stock insurance maintain that the joint stock company form of organisation is not most suited to the peculiar needs of this branch. Judging from the comparatively small amount of business effected by joint stock companies in this class of insurance, it appears that this opinion has some justification. It is nevertheless interesting to note that in France a number of joint stock companies undertaking the insurance of ordinary farm live stock have been quite successful. The following table, however, points to the fact that small local societies reinsuring their risks in regional and national associations are doing the most business.

TABLE XII.

Year.	Local Insurance Societies. Value Assured.	Joint Stock and Mutual Companies. Value Assured.
	Francs.	Francs.
1900	106,807,194	51,544,472
1910	557,887,608	89,546,003
1920	656,915,590	343,073,723
1922	1,257,237,361	430,732,056
1923	1,661,727,787	519,876,176

It is by no means easy for the big companies to overcome many difficulties of supervision, depreciation in values, and constant inspection, which are characteristic of live stock insurance. It means added expenses for the companies and higher premiums for the insured. A farmers' organisation, on the other hand, if based on the principle of mutuality, can overcome these obstacles to a considerable extent by working through its local organisations.

More research work is needed into the problems of selection of risks, management, and finance before one can assert dogmatically which system of organisation would be best suited to this country. The statistical evidence of losses themselves point to the need of some form of live stock insurance. It can only be pointed out here that judged from experience abroad that need could be met most satisfactorily by local farmers' organisations reinsuring their risks with a national federation. Such an organisation would have the advantage of a wide distribution of risks and would also retain that local knowledge which can maintain efficient and inexpensive supervision.

LIVE STOCK IMPROVEMENT AND THE SCRUB BULL.

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In the improvement of live stock, Great Britain has played an infinitely larger part than any other country in the world; but in spite of the fact that we have had "improved" stock for a longer period than any other country, the quality of the average animals throughout the country does not approach that of the improved breeds.

The average level of the quality of the stock in other countries is rapidly improving and the quality of imported meat is steadily rising. Owing to higher costs of production in this country the British farmer finds it difficult to compete with the raisers of live stock in other countries. He is at the mercy of world price fluctuations over which he has not the slightest control. There is, however, one corner of the meat market in the United Kingdom that is not open to world competition. The market for best quality is largely our own. It is therefore logical to state that the British farmer should concentrate upon the production of the best, for he has the market at his door and it is not easy for his competitors to meet that demand. Although these facts have been patent for the past five or ten years, and although the premium bull scheme has been in operation in some parts of the country for considerably longer than that, it is not possible to detect much average improvement in the animals marketed. Further steps seem necessary to secure the improvement which is so imperative for prosperity. Better stock must be bred throughout the country and feeding must be conducted on more economical lines.

The Importance of a Good Bull.—It is an old and well-known saying that the bull is half the herd. The scientist has not only confirmed this by proof but can explain why it is so. Any scheme for the improvement of a large number of animals must be based on this theory, the truth of which may be illustrated by reference to two large scale experiments in the United States. At the Iowa State Agricultural College at Ames a group of "scrub" cows were got together with an average milk production of 400 gallons. They were mated to good bulls and the average production of their daughters was 577 gallons. These in turn were mated to good bulls and the average production of the granddaughters of the original scrub cows was 841 gallons, showing an increase of 110 per cent. in milk production and 101 per cent. in butter fat production in two generations.

At Sni-a-bar farms, near Kansas, 200 "common red cows" were bought in 1912. These were mated to pedigree Shorthorn bulls. The first generation showed a distinct increase in quality and maturity. This has been maintained steadily generation by generation. Over a ten year period the steers of the original cows averaged almost 9 dollars a cwt. Those of the first cross

11 and of the second cross 12, increases of 22 per cent. and 33 per cent. respectively upon the originals. Now, after five generations of cross-breeding, it is not possible to distinguish them from a good pedigree herd. It has been stated by one of the highest authorities in American agriculture that this demonstration at Sni-a-bar farms has done more than anything else to improve the general quality of the beef cattle of the United States in recent years.

Necessity of Co-operation.—To improve the general level of live stock of a country depends not, however, only on a recognition of the well-known fact that it can be quickest accomplished through the use of good sires, but, equally important also, on the co-operation of all breeders. Since in the British live stock industry, largely owing to local conditions, one group of farmers are often breeders and another are feeders, then, if the breeders produce a low grade raw material for the feeders, it is not only they themselves who suffer but the feeders also. The brunt of the burden is really borne by the feeders rather than the breeders, for as a rule it costs considerably more to feed a bad beast than a good one. The breeder of nondescript stock is a danger to British agriculture.

Objections.—If it is granted that by the elimination of the "scrub" bull our live stock can be improved and that those who breed nondescript stuff are a menace to the agriculture of this country, the logical conclusion is that some compulsory measure must be introduced to ensure the breeding of better stock. Not only must breeders of inferior stock be protected from their own foolishness, but other farmers must also be protected from them. There are several chief reasons why many farmers are objecting to legislation which has as its object the prevention of the use of the scrub bull. Let us tabulate them:—

1. Legislation against the use of the scrub bull is an infringement of personal liberty.
2. It implies a number of Government officials for the administration of the scheme and inconvenient and dangerous congregations of bulls for inspection.
3. In many districts the calf is of no matter to the breeder, and it is not economic for him to pay the price of a pedigree bull when all he wants is milk.
4. Out of 2,600,000 calves born every year in Great Britain less than one million are reared.
5. It is not possible to define a "scrub" bull.
6. Cost of licensing.

Before coming to a conclusion as to whether or not compulsory registration of bulls is desirable, let us discuss each of these points.

The first, and a very strenuous objection, is that legislation of this nature is an infringement of personal liberty. We must remember that a definition of personal liberty implies that such liberty is not used against the community. The breeder of inferior stock, however, is damaging not only himself but other agriculturists. The feeder of stock is harder struck than the breeder. Legislation will not prevent the breeder from buying the type of bull he desires. Rather will it safeguard him from buying rubbish. It is difficult to see that there is much infringement of personal liberty.

The objection that compulsory licensing of bulls will lead to the creation of numerous Government officials need not arise if a system of local judges were instituted. There already exist in every district of Scotland competent judges of live stock who could pass judgment upon the wisdom of the use of a bull as a sire, and, if required, the local veterinary surgeon could certify the soundness of the animal or otherwise. These judges of bulls would be the judges of the local shows. For bulls inspected on farms a favourable opinion by two of them, backed, if they require it, by that of the veterinary surgeon, would be sufficient to pass the animal. If they did not agree or if they turned the animal down, there would be an appeal to a higher judgment to be delivered by a judge of national standing. These panels of judges would be appointed for each country by the Board of Agriculture on the recommendation of the local Show Society and Farmers' Union. It might be wiser if they operated not in their own immediate district but in the adjacent ones. The appeal panel would be appointed by the National Societies such as the Highland and Agricultural Society, National Farmers' Union and Chamber of Agriculture. Arrangements would be made whereby all the males entered for the bull sales were examined by such judges. These would leave a comparatively small number to be inspected on the farm. Thus the objection to the possible spread of infection is overcome. Some people may say that it will be impossible to get the services of judges for this purpose, firstly, because they have not time, and secondly, because they will not care to adjudge the quality of their neighbour's stock. These arguments are, however, somewhat specious. If, on these grounds, a considerable proportion of the men best suited for this work refuse, then it will signify a very general lack of desire for the improvement of the stock of the country, and in any case the scheme would have fallen through by that time, for however compulsory it might be it cannot succeed in Scotland without the general support of the agricultural community.

The third objection, that in many districts the calf is of no value to the breeder and that it is not economic for him to pay the price of a pedigree bull is, in a way, a justification for the whole scheme. In illustration of this let me cite the following examples. In Aberdeenshire the practice is steadily growing of rearing two calves on a cow, and perhaps a third, and then carrying them, if not through to the fat stage, at least to where they are sold as thriving young stores which have retained their youthful bloom. The price of suitable calves at seven days old is high in this country and £5 is quite common. A strong black polled one may fetch up to £7. Yet there is a shortage of good calves, despite the fact that many come from Cumberland or Cheshire and some from even the south of England. In Ayrshire, which is closer to Aberdeenshire that any of these places, the type of cow kept is first and last a milk producer. On the majority of farms any kind of bull will do if only he can get the cows in calf. If these cows were mated to an Aberdeen Angus or to a Shorthorn bull their calves, instead of being vealed or thrown out on the midden, would fetch at least £3, leaving £3 to pay the expenses of the middleman in getting them to Aberdeen, where they are wanted.

It will be argued that such calves will not make first quality beef. In many cases this argument is correct, but they will certainly make quite good meat, better perhaps than the average man supposes. In illustration of this there was recently sold from a pedigree Ayrshire herd a ten and a half months old baby beef steer whose dam was a pedigree Ayrshire and who was sired by a Shorthorn. He is a first quality animal, and at Gorgie weighed 6¾ cwts. He cost about £13 to produce and fetched £21, 15*s*., or 63*s*. 5*d*. per cwt.

Even if the average of the quality of the animals produced by this means were only second class, this method would fill a useful niche in the agricultural organisation of the country. The production of best quality meat implies also the production of inferior quality animals. Almost every manufactory has some by-product in addition to its chief article.[1]

A more serious objection to some scheme of crossing such as this is the maintenance of the supply of dairy cows. If all the dairy herds in Ayrshire were to use beef bulls then the Ayrshire cow would cease to exist. That is carrying argument to an absurd degree. The better herds, especially those which were milk recorded, would use bulls of dairy type and would supply those dairy herds which kept beef bulls with heifer calves, basing the price on the milk production of their dam. The money that was received for their calves by the farmers who kept beef bulls would more than pay for this and the result would be a general improvement, for these farmers would be getting better potential dairy cows than they could breed themselves. It is an ideal arrangement for the man with a low grade herd of dairy cows. The man with an intermediate class of dairy cattle could overcome the difficulty of maintaining his stock by having a beef bull for one or two years, then a dairy bull, and after that back to beef, and so on. If the scheme came into operation it would be easier for a man in this position to sell a two year old bull than it is at present, for the occurrence would be more common, and the stigma of sterility would be more or less removed.

[1] Another case similar to Aberdeenshire was reported in the *Scottish Journal of Agriculture* last January. In a survey of the farms of two parishes in Berwickshire the reporters state that the possibility of raising two calves on every cow was ruled out on account of the impossibility of getting suitable calves. "The home breeding and rearing of cattle cannot progress satisfactorily until a better supply of suitable calves at the right time is assured. The elimination of crossbred sires and scrub bulls would be a distinct advance."

The fourth objection, that there are born every year 2,600,000 calves and that, as not one million of these are kept alive, it is therefore not worth while to bother about their quality, is of the same nature as the previous one. While not doubting this statement the writer would like to know from what authority it is derived. Does this statement include calves lost by circumstances over which the breeder has little control, such as contagious abortion, calf scour and other diseases? We think it must. Even if more than half the calves born are not raised to usefulness is this any justification for penalising the survivors? Moreover, surely an exception could be made in the case of those dairy farmers who cannot find a market for good cross calves, and permission should be granted them to use whatever sire they like on condition that every calf born is killed at not later than vealing age.

Definition of "Scrub."—A very general definition of a scrub bull will suffice if it defines the animal as one which "appears unable to leave stock of economic value to the country." For dairy bulls a recommendation might be added stating that they should be out of cows with a certain specified production, which would be determined from time to time by the dairy cattle judges of the appeal panel.

Pedigree need not count in the judges' eyes. A good cross-bred Aberdeen Angus by Shorthorn bull will breed better stuff than a scrub one, however long his pedigree. Bulls which are crosses between types should not be allowed. Otherwise the matter may be left in the hands of practical breeders. Occasionally the standard they set may be too high, but against this there is appeal. Rather is there more danger that it might be too low, but this should right itself after a few years. In any case it is not wise to hurry, for the market must be given time to adjust itself, and the industry cannot face an immediate and wholesale turning down of herd sires.

Finally, there is the plea of cost. The fate of a Bill in Parliament is more likely to depend on this than anything else. At the present time it would be unfair to saddle the industry with the expense, though undoubtedly it would get its money back within a very few years. There should be no fee for inspection of a bull at any of the bull sales. At every sale, however small, there would be sure to be present, in any case, a few judges.

If there is any real general desire throughout the stock-raising community for some Act of this nature—and without such a general desire it would be unwise to proceed—then surely there would be enough stock-raisers of good repute who would be willing to give their services free of charge. It would be sufficient if they received adequate reimbursement of any expenses they might incur on such a piece of work. Perhaps a small fee, of say 5*s*., might be charged for inspection on a farm. This, and the establishment of a small office staff, would constitute the whole expense of the measure.

If these objections, which to some people are very real, are met in this manner, then it is difficult to see how any reasonable person can take exception to an Act of this nature. Much of past and existing criticism of the proposal for the compulsory licensing of bulls has been based on the one word, *compulsory*. It would be better if the scheme were described as one for "the elimination of uneconomic cattle."

Hitherto the writer has refrained from quoting the amazing results which have followed the operation of Acts regulating live stock improvement in other countries. It is, however, impossible to ignore the position in both Northern and Southern Ireland. The result there, in a few years, has been surprising. The Irish store, which used to be considered of inferior quality, is now being preferred in certain Scottish markets to the home-bred one. Canada, New Zealand, Australia and South Africa have all partially adopted or are thinking of adopting some such legislation as that in force in Ireland.[1]

Further, let us remember that we are already on our way to live stock improvement by legislation. In addition to the stallion licensing Acts, which eliminate the unfit and which for at least the past five years no breeder has publicly criticised, there are the various premium bull schemes. These will remain in operation and will substantially mitigate any hardships that there may be under such a scheme for the elimination of uneconomic cattle.

Finally, let it be stated again that Scotland's agricultural prosperity depends primarily on her live stock. Her live stock needs improvement. Under existing conditions it is not being improved. If anything, with an increase in the dairy industry, it may go back. Steps must therefore be taken to improve it. Is the Scottish farmer willing to take those steps which have been adopted by his competitors? If he is unwilling to take them, will he be able honestly to say that he is doing his best to overcome the agricultural difficulties of the present time?

THE CROFTING PROBLEM, 1780-1883.

MARGARET M. LEIGH, M.A.

VI.—EMIGRATION.

A. The Position in 1800.—Of the various solutions proposed for the agrarian problem in the Highlands, emigration, in spite of its initial difficulties, offered the only prospect of permanent success. In this way alone could the land available for crofters at home be divided into sufficiently large holdings, while the surplus population could at the same time be settled on equivalent if not much larger and more productive tracts of

[1] For detailed particulars the reader is invited to study the address of Dr. Gordon to the British Association 1928 (Section M), entitled *The Live Stock Industry and its development.*

land overseas. It has been shown that the Highlanders, unsuited to the cramped and monotonous conditions of town life, made poor factory hands, and that to most of them the possession of land was a social as well as an economic necessity. In the new countries vast expanses of virgin soil were waiting for settlement. The conclusion seems obvious. And yet, especially in the earlier part of the period, the actual difficulties with which emigrants had to contend were sufficiently serious, especially for married men with families—the very class who would most benefit by removal. And apart from this, many preferred a life of semi-starvation in their own country among their own kindred to the unknown evils of a foreign land. A large section of the gentry were strongly opposed to any removal of the population.

Process of Emigration in the eighteenth Century.—At the beginning of the nineteenth century emigration was no new policy. From 1750 onwards it had become increasingly important. The steady rise in rents, the extension of sheep-farming, the increase in population and sub-division of crofts, all helped to induce the more adventurous to seek a living elsewhere. Reports of the success of earlier settlers in America and Canada, and visionary dreams of wealth and happiness beyond the sea, played their part also. And as the system of small-holdings in the Highlands meant that agricultural capital was widely dispersed, a large proportion of prospective emigrants were able to pay their own passage out of the sale of their stock and effects. Every bad season went to swell the stream. When Dr. Johnson visited the Hebrides in 1773 he found there "an epidemical fury for emigration." In 1772 began a large exodus from the Outer Islands, mostly to South Carolina.[1] Between 1772 and 1791, 4,000 people were said to have emigrated from Skye.[2] By the end of the century the movement became so pronounced that a violent outcry was raised by the landlords. None of their objections had any great cogency, and most of them could only have been made by men with little understanding of the economic condition of their country, and less insight into the possibilities of the future.

Objections.—It was urged that emigration would lead to widespread depopulation. A glance at the census tables previously quoted will show how baseless was this fear; and even in 1800 it was clear that the natural rate of increase was great enough to fill up any gaps left by emigrants. The following example, taken from Irvine's "Inquiry into the Causes and Effects of Emigration," shows what must have happened in many other places. "In 1790 a place on the West Coast contained 1,900 inhabitants, of whom 500 emigrated in the same year to America. In 1801 a census was taken, and the same spot contained 1,967, though it had furnished 87 men for the Army and Navy, and not a single stranger settled in it."[3] In any case,

[1] Statistical Account, xiii, p. 299. [2] Selkirk, Observations, p. 117
[3] Irvine, p. 9. Quoted by Selkirk, p. 119.

the first steps towards depopulation had been taken by the landlords themselves when they let their land to the sheep-farmers; and emigration was but a means of relieving the overcrowding in areas limited by their own action. Many critics overlooked the fact that not depopulation, but wrong distribution, was the problem; many inland glens were stripped of their inhabitants, while the coast and islands were becoming impossibly congested. The evils of the over-intensive occupation of an unproductive soil were not properly understood, nor was it realised at the time to what an extent the population, with no check or outlet, would multiply.

Effect of Emigration on recruiting.—It was also thought that emigration would interfere with the recruiting of the Highland regiments. The Highlands had been famous as a nursery of soldiers, and if the most adventurous young men were enticed abroad, the quality and number of recruits were bound to suffer. This fear was natural at a time when protracted war was making heavy demands upon the military resources of Britain. The Earl of Selkirk answered it by showing that quite apart from depopulation, the break-up of the clan system had of necessity changed the character of the Highland regiments. The old feudal relation between chief and clansman, whereby the tenant had given his personal service in war in return for a nominal rent, had gone for good, and the Highland regiments could never again have the special quality of a band of tenants and retainers bound by the tie of personal loyalty to the hereditary chief. It was of course undeniable that emigration tended to remove permanently from the country men whose age and character made them most desirable; and in these earlier days the hardships of the settler's life called for young single men. Thus there were left at home too large a proportion of women and old people, a condition still very noticeable in Highland villages, which can be remedied only by a system of group settlement, scarcely possible at the beginning of last century.

Landlords and the Labour Question.—Although the rate of wages in the Highlands had for the last twenty years been steadily rising, it was still lower than in the south, and landlords were afraid that the labour of a reduced population would command a higher price. Some went as far as to say that sufficient hands would not be left for cultivation, which was obviously absurd; and even were this possible for the moment, the consequent rise in wages would soon keep a larger number at home. The owners of kelp-shores had more reasonable grounds for complaint. This industry required a large supply of labourers, drawn from the very class to whom emigration offered the only hope of security. Any great reduction in the numbers of men available would oblige the landlords either to burn their kelp with a very small margin of profit, or to abandon the industry, consolidate any vacant crofts, and raise the rent of their land to an economic level.

Attitude of Highland Society.—Much anti-emigration propaganda was done by the Highland Society, which issued several reports (unpublished) and claimed to have been responsible for the passing of the Emigrant Bill of 1803, which regulated the conditions of transport and other kindred things. Much stress was laid on the misleading reports about opportunities abroad which were disseminated among the uninformed, and cases of deception, failure, and the censorship of letters were unduly magnified. It was alleged that the promoters of emigration kindled the smouldering resentment of the small tenants against their landlords by seditious talk, as for instance that in America "they were not troubled with landlords or factors, but that all the people were happy and on an equal footing, and that there were no rents paid there."[1] A letter was read from a settler in Canada exhorting his countrymen to "throw off the yoke of bondage and the shackles of slavery, and to quit the land of Egypt, and come to this land of Canaan."

Difficulties of Emigrants.—Opposition did not come from the landed class alone. Many of the people were too much attached to their native land to leave it under any circumstances, and apart from this the difficulties were considerable. A ship had to be chartered privately, and the party must supply itself with provisions enough to last for a voyage which might be indefinitely protracted by contrary winds. On arriving, isolated parties of settlers often found themselves without help or guidance in virgin forests, and spent their money and energies in the mere search for a suitable place to settle. The difficulties of early settlers are vividly described by the Earl of Selkirk,[2] who had seen them with his own eyes. Wishing to direct the stream of emigration from independent America to British Canada, he acquired land in Prince Edward Island, and brought there in 1803 a party of 800 people of all ages, mostly from Skye. The people lived in wigwams on the shore until their lots were apportioned and they were able to build more substantial houses. Before the end of this transition period an infectious fever broke out. Though provisions could be got locally, extortionate prices were demanded for them, and the time that must elapse before the first crops could be gathered was one of great expense and anxiety. And though on the virgin soil heavy crops could be raised with next to no tillage, the land had in all cases to be cleared of trees and brushwood. From 50 to 100 acres were allotted to each family at a moderate price. The experiment seems to have been fairly successful. The settlers were hardy and industrious, and the austere conditions of their native land had given them a good training for the lives of pioneers. This group was, however, settled under a well-organised scheme, and many other less well-directed settlers must have fared much worse. Yet emigration, then as later, appeared to be the one practical solution of the crofting problem.

[1] Selkirk, Observations, Appendix T.
[2] Observations, chapter xii.

B. 1840-1851.—The New Statistical Account of Scotland, published in 1840, gives a melancholy picture of Highland life. Nearly a hundred years had passed since the '45; the old order was gone, and the isolated communities of the glens were still painfully adapting themselves to the new. The adverse factors —growth of population, sub-division, rise of rents and unemployment—had had time to make their full effects felt, until in widespread areas the people were living in abject poverty, and it needed only a bad season to reduce them to starvation. It must be realised that the ordinary standard of living was so low that unfavourable weather—a cold wet spring, which delayed sowing and the growth of seedlings; a wet summer, which prevented the drying of peats; a stormy autumn, which destroyed the crops —might make all the difference between subsistence and famine, and such weather is not exceptional in the West Highlands. More serious was the arrival of the mysterious potato blight, which in a bad season like 1846 might ruin the food supply for three-quarters of the year. There had been periodic lean years in the eighteenth and early nineteenth centuries, as was inevitable in such a climate and under such conditions of agriculture. Evidence given before the select Committee on Emigration in 1841 shows that in the opinion of most witnesses the former scarcities had been much less serious. This was probably true, in spite of the tendency to paint the past in rosy colours; for there were then fewer mouths to feed, and the potato blight does not seem to have appeared in Britain before about 1837. There were other causes at work besides the uncertainty of crops. The kelp industry could only be worked at a loss, and the fisheries were in an unprosperous condition; bounties had been withdrawn, and the incalculable migrations of herring had left many fishing stations idle. The price of black cattle had been steadily falling since 1819.[1]

There was a tendency to lay some blame for this state of things at the door of the landlords. Many of them were non-resident; it was estimated that in 1841, in the distressed districts, 46 out of 195 proprietors were absentees. This tendency had begun in the previous century, when Highland landowners mingled more with the world, and it came to be increasingly common for them to visit their estates only for a few weeks' shooting, especially later, when deer forests and grouse moors became more profitable than sheep-walks. Thus they ceased to be in personal touch with their tenants, and left the transaction of all business to their factors. In time of want they were usually generous in relieving distress; but they were blamed for not taking a larger share in the removal of the superfluous population.[2] They should, it was urged, have followed the example of the proprietor of Canna, who emigrated 200 out of 500 people at his own expense, and divided the land among the remainder, forbidding any sub-division or squatting.[3] But this

[1] Report of Select Committee, 1841, p. 43.
[2] Evidence of C. R. Baird, Hon. Sec. of Glasgow Relief Committee, 1837, given before the Select Committee, 1841. [3] Evidence, p. 40.

proprietor was a man of means, and his estate was small and easily treated as a whole. For most landlords the problem was more difficult. Their revenues were not large, especially since the decline of the kelp industry, and the wholesale removal of one-third of the population overseas was an expensive business. Many no doubt had been led by a misguided humanity to subdivide farms for maintenance of more people on the land; but others had done their best, by the consolidation of vacant crofts and the discouragement of early marriages, to keep the population within reasonable bounds.[1]

In such conditions, public and private charity, or such measures as the fixing of a legal poor law assessment in all districts, could only be palliatives. Nor was the steady movement of young people to the towns the right solution. Many of the more enterprising and better educated made successful careers, but the majority, ill-suited to urban life, fell into a state of misery which was described as worse than that of the Irish immigrants. By 1841, Glasgow was full of Highlanders, who were employed in unskilled labour, where they suffered severely from the competition of the Irish.[2] The removal of a surplus rural population to the already congested cities was clearly no remedy. The needful thing was a comprehensive scheme of State-aided emigration. This was the almost unanimous opinion of the ministers from the distressed districts who contributed to the New Statistical Account of 1840.[3] In the following year, enquiries made from proprietors, factors and clergy showed that in their view one third of the population (i.e. about 70,000–80,000) should be removed. Otherwise the landlords and the public must be prepared to give extensive relief every few years—a policy which in the long run would be more expensive than assisted emigration, and would only perpetuate a miserable and demoralising way of life.

Hitherto Highlanders had emigrated almost entirely to America and Canada, where there were many flourishing communities of people from the same districts. But now Australia also claimed a share. To attract more settlers the Australian administration began to offer free passages to approved immigrants, and in 1851, when a succession of bad seasons had brought the Highlands to an even worse plight, the Emigration Commissioners extended this help to selected families. Large sums were subscribed by the public, and it was suggested that it was better to apply Government and private funds to assisting the people to emigrate than to feeding them on the spot. In answer to an appeal made by local authorities to the Home Secretary, one Government ship was sent to the islands with supplies, and another to embark emigrants for Australia. The Highlands and Islands Emigration Society was founded to encourage and direct intending settlers.

On the whole the emigration policy was well received. Be-

[1] See Evidence, *passim*. [2] Report of Select Committee, p. 4.

[3] See especially Strath, Sleat, Portree, Kilmuir, Snizort, Barra, South Uist, North Uist.

tween 1846 and 1850 a thousand people went to Canada from Tiree alone, and in 1851 the proprietor received a petition from his tenants asking to be allowed to emigrate.[1] A few sentimentalists and political agitators, however, tried to persuade the people that emigration was a cloak under which they were being dispossessed of the land of their fathers, which the cupidity of landlords had wrongfully taken from them. Tracts were written in Gaelic and distributed among the uneducated, who had no means of judging the truth of their contents. The notorious Donald Ross boarded a steamer full of emigrants for Australia and tried to induce them to return; luckily for themselves, they did not listen.[2] Such men took advantage of the irritation against landlords that had been smouldering for the last sixty years; and advocates of emigration pointed out that unless the population had some outlet, this resentment might in future lead to violence and crime.

C. 1883.—In the year 1851 the inhabitants of the Highlands and Islands generally reached the highest point of numbers and the lowest point of poverty. After this, matters began to mend in all districts except Lewis, where the population has been steadily increasing till the present day, and the attendant evils have been, at least until recent years, but little diminished. In certain parts of Skye there was not much improvement. The parish of Bracadale, where in 1840 out of 1,824 persons 64 were receiving parochial relief, in 1883 supported 80 paupers out of 929, thus showing that to halve the population does not necessarily raise the standard of living.[3] However, when the Crofters' Commission came to examine the condition of the Highlands and Islands, they had a more restricted area to deal with. Argyllshire and the mainland of Inverness had become fairly prosperous; the former was not scheduled as a crofting county, and the latter was only included because it embraced Skye and the southern part of the Long Island. In the opinion of the Commissioners the area of extreme poverty, when most complaint was heard about the smallness of holdings, was confined to the northern Hebrides and certain coastal districts of Ross and Sutherland, and it was here that emigration was chiefly to be advocated.

As before, the representatives of the upper and educated classes were in favour of emigration; but many of the crofters and their friends maintained that if the large farms and deer forests were broken up, the population could be supported at home. But in the overcrowded districts like Lewis, even the elimination of the whole wage-paying class would not have produced holdings of an adequate size. The Commissioners estimated that if all the land in Lewis were to be divided into small holdings, the average size would be only 17·50 acres, and the average rental 11*s*. 6½*d*. a head; while on the crofters' own showing the economic holding on such poor soil should be at

[1] Duke of Argyll, Farms and Crofts, p. 19.
[2] R. H. Macdonald, Letter on Emigration, p. 15.
[3] Ibid., p 8.

least 57 acres. Objectors also said that emigration, the panacea of the gentry, had never improved the condition of those who had remained behind. There was some truth in this. When the croft of an emigrant fell vacant, the landlord generally preferred to annex it to some large farm rather than to use it for the enlargement of another inadequate holding. Nor can he altogether be blamed. The increase of the crofting population was a terror to most proprietors, and they seized every opportunity of decreasing the amount of land occupied by crofters. And in many cases the crofters had not sufficient capital to stock and work a larger holding.

The Commissioners recommended a scheme of State-aided emigration for which the Act of 1851 had given a precedent. They considered that family settlement was the only satisfactory course. There were two possible methods of removing whole families overseas : (1) by contract with an employer for a fixed period; (2) by settlement in homesteads with land. The first method alone was suitable for men without capital; but the employer very naturally recouped himself for the trouble and expense of getting his labour by demanding a long period of service. In Canada the conditions of such contracts was laid down by law, and any breach was made punishable. Many emigrants hesitated to commit themselves to employment they were unable to leave at will. The Commissioners recommended that there should be a Government Emigration Agency, which should keep a register of employers and employed, arrange security for the repayment of advances, and regulate terms. But for the crofter with a little capital—£100 to £130 was considered enough—settlement on the land offered the best prospects. The Government should make a small allowance, which could easily be repaid within a few years. The homesteads should be ready for occupation, and provision be made for the support of emigrants until the first crops were harvested. Advice on local conditions should also be available. Enquiries were made from Australia and South Africa on the possibility of settlement from the Highlands, and the following recommendations were made :—(1) Each family should be able to find means of subsistence on the homestead from the day of its arrival; (2) the cost of preparing the homestead and removing the family should not exceed what might reasonably be repaid in eight to ten years; (3) the Colonial Government should take an interest in the success of the scheme, make provision for immigrants on arrival, see them established, and undertake to recover advances made by the Imperial Government. It was also recommended that a separate Emigration Agency should be set up for Scotland, with power to negotiate with the Colonial Governments; and that this body, and not local authorities, who might have ulterior motives, should select intending settlers. Landlords should be obliged to use all vacated crofts under £4 rental for the enlargement of adjacent holdings and to take over the outgoing tenant's stock at valution.

WINTERING OF BEES.

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BEEKEEPERS in the south-western area of Scotland lose, on an average, apart from the incidence of disease, from 15 per cent. to 30 per cent. of their bee colonies each winter. In addition to this, many bee colonies, though surviving the winter, enter on the spring in such a weakened condition that they are of little or no practical value for the production of honey.

The art of successful honey production lies in having the bee colonies strong in numbers when the fields are rich in nectar.

Bees should be wintered properly in order that they may emerge in spring strong in numbers and full of vitality. Bee colonies in such a condition in the early spring build up rapidly, and are ready for the gathering of nectar in the summer.

The successful wintering of bees depends upon certain factors which the beekeeper can control, and these may be enumerated as follows :—

(1) It is important to have a young fertile queen at the head of the colony in the late autumn. This ensures a large number of eggs being laid, which will develop into worker bees. These young bees will not be called upon to do much field work at the outset, and consequently are in the best physical condition to stand the rigours of winter. A colony that has worked through the summer and provided a plentiful supply of honey may be apparently strong in bees in the late autumn; but unfortunately a considerable percentage of these bees is worn out and will not live through the winter. Unless, therefore, there is a plentiful supply of young bees to take the places of those spent or exhausted, the colony will not winter satisfactorily. The worker bee has but a limited life, depending entirely upon the labour it is called upon to perform. It has been likened to a miniature cell battery with a limited amount of energy, which, when that is expended, is finished. There is no such thing as repair of tissues in the worker bee.

(2) The food supply is another important factor in the successful wintering of the colony. The best wintering food is obviously well-ripened honey. Nectar collected late in the season is often not properly matured, and consequently does not form a good wintering food. This is particularly noticeable with bees at the moors. A fall in temperature, accompanied by frost, puts an end to the heather harvest and causes the bees to become inactive and to form a winter cluster. This late-gathered food often ferments in the bee hive and causes trouble.

(3) The hive and its protection is the third vital point in wintering bees. Bees have been known to winter in almost any kind of hive; but as will be observed in another part of this report, not only do certain types of hives, and of insulation, help the bees to pass through the winter successfully, but the bees consume a smaller amount of food.

How Bees pass the Winter.—The bees pass the winter in a semi-dormant condition. When the outside temperature falls to 55° F., there is a very noticeable inclination on the part of the bees to form a cluster, which, in a strong colony, may cover the bulk of the combs in the hive. At a lower outside temperature the cluster crowds into a smaller space. Food is taken by the bees and stored in their bodies: The cells on the centre combs which originally contained the late-hatching bees are now empty, and these help to provide the clustering space for the present population. Each cell will contain another cell of energy, so to speak. The bees maintain heat by the consumption of food, coupled with rapid breathing. Oxygen is thus taken into the body, which, acting upon the saccharine substance, produces heat. The greater the heat produced, the greater the amount of honey consumed; consequently the greater the energy exerted by the bees the shorter their lives. As time goes on and the weather becomes colder the cluster shrinks to smaller dimensions, the loss of life becomes heavier; and the bees entering the depth of winter are faced with the great problem of keeping the home intact through the winter with small means at their disposal. The problem is all the more difficult in those hives where little or no provision is made to help them to fight their battle.

Object of Investigation.—The object of the research was to discover: (1) methods of preventing losses of colonies of bees during winter; and (2) the most efficient means of bringing the colonies through the winter in a condition to ensure the greatest possible profit during the summer. Various types of insulating material were used, particularly those obtainable at a low cost.

Plan of Operations.—It was first of all necessary to make accurate observations at frequent intervals of the temperature of winter clusters of bees under varying conditions. These temperatures were measured by the thermo-electric method, which it is not proposed to describe here but details of which will be supplied to anyone interested who cares to apply for them to the West of Scotland Agricultural College.

A large wooden shed, holding 50 colonies of bees, was set aside for this experiment, the shed being constructed of seven-eighths inch boarding, and built on the lines of a general bee-hive, with shelving holding body boxes, similar to those used in ordinary W.B.C. hives. At the front and back of each body box a glass panel was arranged, and at the front of the box an electric lamp was fixed, together with a reflector. With this appliance any variations in the shape of the cluster, or any movements of the bees, could be seen at a glance. During these observations temperature readings were taken at intervals of two hours.

In the summer, when brood rearing is at its maximum, the temperature of colonies varies from 90° F. to 95° F.; but during the winter months the temperature variations are considerable from day to day. These varying temperatures within are due to (1) variations in the outside temperature; (2) the varying numbers of bees in the hives; (3) the different qualities of foods; and (4) the general condition of the homes. It may be safely stated that temperature uniformity in winter does not approach that of the summer months. Those colonies which have not shown a lower cluster temperature than 50° F. during the colder weather have given the best results.

Winter Losses.—The high death-rate in winter is due to a variety of causes, which include :—

(1) Colonies may be depleted in numbers to such an extent that they have the greatest difficulty in raising and maintaining temperature.

(2) Absence or insufficiency of the requisite heat-producing food.

(3) Insufficient protection in the shape of winter packing or insulation.

(4) Exposure to wet or cold winds.

(5) Too much ventilation at the entrance to the hive.

(6) Disturbance of the colony.

When the cluster is first formed the globular mass of bees is not very dense, as the surrounding air is not sufficiently cold to cause the bees to raise the temperature; but immediately a fall in temperature occurs a close-up movement is observed, breathing is quicker, and a low murmuring hum is heard in the hive. The cluster consists of walls of bees, dense in the centre, but gradually thinning towards the outside. By means of these walls the bees provide their own insulation. The workers on the outside of the cluster bear the brunt of the cold weather, and thus are the first to succumb to low temperature. When the outside temperature was at, or below, freezing point, some of the bees could be seen to drop from the outside edge of the cluster in a dead and dying condition. An examination of such bees showed that they were of all ages. Occasionally a few were revived by artificial heat. It is apparent, therefore, that some means of protecting the bees on the outside of the cluster would reduce winter mortality. It has been suggested by writers in the past that bees on the outside edge of the cluster change places with those in the centre, but we have been unable to verify this statement. The cluster moves very little throughout the winter, and it is only when the outside temperature rises that expansion of this mass of bees takes place.

Their food is the only means that bees have of raising temperature; and unless this consists of the best, the insects have great difficulty in wintering satisfactorily. Pure honey contains very little indigestible matter, a point of great importance to a body of insects which may be confined for several months. Bees discharge their fæces during the act of flight, and when wholesale flying is out of the question these are retained in the large bowel. Inferior food not only means a larger consumpt in the maintenance of temperature, but produces more indigestible matter to fill the bowel. The wastage of life is greater as the insects are continually active, and many leave the hive for a cleansing flight never to return.

The home of the bee has much to do with successful wintering; warmth and dryness are essential to the winter colony. Hives must be watertight, as moisture entering the home has a detrimental effect on the food, in addition to lowering the temperature. Unless dryness prevails in the home the honey deteriorates, fermentation occurs, and energy is lost. The rapid consumption of such food, on the other hand, will shorten the lives of the workers, and produce poor results as far as bodily temperature is concerned. Temperatures recorded in the presence of moisture showed higher and more variable readings than those taken under more normal conditions.

The feeding of candy during winter is another cause of indifferent wintering as shown by practical tests conducted in the apiary. The inclination on the part of the bees to store such food is evident, and unduly high temperatures result. Energy is wasted; flights are indulged in when the outside air is cold, and loss of life is the result. Such colonies pass through the winter in a state of undue activity, and emerge in spring in a weak condition. The beekeeper can avoid such feeding by supplying the necessary winter food during the late autumn.

Recording Temperatures.—During the years 1926–27 temperatures within a group of hives were recorded at intervals of two hours, between 9 a.m. and 6 p.m. A record was also made of the outside temperatures, together with notes on the state of the weather, and these were considered in arriving at conclusions regarding the rise or fall in temperature of the clusters.

As no two colonies gave similar readings, a graph showing temperatures conveyed no information of practical value. There is so much variation in colonies of bees that it is extremely difficult to find two alike, or approximately alike in :

(1) Quality of food.
(2) Value of combs.
(3) Number of bees.
(4) Fertility of queen.
(5) Hardiness or longevity of workers.

It was observed during the whole period of the experiments that colonies strong in bees gave more uniform temperature readings, and it is with these only that temperature values may be estimated. The temperature of the cluster is at its lowest point during December; a gradual rise of temperature taking place as the days begin to lengthen, and increases slowly until brood rearing commences, when more uniform temperatures are maintained. There may, however, be temporary checks in this respect if exceptional weather prevails. During the present year (1928) the upward grade commenced about the middle of January, fairly mild conditions for the time of the year prevailing. At the beginning of March the temperature of the clusters in strong colonies ranged from between 80° and 85° F. One example may be given in detail.

On the 8th of March cold weather set in, the outside temperature falling at times to 26° F. The result of this was immediately reflected in the temperature of the cluster, which dropped to 72° F. at 10 a.m. During the day the outside temperature increased and the cluster temperature rose at mid-day to 75° F., the outside temperature at this time being 40° F. At 2 p.m. the cluster registered 76° F., the outside temperature being then 42° F., while at 4 p.m. the cluster was 77° F. and the outside temperature 43° F. From March 9th to 15th inclusive almost identical outside conditions prevailed, the temperature reading of the cluster corresponding in practically all respects during the seven days with those recorded at the outset on the 9th March. On the 16th March, with the same external temperature of 40° F. at 10 a.m., the cluster temperature gave a reading of only 67° F. Although definite proof is lacking, it may reasonably be inferred that the cold spell had seriously impaired the powers of endurance of the bees. If the cold weather had continued a further fall in the temperature of the cluster would doubtless have occurred. By mid-day the outside temperature had risen to 46° F., and the cluster temperature responded to this influence by rising to 71° F. At 2 p.m. the outside temperature was 52° F. and the cluster temperature 76° F. This evidence goes to prove how essential it is to assist the bees in maintaining cluster temperature.

Different Types of Winter Protection.—In all the experiments under review an endeavour was made to equalize conditions as far as possible in regard to quality of hive, stores, strength of bees, and young queens. As the hive in general use in the College area is the "W.B.C.," this class of hive was used throughout in the experiments.

Temporary Winter Cases. — Twelve colonies of bees in "W.B.C." hives were provided with temporary winter cases. These were constructed of light wooden frames, over which roofing felt was nailed. They were made in four sections with a movable roof, the parts fitting tightly together by means of bolts at top and bottom. The hives were, therefore, entirely protected from the weather. A tunnel leading from the entrance of the hive to an exit in the outer case provided the necessary ventilation, and at the same time afforded the bees an opportunity of flight if desired. The space between the cases and the hive walls was 8 inches back and front, and 5 inches on either side. The twelve hives were arranged in three groups, and the intervening space between the hive walls and the temporary cases was packed with hay, straw, and dead leaves respectively. The result of the use of such packing for the wintering of the bees, in comparison with twelve "W.B.C." unprotected hives containing colonies under similar conditions, proved conclusively the value of such methods of protection.

The practical beekeper is mainly interested in two points, viz., food, and the strength of bees in spring. The protected colonies each gave an extra seam of bees in March, and had sufficient food until the end of April. The unprotected colonies were weak in bees, and required food early in March to keep them alive. While the twelve protected colonies were fairly uniform in strength of bees and food, the unprotected colonies varied considerably in both respects. During the winter months daily inspection was made of the entrances and a record kept of the number of dead bees thrown out and the general activity of each hive. In the protected colonies the death-rate was low; and in the subsequent examination of the dead bees for Acarine disease, it was found that they consisted generally of old bees which would have died in the ordinary course of events. The unprotected colonies gave a much higher death-rate, particularly after frost, and an examination showed bees of all ages. In the unprotected colonies food was more rapidly consumed, and flights were very general at varying temperatures. The protected colonies, on the other hand, showed little or no activity during the winter months.

Insulating Materials: Experiment No. 2.—A test was made to determine the best material to place between the brood box and the outer case. The difference in the construction of "W.B.C." hives is shown in the space allowed between the brood bodies and the walls of the hives. It varies from a minimum of only 1½ inches. This empty space has been erroneously referred to as a dead-air space, but changes of temperature obviously produce circulation of air. Tests were made with broken cork (used in packing grapes), sawdust, chaff, wood shavings, dead leaves, hay, straw, and newspaper. The value of any kind of insulation is dependent to a great extent on the quality of the hive. If the hive is not rain or damp proof the value of the insulation will be lost, or at least much reduced.

To recount the individual experiments is unnecessary; suffice it to say the best results were obtained from the use of broken cork, which has not the tendency to attract and retain the moisture in so pronounced a manner as the other materials named. In comparison with the first method of external cases the results were poor, though in comparison with unprotected colonies, the results were much better, both in regard to the strength of the bees in the spring and the decreased consumption of food. The behaviour, too, of the colonies was different during the winter, quieter conditions being apparent in the protected hives. Unprotected hives, on the other hand, were more or less active all through the winter, and responded to every change of outside temperature.

Overhead Packing.—Bags or cushions of broken cork, chaff, hay, straw, and leaves were tried, and, here again, colonies with broken cork gave the best results.

Outside Protection.—These experiments clearly showed that the greatest success results from adequate outside protection. There are few hives constructed to-day that will stand through the whole winter without permitting moisture or frost to penetrate the outside walls of the hive. In view of this experience several cheap and simple forms of external covering were tested. Ordinary roofing felt can be placed round the hive in such a way as to afford excellent protection from the weather, and so ensure an absolutely dry hive. Further insulation may be incorporated in the structure by placing dead leaves or straw between the outer walls of the hive and the felt.

The old-fashioned straw skep was copied by wooden hives being wound round with straw rope. This type, however, proved a failure in that, instead of providing insulation, it only encouraged damp. Hives were arranged in rows, close together, and liberally covered with straw. Roofing felt was placed over this and tightly secured with tarred string, small entrances being cut in the felt, and this mode of packing gave excellent results.

In practically every experiment where some form or other of insulation was used an improvement in wintering was noticeable.

Protection of Hive Floors.—The circulation of cold air around the bottom of hives is detrimental, and the packing of the space between the legs is of assistance. In many hives the wood forming the base consists of half inch nailed boards. The boards are certainly close together when the hive is made, but after exposure to weather the timber shrinks, leaving open spaces. In the original design of the wooden hive, the floor boards were constructed of 1½ inch pine. The packing of straw underneath the floor board, in comparison with colonies not treated in this manner, was found a definite improvement in wintering.

Size of Entrance.—Experiments were conducted in relation to the size of the entrance. Beekeepers have been advised to give a full entrance, as it was assumed that the bees need a large amount of fresh air in winter. As a result of comparative tests such teaching was found to be erroneous, the adoption of this plan most probably having been the cause of the loss of many stocks. Under such conditions the bees would have greater difficulty in maintaining temperature, and to allow a cold current of air to be passing constantly into the hive only adds to the work of the bees in maintaining warmth. Experiment tends to show that the bees require only a very small opening as an entrance to the hive. Over sixty colonies have been successfully wintered in the apiary with an entrance equivalent to a *bee* space only. This evidence is strengthened by inspection of the skeps of Dutch bees in the College apiary. The entrance to these skeps is about half way up the skep, and the usual circular hole of about an inch in diameter has been reduced by the bees to an actual bee space by the liberal use of propolis.

Wintering Small Colonies.—Tests have been made in wintering very small colonies of bees with the object of saving valuable queens. Colonies of but two or three frames of bees have been successfully wintered on the lines of the "hay box" used in cooking.

During the summer of 1927 five observation hives with bees on two frames were kept in the lecture room of the Bee-keeping Department, where the temperature ranges from 55° F. to 60° F. day and night. These were transferred to four-frame nucleus boxes in October, each being given two empty combs. They were fed with sugar syrup. To-day (March 15th) each of these tiny colonies is covering four frames, with brood.

There is no doubt that; if bees could be wintered in a building at a uniform temperature of 50° F., the problem of wintering would be solved. The idea that bees winter better during long periods of frost must be abandoned; the lower the outside temperature, the greater the energy needed to maintain warmth and the larger the amount of food required, while in a mild winter activity is not so necessary and less food is consumed.

I desire to place on record my appreciation of the assistance I have received from my two colleagues, Mr. James Struthers and Mr. W. Livingstone, without whose help it would have been impossible to conduct these experiments.

This investigation has been made possible by a grant from the Board of Agriculture for Scotland, and I desire to express my gratitude for their very welcome support.

THE BIOLOGIST on the FARM.—No. XXXI.

Prof. J. Arthur Thomson, M.A., LL.D.

University of Aberdeen.

Thousands of Starlings.—A striking feature this summer in certain parts of Scotland has been the huge flocks of starlings. We have seen flocks that must have included thousands. They swirled about like clouds of black smoke, an extraordinary exhibition of the abundance of life. Although we knew well, having examined many stomachs, that the starling is a farmers' friend, destroying great numbers of leather-jackets, wireworms, caterpillars, and so forth, we could not shut our ears to a warning note in the vociferous chattering of the multitudes. For they might so easily become a plague, driving away other birds, and perhaps turning to a vegetarian diet. But let us hope that the increase will be automatically checked.

What do these enormous flocks mean? When we see a really big one, it may be one of three things. (1) It is often the congregating of huge numbers on their way from the feeding-grounds to the nocturnal roosting place. (2) It may be, towards the end of summer, a flitting from one roosting place to another. This is very common, and is perhaps prompted by hygienic disamenities. (3) In autumn there are often partial migrations from an exposed to a more genial countryside. Here may be included the largest flocks of all, those that come, during this month of October, pouring into Britain from the Continent.

Tent Caterpillars.—A common sight on the Riviera is the large silken canopy spun by the procession caterpillars when they are feeding in companies on the leaves of the aleppo pine. It is a communal tent and is often as big as one's head, looking like an enormous and very substantial spider's web. When the procession caterpillars (*Cnethocampa pityocampa*) are full grown they leave their tent and come down from the trees, on which they have often done much damage. They make their way along the ground, sometimes in single file, sometimes in a broad band, seeking for soft soil into which they burrow. During the hot summer they undergo their metamorphosis, and the moths emerge in autumn. As we have said, the caterpillars often do much harm by defoliating the pines, and it is of interest to notice that they are to some extent checked by the larvæ of a beautiful beetle (*Calosoma*) that force their way into the silken nest and slay right and left, destroying more than they can devour. How would the world get on without these checks.

In the United States there is a common tent caterpillar (*Malacosoma americana*), on which Dr. Frank E. Lutz of the American Museum has recently written an interesting article. The egg-masses are laid in midsummer in broad bands round a twig of the wild cherry and covered with a weather-proof varnish. Then the parents die, and it may be mentioned that they are among those insects that do not eat anything after they get their wings. Yet by some sense, probably smell, the mother-moth selects for her eggs and her offspring the kind of tree on which she fed when she was a caterpillar. It is probable that a particular odour pulls the trigger of the egg-laying instinct.

The eggs develop into caterpillars before the cold weather sets in, but they do not break through the egg-envelopes till the young leaves unfold in spring. For the caterpillars do not hold with the fasting their parents indulged in. They remain together and spin a communal tent of silk. After they have finished with feeding, they separate; each goes its own way and finds a safe nook in which to pupate. This brings us back to the moth.

But what interested us particularly in this devious story was the statement made by Dr. Lutz that the tent caterpillars show a tide-like rise and fall. Every ten or twelve years there is a plague of tent caterpillars; then there comes a check, and for five or six years they are on the downgrade. Then the tide turns again. One cause of the ebb seems to be a microbe that attacks the eggs; and nature keeps the balance so well that it hardly seems worth man's while to interfere.

The Living Earth.—We owe to Pasteur the first vivid realisation of the numbers of bacteria in the soil, and long before that there was some recognition of the "underworld" fauna. Thus Gilbert White (about 1777) recognised very clearly that the number of earthworms was very large, and that the work they have done and do is of far-reaching importance. Gilbert White's picture was repainted by Darwin in his well-known masterpiece. Yet we venture to say that one of the twentieth century gains has been a realisation of the literal accuracy of the phrase "the Living Earth." There is for instance an invisible army of soil-Protozoa that we are only beginning to know; and we are far from having an adequate knowledge of the numerous and diverse insect larvæ that live in the soil. Similarly our knowledge of soil nematodes is only incipient. Some recent researches by Dr. David Robertson show clearly that there are many different species and that the number of individuals is often huge.

Taking the second point first, we notice that, as an average of ten samples, Dr. Robertson found in a cubic inch of soil 65 nematodes from oat stubble, 70 from two-years' pasture land, 105 from one year's grass, 115 from a clayey oat field. Of course that means billions to the acre, for even the 55 per cubic inch of potato land means two billions per acre six inches deep; and the low census of 35 per cubic inch of clayey turnip land means far over a billion per acre. There can be no doubt that the nematode or threadworm population is enormous. It would be interesting to have records from wild soil of various kinds. We know that there are multitudinous individuals of *Tylenchus hordei*, if this species-name still survives, boring into the roots of the sand-binding grass at the exposed shore immediately to the north of Aberdeen. This nematode makes galls on the thread-like roots of the Elymus; and the larvæ can survive, as we have verified, for a couple of years the dryness of a shelf above steam heating pipes. After two years of this drought they moved about soon after the galls, soaked in water, were teased out.

The second point is the diversity of species, for Dr. Robertson found eleven different kinds of *Dorylaimus*, two of *Aphelenchus*, two of *Mononchus*, three of *Rhabditis*, one of *Cephalobus* (the viviparous *C. filiformis*), and two of *Tylenchus*. The disease of "Cauliflower" in strawberry plants is due to *Aphelenchus fragariæ*, and *A. olesistus* does much damage to many plants. "Tulip-root" in oats is due to *Tylenchus dipsaci* and "ear-cockles" in wheat to *T. tritici*. It should be noted that many of the soil nematodes are strictly saprophytic, that is to say, they feed on rotten organic matter. Only a minority are known as parasites in plants. One species may devour another; thus Steiner and Heinly observed that an individual *Mononchus papillatus* devoured 83 larvæ of *Heterodera radicicola* in twelve weeks.

Buffaloes in Canada.—Since 1925 over 6,000 plains buffaloes have been successfully moved from the overcrowded National Park at Wainwright, Alberta, to Wood Buffalo Park, near Fort Smith, North-West Territories. This leaves over 5,000 in the Wainwright herd. Thus the position of the protected buffaloes in Canada is at present very satisfactory, and the success of the transport is very creditable.

The buffalo, or bison, probably came to America from Asia during a warm inter-glacial period in the Pleistocene, and it seems to have been a highly successful colonist. It was the mainstay of the Indians, but their demands had no effect on its multitudes. It was the white man's ruthless greed that brought about the tragedy. We read that in 1875 buffaloes were plentiful; in 1885 they were growing scarce; by 1890 they were practically gone. In 1900 none were left in Canada save a herd of the "woodland type," at home where the Wood Buffalo Park now is. This herd is now represented by about 1,500 animals, and to these over 6,000 plains buffaloes have been added.

In 1907 the Dominion bought a pure-bred herd of 709 plains buffaloes from Montana, U.S.A., and these were transported to a fenced reserve at Wainwright, about 15 miles long and 13 wide. In twenty years the 709 had increased to 15,000, and this number has been deliberately reduced, as we have mentioned, to about 5,000. There seems good reason to hope that the buffalo may be profitably reinstated in unsettled lands, in Canadian North.

In 1871 Colonel Dodge drove for 25 miles along the Arkansas River, through an unbroken herd of buffaloes, estimated at nearly half a million head. In those days they often stopped or derailed railway trains. In 1914 Dr. Hornaday estimated the number of buffaloes in the United States at about 300, nearly half of which were in the Yellowstone Park. Since that date, thanks largely to Dr. Hornaday himself, there has been marked improvement and there are probably over 2,000.

There is some discrepancy of opinion in regard to the cross-breeding of buffaloes and domestic cattle. Dr. Hornaday says (1914): "It is now quite time that all such experiments should cease. It has been proven conclusively that it is impossible to introduce and maintain a tangible strain of buffalo blood into the mass of western range cattle. This is admitted with great regret, but, inasmuch as it is absolutely true, the existing herds of buffaloes should not be further vitiated and degraded by the presence in them of animals of impure blood." It is not evident, however, why the introduction of buffalo blood into domestic cattle should affect the buffalo herd. E. W. Nelson writes (1918): "Experiments have been made in crossing buffalo with certain breeds of domestic cattle for the purpose of establishing a new and hardier variety of stock for the Western ranges. These have not proved successful, largely owing to the lack of fertility in the hybrid, which has been called the cattalo. But a recent report from Wainwright gives a different impression, for it is said that crossing experiments have resulted in a new breed containing a four percentage of buffalo blood, a hardier type than ordinary domestic cattle.

The word buffalo should in strictness be kept for wild cattle with no hump, like the African buffaloes. The American buffalo is a bison (*Bison americanus* or *bison*) with a big shoulder hump, like its first cousin the European bison (*Bison europæus* or *bonasus*). This magnificent animal suffered so much during the war and its aftermath that its numbers two years ago were reduced to under a hundred. Yet the successful reinstating of the American species leads one to hope that it may not be too late to save its European congener. But perhaps the remnant has already disappeared.

Sex-Chromosomes in Fowls.—The chromosomes or nuclear rods of the germ-cells are known to be the carriers of many if not all of the hereditary characters of an organism. One of them is often different from the rest and seems to carry the material that determines sex. Thus for some animals it seems to be certain that if an egg-cell with a sex-chromosome is fertilised by a sperm-cell with a sex-chromosome, the result is a female; whereas if an egg-cell with a sex-chromosome be fertilised by a sperm-cell without a sex-chromosome, the result is a male. Perhaps it is the *amount* of the chromatin material that is decisive, giving the developing egg a bias to maleness or to femaleness. But perhaps it is something qualitative rather than quantitative. In some animals the mature egg-cells have a sex-chromosome called the X-chromosome, while the mature sperm-cells are of two kinds, half of them carry an X-chromosome and half of them carry a smaller Y-chromosome. If an egg-cell be fertilised by an X-containing sperm-cell the result will be a female; if it be fertilised by a Y-containing chromosome the result will be a male. A theoretical way of interpreting this is to say that in the presence of two X-elements female characters are activated or liberated, while in the presence of a single X-element or of a Y-element the male characters are activated or liberated.

Let us take a concrete case, that of the domestic fowl, investigated a couple of years ago by R. T. Hance. Two kinds of ripe egg-cells seem to occur, one type with, and the other type without, a particularly long chromosome. But all the sperm-cells are alike in possessing the long chromosome. The presence of two long chromosomes in the fertilised egg-cell leads in this case to a male; the presence of only one leads to a female. In technical Mendelian terms, the hen is heterozygous as regards the long chromosome, for she produces eggs, half with and half without it. But the cock is homozygous as regards the long chromosome, for he produces sperms which all carry it. This conforms with what is known by experiment, that the female bird carries masculine features latent. Thus a duck from which the ovary has been removed will put on drake's plumage at the next moult; and a hen that loses its ovary by disease may begin to crow like a cock and go much further, as has been shown by Professor Crew and others.

Thyroids of Pigeons.—The thyroids are ductless glands which make the hormone thyroxin, essential to the continuance of health. They seem to maintain in the blood a certain amount of an iodine compound, originally provided by the sea and its seaweeds. Thus the evolution of the thyroid gland, as a little pouch from the ventral wall of the pharynx, may have made terrestrial life a possibility for backboned animals. The thyroid acts as a sort of accelerator and brake combined; its hormone controls the rate of energy transformations in the body. It also exerts an influence on the nervous system and the mind. A diet containing thyroid gland makes tadpoles change into frogs while they are still very young and very small; but the precocious differentiation is not in the long run a success.

The thyroid varies in size and activity from individual to individual, and everyone knows that marked thyroid deficiency spells disaster. Looking backwards, we suggest that moderate variations in thyroid activity may have served to bring about new departures in evolution, and we would recall that there seems to have been a very frequent forking or parting of the ways between more energetic (relatively more katabolic) and more easy-going (relatively more anabolic) types. Think of the contrast between herring and globe-fish, frog and toad, lizard and tortoise, bird and reptile. Now in this connection it seems to us of much interest that Professor Oscar Riddle has succeeded in establishing races of doves characterised by large and by small thyroids.

Riddle also finds that the thyroids of various kinds of pigeons show a functional enlargement during the autumn and winter months (when perhaps an accelerator is more needed), and a graduated decrease during spring and summer (when there may be more need of a brake). But this waxing and waning of the thyroid has its converse in the gonads or reproductive organs in various kinds of pigeons and doves, for they enlarge during the spring and summer and decrease during autumn and winter. More attention should be given to the seasonal waxing and waning of organs. In some birds, e.g. rooks, we have noticed an extraordinary dwindling of the gonads after the breeding season.

Inheritance of Melanism.—Albinism, as in white mice and white blackbirds, means that the hereditary factor for pigmentation has dropped out of the inheritance. If an albino is crossed with the normal, the offspring are all apparently normal. But if these are inbred they yield 25 per cent. of pure albinos. In other words, albinism behaves as a Mendelian recessive.

The opposite of albinism is melanism, where there is an unusual development of black pigment. It occurs occasionally among birds, as in sugar-birds, and it is not uncommon among moths. It usually behaves as a Mendelian dominant, and melanic races are sometimes established in Wild Nature.

Professor Heslop Harrison, continuing some important experiments, has shown for a Lepidopterous insect, *Selenia bilunaria*, that melanic variations can be produced by administering food containing manganese chloride. Of course the experiment was made with a strain proved by controls to be free from heritable melanism. In this case the melanism behaved as a Mendelian recessive.

This interesting experiment does not seem to bear directly on the Lamarckian problem whether acquired modifications are in any representative degree transmissible. It is nearer the experiments of Professor W. L. Tower, who showed for potato beetles that environmental changes, e.g. of pressure and temperature, which had no effect on the body of adults, brought about, at particular times, marked variations in the germ cells and the subsequently produced offspring, some of these variations breeding true. In other words the environmental change saturating through the body induced a change in the germ-plasm, a germinal variation. In Professor Harrison's case a heritable variation was induced by means of the food supplied, and the probability is that the agent in inducing the variation in the germ-plasm was the metal manganese.

Ants and Aphids.—It has long been known that "honey-dew," the sugary overflow of the aphids or green-flies which feed on plant juices, is a food greatly prized by many insects, and by ants in particular. Many ants have learnt how to stroke the aphids so that a drop of the syrupy fluid exudes. Some ants do this only when an opportunity occurs, but others have come to depend on this "honey-dew" as one of their principal sources of food. Such ants, as we may read for example in Forel's great book, tend the aphids as carefully as man tends his domestic animals: they keep them, in the cold weather, in their own nests; they guard them; they help in the rearing of each brood.

A case of this sort has recently been examined by Eidmann. He describes how, when the buds open in spring, the guardian ants lead the aphids from the nest and on to suitable trees or bushes. There the ants, of which there is one for each individual aphis, or at least for each small group, mount guard over their "cows," as Linnæus called them, keeping all strangers at a distance. From time to time the ant "milks" the aphis and collects the fluid, either to bring it to the nest or to pass it on to another ant for this purpose. If the night turns cold the ant shepherds the aphis back to the nest; but later in the summer, in warmer weather, the ants retire alone, leaving their aphids on the plants all night. In the morning the ants return and mount guard once more, and Eidmann was able to show that it was always the same ant that returned to one aphis kept under observation. If the ant was taken away another soon took its place.

As the summer grows in strength, and the prolific aphids become more numerous, the traffic between the ants' nest and the plants, the "pastures," becomes greater. Underground tunnels are constructed, or at least covered run-ways, extending even up the trunks of the trees. These protected routes are only used during the day; at night, although the traffic is greater, they are not needed and are deserted.

Eidmann took a census of an average-sized nest of the black ant he studied, *Lasius niger*. He found in it nearly 3,500 adult worker ants, and three times that number of larvæ and pupæ, most of them destined to become workers also. He estimates that in the course of a summer such a colony would consume about a quart of "honey-dew." The aphids thrive so well in the care of the ants that the association may be very harmful to the plants on whose juices the aphids feed.

The Earthworm's Colour.—Things are seldom so simple as they seem, and this may be illustrated in reference to the familiar redness of earthworms. What makes an earthworm red? Is it always blushing? Or is the skin so thin that the red blood shines through? And is there any use in its being red? It seems to have been securely established that the earthworm has in its blood the same red pigment, hæmoglobin, as we and all backboned animals have. But the red blood-pigment in the earthworm is in the fluid of the blood, whereas in backboned animals it is in the red blood corpuscles. This is an unimportant difference, however; for the earthworm and for man the physiological significance of the hæmoglobin is the same, it captures oxygen from the outer world—on the earthworm's skin, on the lining of our lungs—and surrenders it again to the tissues, where it is required to sustain the vital combustion that living implies.

But the redness of the earthworm's skin is not directly due to hæmoglobin; it is due to another pigment called porphyrin. And this requires just a word of explanation. Hæmoglobin is a combination of an iron-containing brownish pigment called *hæmatin* and a white-of-egg-like or protein substance called *globin*. But if the hæmatin in the blood be treated with strong sulphuric acid, the iron is filched away to make ferrous sulphate, and a pigment called hæmatoporphyrin is left. This pigment is also formed in the course of the everyday chemical routine of many animals, and it is not very unfamiliar, because there are traces of it in normal urine, and quantities of it in some kinds of abnormal urine. Well, to come to the point, the pigment in an earthworm's skin is a porphyrin, but Kobayashi has recently shown that it is different from hæmatoporphyrin. The fact is that it is nearer to a porphyrin which can be derived from chlorophyll, the green pigment of plants. It is possible, then, that the redness of the earthworm's skin comes, not from the hæmoglobin of the blood, but from the chlorophyll in the vegetable remains on which the earthworm feeds. A porphyrin of this origin may be absorbed from the earthworm's food-canal by the blood, and then deposited in the skin. This may seem much ado about nothing, but it is a fresh illustration of the danger of thinking of things too simply. As to the use of the porphyrin in the earthworm race, it probably protects the earthworm from the injurious effects of light, to which it is extraordinarily susceptible. This leads our thoughts to the origin of the earthworms' subterranean and nocturnal habits.

Sense of Light without Eyes.—Earthworms have no eyes, yet they are very sensitive to differences of light and shade. Various blind or blinded insects, both adult and larval, are known to react to light. Some investigators have spoken of a

" dermatoptic sense," meaning that the general surface of the insect's body is sensitive to light. In this connection some striking experiments on entirely blinded minnows have been made by Scharrer, proving reactivity to light after the complete removal of both eyes. They put on dark colour when illumined; they assumed a light colour in darkness. In an aquarium constantly but faintly lighted, a stronger light was turned on shortly before and during each meal, and the blind minnows established a conditioned reflex in a few days, and when the light was turned on would snap and jump about in search of the food even when there was none. This reactivity was found to have its seat in a region of the head corresponding to the optic thalami of the brain,—the region from which the paired eyes grow out. This region also gives origin to the parietal organ, which has an eye-like structure in some reptiles, notably in the New Zealand lizard or Sphenodon. The parietal organ is in a very primitive state in bony fishes, and its extirpation does not affect the blinded minnow's reactions to light. It is the whole region of the optic thalami that is important as a seat of sensitiveness to light, and a remarkable feature is that it responds to very slight illumination.

The Intricacy of Life.—The old-fashioned Natural History, which needs no apology when we think of masters like Réaumur and Gilbert White, is being replaced by the modern sub-science of Ecology, which expresses the same ambition to understand living creatures in the plural and in relation to their surroundings, both animate and inanimate. It is what Semper called " the higher physiology," the study of life as it is lived in Nature, where the circle of each individual's interests is intersected by many other circles—such as kindred, members of the same species, neighbours, competitors, deadly enemies, parasites, symbions, and so forth. To Pearse and to Elton we owe two good English-written books on " Animal Ecology," and everyone knows Tansley's " Plant Ecology."

One of the main tasks of ecology is to decipher the patterns in the web of life, and as the inquiry is being pursued with precision and penetration it is becoming plain that the intertwining of the vital threads is even more intricate than was supposed by the old-fashioned Natural History with all its scrutinising insight. Darwin was a modern ecologist in his appreciation of the work of earthworms, so much deeper and more convincing than Gilbert White's anticipations.

For centuries there has been admiration of the parental care exhibited by many insects, but who ever suspected the extraordinary nutritive exchange or " trophallaxis " between some mother-wasps or worker-wasps and the grubs in their cells? In many cases the mothers or the step-mothers feed the grubs with the chewed flesh of insects, the jaw-apparatus of the larvæ being very poorly developed. But when the meal is supplied, and sometimes in defect of it, the larva exudes from its mouth a drop of sweet elixir, which is greedily licked off. In some instances the drones have learned the trick, but they give nothing in exchange. This kind of intricacy is being increasingly revealed. It is not that Nature is more of a tangle than we thought, it is rather that the pattern of her fabric is more intricate than it seemed at first.

For a long time naturalists have been familiar with the dry-as-dust meals of the wood-eating termites or white ants, and some have expressed themselves puzzled by the way these insects thrive on such physiologically unpromising material. But who suspected that the termites can make nothing of their food unless there is in their alimentary system a vigorous culture of beautiful Infusorians, found nowhere else, which do something to the food which makes it available and profitable to the termites. And strange facts emerge when we inquire how the soldiers thrive, whose jaws are so big that they are not suitable for chewing wood. But we forbear.

The diagram that ecology has imprinted on our intelligence is that of a circle intersecting and being intersected by many other circles. Thus the hollow petioles of a South American tree called Tachygalia afford shelter to small beetles, which have established an alimentary partnership with minute mealy bugs. The two insects live together, and the mealy bugs, which feed on the tissue inside the petiole, yield a supply of honey-dew when the beetles massage them, as they do somewhat forcibly. Tree, beetle, bug—a triple alliance; and when certain aggressive ants appear on the scene, there is another intersecting of vital circles! Such is the intricacy of life.

INSECT PESTS.—No. III.

R. Stewart MacDougall, M.A., D.Sc.

Insects injurious to Farm Animals (*continued*).

The two orders of lice, the sucking lice (*Anoplura*) and the biting lice (*Mallophaga*) remain for notice among the insects.

The Sucking Lice (*Anoplura*).—These are wingless parasites found on mammals of various orders, e.g. on rats and mice and voles, on hare, rabbit, squirrel, shrew, deer, goat. Each of our domesticated animals, except the cat, has its specific sucking louse. Marine mammals like the seal and the walrus have their own species of sucking louse, while specific to human beings are the head louse, the clothes or body louse, and the crab louse. The sucking lice have mouth-parts fitted for piercing skin and drawing up blood; the piercing parts are under cover of a sheath.

When not in use the piercing and sucking parts are withdrawn into the head. In the act of feeding while the blood is passing back, saliva from the salivary glands is being passed forwards.

The rapidity with which such lice multiply in conditions that favour them and the irritation and restlessness associated with their presence received full illustration in the Great War. Apart from irritation due to the movement and to the wounding mouth-parts of lice, one recalls what a nightmare Trench Fever proved for a time, and how one of the triumphs of science in the war was the proof that Trench Fever was a louse-borne disease. The parasite—the cause of Trench Fever—undergoes a short life cycle in the body of the louse, and by the eighth or ninth day the louse becomes infective. Should the excreta of such a louse gain entry by a wound to the body of a man, symptoms of Trench Fever appear. This powdery excrement of the infected louse containing the virus of the disease gains entry to the system of the new patient through the sores or skin wounds that result from the repeated scratching that is associated with the presence of the lice. The fact that louse

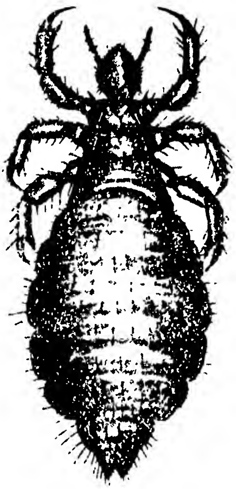

FIG. 1.—The Body Louse.
A female drawn from a specimen. Greatly magnified.

excrement was the chief source of supply of the virus of Trench Fever proved of practical importance, because in disinfestation a higher temperature is necessary to destroy the virus of the disease in the excrement than to kill the lice. The experimental work of Nuttall, Bacot, Hyam, Lloyd, Peacock and others proved that body lice and their eggs are destroyed if exposed for 20 minutes to a temperature of 130° F. (55° C.), and that the virus in the excrement of the louse is destroyed by moist heat (steam) at 140° F. (60° C.) if kept up for 20 minutes. Lice and egg-infested clothing should be steeped for an hour in a solution of lysol at a temperature of 104° F. (40° C.). The strength of the solution should be at the rate of a tablespoonful of lysol for 2½ pints of water. *One should handle lysol carefully.* In dealing with lice there should be no carelessness.

This same parasite is also the carrier from fever-stricken to healthy men of the virus of typhus, a fever characteristic of crowded, dirty, insanitary quarters and areas. The body louse also spreads some forms of relapsing fever.

In the life-history of the *Anoplura* the metamorphosis is incomplete,—there is no resting pupal stage. The eggs on hatching give forth a minute louse resembling in general appearance and in food habits the parent, but immature. In the course of development from this to the adult male or female condition three moults take place. The number of eggs laid, the length of the adult life, the length of a life-cycle, depend partly on the species and a great deal on the environment. Warburton, experimenting with the body louse of the trenches, found that a female, kept at a temperature of the body and allowed to suck blood twice a day, laid 125 eggs in 25 days and then died. Some of these eggs hatched in eight days and others took more than a month. The young reached the adult stage in 11 or 12 days. In experiment the eggs of the sucking louse of the pig hatched in from under three weeks to over three weeks; eggs of the sucking louse of the horse hatched in 15 to 16 days, cold lengthening out the incubation period. This variability in time of hatching and in time of attaining the adult condition according to the environment has relation to the number of dressings that may be necessary in remedial measures, as eggs may resist dressings that kill the lice themselves.

The following is a list of the sucking lice of man and our domesticated animals :—

Name.[1]	*Host.*
Pediculus capitis	Man.
Pediculus vestimenti	,,
Phthirius pubis	,,
Hæmatopinus suis or *urius* ...	Pig.
Hæmatopinus asini	Horse and ass.
Hæmatopinus eurysternus ...	Cattle.
Linognathus vituli	,,
Linognathus ovillus	Sheep.
Linognathus piliferus	Dog.
Linognathus stenopsis	Goat.

One is sometimes asked how these different lice can be distinguished. For the practical man the distinction of species here does not matter much, as in nearly all cases the sucking louse is specific for the special host animal, but the keen worker, with the aid of a microscope, would be able to separate these sucking lice by this key :—

I. Eyes large and pigmented. Antennæ 5-jointed.

A. All six legs equally strong; abdomen elongated.

Pediculus capitis. The Head Louse.

[1] In all but the recent books the first or generic name given for all the sucking lice of our domesticated animals is *Hæmatopinus* (the word means blood drinker). Neumann used the name *Hæmatopinus*. As a result of more intensive study Enderlein on the Continent and Ferris in the United States have split the genus *Hæmatopinus* up. See "A Catalogue and Host List of the *Anoplura*," by G. F. Ferris. Proceedings California Academy of Sciences, vol. vi, May 1916.

Pediculus vestimenti. The Body or Clothes Louse.

B. Front pair of legs much weaker than the other two pairs. Abdomen not elongated, but the body nearly as wide as long.

Phthirius pubis. The Crab Louse.

II. Eyes inconspicuous or absent. Antennæ with 5 joints.

A. All the six legs of same strength; a triangular pad or skeletal structure between the pincer-like claws of the legs; one transverse row of short hairs on the upper surface of each joint of the abdomen.

1. Head elongated and narrow; longer than thorax.

Hæmatopinus suis up to one-fifth inch long.
Hæmatopinus asini, smaller, one-seventh inch.

2. Head nearly as broad as long and about the same length as the thorax; abdomen scarcely as long as broad.

Hæmatopinus eurysternus. The Short Nosed Ox Louse.

B. Front pair of legs smaller than the middle and hind pairs; no triangular pad; edges of abdomen smooth; more than one transverse row of hairs on back of each joint of abdomen.

1. Head elongated and narrow, longer than thorax.

Linognathus vituli, the Long Nosed Ox Louse, about one-eighth inch long, with elongated narrow abdomen and the head behind fitting into the thorax in notch-like fashion.

[1] *Linognathus ovillus*, one-twelfth to one-tenth inch long.

Linognathus stenopsis, one-twelfth inch long; the narrow head is rounded in front.

2. Head short and broad, about the length of thorax.

Linognathus piliferus. The thorax in front is very little wider than the head.

In all species the male is rather less in size than the female.

The sucking louse of the pig is the largest of the species that infest our domesticated animals; it may be taken as the type to illustrate something of the structure of a sucking louse.

The pig louse—grey or yellow-grey in colour with brown-red thorax—is readily visible to the naked eye, the male measuring one-sixth inch long and the female one-fifth inch; the

[1] *L. ovillus* was taken for the first time in Britain in 1906 by Evans, from a black-faced sheep on the Pentland Hills. Other records are desired. The lice might be found by brushing the face of the sheep into a receptacle and examining the contents.

two sexes are easily distinguished by aid of a hand lens, the male having the hind end of the abdomen rounded while the larger abdomen of the female ends in a triangular or V-shaped notch. The head is long and narrow with almost parallel sides and has the mouth opening at its tip; on each side the head carries a five-jointed antenna. The thorax is distinctly wider than the head, a fact worthy of note, for apart from differences in the mouth-parts a sucking louse can always be told from a biting louse by the thorax being *broader* or *wider* than the head; the head in a biting louse is as broad or broader than the part of the thorax next it.

The thorax carries six strong legs; each leg ends in a curved pointed claw; on the opposite side from the claw the part of the leg before the foot (the tibia) is prolonged into a strong thumb-like projection. Under the microscope there can be seen

FIG. 2.—*Hæmatopinus suis.*
From nature. Magnified.

between the " thumb " and the claw a triangular spiny pad,[1] a helpful adaptation for keeping a good grip of the pig's bristles; the bristle is pulled against the triangular pad by the claw and held there by the thumb (in some sucking lice the pad is absent). The abdomen consists of nine joints; it is flat and elongated. Joints 3 to 8 have at their sides brown-black horny protuberances, and these give the sides a wavy notched appearance.

This louse of the pig does not live on any other domesticated animal, due partly to this, that sucking lice have mouth-parts adapted to skins of various degrees of thickness, and their claws are adapted to the thinner or coarser hair of different animals. The eggs, known as " nits," measure in length one-twentieth to one-eighteenth inch; they are white or yellow-white in colour and are slightly thinner at the lower fixed end; at the free end is a little cap, pushed off when the young louse hatches. The eggs are fixed at the base of the hair by a cement, and the

[1] This skeletal structure is known technically as the "pretarsal sclerite."

number, one or more on a hair, depends on whether the pig harbours only a few lice or whether it is badly infested. The eggs are laid chiefly on the sides at the lower part of the body and above the shanks. "The majority of the eggs are found on well-defined areas which form a broad band running chiefly around the lower parts of the body, including the sides of the neck, the lines of meeting hairs between the neck and the joint, the breast, forelegs and fore flanks, the lines of meeting hairs between the sides and the belly, the rear flanks and hocks. They are found only in limited numbers on the upper parts of the body and rarely, if ever, on the shanks or tail." [1]

When the eggs have hatched the empty eggshells may remain attached to the bristles for a considerable time. One observes them sometimes on brushes made from pigs' bristles, just as, for example, one may see on muffs made from one of the expensive furs of the day numbers of the empty egg-shells of the louse that affects the animal whose fur is so sought after. Sometimes imitations are passed off as the real thing, and a trade way of detecting the imitation fur is by the absence from it of the egg-shells. Incidentally it may be noted that for removal of eggs from the hairs of domesticated animals suffering from lice thorough grooming is necessary. A painter's flare in a steady hand is sometimes used.

In a fortnight from the time of hatching from the egg, the pig louse, in favouring conditions, is full grown. Pairing takes place and the female fixes her eggs to the base of bristles. The eggs hatch in from less than three weeks to over three weeks. The young lice resemble the parent in appearance and food habit; they feed at once on hatching, grow, and after three moults reach the adult stage. The length of the life-cycle of this species varies with the environment. Watts, working in Tennessee, found it to be normally 29 to 40 days, but with variations from 24 to 63 days. The louse of the pig cannot live away from the host more than a few days.

The general details of this life-cycle apply also to the other sucking lice. In the case of the sucking louse of the horse the pests are found in the long hair of the leg and the dorsal aspect of the body, especially about the shoulders, flanks, and root of mane and tail. Sometimes it is present in great numbers in the lower part of the limbs—chiefly in the heavy type of horse, in which the coarse hair provides shelter—especially the hind limbs, and in consequence there may be much stamping and difficulty in shoeing owing to the itchiness. *L. piliferus* (piliferus means bearer of hair) of the dog has a very hairy abdomen; it is found especially about the shoulders, the loins, under the neck, and the base of the ears. *H. eurysternus* on older cattle and *L. vituli*, sometimes in numbers on calves, can both be troublesome.

Effect of Sucking Lice on the Host.—When present in numbers a harsh dry coat results. There is loss of blood due to

[1] The Hog Louse, Bull. No. 20, Agriculture Experiment Station of the University of Tennessee, 1918, by H. R. Watts.

the feeding of the lice. The affected animal is restless, bites itself, and rubs itself against any convenient object, and so irritates the skin. Bleeding and sores follow. The animal becomes listless and disheartened and unthrifty, and there is interference with growth.

General Methods of Treatment for Lice.—Thorough cleanliness and proper grooming are the best preventives. Against the louse of the pig Watts found that any oil killed both lice and eggs. Crude petroleum proved one of the best materials. Kerosene mixed with an equal part of cotton-seed oil was equally good. Against the horse louse one of my colleagues has found the following successful :—

> Arsenious acid 1 oz., soft soap 2 oz., carbonate of soda 1½ oz., water 2 pints.

Dissolve by boiling, dilute to 5 gallons with water, and apply after clipping body and limbs. In thin-skinned horses this sometimes caused slight irritation of skin but never anything of moment. The dressing is both cheap and efficient. There should be at least two dressings at intervals of six to ten days. *If this dressing be chosen there must be caution against the use of drinking buckets for holding the preparation.*

Another useful dressing is a 2 per cent. solution of creolin. Stronger solutions are unnecessary and irritant. In the case of dogs it is safer that the creolin bath should not be stronger than 1 to 2 per cent.; a strength exceeding 2 per cent. is dangerous. (This applies also to cats, but the cat has no sucking louse, although it has a biting species. Such lice, however, are uncommon in the cat, it is the flea which is most troublesome.) Principal Hobday [1] in a series of experiments on the toxicological effect of creolin on dog and cat showed that creolin is a narcotic and irritant poison to dog and cat, and that its use in these animals must be watched with the greatest care. It is especially toxic when spread in emulsions of a certain strength over a large area of the body. The toxic doses are not just easy to determine on account of the variation in weight and also because of differences in delicate and coarser breeds. Creolin is Jeyes' Fluid of a quality sold for dispensing purposes. For pet dogs creolin is sometimes objected to because of the odour as well as the risk of poisoning by skin absorption. Save for very delicate lap dogs the strength suggested above is safe. Fresh pyrethrum powder sprinkled over the skin is suitable for such small animals. Sometimes a mercurial soap is used in the case of the dog, but with this as with all poisonous dressings, care must be taken to prevent the dog from biting or licking itself. Vinegar diluted with double the quantity of water is serviceable against the eggs.

As regards cattle the ordinary dips destroy lice, but in a special report on the Diseases of Cattle, issued in 1916 by the United States Department of Agriculture, it is stated that

[1] M'Fadyean's *Journal of Comparative Pathology*, vol. ix, March 1896.

"though lime-sulphur is an excellent mange remedy it is less satisfactory for lice, especially the sucking lice of cattle." As regards dairy cattle, while the arsenical preparation and creolin are effective, their poisonous properties like smell of creolin have to be considered in relation to milk.

A very excellent dressing is Derris powder. In some experiments with this against Hæmatopinus on the horse I had very good results.

One should keep in mind the general principle of destruction of clippings and combings; the destruction of bedding; the disinfection of stalls, stable utensils, kennels, &c., say with 4 per cent creolin followed where practicable by lime washing. A solution of creolin is not hurtful to leather.

Biting Lice (*Mallophaga*—the word means eater of wool).—These are small wingless insects with a large head and with the body flattened; the wall of the body is chitinous and firm. The head, which varies in shape, bears two short 3 to 5-jointed antennæ, simple eyes on each side of the head behind the antennæ, and the mouth-parts. The mouth-parts are mandibulate, being adapted not for piercing and sucking but for biting, the food consisting of pieces of hair, epidermal scales, debris on the skin, and, in the species infesting birds, pieces of feather bitten off by the mandibles. When the numbers are large the skin is wounded to the drawing of blood, while badly infested hosts rub and bite themselves. Itching and irritation result, partly from the movement of the parasites and partly by their feeding. The thorax has the usual three segments; of these the prothorax is always distinct; the mesothorax and the metathorax may also be distinct, but in some species they may be so joined as to appear a part of the abdomen. The six legs are strong and flattened and are fitted for clinging and running; in some species, e.g. those found on mammals, the leg ends in a single claw; in species found on birds there are two claws. The abdomen has 8 to 10 joints. The life-history resembles that of the sucking lice. The eggs are glued singly to hair or feather; the young on hatching resemble the parent in external form and way of feeding; they grow and moult, attaining maturity without any pupal or resting stage. The *Mallophaga* keep closely to their hosts, from which they derive shelter, warmth and food, and do not survive, away from their host, more than a few days. A large number of species are parasitic on birds hence the *Mallophaga* are often known as the Bird Lice. The genus *Trichodectes* (the word means biter of hair) is found on mammals.

The species on our domesticated animals are :—

Trichodectes latus on the dog.
Trichodectes pilosus on the horse and ass.
Trichodectes scalaris on cattle.
Trichodectes sphærocephalus on sheep.
Trichodectes subrostratus on the cat.
Trichodectes climax on the goat.

All *Trichodectes* species have 3-jointed slender but quite visible antennæ, a tarsus (foot) ending in one claw, and mouth-parts without palps.

The *Trichodectes* of the horse measures about one-sixteenth inch; the head is square and broader than the part of the thorax that immediately follows it (an easy general difference between the biters and the suckers); the abdomen is yellowish (paler in the young) with the edges darker. This parasite is much less common than the *Hæmatopinus* of the horse but occasionally specimens reach me for determination.

T. latus of the dog, another minute form, is yellow in colour and, as its name implies, broad for its length, being more than half as broad as long; it may act as the intermediate host of the dog tapeworm, *Dipylidicum caninum*, a tapeworm also found some-

Fig. 3.—*Trichodectes latus.*

Fig. 4.—*Trichodectes scalaris.*

From nature. Forty times natural size.

times in the intestines of children. The cat species is recognisable by its pointed head; it also may act as the intermediate host of the dog tapeworm. *T. scalaris* found on both old and young cattle measures one-twentieth inch; the head and thorax are shining red-brown and the abdomen tawny; the head is heart-shaped and shows dark spots in front; the joints of the abdomen have on their upper surface dark transverse bands. The *Trichodect* of the sheep has a blunt, rounded head (sphærocephalous means round headed); the species is pale coloured. All these parasites require the microscope for any real examination, but the fact that each keeps to its own host is helpful in the naming.

Generally it may be said that in the open and in a state of nature the *Trichodects* are not troublesome, but when, because of conditions that favour their increase, they become numerous on an animal they cause irritation and restlessness. The measures suggested for the *Anoplura* will also serve here.

It is on birds, and especially poultry, that *Mallophaga* will be found most troublesome, ducks and geese, and hens and chickens. On wild birds of many kinds different *Mallophaga* are found. The distinction of the various species is a specialist study, and it would serve no useful purpose to detail differences here. Sufficient to say that our bird-infesting forms are arranged in two series, one in which the antennæ are 5-jointed and the leg ends in two claws, e.g. *Lipeurus*, and the other, in which comes the common and troublesome Menopon of the fowl, with 4-jointed antennæ and two claws; the antennæ are club-like or rounded at the tip and are hidden in hollows on the under side of the head; 4-jointed palps are a feature of the mouth-parts. Again all these details need a high power of the microscope.

As an example of a poultry species we may take the wing louse of the hen (*Lipeurus variabilis*). This species, found commonly on the large wing-feathers of chickens, measures one-twentyfifth inch in length. It is not difficult to recognise owing to its elongated narrow body with almost parallel sides; it is dirty-white or grey in colour with paler head; antennæ long and yellow; abdomen with a dark margin and with interrupted dark-coloured bands.

The female, after pairing, lays her eggs between the small barbs of the primary and secondary feathers. From these hatch young resembling in external appearance the parent; the adult stage is reached after feeding and moulting. An individual life-cycle takes on an average about three weeks. Bishopp and Wood[1] after experimenting with and testing a number of materials used in destruction of poultry lice recommended as effective sodium fluorid—powdered commercial 90 to 98 per cent. sodium fluorid—applied as a dusting powder or as a dip. They recommend the following method :—Place the sodium fluorid in an open vessel, and hold the fowl by the legs in one hand, and with the other place a small pinch of the chemical among the feathers next the skin, thus :—one pinch on the head, one on the neck, two on the back, one on the breast, one below the anus, one on the tail, one on either thigh, and one scattered on the underside of each wing. Each pinch can be distributed somewhat by pushing the thumb and fingers among the feathers as the material is released. One pound of the fluorid will dust 100 fowls.

In using sodium fluorid on animals certain precautions are necessary :—

1. There may be slight irritation of the air passages of the bird, but this soon passes off.
2. Do not allow the material to get into the fowls' food or drinking water, *as sodium fluorid is a poison taken internally*.
3. The worker must not have wounds on his hands.

[1] **Mites and Lice on Poultry, by F. C. Bishopp and H. P. Wood. Farmers' Bulletin, No. 301, United States Department of Agriculture.**

4. As tender parts of the worker's skin may be burned if the material remains in contact with the skin for some hours, fowls should not be held between the legs but should be dusted on a table.

5. The operator should wear a dust-guard over the nose or a piece of wet cloth over nose and mouth.

6. Sodium fluorid solution injures galvanised containers.

Naphthalene is a not uncommon ingredient in lice powders, but if the powder—used with some carrier—contains under 5 per cent. of naphthalene it is of no service. A too strong percentage of naphthalene can be very hurtful to the hens if it be rubbed into the skin. A dusting with 10 per cent. of naphthalene is effective. The sprinkling over the fowls at roosting time is favourable, but the birds must not be so disturbed as to make them shake off the powder.

The vapour of naphthalene is heavier than air, and Abbott[1] experimentally has proved that sitting hens and the eggs and possibly any hatched chickens are injured by naphthalene eggs used in the nest.

Generally in relation to all bird lice one should remember the value of dust baths. Roosting and breeding places must be kept clean.

ARACHNIDS TROUBLESOME TO STOCK.

Agreeing with insects in being jointed-footed invertebrates and often confused with insects we have a class of mammals known as *Arachnids* (the word means spinners, e.g. *Arachne* the spider). These differ from true insects in the body not showing the three clearly marked divisions—head, thorax, abdomen, in the absence of true antennæ, and the possession of eight legs, when adult, instead of six. There is no complete metamorphosis, and no *Arachnid* has wings. Examples are the spiders, scorpions and mites. It is with the last of these—the mites—that we are concerned here.

Mites or Acarina.—This is a great section of *Arachnids* numerous in family and rich in species. They are mostly very tiny forms, consisting of head with mouth-parts, and body. Most are rounded or oval, some are elongated. The head with its mouth-parts often presents a sort of beak with the parts adapted for piercing and rasping and grasping. The food habit is very varied; some live on decaying matter, some on the juices of living plants; others are enemies of stored products, and others again are parasitic on animals. It is with the last that we are concerned here and briefly with the following families :—

The Mange Mites or *Sarcoptidæ*.
The Hair Follicle Mites or *Demodecidæ*.
The Ticks or *Ixodidæ*.
The Harvest Mites or *Trombidiidæ*.
The Fowl Mites or *Gamasidæ*.

[1] Naphthalene for Chicken Lice, by W. S. Abbott. *Journal of Economic Entomology*, vol. 12, 1919.

Sarcoptidæ, The Mange, Itch or Scab Mites.—These are microscopic forms, rounded or somewhat oval in shape, with a beak in which the mouth-parts are scissor-like or pincer-like. The external covering shows, under the microscope, fine lines and wrinkles and sometimes little spines or thorns. The legs are short and stumpy, arranged two pairs more forward and two pairs rather further back; the legs may end in a small stalked sucker, or some in a long hair only. Eyes are absent, and there are no definite breathing organs, respiration being entirely through the skin. In the family *Sarcoptidæ* (the word means flesh piercer) are some of the farmer's worst enemies.

The three manges of stock (some animals may have all three kinds) are the Sarcoptic, the Psoroptic and the Chorioptic or Symbiotic, according to the genus of attacking mange mite. It is difficult without practice to distinguish the three kinds of mange mite and a high power of the microscope is necessary. I am often told by interested and wisely inquisitive people that even with the microscope they fail to make out the mites. But the student of mange mites must first make sure that the mites are present, in a case of mange, by taking a scraping from the skin, that should draw even a little blood, and then placing it in a watch glass containing a small quantity of 10 per cent. caustic potash. This should be allowed to stand overnight, or with very scanty material for ten minutes at least, when small particles of hair and scurf will have been dissolved and sufficient cleaning have taken place to enable the worker to find the mites without difficulty. Because of legislation and penalties in connection with different manges, it is often important that the actual species be determined. The dog and the cat may each be attacked by two species of these mites, while the horse, and cow and sheep may suffer from three kinds of mange, viz. Sarcoptic, Psoroptic and Chorioptic. The following key is offered as a help in the microscopic examination :—

Sarcoptes.	*Psoroptes*	*Chorioptes* or *Symbiotes.*
Body round.	Body more oval.	Body more oval.
A short wide beak.	More pointed and elongated beak.	Beak blunt—as wide as long.
Legs short; the four front legs spring from the edge of the body and are visible from above; the four hind legs arise from the under-surface, and are almost concealed from above under the body when the mite is resting or walking.	Legs longer; all four pairs easily visible as they project from the sides of the body.	Legs long, and all four pairs visible from above.
The tarsus (the furthest out part of the leg) carries a rather long stalk, which is unjointed and ends in a small sucker.	The tarsus bears a three-jointed stalk ending in a sucker.	The tarsus bears a short unjointed stalk with a wide sucker.

The Sarcoptes Mange Mites are parasitic on mammals, e.g. on man, horse, dog. (The Sarcoptes mange of the cat is now known as Notoedres as the anus is dorsal; the anus is ventral in true Sarcoptes.) The Sarcoptes form of scab is always very troublesome, as the females mine into and make galleries under the skin. The Psoroptic and Chorioptic mites do not burrow, but live in parts sheltered by hair and wool and under crusts. The Psoroptic mange mites are parasitic on mammals, the most troublesome species being the cause of "Sheep Scab." The Chorioptic mange mites are also parasitic on mammals, e.g. horse, ox, sheep, goat. Close to *Chorioptes* is the genus *Otodectes*, the cause of itch in the ears of dogs and cats.

It is important to keep in mind how infectious itch can be, and the possibility of the disease passing not only from man to man—as it so readily can do in the scabies or itch of human beings—but from domesticated animals to man. The Sarcopt of the horse passes readily to the ass and the mule, and is transmissible to man. The Sarcoptic mange of the cow can also pass to man (there is no doubt about this, although it is sometimes disputed). The Sarcopt of the dog is communicable to man, as is also the mange of the cat.

One or two examples may be taken as affording an idea of the round of life of a scab mite, how infected animals suffer, and what remedial measures may be adopted.

Sarcoptic Mange of Horses.—This is due to the mite *Sarcoptes scabiei* var. *equi*, a mite with a rounded body, greyish in colour with a tinge of red. The male measures about $\frac{1}{100}$ inch and the female up to $\frac{1}{65}$ inch. Under the microscope short cone-like projections are seen on the shoulders, and on the back tiny scales with backwards-directed points. Of the four pairs of legs in the male, one, two, and four have the last joint (tarsus) carrying a stalk terminated by a sucker; the two legs of the third pair end in a long hair, no stalk or sucker being present. In the female the front two pairs of legs have the stalk and sucker; the two hind pairs of legs end in a long hair. The female *S. equi* mines in the skin of the horse, laying her eggs as she progresses; the gallery is made by the mouth-parts and the mite moves always forwards, the scales and spines on her body preventing a backward movement; in her wake eggs in different stages of development are found and dark excrement. At the front end the female herself may be found on careful search. From the egg hatches a larva resembling the parent in external form but with only six legs. In over a week the young scab mite, which has come to the surface and outside of the skin, moults, reaching the nymph stage characterised by eight legs; by a week another moult results in the adult males and females. The female moults still again and then proceeds to her egg-laying. The whole life cycle can be completed in a month.

The Sarcopt of the horse generally begins about the withers or shoulders, and spreads to the sides of the neck and to places in contact with the saddle and girth. In the spread of the disease long-haired parts are avoided. Noël-Pillers finds the parts most affected to be "the sub-maxillary space, the tracheal region, the brisket, the belly," all thin-skinned places (just as the favourite places for infection in man are thin-skinned places).

The symptoms are restlessness and an itching, worse when the skin is overheated or warm. The horse bites itself and rubs itself against convenient bodies; shows pleasure when groomed, leaning towards the brush or currycomb; it may also turn its head to the side and make a characteristic movement with the lips—a movement which is a useful diagnostic feature in early stages of the disease. Later, before there is any loss of hair, small pimples or elevations can be felt as the fingers are passed over the skin. These pimples consist of " crusts " round the bases of a few hairs. The pimples are at first scattered; later they burst with the rubbing and the secretion from them dries into a crust. As the disease spreads patches run together and a large crust may be

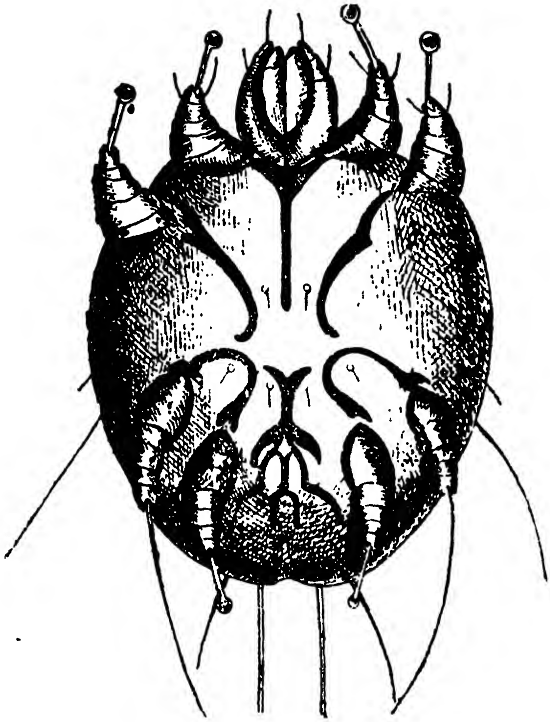

FIG. 5.—*Sarcoptes scabiei.*
Greatly magnified. (After Lohmann in Das Tierreich.)

formed. The hair drops out and the skin wrinkles and thickens. Rubbing causes bleeding. There is a purulent exudate and a sour fœtid odour is given off.

Psoroptic Mange of Horse.—This scab mite (*Psoroptes communis* var. *equi*) affects horse, ass and mule, but does not pass to any other domesticated animal. The male measures $\frac{1}{50}$ inch in length and the egg-laying female up to $\frac{1}{38}$ inch. In the male the first three pairs of legs end in a three-jointed stalk with sucker; the hindmost two legs are short and are without stalk and sucker; the third pair of legs are longer than the other legs; at the hind end of the abdomen are two lobes, and also two suckers used in pairing. The female has a three-jointed stalk and sucker to the first, second and fourth pairs of legs; the third pair of legs end in two long hairs and are without stalk and sucker; no abdominal lobes or pairing suckers are present.

While the Psoropt of the horse may be found on almost any part of the body, the common places for infestation are parts protected by hair. This scab mite does not mine into the skin, but the pests give rise to intense itching owing to the constant pricking of the skin by the mouth-parts. Whether a marked part of the irritation is due to introduced microbe or fungus or toxic substance in the parasite's saliva remains for proof. As a result of irritation and friction papules appear; these break and a

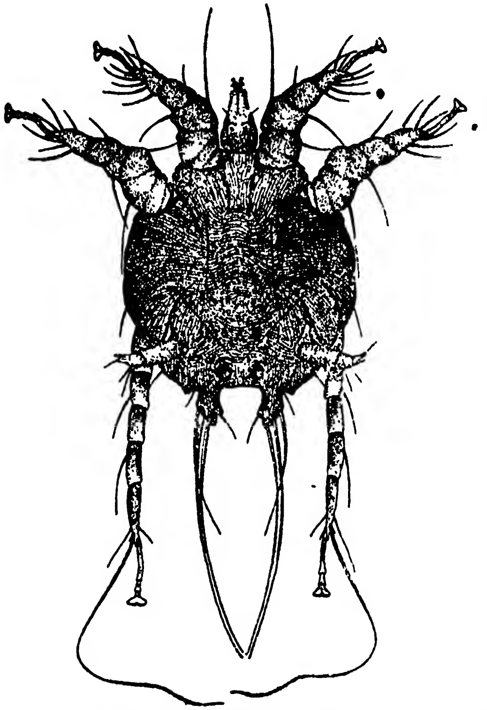

FIG. 6.—Adult male of *Psoroptes communis* from under surface. Greatly magnified. (After Salmon and Stiles.)

fluid exudes; the fluid dries and crusts are formed. Under the crusts and at the edges of them the mites live and propagate. The stages in the life-cycle are the same as in Sarcoptes,[1] *Chorioptic or Symbiotic mange* of horse. This scab mite (*Chorioptes* (*Symbiotes*) *equi*) measures $\frac{1}{75}$ inch in length in the male and in the female $\frac{1}{65}$ inch. In the male all four pairs of legs end in stalk and sucker, but the stalk is very short, so that the large sucker may seem to be sessile; the legs of the fourth pair

[1] Sarcoptic and Psoroptic mange of the horse are notifiable diseases. See the Parasitic Mange Order of 1911 and the Parasitic Mange (Amendment) Order, 1918, of the Board of Agriculture.

are much thinner than the others; abdominal lobes and pairing suckers are present. In the female the first, second and fourth pairs of legs end in stalk and sucker; the legs of the third pair end in two hairs; there are no abdominal lobes and no copulatory suckers. This mange is often known as pastern mange or leg mange. It is usually confined to the limbs, and only in very bad cases is it high up on these. This kind of itch spreads very slowly in a stable as compared with the other kinds. Changes in the skin and hair do not become very pronounced until the

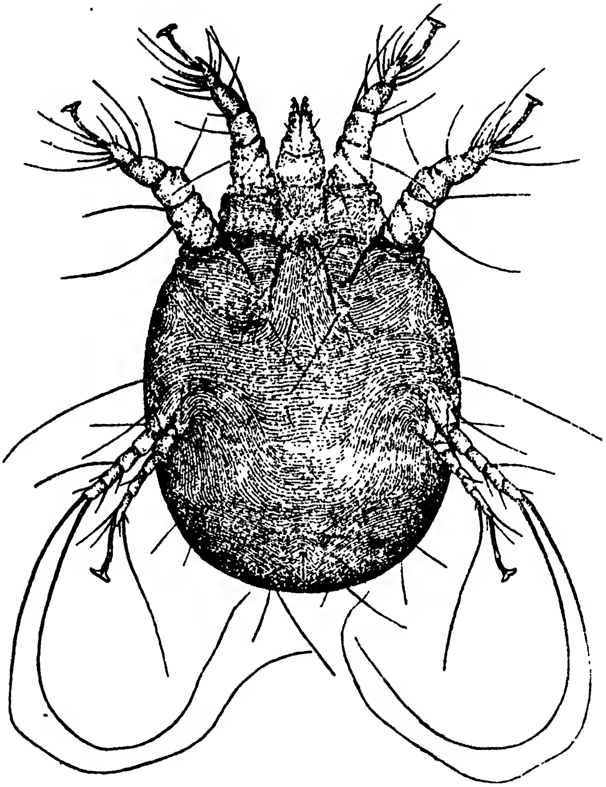

FIG. 7.—Adult female of *Psoroptes communis*. Greatly magnified. (After Salmon and Stiles.)

disease has been in progress for a considerable time. A symptom of attack in the early condition is repeated stamping of the hind legs.

Treatment for Mange.—Too much stress cannot be laid on the importance of thoroughness in treatment. Where mange has made progress cure is stubborn, especially in Sarcoptic mange. In order that the dressing may the better reach the parasites clipping should take place. Then there should follow a washing with soap and water, a lather being formed. After washing down with water the body should be scraped dry with a straw wisp (the straw wisp should be burned immediately after use). The patient is now ready for the dressing which will kill the parasites. There are various recommended dressings, e.g. mercurial preparations, tobacco preparations, paraffin-emulsion preparations, but none are more generally satisfactory than sulphur, potassium carbonate and an oil. One such dressing is :—

> Sulphur 1 ounce, oil of terebinth 1 ounce, spirits of tar 1 ounce, liquor of potass 1 ounce, rape oil 1 pint.

Another highly recommended dressing is :—

> Sulphur 1 part, potassium carbonate ½ part, sperm oil 4 parts.

Thoroughly mix together the sulphur and the potassium carbonate and stir in the oil gradually. This is applied to the animal after the clipping and washing.

For a week or a little longer the horse should be looked at now and again so that any affected parts, that have been rubbed bare, may be redressed. Then should follow a thorough washing down with soap and water in order to remove all of the previous dressing.

A second course of treatment should follow on the same lines and then a third,—i.e. the animal would be three times treated in three weeks to a month.

Very great care has to be taken against spread of the disease. No treatment can be considered satisfactory which neglects the great risks of infection. The disease can spread very easily from horse to horse, therefore scab-infested patients should be isolated. When the horse is clipped small pieces of crust fall away with the hair, and both hair and crust probably harbour the mites, therefore there should follow a sweeping together and burning. Before sweeping it is a good plan to disinfect by spraying with paraffin-emulsion or a 4 per cent. solution of carbolic acid. Stalls, litter, harness and articles used about the animal should be carefully disinfected. A painter's flare may be used in part of this work. Brushes, currycombs, clippers should be dipped in paraffin-emulsion after use; harness should be scrubbed in a 3 per cent. solution of creolin.

At the close of treatment one should not feel absolutely sure of complete success; the animal should be kept under observation for a month.

A very useful mange dressing can be made from :—Derris powder 6 drachms, powdered hard soap 2 drachms, water 2 pints. This may be used for example as a bath for dogs. If only heavily infested patches are to be treated then double the above strength can be used. If used as a dressing for dogs the dressing should be allowed to dry on the coat. A bath may be given every five days. In working with Derris powder one should prevent as far as possible the entrance of any of the powder to nostrils and mouth.

The worker with an affected animal should very thoroughly cleanse his hands with soap and hot water, and where he has had

to dress a badly infested animal it is well worth the extra trouble to take some sulphur ointment and wash the hands with it, specially rubbing the fingers together so as to get into the spaces between them. Of cases known to me where infection passed from animals to man I recall a comparatively recent one, partly, because of its innocent and somewhat amusing association. On a Saturday morning in spring six happy young fellows were, for a brief period, in contact with a horse not known to be suffering from Sarcoptic mange. The animal was rather a sorry-looking scrub, and its miserable appearance was the cause of chaffing remark. One man, I remember, mounted and pretended to be riding a Derby winner, others leaned lazily against the poor beast, and all six unsuspectingly handled it in some way, more or less facetiously. All six became temporary patients of mine and I verified the pest as *Sarcoptes scabiei*. The note of one patient's case is as follows :—Contact with horse took place on Saturday. On the Sunday evening, while sitting in front of the fire, the patient became aware of a slight irritation between two fingers, and on examination of the hands each interdigital space was found to be the site of a small reddened area about the size of a pin head. On the Monday morning the patient was awakened by an intense itching in arms and legs, and lesions resembling those between his fingers were now found all over the body with the exception of the face. The sufferer was now subjected to thorough treatment and recovery was rapid, followed, however, by an outbreak on the back and sides of the hands of little swellings, non-irritant, but each containing a small quantity of colourless serum. It took another fortnight before recovery was complete.

Sheep Scab.—The present importance of sheep scab calls for a notice of it here. Sheep, as stated earlier in this article, may suffer from all three kinds of scab.

Sarcoptic scab of sheep is sometimes known as head scab, as the head is the chief place for it. Showing on upper lip, nostrils eyelids, ears, face, it may in severe cases spread to other parts of the body where the wool is not thick. This scab mite of the sheep passes readily to the goat, and one or two cases have been recorded of the affection passing to man. Experimentally placed by Gerlach on ox, horse and dog, a local eruption was produced which quickly passed off; there was no permanent disease.

Chorioptic scab of sheep is known as foot scab, as it affects the feet and limbs. This kind of scab spreads only slowly and yields readily to treatment.

Psoroptic scab is caused by *Psoroptes communis* var. *ovis* and is the dreaded scab of the sheep.[1] The mite has a world-wide distribution and legislation has been directed against it in many countries. After great effort it has been stamped out in several British Colonies. This kind of scab is not transmissible to the other domesticated animals. It is the cause of loss in various

[1] Psoroptic mange of sheep is a notifiable disease. See Sheep Scab Order of January 1928 and Sheep Scab (Amendment) Order of 5th June 1928 issued by the Minister of Agriculture and Fisheries.

ways—hindrance to development and growth of young lambs; loss of weight and general condition; damage to wool and hides; abortion; failure to become pregnant in badly affected ewes; in neglected cases, death.

Psoroptes communis of the sheep is just visible to the naked eye if the background be favourable and the parasite be moving about. The male measures $\frac{1}{50}$ inch in length; at the hind end are two abdominal lobes or projections bearing long hairs and two pairing suckers; of the eight legs the first three pairs end in a three-jointed stalk and sucker; the fourth pair of legs is rudimentary.

The egg-laying female measures $\frac{1}{40}$ inch in length; the first, second and fourth pairs of legs end in a three-jointed stalk and sucker; the third pair of legs end in two long hairs; no abdominal lobes and no pairing suckers. In both sexes the body is oval-rounded and the beak coneshaped and elongated.

The oval eggs are laid on the skin or attached to the wool near the skin. Hatching takes place in four or more days according to the conditions. From the egg comes a minute six-legged larva whose two front pairs of legs end in stalk and sucker, the third pair ending in two hairs. In due course a moult takes place resulting in the nymph, a stage characterised by eight legs, the two front pairs ending in stalk and sucker, the two hind pairs ending in long hairs. After another moult we have the male and female, the fertilised female moulting still once more in preparation for egg-laying; this final stage of the female is recognised by the genital opening anterior in position between the second pair of legs. The round of life may be completed in a month.

This mite chooses for attack the woolly parts of the body; less hairy parts nearly always escape (this applies also to the Psoropts of other animals). The restlessness of the sheep owing to intense itching calls attention to the disease; the sheep rub and bite and scratch themselves and the wool becomes soiled. On close examination of scabby sheep, when the wool is pulled aside, small elevations or papules are seen which have a pale-greenish-yellow appearance. In time the papules run together, and a fluid is exuded which dries into greasy-looking yellowish crusts. The constant scraping and rubbing themselves by the sheep induce severe inflammation; increasing quantities of serous fluid are given out, and by the drying of this the crusts become larger and thicker and the skin hardens. The parasites multiplying and continuing to feed seek the edges of the crusts and the area of infection spreads. The fleece comes to look broken and tufted; here and there the wool is matted; tufts and tags of wool hang down, and the animal has an unsightly ragged appearance. The late Sir Stewart Stockman's Reports show that in Britain the disease is most prevalent from October to January, and declines to a minimum in July and August. Infection is got by contact with scabby sheep, and from tags of wool and pieces of crust adhering to rubbing posts and fences, or dropped as the sheep move about.

Treatment.—Dipping is the only reliable may of dealing with this sheep scab. Very efficient proprietary dips are on the market. Over 300 dips have received the approval of the Ministry of Agriculture, about one-third being arsenical and the rest non-arsenical. For example in the Sheep Scab Order of 1928 on page 22 three dips are detailed with mode of preparation.

In connection with the Double Dipping Sheep Order of the Ministry, where the second dip had to take place not earlier than the tenth and not later than the fourteenth day, complaints reached the Ministry of losses in sheep dipped twice with arsenical dip, and as a result an Order was promulgated in 1926 prohibiting the use of an arsenical dip for the second dip. In time, however, appeals reached the Ministry from farmers in different parts of the country asking that they be permitted their " former discretion in the choice of an approved dip, so that they might use an arsenical dip for both dippings when desired." Matters have been arranged satisfactorily between farmers and the manufacturers of arsenical dips, and the Ministry by an Order in June of this year removed the prohibition of the second dip being an arsenical one. Whenever a double dipping is required the owner of the sheep may use any of the over 300 dips approved by the Ministry. Where the second dip is again an arsenical one the Ministry recommends that the second arsenical dip be at half strength.

The Scab Mites of Poultry.—Close to *Sarcoptes* is the genus *Cnemidocoptes* parasitic on birds; the mites are extremely minute; the males have stalk and sucker on all the legs; the legs of the female lack stalk and sucker. Examples are the mites which are the cause of Scaly Leg and Depluming Scabies.

Scaly Leg (*Cnemidocoptes mutans*). (The old name was *Sarcoptes mutans*).—This mite lives under the epidermal scales of the leg of the fowl; the attacked place is the part of the leg without feathers and the upper part of the toes. The disease is communicable to the turkey, pheasant, partridge, guinea fowl, parrot, and small cage birds like finches.

The females enter the skin under the epidermal scales; in time these scales become raised, and underneath them is found a chalk-like powdery mass glued together by serous exudate. This exudate is due to the irritation set up by the parasitic mites; the exudate dries and gradually, by coalescence, rough crusts are formed, greyish on the outside and white below. These crusts are most numerous on the front of the leg but are also present behind and under the toes. The crusts are thick and irregular, and when removed the exposed skin is seen to be bloody. If one examines the inside of the crusts minute pits may be noticed, the deeper ones housing an egg-laying female. The six-legged larvæ, the eight-legged nymphs and the males and unfertilised females are more active, and may be found wandering about under the spongy crusts. Diseased birds are lame; they cannot perch properly, and a toe may drop off. Appetite fails and the bird pines away.

Treatment.—Isolate infected birds. Soften the loose crusts by bathing the leg in hot water and remove these crusts by aid of a brush. A dressing recommended in America for applying after the softening of the crusts is a mixture of 1 part caraway oil to 5 parts of white vaseline or lard; the dressing to be repeated every few days.

Roosting places and places that have housed fowls suffering from Scaly Leg should be thoroughly cleansed and disinfected. In a favouring temperature this enemy of the fowl can survive for some weeks away from its host.

Depluming Scabies.—This is due to the parasite *Cnemidocoptes lævis.* The birds irritated by the mites at the base of the feathers pull out the feathers; feathers are also broken across at skin level. The tiny mites from $\frac{1}{70}$ to $\frac{1}{140}$ inch in length can be found in various stages of development in the powdery epidermal scurf at places where the feathers have been pulled away.

For fowls the disease is very contagious, and infected fowls should be isolated. A practised treatment is wetting the bases of the feathers with soapy water and then dusting with fresh pyrethrum powder or sulphur,

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THE following article on the increase in flocks and wool production in the world is quoted from a recent issue of the *International Review of Agriculture* :—

The World's Flocks.

During the war the number of sheep and the production of wool declined considerably, owing, in Europe, to losses suffered by flocks in belligerent countries, and outside Europe, partly in consequence of adverse climatic circumstances and partly due to the high prices of competing products (meat and dairy produce). However, the heavy stocks which owing to the difficulty of transport had accumulated in transoceanic centres of production enabled post-war requirements to be easily met. Between the middle of 1920 and the beginning of 1921, after a period of active demand and high prices, quotations collapsed, thus conforming to the general crisis which characterised that period. There was then an impression that supplies were excessive, considering the falling off in demand, and the general diminution in consumption which followed the impetuous course of the raw material immediately after the war. But the moment of panic having passed, and thanks also to the deliberate policy of gradually releasing accumulated stocks, the conditions of the wool market improved, and prices quickly trebled themselves towards the end of 1924, compared with the minimum reached during the crisis of 1921. The great sheep-rearing centres, and also some European countries, were thus induced to give a new impulse to the breeding of sheep. The effects of this—although in 1925 and 1926 prices underwent a reaction—are reflected in a gradual increase in wool production, which in the 1926–27 season reached its highest figure. In 1927–28 there was a slight diminution, due, however, to drought in Australia and the Union of South Africa, and which would therefore not seem to indicate a change in tendency.

The recovery in sheep rearing has been especially important in Australia, New Zealand and the Union of South Africa, where the number of sheep shows the following variations :—

Number of Sheep (in thousands).

	Australia.	New Zealand.	South Africa.	Total.
1913	89,096	24,192	35,808	149,096
1922	82,701	22,222	28,496	133,419
1927	103,000	25,649	40,110	168,759

For Argentina and Uruguay annual live-stock statistics and recent censuses are not available, but on the basis of wool exports it may be argued that the number of sheep, which was considerably reduced during the war, is now approaching the pre-war level.

There has also been a considerable increase in the United States, where the number of sheep, reduced from 40,700,000 in 1913 to 36,186,000 in 1922, at the beginning of 1928 had again reached 44,545,000.

The situation in Europe is less uniform in character. In some countries sheep rearing (as in Germany) is on the decline, or while having experienced a recovery, still remains (as in France) considerably less than before the war, whereas elsewhere (as in England) its progress has been the same as in overseas centres. In any case, on the basis of available data, there has also been in this continent from 1922 to 1927 an increase in the number of sheep which tends to approach the pre-war figure : for 14 countries representing three-quarters of European sheep flocks (excluding U.S.S.R.) there were during 1927 about 84 million sheep against 78 million in 1922 and 87 million in 1913.

In the U.S.S.R. sheep rearing underwent a vigorous recovery after the losses of the war period, and the Government is also endeavouring to improve the quality of the wool.

If the increases experienced in other centres of production are taken into account, it may be assumed with sufficient approximation that the number of sheep to-day exceeds by perhaps 100 million head that of 1922, and has not only reached, but slightly surpassed, the pre-war level. The production of wool has increased to a greater extent, compared with the pre-war period, owing to the increase in the average weight of the fleece. The surest index of the development of production is furnished by the export figures of the five countries supplying the greater part of the wool used in industry.

Exports of Wool (millions of pounds).

	Average 1909-1913.	*1924.*	*1925.*	*1926.*	*1927.*
Australia	625	*526	671	781	764
New Zealand	188	206	206	213	220
Argentina	319	270	250	318	346
Uruguay	139	100	89	119	152
Union of South Africa ...	145	·175	209	212	260
Total	1,416	1,277	1,425	1,643	1,742

* Fiscal year 1923-24.

It should be borne in mind that notwithstanding the recent recovery, the production of wool has increased in the last thirty years much less than that of other textile fibres. The adverse climatic conditions, which from time to time have reduced flocks in some important breeding centres subject to drought, the intensification of agriculture, which in some countries has favoured cattle at the expense of sheep, the substitution of mutton-producing breeds for wool-producing breeds, have all combined to retard the increase of wool production after the period of rapid development in sheep rearing which coincided with the occupation of virgin lands, where the pastoral industry was the first form of economic activity on the part of pioneers. As regards demand, fashion has favoured the use of other textile fibres in substitution for wool, and has reduced the individual requirements of woollen manufacturers. The unfavourable economic conditions of large sections of the population in various countries have contributed in the post-war period to reduce consumption, notwithstanding the increase in population and the gradual extension of Western modes of clothing, including the use of wool, to the peoples of the Asiatic East.

However, the ease with which the market absorbed the abundant clip of 1926–27, without leaving any considerable carry-over, gives reason to believe that the increase in production experienced during recent years has not been in excess of world requirements. In fact, notwithstanding increased supplies, prices, after the decline registered in 1925 and 1926, have shown from the beginning of 1927 until the end of April 1928 a general tendency to increase.

Notes from Craibstone.

Grasses and Clovers in 1928.—One of the most interesting features in 1928 was the effect of alternating frosts and thaws on different samples of broad-leaved red clover when sown in rows. A large proportion of the plants of Chilian, French, and other samples from warm countries were thrown out. In some cases as much as 1½ to 2 inches of the bare tap root was sticking out of the ground in spring, whereas very few plants of any sample of English were thrown out at all. The result was that many of the plants that had been thrown out by frost died, and those that did survive grew into weakly plants.

Where the samples were sown in turn as part of the same seed mixture the difference between the various samples was even more marked owing to the competition of the grasses being more severe on the weakened plants. Plots where the English samples were sown were, as usual, as thick as one could wish with vigorous plants, whereas samples sold as French, American, Canadian, Chilian, Hungarian, Italian, Lombardy, Brittany, Mountain, Polish, Russian and Tyrolese Alps were all poor, there being a very small amount of clover in the hay.

In the case of the late-flowering type, all the English samples were good, as usual, and so also were Swedish, Norwegian, Danish Hersnap and Altaswede. American Mammoth on the other hand was hardly so good. One sample of English late-flowering (out of 15), one sample of Montgomery late-flowering (out of 10), and one sample of Cornish Marl (out of 9), turned out to be of the broad-leaved type.

Five samples of "yearling" seed were compared with fresh seed of the same stocks. In three cases the crop from the yearling seed was quite as good as from fresh seed, whereas in the other two cases it was inferior. This was due to the seed having lost vigour, as germination tests showed that the germinating energy was low.

Many are of opinion that true wild white clover can be obtained only from Kent. During the last year or two, samples have been obtained from many other counties. While some of these have not been so lasting, others have been quite as vigorous during the third or fourth year as that obtained from Kent. In all cases the good samples had given a strong chemical reaction, while the short-lived samples had given weak or negative reactions. Evidently they had been cultivated samples seeded early.

New Zealand white clover is sold under a number of different names, such as wild, certified, indigenous, virgin, and from old pasture. These names, however, give no indication as to the value of the sample; in fact, one sample labelled ordinary white gave as good results and lasted as long as any. Those that have lasted longest and done best in the pasture gave the strongest chemical reaction, while those that have done poorly gave weak or negative reactions.

In a former note dealing with this subject attention was drawn to the effect of the previous management on the amount of white clover in the pasture. This was demonstrated quite clearly this year in third year's grass. Where the hay had been late in being cut white clover was scarce. It was even scarcer, and the surface was opener, where the aftermath had been allowed to be well up before being eaten down, whereas in the part where the hay had been cut early and the aftermath eaten down early the sole was thick with white clover, the same amount of seed, ½ lb. per acre, having been sown in all cases.

In a poor field of second year's grass the effect of putting in a crop between the turnip crop, which was dunged in the spring, and the nurse crop with which the grass and clovers were sown out was very marked. Part of the field got dung and was in turnips in 1924. In 1925 this part was cropped with marrow-stem kale, to which, however, no dung was applied. In 1925 the other part of the field got dung and was in turnips. Then in 1926 both areas were sown out with grass and clover seeds, the nurse crop being barley. In the former area white clover is very scarce, whereas in the other part there is a very satisfactory sole.

In third year's pasture the value of leafy selections of grasses was very marked. In the case of perennial ryegrass, Ayrshire and Home-seeded went into ear early in the season, and the amount of leaf blades was very small compared with some of the "Evergreen" samples. It should be noted that there appeared to be intermediate and late types among the "Evergreen" samples.

In the case of cocksfoot, Danish samples were very inferior, had very few leaves and went into ear very early, whereas the New Zealand Akaroa, English Selected and a Craibstone selection had a much larger number of leaves and were much later in flowering.

These leafy grasses are worthy of attention, especially by those who are laying down permanent pasture.

Opinions differ greatly as to the relative feeding values of perennial ryegrass, cocksfoot and timothy. In order to gain information on this point, three plots of one acre each were laid off, the seeding being 26 lb. perennial ryegrass in the first, 16 lb. cocksfoot in the second, and 12 lb. timothy in the third. In each case the ordinary mixture of clovers was sown, viz. 3½ lb. mixed red clovers, 1 lb. alsike and ½ lb. wild white clover.

During the past season these plots were grazed with sheep, and the results obtained so far are as follows :—

Cocksfoot—live-weight increase, 168 lb.
Timothy—live-weight increase, 255 lb.
Perennial ryegrass—live-weight increase 126 lb.

As will be seen from these figures, timothy has given much the best return. This may be due partly to the fact that the season was wet and therefore suited to the timothy, which remained fresh and green much longer than either the cocksfoot or perennial ryegrass. On the other hand, it should be pointed out that the cocksfoot seed sown was a Danish sample, and from other experiments it has been found not to be particularly suitable for grazing purposes, as it goes into ear very early.

Several small trials were made with sulphate of ammonia on first year's grass, one particular object being to find out the best time of application. To one plot sulphate of ammonia at the rate of 1 cwt. per acre was applied in the beginning of January, to a second on the 1st of February, to a third on the 1st of March, and to a fourth on the 2nd of April. The crop on all the plots was cut on the 1st of May, and the result showed that there was practically no difference between the January; February and March plots, but that of April was lighter.

In another trial the object was to find the value of different quantities of sulphate of ammonia. To one plot 1 cwt. was applied in March, to a second plot 1 cwt. was applied in March, June and August, a total of 3 cwts., and to a third 1 cwt. in March, May, June, July and August, a total of 5 cwts. The crop on all the plots was cut in May, June, July, August and September. The following table gives a summary of the results for the season, the weights for the grasses and clovers being given separately for the purpose of showing the effect which the heavy dressings had on the development of the clover.

Weight of Green Crop.

Cut beginning of May, June, July, August and September.

	Cwt. per acre.		
	Grass.	Clover.	Total.
No Nitrogen	70·9	69·0	139·9
1 cwt. (March)	93·4	62·1	155·5
3 ,, (March, June and August)	182·0	38·6	220·6
5 ,, (March, May, June, July and August) ...	249·4	30 1	279·5

The chief points to note in this trial are (1) the sulphate of ammonia has in all cases largely increased the crop, and (2) the amount of clover is inversely proportional to the amount of sulphate of ammonia applied.

It was also noted that the effect of the 1 cwt. applied in March was entirely exhausted by the first cut, and that the subsequent crop on this plot was no better than the plot to which no sulphate of ammonia had been applied.

In another trial 1 cwt. sulphate of ammonia was applied three times to one acre and an acre alongside was untreated. Both plots were grazed by sheep, and, calculated on the basis of the number of days that each was capable of carrying one sheep, the sulphate of ammonia plot gave a return of 1,604 days and the untreated plot 936. Taking the value of the increase as 4*d.* per week per head, the difference between the two was just sufficient to pay for the manure. Any higher value would of course be profit.

Committee on Education and Industry in Scotland.

THE Committee on Education and Industry in Scotland appointed by the Secretary of State and presided over by Lord Salvesen have now issued their second Report. In their first Report the Committee dealt with the reference to them to consider the adequacy of the arrangements for enabling young persons to enter into and retain suitable employment. The other part of their remit was to enquire into and advise upon the public system of education in Scotland in relation to the requirements of trade and industry, and this is the matter of the second Report.

The Committee emphasise the importance of a thorough grounding in the three " R's," the need for increased provision for manual training, the desirability of varying and broadening the curriculum of secondary schools beyond the traditional academic course, and of adding a final year of intensive commercial or industrial instruction. They recommend the limitation of hours of employment of young people in order to permit their attendance at continuation classes, and the provision of further facilities in these classes for instruction in commercial and technical subjects.

So far as rural districts are concerned, the Committee advise the teaching of rural science in the primary schools, and they suggest that some consideration should be given to the possibility of providing in provincial secondary schools a natural science course, with an agricultural direction.

A useful suggestion is made that the Scottish Education Department should issue for the information of the general public a short description of the public system of education in Scotland. There is undoubtedly a surprising lack of knowledge in the public mind regarding the details of educational organisation, and a guide to these would tend to increase the interest of the ratepayer in this most important of his responsibilities.

Agricultural Produce (Grading and Marking) Act, 1928.

THIS Act, which received the Royal Assent on 3rd August last, is intended to encourage the development of modern methods in the marketing of home produce with a view to enabling home producers to meet the competition in the home market of foreign suppliers, whose success has been due largely to their ability to supply produce of standardised quality of the grades demanded by the British consumer.

In its application to Scotland the Board of Agriculture for Scotland are authorised to make regulations (1) prescribing " grade designations " to indicate the quality of any articles of agricultural or horticultural produce, and (2) defining the quality, &c. indicated by every " grade designation " thereby prescribed. The Board are also empowered to prescribe " grade designation marks" to represent the "grade designations," and to authorise, subject to conditions, any person or body of persons to use such marks.

It will not be compulsory to sell produce under the prescribed grade designations, but, where any person sells any article of agricultural or horticultural produce to which a particular grade designation is applied, it will be deemed to be a term of the contract of sale that the quality, &c. of the article accords with the statutory definition indicated by such grade designation.

The Act also contains special provisions relating to the sale of preserved eggs. After 28th February 1929 it will not be lawful to sell any egg which has been subjected to any process of preservation unless the egg is marked in the prescribed manner. If and so long as any Order in Council made under the Merchandise Marks Act, 1926, is in force prohibiting the sale in the United Kingdom of imported eggs unless they bear an indication of origin, premises used for the cold storage or chemical storage of eggs must be registered with the Local Authority, and all British eggs which have been kept in cold storage or chemical storage in such premises must not be removed therefrom unless they have been marked in the prescribed manner.

Animal Breeding Research Department—Edinburgh University.

Prior to the war a comprehensive scheme for the development of agricultural education and research in Great Britain was instituted by the Development Commission in conjunction with the Departments of Agriculture. Included in this scheme was a proposal for assisting research in animal breeding at Edinburgh, and in June 1913 a Joint Committee on Research in Animal Breeding, representative of the University of Edinburgh and of the Edinburgh and East of Scotland College of Agriculture, was formed. The outbreak of war interrupted the work of the Committee and it was not until late in 1919 that its activities were resumed.

In 1920 Dr. F. A. E. Crew was appointed head of the Department and work, necessarily restricted in its scope by the limited accommodation, was commenced in a disused block of buildings at High School Yards placed at his disposal by the University.

From 1920 to 1924 work was carried on there, but at the end of this period the Department had grown too large for the accommodation at High School Yards, and in December 1924 the University placed temporarily at its disposal a portion of the Chemistry Department, King's Buildings, and 7 acres of grass land. It was recognised that in a few years this accommodation would be required by the University for the purpose for which it had been provided, and that it would be necessary to find permanent buildings suitable for the Department's special requirements and more accommodation for the experimental animals.

The work of the Department had meantime attracted the attention of the International Education Board of New York, and after a representative of that body had satisfied himself that the Department, if properly extended, would serve for the training of research students from all parts of the world, an offer was made of a grant of £30,000 towards the building and equipment of a suitable Department and endowment of a Chair of Animal Breeding in the University of Edinburgh, subject to a like amount being raised from other sources and to the provision of certain funds for maintenance.

Through the generosity of Lord Woolavington and by means of grants from the Empire Marketing Fund, the Development Fund and the University, the conditions attached to the grant from the International Education Board have been fulfilled, and suitable buildings are now in course of erection on ground adjoining King's Buildings which has been placed at the disposal of the Department by the University.

The Chair of Animal Breeding has now been endowed. Dr. Crew has been appointed Professor of Animal Genetics, and the University has accepted responsibility for the administration of the Department as from 1st April 1928. An Advisory Committee has been appointed which will ensure the close relation of the work of the Department to problems of practical agricultural importance. With the appointment of this Committee and the transfer of the administration of the Department to the University, the Joint Committee of the University and the College of Agriculture has been dissolved. During the fifteen years of its existence the Joint Committee has given valuable service in the administration and development of the department under its control.

Papers on Agricultural Research.

A PUBLICATION of the Imperial Agricultural Research Conference, recently issued, contains abstracts of papers by research and advisory workers in Great Britain and Northern Ireland, which were published in the year October 1926 to September 1927. The large volume of work summarised in this publication is presented under fourteen headings such as soils, entomology, animal diseases, dairying, &c.

The primary purpose of the publication is to inform agricultural research and advisory workers in other parts of the Empire of the work which is being done in the mother country; the volume should, however, prove of great interest to all who are concerned with agriculture and allied industries, both at home and abroad.

The price of the publication is 1*s*. net, post free; it is obtainable from the Ministry of Agriculture and Fisheries, 10 Whitehall Place, London, S.W.1.

Agricultural Conditions.

THE weather during June was cold for the time of the year; night frosts occurred in exposed districts, and the development of the crops was much retarded throughout practically the whole country. In the south-western counties rain showers were frequent all through the month; elsewhere the rainfall during the earlier part of the month was exceptionally light, but the last ten days were unsettled. Throughout July the weather was favourable in eastern districts for both crops and live stock; the first two weeks were rather cold and dull and showers occurred locally, but, taken on the whole, the weather was fairly dry. During the second half of the month rain became more general in this area; the temperature, however, was higher, and there were frequent bright and sunny intervals. In the northern and western districts cold, windy and unsettled conditions prevailed throughout the whole of July and the growth of crops and pastures was considerably retarded. During August unsettled weather was general. Rain was frequent, more especially during the latter part of the month, and there was everywhere a great lack of sunshine. The showery conditions delayed the hay harvest in most districts, and in some areas a considerable proportion of the barley and oat crops was lodged; potatoes and root crops, however, benefited from the rains. In North-East Aberdeen on 1st August some damage was caused to the potato crop by frost.

Wheat made slow progress at first, and at the end of July the plants were still rather thin on the ground in some districts; owing to the lack of sunshine the grain ripened slowly. During August some lodging occurred in a few areas, but at the end of the month the crop was reported to be standing well in most districts. Cutting had only just commenced at the beginning of September. The estimates of produce are satisfactory, an average yield or over being expected in most of the districts in which the crop is principally grown. In South-West Angus and Berwick, however, the estimated yield is given as 5 per cent. below the normal.

Speaking generally, the barley crop is vigorous and healthy and no complaints of damage by disease or insect pests have been received. As in the case of wheat, ripening was slower than usual, and in the eastern counties considerable portions of the best and heaviest crops were laid by rain. In several of the early districts some of the grain was ready for cutting at the end of August but the weather was then unfavourable for a start to be made, and harvest was not general until about the second week of September. In most areas an average yield is estimated, while in Fife, North-East Aberdeen and Roxburgh it is thought that the produce will be from 5 to 10 per cent. above the normal; in Moray, North-West Aberdeen, the Lothians and Berwick, however, the forecast of the yield is slightly below the average. Bere progressed well, and average yields or over are expected in most districts where it is grown. Cutting commenced during the last few days of August.

The growth and development of the oat crop varied very much according to the locality and the quality of the soil; where grown after turnips, and especially on wet land, the crop was backward and irregular, but where grown after lea it was strong and healthy. Damage by grub was reported from practically all of the eastern counties. Oats did not withstand the effects of the wet weather so well as wheat or barley, and in many cases portions of the crop were badly lodged. Harvest was in progress at the beginning of September in a few districts, but on most farms throughout the country the work was not in full swing until the second or third week of the month. In Fife, Angus, the Lothians, Berwick and parts of Perth the ultimate yield is expected to be somewhat below the usual, but elsewhere the produce of the crop is estimated to be, at least, a full average one.

Beans were generally reported to be healthy although rather late in maturing; the plants, however, podded well and there was a good length of straw. In Stirling and a few other districts it is estimated that the crop may bulk from 5 to 15 per cent. above the average.

Potatoes generally made slow progress during June and July, and at the beginning of August the haulms were said to be rather stunted and backward in several districts. The general condition of the crop showed considerable improvement during the next few weeks, however, and although disease was observed in a few scattered districts, the reports at 1st September indicated that in most cases the trouble was not serious. The estimates of yield are satisfactory in practically all districts, and in some cases, where at the end of July the prospects were not very good, it is now thought that the crop will be up to the average. In Sutherland, Dumbarton, South Ayr and Shetland, however, the estimate of the yield is about 5 per cent. below the normal.

The reports on turnips and swedes improved steadily as the summer advanced. Where sown early the plants at first suffered from drought and resowing on a considerable scale was necessary in many districts; in late-sown fields, however, the crop generally brairded satisfactorily, despite the cold weather. At the end of July complaints of " finger-and-toe " were received from a number of eastern districts, and weeds were stated to be unusually troublesome in a few of the south-western counties. During August, however, the crop showed vigorous and healthy growth, and at the beginning of September the reports from some of the eastern districts stated that the roots were bulbing exceptionally well. A full average yield is expected in most areas and in several cases the estimate is somewhat above the average. Mangolds are generally described as a healthy crop but the bulbs are small, and it seems probable that the crop will be lighter than usual. Sugar beet has shown fairly good growth in some districts but elsewhere the crop is rather disappointing. A report from Central Perth at the end of August stated that in that district the prospects of the crop were not so good as last year.

As a consequence of disease the yield of strawberries in Lanark was fully 15 per cent. below the average, while in North-East Angus the crop was about 10 per cent. below the normal; elsewhere the yield generally proved to be a fair average. Other varieties of small fruits generally gave satisfactory yields, but in many cases the quality of the fruit was adversely affected by wet weather. In North and East Perth the yield of raspberries exceeded expectations and the crop proved quite a heavy one; in South-East Perth the yield was satisfactory, although not quite so large as in other parts of the county. Currants and gooseberries were average crops generally. Apples, pears and plums are good crops but, owing to the lack of sunshine during August, tree fruits ripened slowly.

As a consequence of the cold weather in June, grass was unusually scarce and additional feeding was necessary in many districts. Later on, however, pastures improved and grazing cattle made more satisfactory progress. Dairy cows milked fairly well, but the yield would have been below the seasonal average in several districts if it had not been maintained by hand feeding. Sheep on arable and hill farms made slow progress generally, and when the lambs were marketed many were not in as good bloom as usual.

In most localities the bee stocks are reported to be healthy. The weather was, however, unfavourable for the gathering of honey, and, generally speaking, the yield of clover honey was small.

The supply of regular workers has been adequate for requirements, but casual labour for turnip-hoeing and haymaking was short in some districts. In the south, numbers of Irish labourers were employed.

Agricultural Returns, 1928.

THE Preliminary Statement of the Agricultural Returns taken in Scotland on 4th June 1928 shows that the total area under crops and grass amounts to 4,673,000 acres, comprising 3,141,000 acres of arable land and 1,532,000 acres under permanent grass. The total acreage is the smallest recorded since 1877, while the area of arable land is the smallest recorded since the Returns were first taken in 1866, being less than in 1927 by 27,000 acres. The area under permanent grass has, however, increased by 19,000 acres, and the diminution in the total area under crops and grass is thus 8,000 acres.

The area under rotation grasses and clover, 1,502,000 acres, has increased by 6,000 acres, while the area under other specified crops is 33,900 acres less than in the previous year.

The total decrease is accounted for by wheat, barley, oats, rye, potatoes, sugar beet, rape and vetches, tares, &c., which combined show a diminution of 34,900 acres. Mixed grain, beans, peas, mangolds and cabbage show small increases, amounting in all to 1,000 acres.

The area under wheat, 61,000 acres, is less than in 1927 by 6,000 acres; that under barley, 114,000 acres, is the smallest ever recorded, and is less by 3,300 acres than that of last year; while that under oats, 882,000 acres, is 15,000 acres less than in 1927, and is also the smallest on record. The area under turnips and swedes is unchanged, while that under potatoes is 145,000 acres as compared with 147,000 acres in 1927. Sugar beet, with an acreage of 3,500, shows a decrease of 6,800 acres, or 66 per cent., as compared with last year's area of 10,300 acres, the area this year being about the same as in 1926. Small fruit is unchanged in area. Minor crops for which returns are made, but which are not separately shown in the accompanying table, all show slight increases in area except flax and onions, which have decreased by about 120 acres and 10 acres respectively.

Of the area under permanent grass, 172,000 acres were cut for hay and 1,360,000 acres were grazed, while of the area under rotation grasses and clover, 401,000 acres were cut for hay and 1,101,000 acres were grazed. The areas under permanent grass for mowing and under rotation grass for mowing were greater than in 1927 by 5,000 and 2,000 acres respectively; the total area cut for hay is thus increased by 7,000 acres.

The live stock returns show that horses, cattle, sheep and pigs have all diminished in number.

Horses used for agricultural purposes, numbering 126,400, are fewer by 3,100, the total being the smallest on record. Unbroken horses of one year and above are fewer by 400, or 2·3 per cent., while foals show a decrease of 500, or 8·8 per cent. All classes show decreases, the decrease in horses of all kinds being 4,900 or 2·8 per cent.

The total number of cattle, 1,209,300, shows a decrease of 1,100, or 0·1 per cent. The number of cows in milk, heifers in calf, bulls being used for service, and other cattle two years and above are less than in 1927, but the remaining classes show increases. Cows in milk and heifers in calf are fewer by 500 and 2,600 respectively, while cows in calf show a small increase. Bulls being used for service have decreased in number since 1927 by 400, and feeding cattle over two years old by 9,100, while yearling feeding cattle and calves show increases of 7,400 and 4,000 respectively.

Ewes, which number 3,240,900, show the highest total ever recorded, and are more numerous than in 1927 by 1,700. The number of lambs, 3,194,400, is less than last year by 16,200, that of rams by 1,000, and that of other sheep one year and above by 15,100. The total number of sheep, 7,504,900, shows a decrease of 30,600, or 0·4 per cent. on last year's figure.

Pigs, numbering in all 194,400, show a decrease of 2,200, or about 1 per cent., on the high figure of 196,600 recorded in 1927. The number of sows is less by 3,600, and that of boars by 100, while other pigs show an increase of 1,500.

AGRICULTURAL RETURNS FOR SCOTLAND, 1928.

PRELIMINARY STATEMENT for 1928, compiled from the Returns collected on 4th June; and comparison with 1927. The figures for 1928 are subject to revision.

CROPS AND GRASS.

Distribution.	1928.	1927.	Increase.		Decrease.	
	Acres	*Acres.*	*Acres.*	*Per Cent.*	*Acres.*	*Per Cent.*
TOTAL AREA (excluding WATER)	19,069,403	19,069,403	..	..	..	..
TOTAL ACREAGE under all CROPS and GRASS (*a*)	4,673,000	4,681,000	..	..	8,000	0·2
ARABLE LAND	3,141,000	3,168,000	..	..	27,000	0·9
PERMANENT GRASS (*a*) — For Hay ..	172,000	167,000	5,000	3·0	..	..
PERMANENT GRASS (*a*) — Not for Hay ..	1,360,000	1,346,000	14,000	1·0	..	..
PERMANENT GRASS (*a*) — TOTAL ..	1,532,000	1,513,000	19,000	1·3	..	..
Wheat	61,000	67,000	..	..	6,000	9·0
Barley (including Bere)	114,000	117,300	..	..	3,300	2·8
Oats	882,000	897,000	..	..	15,000	1·7
Mixed Grain	1,800	1,200	600	50·0	..	..
Rye..	3,500	3,800	..	..	300	7·9
Beans (to be harvested as Corn)	3,700	3,600	100	2·8	..	..
Peas	500	400	100	25·0	..	..
Potatoes	145,000	147,000	..	..	2,000	1·4
Turnips and Swedes	377,000	377,000	..	..	..	..
Mangolds	1,200	1,100	100	9·1	..	..
Sugar Beet	3,500	10,300	..	..	6,800	66·0
Cabbage	4,300	4,200	100	2·4	..	..
Rape	11,900	12,900	..	..	1,000	7·8
Vetches, Tares, Beans, Peas, Mashlum, etc., for Fodder	11,000	11,500	..	..	500	4·3
Small Fruit	8,000	8,000	..	..	..	..
RYE-GRASS and other ROTATION GRASSES and CLOVER — For Hay	401,000	399,000	2,000	0·5	..	..
RYE-GRASS and other ROTATION GRASSES and CLOVER — Not for Hay ..	1,101,000	1,097,000	4,000	0·4	..	..
RYE-GRASS and other ROTATION GRASSES and CLOVER — TOTAL	1,502,000	1,496,000	6,000	0·4	..	..
OTHER CROPS	4,200	3,600	600	16·7	..	..
BARE FALLOW	6,400	6,100	300	4·9	..	..

LIVE STOCK.

Distribution.	1928.	1927.	Increase.		Decrease.	
	No.	*No.*	*No.*	*Per Cent.*	*No.*	*Per Cent.*
Horses used for Agricultural purposes (including Mares for Breeding)	126,400	129,500	..	..	3,100	2·4
Unbroken Horses (including Stallions) — One year and above ..	16,800	17,200	..	..	400	2·3
Unbroken Horses (including Stallions) — Under one year ..	5,200	5,700	..	..	500	8·8
TOTAL	148,400	152,400	..	..	4,000	2·6
Other Horses	18,800	19,700	..	..	900	4·6
TOTAL OF HORSES	167,200	172,100	..	..	4,900	2·8
Cows in Milk	354,900	355,400	..	..	500	0·1
Cows in Calf, but not in Milk..	49,400	49,300	100	0·2	..	..
Heifers in Calf	53,000	55,600	..	..	2,600	4·7
Bulls being used for Service	17,200	17,600	..	..	400	2·3
Other Cattle:—Two years and above ..	199,300	208,400	..	..	9,100	4·4
,, ,, One year and under two ..	284,200	276,800	7,400	2·7	..	..
,, ,, Under one year	251,300	247,300	4,000	1·6	..	..
TOTAL OF CATTLE	1,209,300	1,210,400	..	..	1,100	0·1
Ewes kept for Breeding	3,240,900	3,239,200	1,700	0·1	..	..
Rams to be used for Service in 1928	89,700	90,700	..	..	1,000	1·1
Other Sheep:—One year and above . ..	979,900	995,000	..	..	15,100	1·5
,, ,, Under one year	3,194,400	3,210,600	..	..	16,200	0·5
TOTAL OF SHEEP	7,504,900	7,535,500	..	..	30,600	0·4
Sows kept for Breeding	23,100	26,700	..	..	3,600	13·5
Boars being used for Service	2,600	2,700	..	..	100	3·7
Other Pigs	168,700	167,200	1,500	0·9	..	..
TOTAL OF PIGS	194,400	196,600	..	..	2,200	1·1

(*a*) Excluding Mountain and Heath Land used for grazing.

SCIENCE AND PRACTICE.

The following extracts and summaries are supplied by members of the staffs of Scottish agricultural colleges and scientific institutions or are taken from recent bulletins of the International Institute of Agriculture. Full references to the original publications may be obtained on application to the Secretary, Board of Agriculture, York Buildings, Edinburgh.

CROPS AND SEEDS.

Introduction into France of the Lombardy Method of Haymaking. *M. Paon et Dornon. Comptes rendus de l'Académie d'Agriculture de France, Paris*, 1927, *t. XIII, No.* 29.—The methods of haymaking (" foin brun ") used in Italy, especially round Brascia, Chiari and Lonato, has been introduced with successful results by Italian immigrants into the South-West of France. The method is as follows :—The grass is cut before flowering; it is then left to wilt *in situ* for one or two days in normal weather of a good season; it is turned once on the second day, but a complete drying is avoided; if wet it is put in heaps and allowed to heat; it is then loaded and removed, to be unloaded and made into ricks or put in silos, heaping up the fodder as much as possible. Advantages are :—easy use and higher nutritive value; saving of labour. Disadvantages :—necessity for continuous watch (risk of fire) during its fermentation in the rick (30–40) days; the hay, though excellent for milch cows, does not suit horses or draught animals in general.

Self-Fertilisation in Relation to Forage Crop Improvement. *Lawrence E. Kirk, Scientific Agriculture, Volume VIII, No.* 1. *September* 1927.—The writer describes the results of self-fertilisation studies with alfalfa, brome grass, and red clover in relation to vigour of growth, seed production, winter-hardiness, and reduction in variability in morphological characters.

The object was to study biologic phenomena associated with self-fertilisation from a practical plant-breeding point of view.

Methods which had yielded promising results with maize were used to a greater or less extent with a large number of widely different kinds of crops. Selfed lines of alfalfa were on the average markedly reduced in vigour of growth. Inbreeding alfalfa resulted generally in a progressive decrease in yield with each of the three generations of selfing. Red clover was different from alfalfa, in that a greater reduction in vigour was observed in the first generation of selfing. With brome grass, however, relatively little reduction in vigour of growth was observed. The results obtained with this crop seemed to be more nearly in agreement with those which had been obtained for timothy.

Second and third generations selfed lines of alfalfa demonstrated the fact that inbreeding tended to isolate types which were as distinct from each other as the most strongly contrasted varieties.

Selection within self-fertilised lines appeared to provide a promising mode of attack for the breeding of improved varieties of alfalfa.

The experiments with brome grass showed that it was possible to secure satisfactory quantities of self-fertilised seed for purposes of breeding by the method of selection within self-fertilised lines. Characters of high and low fertility were apparently inherited. By selfing, lines were obtained which were more uniform than the commercial variety in practically all morphological characters. With one or two exceptions all the selfed lines appeared to be perfectly healthy and vigorous, but most of them yielded less than plants from cross-fertilised seed. Red clover possessed a high degree of self-sterility, but it was found that a small proportion of red clover plants were fairly self-fertile when artificially self-pollinated. The results obtained strongly supported the conclusion that controlled pollination with selection in self-fertilised lines provided a logical mode of attack in the systematic breeding of those crop plants which are normally cross-pollinated.

Dry-Rot of Swedes and Turnips: Its Cause and Control. *By G. H. Cunningham, Mycologist, Biological Laboratory, Wellington.* (*New Zealand Department of Agriculture, Bulletin No.* 133.)—The following is taken from the author's summary :—Dry-rot was first recorded in New Zealand in 1905; since then it has become the most serious disease of swede and soft turnips.

An intensive series of cultural experiments has demonstrated (*i*) that it may persist for several weeks in mummied bulbs lying on the surface of the ground, a source of infection which can persist only so long as the bulb escapes decay; (*ii*) that it is carried in the seed.

The spores are embedded in mucilage within the pycnidium. The mucilage is highly hygroscopic, consequently during wet weather it swells and is forced from the pycnidium through an opening provided for the purpose as a long tendril in which the spores are embedded. During wet weather the mucilage is partially dissolved and the spores washed in raindrops to the bulb by way of the channelled surface of the petiole, or carried from an infected to a healthy plant by means of contiguous leaves coming in contact with tendrils, the spores in turn being washed from these leaves to the bulbs.

Spread being governed by the amount of moisture present in any one area, it is evident the disease is most severe in low-lying areas and general only where rainfall is abundant. In dry seasons or dry localities it may be slight or absent.

The casual organism has been found to consist of several strain-groups, which are characterised by their growth-curves, colour of the mycelium produced on standard media, degree of sporulation, whether staling or non-staling types, whether staining the media or not. Cultures of *Phoma lingam, P. napobrassicæ, P. brassicæ* and *P. oleracea*, obtained from abroad, all fall into certain of these strain-groups.

Phoma lingam has in New Zealand been found on swede, turnip and cabbage. Hosts elsewhere recorded are also appended following the technical description.

A detailed description of the symptoms produced on leaves, stems, siliquas and bulbs is given.

Laboratory experiments in control have been dealt with fully. The treatment finally adopted—steeping seed for one hour in Semesan 0·25 per cent. solution held at 115° F.—has been shown to give complete control without appreciable damage to the seed, provided the latter is of high germination.

This method has been tried out on a field scale, but results were mostly unsatisfactory in that contamination of the treated areas was frequent through the use of cultural implements, &c., though where contamination has been avoided complete control was secured.

Blindness in Barley. *W. A. Millard and R. Burgess. University of Leeds, Pamphlet No.* 151, 1927.—It was found that " blindness " or " deafness " in barley was of two kinds. One, which has been called " Striped Blindness," a symptom of which disease was discoloration of the affected ear, was due to the action of the striped fungus (*Helminthosporium gramineum*). The other, which has been called " True Blindness " or " Physiological Blindness " or " Gapping," may be observed from soon after the ear has emerged from the sheath by the transparent appearance of the affected spikelets. In this case there is no discoloration of the ear. This form of " blindness " was much more common than " Striped Blindness."

The cause or causes of " True Blindness " are uncertain, but it appears that the disease is transmitted from one generation to the next. The conclusion reached was that Thrips, a small insect, is an important factor in the extent of this complaint and that the complaint is hereditary. Certain varieties were much more susceptible to " blindness " than others. Standwell and Plumage were very susceptible; Brewer's Favourite and Golden Pheasant less susceptible; Spratt Archer, Plumage Archer, Archer Goldthorpe, Binder, Primus and Gold appeared to be highly resistant. There was less " blindness " in early-sown crops than in later-sown crops.

Artificial Drying of Crops. *W. Aitkenhead. Some Stock and Grain Drying Results. Agricultural Engineering, Bridgmann, Mich.*, 1928, *Vol.* 8, *No.* 8, *pp.* 218–219, *illust.*—An account of experiments on alfalfa and soya bean stacks carried out at Purdue University in 1926.

The general plan is similar to that developed at the Institute of Agricultural Engineering, Oxford, but in the Purdue drier the hot combustion gases are mixed with the air blown into the sack. The fan has a capacity of 7,000 cubic feet per minute. Six gallons of kerosene were consumed per hour in heating the air to 190° F., the atmospheric temperature being about 60° F. The fan power necessary was 16 h.p. Proper precautions were taken to prevent the entry of sparks into the stack, a deflector eliminating any heavy material and a steel wool mesh catching the light particles afterwards.

Stacks dried.—The stacks were built over a conical pole frame, an air trench 18 inches square leading into the centre of the cone having been previously dug out and boarded over. The first stack was a 5 ton one of fresh cut alfalfa. It was found that the inside cone had been made too small and the building had not been done evenly enough. Thus after four hours blowing some parts were dry from centre to circumference, whilst in others the hay was still wet at the outside. Two soya bean stacks of 12 and 8 tons were next attempted. The former was greatly overdried by 11 hours' blowing. The latter was well dried by 5 hours' blowing at 150° F. In both cases the stacks were cooled by turning off the heat and blowing cold air for an hour. Both were in good condition when threshed two weeks later. A heavy shower preceded the building of the last, a 10 ton alfalfa stack. It was blown for 7½ hours at a temperature of 162° F. Owing to uneven building it dried somewhat patchily, but the small areas of damp did no harm to the dry hay when stored. Without artificial drying this hay would probably have been lost.

The cost of fuel for heater and tractor came to 63 cents per ton of green hay. In the opinion of the writer the availability of a crop drier is an insurance against losses in a wet season.

SOILS.

The Relation of the Concentration of Calcium Ion required by Alfalfa to the Amount present in the Soil Solution. *Harold W. E. Larson, Oregon Agricultural Experimental Station. Soil Science, XXV*, 5, 399 (1928).—Experiments carried out with water cultures for the purpose of studying the calcium requirement of the alfalfa plant appeared to indicate that the minimum concentration of the calcium ion required by alfalfa is in the region of 16 parts per million. The most economical growth, however, was produced with a concentration of about 32 parts per million, and excessive quantities of calcium did not appear to be toxic to the plant.

Further experiments on the water-soluble calcium content of certain soils indicated that the amount present was lower than that necessary for satisfactory growth of alfalfa in culture solution. The application of sulphur or ground limestone to these soils had the effect of increasing the amount of water-soluble calcium.

It is probable that the application of ground limestone to many soils would be beneficial not only from the soil reaction standpoint, but would also prove of nutritional value to such crops as alfalfa.

A "Deficiency Disease": The Lack of available Manganese in a Lime-induced Chlorosis. *Basil E. Gilbert and Forman T. M'Lean, Rhode Island Agricultural Experimental Station. Soil Science, XXVI*, 1, 27 (1928).—The authors call attention to the results of experiments on the correction of chlorosis as noted on crops growing on neutralised soils. The experiments extend over a period of three years, and the results indicate that the yellowing of the plant, resulting from the lack of available manganese, may be prevented or remedied by applications to the soil of small amounts of manganous sulphate. This may be applied either incorporated with the chemical fertiliser application or as a solution in the form of a spray to the growing plants. Evidence is given which indicates that better results are obtained when the manganous salt is applied in the form of solution.

The Calcium Carbonate: Soil Equilibrium and the Lime Requirement. *Sante Mattson, Bureau of Soils, U.S. Department of Agriculture. Soil Science, XXV*, 6, 429 (1928).—When calcium carbonate is added to a soil, part of the calcium is absorbed by the soil and part, through the agency of the liberated carbon dioxide, passes into solution as calcium bicarbonate.

Experiments appear to indicate that by estimating this absorbed calcium a measure of the degree of unsaturation and hence the lime requirement of a soil may be obtained. The author describes a method of estimating this absorbed calcium by placing the soil material plus water in a parchment bag, which is brought in contact with a paste of calcium carbonate for a period of seven days till the soil-calcium carbonate equilibrium is obtained. The soil material is then removed from the bag and the calcium replaced by the action of a solution of ammonium chloride and estimated in the usual manner.

ANIMAL BREEDING.

Horses.

Causes of Variations in the Length of the Period of Gestation in Mares. *F. Bilek. La Revue de Zootechnie, Paris*, 1928, *year* 7, *No.* 1.—Making use of a large number of animals the writer has studied the various influences due to the mare, the sire, or to the offspring itself, which contribute to the lengthening or shortening of the duration of the period of gestation.

The material of the paper was supplied by the stud books of the Czechoslovak breeding stud of Kladrub, as well as the stud books of some other races reared in the country.

Among the influences which, on the part of the mare, mainly affect the duration of the period of gestation is noted precocity according to the breeds, which is shown in the following table :—

Average duration of the period of gestation in various breeds of horses.

	Old breed of Kladrub.	English thorough-bred.	English half-bred.	Noric breed.	Belgian breed.
Average duration of gestation days	345·425	337·725	337·749	335·852	333·789
Limits of variation ... ... ,,	312–379	299–381	301–374	289 383	304–364

Heavy draught breeds, more precocious than riding breeds, have generally shorter periods of gestation. The duration of gestation is an individual character, expressing a determined constitution and influenced by the endocrine system which causes a great precocity or a delayed maturity of the individual; in fact, if the first period of gestation of a mare is short, the average duration of successive gestations is also short. This duration is a hereditary character: it has been mathematically ascertained that fillies of mares with long gestations have also long gestation. Pigmented mares often have shorter periods of gestation than those non-pigmented.

It has also been observed that mares of the old Kladrub breed have now a longer period of gestation than a century ago, which may be explained by the selection of well-shaped stallions, of greater height and consequently more backward. For English half-bred mares the same comparison shows on the other hand an insignificant difference, scarcely greater than the average probable error.

The duration of gestation of mares which foal in summer is greater than that of mares which foal in autumn and winter; this may be attributed to the greater amount of exercise which the animals take in the fine season. No relationship was found between the age of the mare, the number of her foalings and the length of gestation. Mares covered by young stallions have often shorter gestations than those covered by stallions of advanced age. The fœtus itself can, by its endocrine system, have much influence on the duration of gestation. It is not possible to generalise the idea that twin foalings always follow a shorter period of gestation.

In light draught breeds male foalings have longer periods of gestation than female; in heavy draught breeds (Noric and Belgian) no difference was noted. The greater degree of precocity in the latter undoubtedly suppresses the influence of sex. According as the age of the mares advances the number of male foalings is increased; it is probably a case of very complicated modification of their internal secretion determining an ageing of the two forms of spermatozoa or a different resistance. With older stallions there is more often procreation of male foals than with young stallions, which on the contrary engender a greater number of female foals; this is no doubt due to the changing vitality of the two kinds of spermatozoa which show themselves in the stallion, the boar and the bull. It should, however, be noted that all the various influences above referred to should be considered apart and should not be aggregated.

Pigs.

The Influence of certain environmental Factors on the Development of Bacon Hogs. *R. D. Sinclair and J. P. Sackville, Scientific Agriculture, Ottawa,* 1927, *Vol. VIII, No.* 4.—The objects of this three year trial at the University of Alberta, 1923–24–25, were to compare results of :—(1) self-feeding and limited hand feeding; (2) skim-milk *versus* tankage; (3) pasture *versus* dry lot management; (4) different methods of feeding and breeding, as affecting the bacon produced.

A summary of the conclusions reached would be as follows :—(1) Self-feeding gave better results in the development of the select bacon type than limited hand feeding, and may therefore be confidently recommended in case of labour scarcity. (2) Self-fed pigs slaughtered will invariably conform to the bacon standard in underline and tend to yield a carcase with thicker, firmer body. (3) Tankage produced a slightly higher percentage of " selects " than skim-milk, but the carcases revealed a higher percentage of suitable " Wiltshires " in the skim-milk fed group. (4) Pigs fed solely on grain developed a coarseness of hair and bone and a tendency to excessive paunchiness, consequently a smaller percentage of selects or Wiltshires. (5) Under conditions obtaining in the experiment little difference was noticeable between quality of carcass from pasture fed and dry lot fed pigs, nor did exercise appear to induce greater length of carcass. (6) Generally speaking, carcass dimensions were not modified significantly by any particular ration or method of feeding.

Poultry.

New Breed of Spanish Poultry. *E. Castelló. Mundo avicola, Arenys de Mar*, 1927, *No.* 72.—After ten years' continuous work the writer has succeeded in creating a new breed of white poultry called "Paraíso," which is a valuable step in the industrialisation of agriculture. It results from crosses between the native "Prat" breed and a white Orpington cock, and between the ordinary native breed and a White Rhode Island cock. The birds possess plenty of fine quality meat and weigh 2·3 to 3·0 kg., reaching 3·0 to 4·5 kg. when adult. The "Paraíso" cockerels attain sexual maturity early, and the pullets rarely start to lay at later than six months from hatching. The eggs are of medium weight and size, the average yearly number being from 130 to 145, though more than 25 per cent. lay over 150 in their first year. They sit well and the chicks grow and feather quickly.

ANIMAL NUTRITION.

Protein and Lime in the Ration of Fattening Pigs. *T. J. Shaw, J. Min. Agr.*, 35, 1928, *p.* 342.—The investigation quoted was undertaken to demonstrate the effect on the growth, food requirements, cost of production and the quality of the carcase of pigs when fed rations deficient in lime and in protein. Three pens of six newly-weaned pigs were used and the basal ration consisted of middlings and barley meal. The ration of Pen A was balanced by the addition of lime and a specially prepared meat meal with a low mineral content. Pen B had a similar ration but without the addition of lime, while Pen C had lime but no meat meal.

The pigs on the complete ration made the best and most economical gains throughout the experiment, putting on an average of 1·2 lbs. live weight increase at a cost of 4·2*d*. per lb. The pigs in Pen B grew normally till about 18 weeks old, after which the growth rate slowed down, and most of the pigs went off their feed. Over the entire experiment, the pigs in this group put on 0·95 lbs. live weight increase at a cost of 4·85*d*. per lb. The pigs in Pen C made small increases in growth up to the age of 24 weeks, after which they grew rapidly. The average daily gain per pig was 1·1 lbs. at a cost of 4·6*d*. per lb. The pigs in Pen B were 37 days and those in Pen C 14 days longer in attaining bacon weight than the pigs in Pen A on the balanced food.

A deficiency of lime in the ration, therefore, appears not only to affect the rate of growth but also the health of the pig. A deficiency of protein limits growth very appreciably during the earlier stages of fattening, but has little or no effect during the final feeding period.

The Anti-Rachitic Properties of Cod Liver Meals. *Bethke, Zinzalian, Kennard and Sassaman. J. Agr. Res.*, 36, 1928, *p.* 747.—In the production of cod liver oil from the livers of cod fish there remains a residue, which in recent years has been dried and sold in the open market under the name of "Cod Liver Meal." It has already been shown that cod liver oils may vary greatly in their vitamin A and D content, and the authors set out to determine how far these cod liver meals differed in their anti-rachitic properties. As a result of experiments on chickens and rats, it has been shown conclusively that the dried residues remaining after the extraction of oil from fresh cod livers vary markedly in their anti-rachitic properties, and that the anti-rachitic variation was not proportional to the residual fat-content of the livers, nor did the ether-extractable fraction prove nearly as potent as ordinary cod liver oil.

The authors conclude, therefore, that it would be unwise to use the cod liver meal as an anti-rachitic substitute for a good grade of cod liver oil in either poultry or live stock production.

Substitutes for Fish Meal in the Rations of Fattening Pigs. *H. R. Davidson. J. Min. Agr.*, 35, 1928, *p.* 409.—This report gives a summary of experiments carried out at various Institutes in Britain, working in collaboration, on the value of fish meal as a food for pigs and on the use of proteins of vegetable origin, buffered with mineral mixtures, as substitutes for fish meal. In evaluating the results of the various experiments the quality of the carcases produced was taken into consideration in addition to the rate of live-weight increase on the different rations. As a result of numerous experiments it has been shown that the value of fish meal for feeding to pigs as a supplement to a ration of cereals is associated with the protein, and particularly with the amount and proportions of the mineral ingredients. The oil in fish meal not only appears to be of no special value for growth, but to have a slightly depressing effect on live-weight increase. Vegetable proteins, when used in proper proportions and when carefully supplemented by mineral mixtures, give as good results as the animal protein in fish meal. In neither case, however, was a carcase of first-class quality obtained.

Of the various vegetable proteins used in the investigation, extracted soya-bean meal gave the best results. Minerals may be supplied separately from the rest of the ration, either in the form of a simple mixture in one box or individually in a box containing four or five compartments. If supplied individually, compartments should be provided for (1) ground limestone, slaked lime or chalk; (2) bone meal; (3) common salt; and (4) a mixture of coal and wood ashes. It was also found that the quality of the fat and the conformation of the carcase are not always best in the case of pigs with the greatest live-weight increase.

Soy Beans and Soy Bean Hay in the Dairy Ration. *O. G. Schaefer. Agricultural Experiment Station, Minnesota, Bull.* 239, *August* 1923.—Results of experiments are given to test the value of soy beans and soy bean hay for milk production. In the first test soy beans were compared with linseed oil meal, in which the latter proved slightly more valuable than the ground soy beans. Soy beans, however, proved superior for butter-fat production. It was found that, for all practical purposes, 1 lb. of ground soy beans will replace 1 lb. of linseed oil meal in the dairy ration. Feeding on ground soy bean supplement resulted uniformly in raising the percentage of butter fat in the milk. The average butter fat for the ground soy bean group was 4·01 per cent. as compared to 3·82 per cent. for the linseed oil meal group.

In the second test, soy bean hay was compared with timothy hay. Here the soy bean hay proved more palatable than the timothy, the consumption of soy bean hay being 34 per cent. greater. The feeding of the soy bean hay instead of the timothy resulted in a 46 per cent. saving of concentrates. Feeding the low protein timothy hay required the purchase of 53 per cent. concentrates as compared to only 5 per cent. when soy bean hay was fed.

DAIRYING.

Sunflower Silage *versus* **Corn Silage for Milk Production.** *H. O. Henderson and W. Gifford. W. Va. Agr. Expt. Sta. Bul.* 210 (1927).—In a series of three trials with 28 cows it was found that 96 per cent. as much milk and 98 per cent. as much butter fat was produced on sunflower silage as on maize silage. It was concluded that sunflowers would make a satisfactory substitute for maize as a silage crop where the latter could not be grown.

The Effect of High and Low Protein Rations on the Food Value of Milk for Calves. *C. C. Hayden and W. E. Krauss. Oh. Agr. Expt. Sta. Bimon. Bul.* 13, *No.* 2, *pp.* 55–58 (1928).—One group of cows was fed a ration with a nutritive ratio of 1 : 2, while the nutritive ratio in the ration of another group was 1 : 13. The milk from these groups was fed to calves which had suckled their dams for three days after birth. At three to four weeks of age lucerne hay and a grain mixture were introduced into the rations of the calves.

The growth of the calves on the milk of the cows fed the low protein ration tended to lag somewhat until hay and grain were fed, but after that there were no differences of note. It was concluded that the method of feeding the cows had no influence on the value of the milk for calves.

The Influence of Temperature and certain other Factors upon the Percentage of Fat in Milk. *E. Weaver and C. A. Matthews. Ia. Agr. Expt. Sta. Res. Bul.* 107 (1928).—The percentage of fat in milk varies with the season, being highest in the first half of winter, declining in the second half of summer, and then rising throughout the autumn. It was also found that when temperatures were low the butter-fat percentage was high.

The butter-fat percentage tended to be high immediately after calving, declined for two or three months and then rose. An advance in the stage of gestation was also followed by an increase in fat content of the milk.

Influence of Environment and Breeding in increasing Dairy Production—III. *E. Weaver, C. A. Matthews and H. H. Kildee. Ia. Agr. Expt. Sta. Bul.* 251 (1928).—This is the third report on a breeding test which has been running for 21 years. Pure-bred bulls of the Guernsey, Friesian and Jersey breeds have been used to grade up a herd of scrub cows. Records of several generations are now available.

The first three generations of grades were not only more abundant producers than their scrub ancestors, but they were more economical in their use of feed and they returned greater profits over feed costs. The fourth generation of grades did not prove to be quite as good as the third generation.

Of the 14 pure-bred bulls used, 3 were valueless, 4 were very valuable, while the others were quite fit for use in reasonably good herds.

Effect of Pasteurisation on Tuberculous Milk. *A. Michel. Ann. falsf.* 21, 101–3 (1928).—The experiments conducted by Michel establish the fact that commercial pasteurisation (145° F. for 10 min. or 150° F. for 5 min.) is effective in completely destroying the tuberculosis bacillus.

Concentrated Sour Skim Milk. *U.S. Dept. Agric. Circ.* 404.—A convenient method of utilising surplus separated or skim milk is to convert it into semi-solid or concentrated sour milk. This may be done by inoculating the pasteurised (or raw) skim milk with an active culture of *B. bulgaricus* and a yeast (*mycoderma sp.*), and incubating the inoculated milk at 104°–112° F. until it reaches an acidity of 1·8–2·0 per cent. lactic acid. It is then condensed in a vacuum pan to about one-third of its original volume. This gives a product with a pasty texture and an acidity of approximately 6 per cent. which inhibits the growth of bacteria and yeasts. Its principal use is as a poultry food.

Effect of the Duration of Keeping on the Pasteurisation of Milk. *A. Wolff. Milchwirtschaftliches Zentralblatt, Hanover* 1927, *year* 56, *No.* 11.—The writer pasteurised at 62°–63° C. samples of milk which had been kept for various periods and at various temperatures. By means of cultures on agar and gelatine to control the number of germs per cubic centimetre, the writer noted that the number and percentage of germs which survived pasteurisation were higher in samples of milk kept for some hours before pasteurisation than in those pasteurised immediately after milking. Moreover, the latter were more stable than those kept for some hours at various temperatures before pasteurisation.

MISCELLANEOUS.

An Agricultural Week by Radiotelegraphy.—The *Union des Grandes Associations Françaises pour l'Essor National* organised from Saturday, 10th March, to Sunday, 18th March 1928, with the help of the *Société* and the *Union Centrale des Syndicats des Agriculteurs de France,* a week of agricultural radiotelegraphy with the object of disseminating information on the products and actual conditions of French agriculture. Two public meetings were held in the large hall of the *Société des Agriculteurs de France* on 10th and 16th March. Addresses of great interest were given by both the chairmen on the agricultural crisis and on organisation of the farmers. Other addresses and lectures were given during the week.

The wide range of the subjects under discussion made it impossible to examine more than a few points, but this pioneer experiment of the farmers of France will be followed by others elsewhere, and the most powerful method of modern propaganda will be made available for agriculture, a pursuit which has so far said too little about itself.

STATISTICS.

PRICES of AGRICULTURAL PRODUCE, FEEDING STUFFS and FERTILISERS in June, July and August 1928.

Live Stock : Monthly Averages of Prices at certain representative Scottish Markets.

(Compiled from Reports received from the Board's Market Reporters.)

Description.	June. 1st Quality	June. 2nd Quality	June. 3rd Quality	July. 1st Quality	July. 2nd Quality	July. 3rd Quality	August. 1st Quality	August. 2nd Quality	August. 3rd Quality
FAT STOCK :—									
*Cattle—	per cwt. s. d.	per cwt. s. d.	per cwt. s. d.	per cwt. s. d.	per cwt. s. d.	per cwt. s. d.	per cwt. s. d.	per cwt. s. d.	per cwt. s. d.
Aberdeen-Angus ...	74 4	67 2	51 6	73 2	66 3	50 6	70 4	63 2	45 11
Cross-bred (Shorthorn)	69 7	62 7	45 4	67 8	60 9	44 3	64 0	57 4	40 11
Galloway	68 0	62 0	...	67 1	60 3	..	60 0	55 5	...
Ayrshire	67 3	55 6	40 6	61 9	52 3	39 0	59 7	50 2	39 10
Blue Grey	74 5	...	...	71 10	...	...	...	...	...
Highland	...	...	...	63 6	...	...	...	...	...
	per lb. d.	per lb. d.	per lb. d.	per lb. d.	per lb. d.	per lb. d.	per lb. d.	per lb. d.	per lb. d.
†Veal Calves	15	8½	5	15	8½	5	15	8½	5
†Sheep—	Hoggs under 60 lb. per lb. d.	60 lb. and upw'ds. per lb. d.	Ewes per lb. d.	Hoggs under 60 lb. per lb. d.	60 lb. and upw'ds. per lb. d.	Ewes per lb. d.	Hoggs under 60 lb. per lb. d.	60 lb. and upw'ds. per lb. d.	Ewes per lb. d.
Cheviot	17	16	11½	15¼	14½	10¾	14¼	13¼	10½
Half-bred	16	...	10	15	14¼	9½	13¾	13	9
Blackface	16¼	15¾	11	14¼	14	10¼	13	12½	9¾
Greyface	16¼	16	11¼	15¼	14½	10¼	14	13	9¼
Down Cross	16¾	16	8½	15¾	14¾	8¼	14	13	8
†Pigs—	per stone. s. d.	per stone. s. d.	per stone. s. d.	per stone. s. d	per stone. s. d.	per stone. s. d.	per stone. s. d.	per stone. s. d.	per stone. s. d.
Bacon Pigs	11 4	10 0	...	11 7	10 1	...	11 6	10 3	..
Porkers	11 5	10 3	...	11 7	10 3	...	11 9	10 5	...

* Live weight. † Estimated dressed carcase weight.

Live Stock : Monthly Averages of Prices at certain representative Scottish Markets—*continued.*

Description.	June. 1st Quality	June. 2nd Quality	June. 3rd Quality	July. 1st Quality	July. 2nd Quality	July. 3rd Quality	August. 1st Quality	August. 2nd Quality	August. 3rd Quality
STORE STOCK :—									
Cattle—	Per head.	Per head.	Per head.	Per head.	Per head.	Per head.	Per head.	Per head.	Per head.
Aberdeen-Angus :	£ s.	£ s.	£ s.	£ s.	£ s.	£ s.	£ s.	£ s.	£ s.
Yearlings	18 4	14 18	12 7	18 17	14 12	12 13	17 13	14 4	13 0
Two-year-olds ...	25 8	20 15	16 11	24 17	20 0	16 15	24 11	19 19	15 17
Cross-bred (Shorthorn) :									
Yearlings	16 19	13 9	11 1	16 16	13 7	11 4	15 15	12 19	12 0
Two-year-olds ...	24 4	19 10	16 8	23 17	18 13	16 0	23 2	18 12	15 10
Galloway :									
Yearlings	15 18	...	...	14 1	...	...	14 15	11 0	...
Two-year-olds ...	24 13	...	...	22 15	18 13	...	...	18 0	...
Ayrshire :									
Yearlings	10 19	...	...	11 13	10 10	...	...	...	...
Two-year-olds ...	16 10	...	...	17 10	15 10	...	...	...	..
Highland :									
Yearlings	10 19	9 11	7 13	11 11	9 0	7 8	10 8	8 5	6 5
Two-year-olds ...	15 3	12 17	11 0	14 5	12 9	...	...	...	...
Three-year-olds ...	18 8	14 11	13 10	...	15 8	13 15	...	...	...
Dairy Cows—									
Ayrshire :									
In Milk	28 13	20 0	11 10	29 5	21 3	12 0	28 6	21 5	12 0
Calvers	28 8	20 9	13 15	28 12	21 7	14 10	28 1	21 1	14 6
Shorthorn Cross :									
In Milk	30 4	20 13	...	31 12	22 6	20 13	31 8	22 1	19 0
Calvers	28 5	19 19	15 11	30 19	21 8	16 18	30 8	21 11	17 5
Sheep—	s. d.	s. d.	s. d.	s. d.	s. d.	s. d.	s. d.	s. d.	s. d.
Cheviot Hoggs ...	50 3	39 8	34 0	52 6	...	...	...	...	...
Half-bred Hoggs ...	50 0	49 8	...	...	48 11	38 6	...	...	...
Blackface Hoggs ...	40 1	29 6	23 6	45 0	...	...	...	...	...
Greyface Hoggs ...	53 5	45 5	38 8	55 0	43 9	...	...	...	...
Down Cross Hoggs	...	46 6	...	...	...	...	...	...	...
Pigs—									
(6 to 10 weeks old)	26 1	16 3	...	23 11	15 7	...	23 11	15 10	...

DEAD MEAT: Monthly Average Prices at Dundee, Edinburgh, and Glasgow.

(Compiled from Reports received from the Board's Market Reporters.)

Description.	Quality.	June.			July.			August.		
		Dundee.	Edinburgh.	Glasgow.	Dundee.	Edinburgh.	Glasgow.	Dundee	Edinburgh.	Glasgow.
BEEF:—		per lb. d.	per lb. d.	per lb. d.	per lb. d.	per lb. d.	per lb. d.	per lb. d.	per lb. d.	per lb. d.
Home-fed—										
Bullock or Heifer ...	1	11⅞	11½	12½	12	11¼	12½	10⅞	9⅞	12¼
	2	11⅛	...	11½	11	10	10⅞	10¼	...	9⅞
Bull	1	8⅞	8⅝	9	9	8½	8¾	8¼	7⅞	8
	2	8	7⅜	8½	8	7	8¼	7¼	6⅝	7½
Cow	1	7¾	7	8⅞	7½	7⅛	8⅜	7	6⅝	7¾
	2	7⅛	...	8⅜	6½	6	7⅞	6	...	7
Irish—										
Bullock or Heifer ...	1	...	...	10⅝	...	...	9⅝	...	...	8½
	2	...	...	10⅜	...	...	9⅛	...	...	7¾
Argentine Frozen—										
Hind Quarters ...	1	...	7¼	6½	...	8⅛	6½	...	7½	7
	2	..	6⅛	6	...	7⅛	6	...	6¼	6½
Fore ,, ...	1	...	4¾	4¼	...	4⅞	4¼	...	4⅝	4¼
	2	...	4⅜	4	...	4⅛	4	...	4¼	4
Argentine Chilled—										
Hind Quarters ...	1	8¼	8⅛	8¼	7⅞	7⅝	8	8½	8⅛	8¼
	2	7¼	7⅞	7¾	...	6⅝	7½	8¼	7⅝	7⅝
Fore ,, ...	1	5¼	5⅛	5¼	4¾	4½	4⅝	4⅞	4⅝	4¾
	2	4¾	4⅝	4⅞	...	4⅛	4¼	4⅝	4⅝	4⅝
Australian Frozen—										
Hind Quarters ...	1	...	...	5½	...	...	5½	...	...	6⅞
	2	...	...	5	...	...	5	...	...	6⅜
Crops	1	...	..	4	...	...	4	...	...	4
New Zealand Frozen—										
Hind Quarters ...	1	...	...	6	...	...	6	...	...	7
	2	..	...	5½	...	...	5½	...	...	6½
Fore ,, ...	1	...	...	4	...	...	4	...	...	4
MUTTON:—										
Hoggs, Blackface ...	under 60 lb.	17½	15	15¼	15½	12⅛	12⅜	13⅜	10⅞	10½
	60 lb. & over	...	...	14¾	...	...	11⅞	11⅜	...	9⅞
,, Cross	under 60 lb.	17½	15	15¼	15½	12¼	12⅜	12⅜	10¾	10½
	60 lb. & over	...	...	14¾	...	...	11⅞	11⅜	...	9⅞
Ewes, Cheviot	1	...	9½	10⅜	...	8⅜	9¾	...	7¾	7⅞
	2	...	...	9⅞	...	...	9¼	...	...	7½
,, Blackface ...	1	11¾	9½	10⅜	11	8⅜	9¾	9¾	7¾	7⅞
	2	10	...	9⅞	10	...	9¼	9¼	...	7½
,, Cross	1	9	9½	8⅜	8	8¾	7⅜	7	7¾	6⅛
	2	...	...	7⅜	...	...	6¾	...	...	5⅝
Argentine Frozen ...	1	...	...	6½	...	...	6½	...	6½	6½
	2	...	...	5½	...	...	5½	...	5¾	5½
Australian ,, ...	1	...	6⅞	6	...	6½	6	...	6½	6
	2	...	5¾	5½	...	6	5½	...	5⅞	5½
New Zealand ,, ...	1	...	...	7	...	...	7	...	...	7
	2	...	...	6	...	...	6	...	...	6
LAMB:—										
Home-fed	1	17⅛	16	16⅝	16	14½	14	13	12⅛	11⅞
	2	...	...	16⅛	...	...	13½	...	...	11⅜
New Zealand Frozen ...	1	...	11⅛	10½	...	10⅞	10⅜	...	10⅞	10¼
	2	...	10⅜	10	...	10⅜	10	...	10¼	10
Australian ,, ...	1	...	...	8¾	...	...	8¾	...	...	8¾
	2	...	...	8½	...	...	8½	...	...	8½
Argentine ,, ...	1	...	...	8	...	...	8	...	...	8
	2	...	...	7¾	...	...	7¾	...	...	7¾

PROVISIONS: Monthly Average Wholesale Prices at Glasgow.

(Compiled from Reports received from the Board's Market Reporter.)

Description.		Quality.	June. s. d.	July. s. d.	August. s. d.
BUTTER:					
Irish Creamery	per cwt.	1	170 3	176 3	181 2
,, (Unsalted) ...	,,	1	173 3	180 3	185 0
Danish	,,	1	175 6	182 3	189 2
,, (Unsalted) ...	,,	1	179 3	186 9	194 2
New Zealand	,,	1	179 0	186 0	190 10
,, (Unsalted) ...	,,	1	181 6	188 0	193 7
Australian	,,	1	170 3	178 0	176 5
,, (Unsalted) ...	,,	1	...	180 0	180 0
Siberian	,,	1	164 0	165 0	166 0
Swedish	,,	1	...	178 9	182 5
CHEESE:					
Cheddar	,,	1	101 3	115 6	125 7
		2	98 0	110 0	117 7
Cheddar (Loaf)	,,	1	...	130 0	132 0
Dunlop	,,	1	99 8	114 0	119 7
		2	98 0	107 0	111 7
Canadian...	,,	1	...	115 4	116 7
New Zealand (Coloured)	,,	1	108 9	114 6	119 5
,, (White)	,,	1	108 9	114 6	119 5
BACON:					
Ayrshire (Rolled) ...	,,	1	129 6	130 6	132 0
Irish (Green)	,,	1	126 0	126 0	126 10
,, (Dried or Smoked)	,,	1	134 0	134 0	134 10
,, (Long Clear) ...	,,	1	119 0	120 6	126 10
Wiltshire (Green) ...	,,	1	128 3	129 0	125 7
,, (Dried or Smoked)	,,	1	135 3	136 0	132 7
American, Short Clear Backs	,,	1	92 6	97 0	103 2

Description.		Quality.	June. s. d.	July. s. d.	August. s. d.
BACON—*continued.*					
Canadian Sides	per cwt.	1	104 0	103 6	100 0
Danish Sides	,,	1	110 0	116 0	115 10
Dutch, Wiltshire Style (Green)	,,	1	101 0	101 0	101 7
HAMS:					
Irish (Smoked)	,,	1	187 0	187 0	193 0
		2	171 0	170 0	176 10
American, Long Cut (Green)	,,	1	100 0	109 9	123 2
American, Short Cut ...	,,	1	98 0	106 6	121 10
EGGS:					
Country	per doz.	1	1 5	1 6	1 10
		2	1 4	1 5	1 9
Irish	per 120.	1	12 2	13 4	17 0
		2	11 5	12 2	15 9
,, (Duck)	,,	1	11 5	10 2	14 3
Belgian	,,	1	11 6	12 5	16 0
		2	11 0	11 9	15 1
Danish	,,	1	14 3	13 3	15 4
		2	13 6	11 9	13 6
Dutch	,,	1	10 3	11 9	15 0
,, (Duck)	,,	1	11 5	9 9	...
Swedish	,,	1	14 0	12 11	16 2
		2	13 3	11 9	16 0
Polish	,,	1	8 7	8 2	10 1
		2	7 5	...	...
Russian	,,	1	8 7	8 5	10 5
		2	7 4	7 0	10 3

FRUIT AND VEGETABLES: Monthly Average Wholesale Prices at Glasgow.

(Compiled from Reports received from the Board's Market Reporter.)

Description.	Quality.	JUNE.	JULY.	AUGUST.
FRUIT:—				
Apples—		s. d.	s. d.	s. d.
American ... ... per case.*	1	...	...	15 10
Australian ... ... ,,	1	14 8	14 6	15 6
Tasmanian ... ... ,,	1	14 0	...	...
New Zealand .. ... ,,	1	...	16 8	18 3
Pears, *South African* per box of 25.	1	7 6	...	...
Greengages, *Imported* ... per lb.	1	...	0 9½	0 9
Gooseberries, *British* ... ,,	1	...	0 3	0 2½
,, *Imported* ... ,,	1	0 2½	0 2	0 2
Strawberries, *Scotch* ... ,,	1	...	0 9½	1 0
,, *English* ... ,,	1	1 0	0 6½	...
Currants, Black ... ... ,,	1	...	0 9¼	1 1
,, Red ... ... ,,	1	...	0 8	0 7¾
Plums, Victoria ... ... ,,	1	...	...	0 7
VEGETABLES:—				
Beet ... ... per cwt.	1	18 0	6 0†	4 10†
Cabbage, Coleworts ... per doz.	1	1 6	1 8	2 6
Carrots ... ... per doz. bunches.	1	5 11	4 5	4 2
Cauliflowers, *Dutch* ... per doz.	1	5 8	5 0	5 0
Cucumbers ... ... per doz.	1	5 6	5 6	5 10
Lettuce, Cabbage ... ,,	1	1 8	1 6	2 0
Onions, *Valencia* ... per bag.**	1	...	13 6	12 1
,, *Egyptian* ... ,,‡	1	9 6	8 0	...
,, *Spring* ... ... per bunch.	1	0 11	0 11	0 6
Parsley ... ... per cwt.	1	37 6	28 0	16 0
Peas ... . ,,	1	...	24 0	20 10
Rhubarb ... ... ,,	1	4 9	5 0	6 0
Tomatoes, *Channel Islands* per lb.	1	0 8½	0 6½	0 6
,, *Home-grown* ... ,,	1	0 10½	0 8	0 7½
,, *Dutch* ... ,,	1	...	0 5	...
Turnips ... ...per doz. bunches.	1	4 6	4 9	4 6

* 40 lbs. (approx.). ** 9 stones (approx.). ‡ 8 stones (approx.). † Per doz. bunches.

POTATOES : Monthly Average Wholesale Prices at Dundee, Edinburgh, and Glasgow.

(Compiled from Reports received from the Board's Market Reporters.)

MARKET.	Quality.	First Earlies.	Second Earlies.	Late Varieties. Red Soils. Golden Wonder.	Late Varieties. Red Soils. Other.	Late Varieties. Other Soils. Golden Wonder.	Late Varieties. Other Soils. Other.
		£ s.	£ s.	£ s.	£ s.	£ s.	£ s.
JUNE.							
Dundee per ton.	1	...	...	...	...	...	9 0
Edinburgh ,,	1	11 10	...	...	...	...	12 0
Glasgow ,,	1	...	...	16 0	12 0	13 7	10 13
JULY.							
Dundee ,,	1	7 13	...	...	...	...	8 0
Edinburgh ,,	1	7 8	...	...	...	...	...
Glasgow ,,	1	7 15	...	...	..	...	...
AUGUST.							
Dundee ,,	1	7 0	6 7	...	...	...	...
Edinburgh ,,	1	6 12	5 15	...	...	...	...
Glasgow ,,	1	7 0	7 9	...	...	...	...

ROOTS, HAY, STRAW, AND MOSS LITTER : Monthly Average Prices at Dundee, Edinburgh, and Glasgow.

(Compiled from Reports received from the Board's Market Reporters.)

MARKET.	Quality.	Roots. Carrots.	Roots. Yellow Turnips.	Roots. Swedes.	Hay. Rye Grass and Clover.	Hay. Timothy.	Straw. Wheat.	Straw. Barley.	Straw. Oat.	Moss Litter.
		s. d.	s. d.	s. d.	s. d.	s. d.	s. d.	s. d.	s. d.	s. d.
JUNE.										
‖ Dundee ... per ton.	1	...	...	40 0	117 6 † 112 6 ‡	...	57 6	57 6	57 6	52 6*
Edinburgh ,,	1	...	...	...	108 9 † 108 9 ‡	...	50 0‡	37 6§	50 0‡	...
‖ Glasgow ,,	1	...	...	...	80 0 †	85 0†	45 0	...	45 0	31 0**
JULY.										
‖ Dundee ... ,,	1	...	...	...	125 0 † 120 0 ‡	...	70 0	...	60 0	52 6*
Edinburgh ,,	1	...	...	...	103 9 † 100 0 ‡	...	50 0‡	37 6§	50 0‡	...
‖ Glasgow ,,	1	...	...	...	85 0 †	85 0†	40 0	...	42 6	31 0**
AUGUST.										
‖ Dundee ... ,,	1	...	...	...	122 0 † 106 6 ‡	...	68 0	...	60 0	52 6*
Edinburgh ,,	1	...	...	...	90 0 † 82 0 ‡	...	50 0‡	...	46 0‡	...
‖ Glasgow ,,	1	...	...	...	85 0 †	85 0†	40 0	...	42 6	31 0**

Baled Straw delivered.
Baled and delivered.
Delivered loose.

§ Baled : on rail at Musselburgh.
* Foreign (ex quay).
** Home (in 1½ cwt. bales).

FEEDING STUFFS: Monthly Average Prices at Glasgow and Leith.

(Compiled from Reports received from the Board's Market Reporters.)

Description.	June.		July.		August.	
	Glasgow.	Leith.	Glasgow.	Leith.	Glasgow.	Leith.
	per ton. £ s. d.	per ton. £ s. d.	per ton. £ s. d.	per ton. £ s. d.	per ton. £ s. d.	per ton. £ s. d.
Linseed Cake—						
Home	12 10 0	12 0 0	12 10 0	12 2 6	12 17 6	12 12 0
Foreign	12 3 9	...	12 10 0	...	12 12 0	...
Decorticated Cotton Cake	12 1 3	12 0 0	12 5 0	12 5 0	...	12 5 0
Undecorticated Cotton Cake— Bombay (Home-manufactured)...	8 6 3	7 15 0	8 5 0	7 16 11	8 5 0	7 16 6
Egyptian... ...	8 15 0	..	...	...	9 0 0	...
Palmnut Kernel Cake	11 3 9	...	11 2 6	...	11 2 6	..
Soya Bean Cake ...	13 8 4	11 15 0	13 3 4	11 11 3	13 2 0	11 18 9
Coconut Cake ...	12 0 0	...	12 4 2	...	12 8 6	...
Groundnut Cake, Undecorticated— 37 per cent. Oil and Albuminoids	10 1 11	...	10 0 0	...	10 2 0	...
40 per cent. do.	10 7 6	...	10 6 8	...	10 5 6	10 2 6
Maize Germ Cake— Home	...	..	11 4 2	...	11 19 0	...
Foreign	...	..	11 5 0	...	...	...
Maize Germ Cake Meal	10 15 0	...	10 17 6	...	10 18 4	...
Barley Meal ...	12 11 3	11 15 0	12 2 6	11 10 0	12 0 6	11 6 8
Bean Meal	13 18 2	12 7 6	13 17 6	12 10 0	13 16 0	12 10 0
Maize Meal— Home Manufactured	12 13 2	11 16 11	12 13 9	11 18 9	12 3 6	11 10 0
S. African (Yellow)	11 5 0	9 15 0	11 7 6	...	11 4 6	9 17 6
Do. (White)	10 6 3	...	10 11 3	...	11 4 6	...
Rice Meal	9 0 0	...	9 0 0	...	8 14 0	...
Locust Bean Meal ...	10 5 8	10 0 0	10 6 8	9 12 6	10 0 0	9 10 0
Locust Beans, Kibbled & Stoned	9 10 10	9 5 0	9 10 0	9 5 0	9 12 0	9 5 0
Maize Gluten Feed (Paisley) ...	10 0 0	...	10 1 3	...	10 5 0	...
Maize—Plate ...	11 12 6	11 1 11	11 5 10	11 2 6	11 0 0	10 11 6
Do. American No. 2 (Mixed)...	...	...	11 2 6	...	11 1 6	...
Oats—Home ...	12 16 11	13 3 9	12 12 6	12 15 0	11 14 6	11 10 0
Do. Plate ...	12 8 4	...	11 6 3	...	9 18 0	...
Do. Canadian No. 2	12 10 0	...	...	...	10 13 2	9 18 0
Do. do. No. 3	12 8 9	...	12 0 9	...	10 6 6	...
Barley Feeding ...	11 5 8	10 15 0	11 7 6	10 5 0	10 14 0	...
Do. Bran ...	10 16 8	...	10 15 0	...	9 17 0	...
Wheat—Home ...	11 12 6	11 15 0	11 13 2	10 17 6	11 5 0	9 11 0
Do. Imported...	11 10 0	...	11 12 6	...	9 15 0	
Malt Culms... ...	8 5 0	...	7 18 9	...	7 19 0	...
Distillery Mixed Grains—Dried	9 6 3	9 5 0	9 2 6	9 3 9	9 13 6	9 7 6
Brewers' Grains—do.	8 18 9	8 18 9	9 0 0	8 5 0	9 1 0	8 4 0
Distillery Malt Grains—Dried	8 18 4	...	9 0 0	..	9 1 11	...
Wheat— Middlings (Fine Thirds or Parings)	10 12 6	9 13 9	10 15 0	10 1 3	10 15 0	10 6 0
Sharps (Common Thirds) ...	8 9 5	8 12 6	8 16 11	8 12 8	9 0 0	8 14 6
Bran (Medium) ...	7 18 2	7 13 9	8 0 8	7 13 2	8 9 0	8 4 0
,, (Broad) ...	8 2 6	8 12 6	8 5 8	8 8 2	8 16 0	8 19 0
Feeding Treacle ..	6 17 6	7 0 0	7 0 0	7 0 0	7 0 0	7 0 0
Crushed Linseed ...	21 2 6	...	21 0 0	...	20 13 6	...
Fish Meal	20 5 0	22 0 0	20 8 4	21 2 6	19 16 0	20 0 0
Beans—English ...	13 1 3	...	13 0 0	...	13 0 0	...
Do. China ...	12 10 0	...	12 10 0	...	12 10 0	...
Do. Rangoon (White)	10 8 2	...	10 11 3	...	10 15 0	...
Do. Sicilian ...	...	...	...	...	12 10 0	...
Pease, Calcutta (White)	12 2 6	...	12 0 0	...	13 4 0	...

FERTILISERS : Monthly Average Prices at Glasgow and Leith.

(Compiled from Reports received from the Board's Market Reporters.)

Description.	Guaranteed Analysis.	June. Glasgow.	June. Leith.	July. Glasgow.	July. Leith.	August. Glasgow.	August. Leith.
	%	per ton. £ s. d.	per ton. £ s. d.	per ton. £ s. d.	per ton. £ s. d.	per ton. £ s. d.	per ton. £ s. d.
Nitrate of Soda ...	N. 15½	11 5 0	11 7 6	11 5 0	11 7 6	11 5 0	11 7 6
Sulphate of Ammonia (Neutral and Granular) § ...	N. 20·6	10 13 0	10 13 0	...	10 13 0	10 0 0	10 0 0
Superphosphate ...	S.P. 30	2 7 6	...	2 7 6	...	2 7 6	...
"	S.P. 35	2 12 6	...	2 12 6	...	2 12 6	...
Bone Meal—Home	N. 5, I.P. 40	9 0 0	...	9 0 0	...	9 0 0	...
" " Indian	N. 3¾, I.P. 45	9 0 0	...	9 0 0	...	9 0 0	...
Steamed Bone Flour	N. 1, I.P. 60	6 10 0	...	6 10 0	...	6 10 0	...
Ground Mineral Phosphate † ...	I.P. 58/60	2 3 6	...	2 3 6	...	2 3 6	...
Basic Slag	T.P. 26	*2 8 0	...	...	...	...	...
" "	" 28	*2 11 6	...	...	...	...	..
" "	" 30	*2 15 6	...	...	..	...	...
" "	" 40	...	‡2 15 0	...	...	...	...
" "	PH.A. 11	...	...	...	...	*2 1 9	...
" "	" 12	...	...	*2 2 9	...	*2 2 9	...
" "	" 13	...	...	*2 3 9	...	*2 3 9	...
" "	" 14	...	...	*2 5 9	...	*2 5 9	...
" "	" 15	...	...	*2 7 9	...	*2 7 9	...
Sulphate of Potash (on basis of 90 per cent. purity)	Pot. 48·6	11 2 6	...	11 2 6	...	11 2 6	...
Muriate of Potash... (on basis of 80 per cent. purity)	Pot. 50	9 0 0	...	9 0 0	...	9 0 0	...
Potash Salts ...	Pot. 20	3 10 0	...	3 10 0	...	3 10 0	...
" " ...	Pot. 30	4 17 6	...	4 17 6	...	4 17 6	...
Kainit (in bags) ...	Pot. 14	3 1 0	...	3 1 0	....	3 1 0	...

Abbreviations:—N. = nitrogen ; S.P. = soluble phosphate ; I.P. = insoluble phosphate ; T.P. = total phosphate ; PH.A. = Phosphoric Acid.

§ Carriage paid in 6-ton lots.

† Fine grist 80 per cent. fineness through standard 100 mesh sieve; 80 per cent. fineness through 120 mesh sieve 2s. 6d. per ton dearer.

* Carriage paid to Lanarkshire and Renfrewshire. ‡ Foreign slag at Leith.

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