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The Scottish Journal of Agriculture.

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SCOTTISH AGRICULTURE.

Its Present Position and Future Prospects.

THE period of depression through which the agricultural industry in this country has been passing is engaging the serious attention not only of farmers themselves, but of all sections of the community. The decline in agriculture is adversely affecting other spheres of national effort, and there is a growing appreciation of the necessity for improving the conditions and prospects of the industry.

It was thought that at this time readers of the JOURNAL would be interested to view the problem, as it affects Scotland, through the eyes of experienced observers. A number of individuals whose prominent association with our national agriculture entitles them to speak with authority were accordingly invited to contribute a brief note on the subject.

We desire to express our cordial thanks to those gentlemen who willingly accepted the invitation to express their views for the benefit of our readers. The contributors are :—

The Duke of Atholl, K.T., G.C.V.O., C.B., D.S.O.
The Duke of Montrose, C.B., C.V.O.
Lord Lovat, K.T., K.C.M.G., D.S.O.
The Right Honourable Sir John Gilmour, Bart., D.S.O., M.P.
Sir Archibald Sinclair, Bart., C.M.G., M.P.
Sir Harry Hope, M.P.
Major C. R. Dudgeon, M.P.
Major Walter Elliot, M.C., M.P.
Mr. Joseph Duncan, Secretary, Scottish Farm Servants' Union.
Mr. J. C. Henderson, President of the Scottish Chamber of Agriculture.
Professor J. Hendrick, B.Sc., F.I.C., North of Scotland College of Agriculture.
Mr. J. H. Milne Home.
Lieut.-Colonel W. T. R. Houldsworth, President, Ayrshire Cattle Herd Book Society.
Major J. Keith.
Mr. J. A. Lennox, ex-President of National Farmers' Union of Scotland.
Mr. John Mackie, Chairman of Governors of the North of Scotland College of Agriculture.

Mr. A. W. Montgomerie.
Principal W. G. R. Paterson, B.Sc., N.D.A., West of Scotland Agricultural College.
Professor E. Shearer, M.A., B.Sc., Principal, Edinburgh and East of Scotland College of Agriculture.
Major Mark Sprot, President of the Scottish Agricultural Organisation Society.
Mr. J. P. Ross Taylor, President of the National Farmers' Union of Scotland.
Mr. J. Harling Turner, C.B.E., F.S.I., Chairman of Governors of the West of Scotland Agricultural College.
Professor J. A. Scott Watson, M.C., B.Sc., Professor of Agriculture, Oxford University.

The Right Honourable William Adamson, M.P., Secretary of State for Scotland, and Mr. Thomas Johnston, M.P., Under Secretary of State, have been good enough to write introductory statements.

The Secretary of State:—

All who have the welfare of Scotland at heart must wish that its agriculture should prosper, for agriculture is the basis of all its industry, and the very foundation of its social structure. To most readers of this JOURNAL that is perhaps a mere commonplace, but I state it here in order to emphasise the fact that by none is that view more strongly held than by the present Government, of which I have the honour to be a member.

It is therefore with pleasure that I commend for consideration the weighty and representative opinions contained in the following pages, and I thank the writers for their kindness in contributing them. Neither I nor any other reader will agree with all the views expressed, but whether we agree or disagree, their publication should assist in concentrating public attention on the agricultural problems of the day, and in stimulating thought that may aid in solving them.

It is, unfortunately, only too true that a large and important section of Scottish farmers are passing through a period of great economic difficulty. It is equally true, I think, that there is not available any single specific remedy for their trouble. The Government has already, in various ways, given practical proof of its desire to help; whatever further action it is practicable for it to take will be taken. But the farmers too must do their share, as I am sure they will, by adapting their methods, so far as may be, to changing conditions, and by considering, on their merits and without prejudice, new ideas regarding both the production and the marketing of their produce. No one who has the confidence that I have in the skill and energy of the Scottish farmer and farm worker can believe that Scottish agriculture is doomed to failure. Given the hearty and broad-minded co-operation of all men of goodwill, whether they be in Parliament or on the farm, in the laboratory or in the market place, we can face the future with reasonable hope of success.

(Signed) WM. ADAMSON.

The Under-Secretary of State:—

The Secretary to the Department of Agriculture for Scotland asks me to contribute a brief prefatory note to a symposium on "The Present Condition and Future Prospects of Scottish Agriculture." The title-piece sounds somewhat like a toast at a banquet; but there is no subject of more serious economic and indeed racial import to the people of Scotland. If our agriculture be in such condition that the "fermoraris" of the ground, as they used to be called in the old law books in the days when we had a Parliament of our own, are unable to win a little prosperity and comfort from their labours, then is our national outlook black and menacing.

We may lose our trade in chocolate mice, sky advertisement signs and the like, and still survive. But woe betide us if we cannot make such arrangements in our body politic that agriculture, the oldest, the most important, the most necessary of our industries, secures to its participants an adequate guarantee of the necessities and comforts of life. It is said that a city family unless fed by fresh country blood dies out in four generations. That may or may not be strictly accurate, but it is true that our national brawn and strength is maintained generation after generation by those who cultivate the fields and herd the flocks on the hills, and it is our urgent national business to create such conditions as will maintain a virile population on the land. Otherwise we perish.

As I see it we must devote labour and capital to the better organisation of our marketing and to the avoidance of gluts. We must stop the scramble for what is often an uneconomic price. We must eliminate the waste of competition when co-operation would save time and money to the harassed producer. We must grade our products. We must apply brains and capital to drainage, to the destruction of pests and to the prevention of disease. In other words, the great problem before this generation—and never in our history have we had a generation better fitted in every way to tackle the problem—is how to ensure that the agricultural producer will receive a bigger share of the produce of his labour, and that there will be a bigger and a better quality product to divide.

(Signed) THOMAS JOHNSTON.

The Duke of Atholl:—

We all know what the present condition of Scottish agriculture is, but it is difficult to foretell the future.

There is nothing actually wrong with the system of Scottish agriculture, and that it is not flourishing in an economic sense is due to causes outwith its own control. If anyone could tell me what is to be the future political policy of this country, I should have little difficulty in telling him what the future of agriculture would be. Whether for evil or for good, politicians of Great Britain decided many years ago to support industrialism and to sidetrack agriculture. Much of the political interest taken in agriculture during the last fifty years has been directed more towards improving the conditions of people on the land rather than towards improving agriculture itself.

Politically it may still suit this generation to obtain its food from abroad below the cost at which our farmers can produce it; but if this continues, more and more land will go out of cultivation, and some day the people of this country will find that they have lost not only the farm hands but the farms. When that day comes, they will be entirely dependent upon outside sources for the whole of their existence, and will have to pay the price. A countryside filled with bungalows for jaded city workers will be but a poor exchange for the farms, from which springs the human stock which rejuvenates the blood of the people in our cities.

Science, improved methods of cultivation, sugar beet instead of turnips, broccoli, Brotex for paper making, co-ordination in marketing, marking eggs and branding bacon are really only palliatives, or else secondary to production, and do not get down to the bottom of the whole trouble, and that trouble is unfair foreign competition. When I say "palliatives," I mean that, though improvements in agriculture are absolutely necessary in order to make the soil produce its best, many of these improvements are common to all nations, and therefore can and will be used against us as well as in our favour, or else leave us just where we are; when I say "unfair competition," I refer to difficulties raised against us, both natural and created in other parts of the world.

If this country is not prepared to pay a reasonable price for a good article grown in this country, the people of this country will alone be to blame if the agricultural population leaves the rural districts.

For our grain and meat we have to compete against the vast areas lying overseas, and for the sake of a fiscal shibboleth we are prepared to knuckle under even to subsidized oats from

Germany. Was it for this that the flower of our farming stock served and died in the late war? And yet with our great population we have the finest market in the world if we choose to use it.

We see much trumpeted missions going to the Argentine, the net result of which is that the Argentine agrees to purchase our manufactured goods if they are of the right quality and of a price which suits them. In return, we are asked to sign an agreement that *never* shall there be taxation on any articles of food that they send us, though they reserve the right of taxing everything we send them.

The cost of living generally has increased since before the war, and it is right that the wages of farm hands should increase in proportion; it is right that the labourer should live in a modern, sanitary house; it is right that his child should have all the education at school that it can usefully assimilate. But if we concede the above, we must surely also concede the full safeguarding of and, if possible, an increase in the wage fund and general income of the industry. How this is to be done under our present fiscal system is beyond my comprehension.

Keeping boys at school when they might be learning to work, giving them doles to keep them from working, the general increase of taxation for many objects no doubt good in themselves but which we cannot afford, are all a burden on agriculture, while high death duties have bankrupted the greatest of the agricultural funds.

If we were to treat the foreigner as he treats us, things would be different. Our present system of giving subsidies and doles to our people only makes them blind to the facts of foreign competition, and is in effect the giving of a subsidy to our competitors who, in order to sell in our market, ought to be contributing to our standard.

We have apparently anchored ourselves to the fetish of " not " cheap food, but food below the cost of production. We insist upon a certain standard of living and we do not encourage work. Therefore, it is of no use to blame the landlord, the farmer, or the farm hands. Killing off each in turn and giving the next on the list part of the goods of the last killed will not mend matters. If we pursue the present policy, the best of our agricultural lands will drop into grass, and the worst of our grass will go back into moorland; that is what is happening now. It is ridiculous to say that, where large farms cannot make both ends meet, small holdings will save the situation. Nationalisation will not help matters, as the financial burdens will be the same and the outside competition will be similar.

Can anything be done to ease the trouble? I think it can, and while it may not cure the disease, it may at least make it less painful and wasting. The remedy lies in better co-operation in buying and in selling. This means the elimination of the middleman as we know him, and using his profits and expert knowledge more to the direct advantage of producers and consumers. The producer is seldom a good salesman. Farming is one thing; selling is another, and each requires a different type of brain. On the other hand, there is not room for these two independent profits. Anything that would tend to stabilise prices would help the farmer to budget. State-managed institutions are proverbially expensive, but I believe that large selling organisations, assisted and fathered by the State in which the industry is interested, are a not impossible partial solution. Otherwise some form of control of the price received by the farmer and paid by the consumer, whereby both would benefit, might be arranged.

This of course brings us down to standardisation of price according to quality; but it cannot be effective unless imports are controlled and also contribute. If we could settle what a fair price should be, we should also settle that the foreign goods should be sold at the same price and should not be allowed to undercut us in our own market. Further, our farmers should, so far as is possible, be given flat or freight rates for the principal agricultural commodities to the principal home markets, no matter how distant they may be, as a set off against the flat and cheap freights from overseas.

At present we tax all our own commodities, directly or indirectly, but admit foreign and possibly bounty-fed products free. Timber gives as good an example as any of the principle, as it takes thirty years to mature and is taxed for income tax and death duties, while foreign wood gets in free. Yet timber-growing, if treated sensibly and reasonably, keeps more people on poor land than anything else. The result is that private people have had to stop planting. It all seems so silly. Ordinary agriculture is going the same way.

The Duke of Montrose:—

The existing depression in agriculture would seem to be due, in a large part, to this country being over-industrialised, and the balance between urban and landed interests not being equally adjusted. The result of this lop-sided situation is that political measures in general are biased and in favour of the towns rather than the land.

For instance, in manufacture, shipbuilding, engineering or mining it is generally recognised that all labour must be up to Trades Union standard; and all labour not so, shall be considered as "black-leg." If the conditions of the industry show that importation of foreign goods, made under unfair conditions, prevents our manufacturers from competing and maintaining Trades Union standards, it is held that a case has been made out for "safeguarding"; and necessary steps can be taken by a modified tariff, or otherwise, to shelter the industry and those who work in it.

But it has been declared that no matter what "black-leg" imports come into this country and affect agriculture, this industry alone, of all industries, shall remain unsheltered; and those who work in it must therefore rest content with inferior conditions and wages.

Mr. Thomas, the Cabinet Minister specially in charge of Employment, has declared with wisdom "that one cannot get more out of an industry than there is in it"; and it is obvious that if Scottish agricultural prices have to be maintained at a low level to meet the assault of foreign "black-leg" imports (often bounty fed), then Scottish wages and Scottish farming generally must remain at a depressed level. When German oats are imported at 6*s*. 11*d*. per cwt. c.i.f. prices, and Dutch potatoes at £2 per ton, it would seem as if some enquiry ought to be made as to the wages paid and the conditions under which they are produced.

In face of facts such as these, the Three Party Conference, for which Mr. Noel Buxton has just issued invitations, ought not to be debarred from examining the question of extending the Safeguarding Act in the case of imports of agricultural produce where it can be shown that these are produced under inferior labour, sanitary or social conditions compared to those enforced upon growers in this country.

Every effort ought to be made to raise the standard of wages in the foreign countries supplying produce to Britain, and when that standard equals our own, then all claim for safeguarding will have disappeared.

There is need in Scotland for a very much more sympathetic attitude towards landed interests than rules at present, and if this prevailed it would have some effect in improving rural life. Why should not capital invested in afforestation of land, farm buildings, cottage buildings, and lime quarries be free for ten years from income tax and surtax? This would undoubtedly encourage money to flow to our own productive industries rather than to overseas enterprises.

What is wanted is greater inducement for people to sink their money in our own land and not abroad. This would in turn give employment and probably more genuine work than can be found in many of the so-called "unemployment schemes." Marketing conditions, organisation and co-operative effort all require attention, but none will succeed unless agriculture and rural life are first made possible and reasonably profitable.

Lord Lovat:—

Communications.—On the mainland of the Northern Highlands nearly £1 per ton is paid on all deliveries by rail from manufacturing centres and approximately the same sum on agricultural produce despatched to the consuming centres, even when such exports are forwarded in bulk. Agriculture cannot bear such a burden. Many lines of production which formerly paid their way are being abandoned. A considerable number of the higher-lying crofts are going out of cultivation, while others not suitably situated for employment are being left derelict.

Attention has frequently been called in Parliament to the necessity for improved transport facilities in the Inner and Outer Hebrides. A similar need exists in the case of the mainland of the Northern Highlands. The whole question of coastal communications—East Coast as well as West—piers, freights, &c., calls for early attention.

Drainage.—On the average Scottish estate drainage on any considerable scale is seldom put into practice except when agricultural prosperity is such that landlord and tenant can each pay his share of the cost. I offer the opinion that we are only now beginning the era of replacement of drains constructed during the last extended period of agricultural prosperity. The driblets of drainage money given by the last and present Governments are barely sufficient to "mark time" in this respect, let alone make any progress towards improvement in the drainage of Scottish agricultural land as a whole. If any real advance is to be made, and the agricultural land of Scotland is to be put in a position to give increased yields and offer opportunities for increased employment, the State's contribution must be extended relatively as well as absolutely.

At the present time the position of agriculture is such that neither farmers nor landowners are in a position to make an adequate contribution.

Lime.—Much of the land of Scotland is short of lime. Thirty years ago limestone quarries and lime kilns were to be seen in many of the districts where suitable rock existed. In the latter part of last century and in the beginning of this, the increased cost of labour, improved machinery, railway facilities, &c. caused the production of lime to be concentrated at a few specially selected centres. It would appear to-day that we should seriously consider whether resort should not again be made to local production in view of (1) the satisfactory results obtained from the use of ground lime; (2) the efficiency and low cost of small hydro-electric schemes; (3) the extension of the "grid"; (4) high railway freights; (5) the relative cheapness of road transport; (6) the Government grants or guarantees which can be obtained under one or other of the unemployment schemes.

Scrub Bulls.—For many years Ireland has been buying well-bred Scottish bulls for crossing with commercial cattle. In 1928-9 the Soviet of Russia embarked on the same line of action.

Whether Scotland will continue to maintain her supremacy in commercial feeding stock will depend to a considerable extent on the bulls which are used in the breeding herds.

The question is of sufficient importance to warrant investigation by a Committee of feeders and commercial breeders assisted by a leading authority from the School of Animal Genetics, so that practice and theory may be combined in a single enquiry.

Statistics.—It is often asked whether the statistics produced by the Departments of Agriculture in Great Britain are as helpful as those produced by similar Departments in new and, it is sometimes suggested, more progressive countries. What the intelligent farmer wants to know is not only whether the crops grown in his own country or the amount of stock held there are equal to or greater than those of previous years; but also to have some idea of world production, so that he can fix his farm policy with some knowledge of world demands and world prices. The wheat situation to-day is a case in point. Statistical authorities are agreed that the World carry-over of wheat (May 1929) from the northern hemisphere crops of 1928 and the southern hemisphere crops of early 1929 was the greatest on record.

In view of the comparative failure of wheat crops in Northern America, the droughts in Australia, rust trouble in the Argentine, it would be interesting to many Scottish farmers to have a summary of the returns of the Departments concerned on which the estimates for the World carry-over of May 1930 will be founded.

Sir John Gilmour:—

"The poor husbandman who lives honestly and cultivates his land industriously is better than a proud philosopher who neglects himself, and studies the motions of the heavenly bodies." So wrote Thomas à Kempis about 1400.

To-day the problem of agriculture is one of world competition, to the accurate study of which the philosopher may contribute—and the heavenly bodies represented by droughts and frosts may play a decisive part between success or failure.

To cultivate the land industriously must ever be the real basis of agriculture, and our people must have a love of the soil and a live interest in their work.

Scientific research applied to soil so that the greatest yield may be obtained, efficient drainage and sufficient liming or use of other suitable fertilisers call for greater attention.

The use of the best stock and the elimination of scrub bulls and indifferent rams can alone permit of early maturity and profit in stock raising.

The study of marketing and mutual association in the purchase and sale of agricultural commodities points the way to progress.

My belief that the future prosperity of agriculture in the main depends on the partners in the industry themselves is strengthened by experience as a farmer, and as one lately responsible for administration as Secretary of State for Scotland.

That the present condition of agriculture is not without its difficulties may be readily admitted; but its future lies in an intelligent use of past experience, combined with scientific and organised efforts of production, sale, and distribution; the eradication of disease; and improved, and above all cleanly, methods of production to command public confidence.

The State and Parliament can no doubt materially assist by wise negotiations with Foreign Powers and the Dominions on all questions affecting the industry; by the maintenance of an efficient Department of Agriculture charged with the duty of promoting the interest of every branch of an intricate and varied pursuit from the smallest to the largest holding.

And perhaps the most hopeful line for the future the State can foster and develop is agricultural research. This should be co-ordinated through the colleges, institutes, and universities, and should be linked up by the Empire Marketing Board with scientific workers in every part of the British Empire.

Sir Archibald Sinclair :—

The less said about the present condition of agriculture the more space to discuss its future prospects—a less depressing topic. I look to the future with hope. Scottish farmers, Scottish farm labourers and Scottish farm stock have no equal in the world; although farmers are passing through a period of the utmost difficulty and deserve our wholehearted co-operation, there are signs that better times are at hand.

In the first place there is the prospect of a considerable—and from the farmer's standpoint not unwelcome!— diminution in our supplies of beef from the Argentine—supplies which, as Sir William Haldane has proved in a remarkable series of articles in *The Times*, cannot in a substantial measure be replaced from sources overseas. Then there is the increasing strength of the consumers' demand, fostered by the Empire Marketing Board, to which the National Mark will enable effective expression to be given, for home-grown meat and other produce. Dairy farmers can look for an increasing demand for milk, especially since the remarkable experiments carried out under the auspices of the Medical Research Council and the Empire Marketing Board have clearly demonstrated the almost miraculous results upon the health and physique of school children achieved by the simple process of adding a small ration of milk to their diet. The progress of co-operative marketing along sound lines is strengthening the economic structure of the industry. Another encouraging feature in the situation is that no country in the world possesses a better equipped and better manned group of agricultural research stations and colleges than Scotland. The organisation of their research, the arrangements for large scale experiment and the testing of results under working conditions, as well as the means of disseminating the practical knowledge thus acquired, may be capable of improvement, but by the unanimous testimony of instructed observers the quality of the work is unsurpassable. The fruitful stream of results from these research institutes which has so strongly influenced agricultural practice in every county in Scotland is swelling from year to year, and the work now proceeding on such questions as the mineral content of pastures and the eradication of bracken is not the least of the hopeful auguries for Scottish agriculture.

There are many depressing features in the situation, but progress can be made only by striving along hopeful lines of advance—not by kicking against the pricks of economic circumstance. At this crisis in the history of Scottish agriculture the Government and all political parties should rally to the support of the industry, and co-operate in creating those conditions in which its prosperity can be ensured and the Scottish countryside regenerated.

Sir Harry Hope:—

Depression in agriculture is of long standing, but, at the present time, it is in arable farming that the acute depression exists. The sheep breeding districts, especially the hill districts, are doing fairly well. In considering this situation and its effect on our national life, it is well to recognise that the maintenance of a large population in our rural districts depends on prosperity in arable land farming.

Can the nation afford to allow an industry which is of such vital importance, not only as a producer of food, but as one which supplies it with a sound and healthy stock of manhood, to wither and decay?

Thoughtful public opinion undoubtedly will say "No."

Sound and wise statesmanship will yet take steps to maintain a great asset of our national life.

Under "Free Trade," assisted by the development of modern transport and of scientific methods of "preservation," supplies of every kind of food stuffs, from every part of the globe, come to our shores. The industry does not suggest that they be stopped. It recognises that that would be impossible.

But, while they come in unhindered, the free importation of subsidised supplies—such as German wheat and oats receiving a subsidy from the German Government—should not be permitted. If preferential treatment of this kind is permitted to continue and to develop, importations of all kinds—receiving foreign subsidies—may extend and a negation of the "Free Trade" principle result.

If our foreign commercial treaties have been so loosely drafted that this procedure is technically "correct," then it is time for our Foreign Office to revise and regularise them.

The present Prime Minister has said :—"With Labour in power they could fix farmers' prices in such a way that would be good for the farmers and, at the same time, fair to the community." Here he has a chance.

We can produce all the potatoes we consume; they are the only agricultural crop which we can produce in sufficient quantities to meet our requirements. We need the foreign article only when the home crop has been a failure—and now, with scientific treatment, that never occurs.

Let a maximum price be fixed so that, as long as home produce is available, foreign supplies would not be imported.

By this means a full supply of home-grown produce would always be available at a reasonable price, and, as potatoes employ more labour in their cultivation than any other agricultural crop, employment and prosperity in our country districts would be maintained.

The agricultural industry can be helped by its own action as well as by that of the Government, and "self-help" should always come first.

Merchants and middlemen have rendered valuable services, but the evolution of events and of the methods of our competitors demand that we adopt some of their methods in the presentation of our goods and in the pruning of expenses of distribution.

More combination is needed, both for the sale of the produce and for the purchase of requirements.

The Empire Marketing Board might be the medium used for initiating a system which in time would remodel our methods and place us in line with our competitors.

Space is too short to expound other causes which prejudicially affect the industry. We will mention only two: (1) "foot-and-mouth" disease treatment, and (2) importations of foreign condensed skim milk. In the former we heedlessly neglect our own agricultural welfare by permitting hay and straw from the infected continental farms to come in as packing material; in the latter, we pass exacting legislation imposing regulations on home producers of milk, yet we permit the foreign article to come in without a sufficient guarantee that it also conforms to hygienic conditions.

How can the industry be helped? That is the all-important question.

Its welfare is vital to the national weal. Let it be taken out of the arena of "party politics." If a conference representative of all three political parties were held, we might arrive at some agreed and practical measures which might bring some relief to an industry on which the welfare and permanence of a State ever depends.

Major C. R. Dudgeon:—

The present agricultural position in Scotland calls for the most careful consideration. If the condition of agriculture in Scotland, or indeed throughout Great Britain, was exceptional to that pertaining to the industry in most civilised countries to-day, a remedy might be more easily found. Other industries are adopting methods of mass production to reduce costs, thereby ensuring extending markets for their products. It is not practicable, however, to apply mass production methods to agricultural production. The remedy for the existing widespread agricultural depression must be found in reducing the cost of distributing agricultural products, and in adopting co-operative methods of purchasing at reduced prices the necessary articles for agricultural production. Farmers, barred from mass production, must adopt mass sales and purchases.

Agricultural co-operation in Scotland, with a few notable exceptions, has made but slow headway during the last 25 years, and little progress is possible until a special section of the Department for Agriculture in Scotland is set up, with sufficient financial resources, not only to assist the voluntary agricultural co-operative societies in carrying out propaganda, but definitely to organise and, where necessary, maintain for a certain period agricultural trading organisations.

The purchase of requirements such as artificial fertilisers, concentrated feeding stuffs, seeds and implements on a co-operative basis is a comparatively easy matter; but the sale of agricultural products with a view to obtaining the best results is much more complicated, because, if extended markets are to be obtained and higher prices realised, it is necessary that agricultural produce should be systematically graded and classified under a national scheme.

Though the difficulties are great in instituting a satisfactory scheme for the grading, classification, and sale of agricultural products, they are by no means insurmountable.

My concrete suggestions are as follows :—

In areas surrounding existing marketing centres co-operative trading societies should be set up under statute. These societies would not only purchase the requirements of their members, but would be responsible for the grading of as wide a range of agricultural products as possible under national regulations.

The sale of the graded products from the local centres would be in the hands of a national organisation, and if possible it would be desirable to utilise the services of such a firmly-established institution as the Scottish Wholesale Co-operative Society. This Society would be in a position to dispose of a very considerable portion of the graded products at fixed prices to its own affiliated retail Co-operative Societies. At the same time it would be necessary to ensure that the individual retailer received adequate supplies of the graded products that were being handled solely by the central organisation.

I am firmly convinced that practically the only hope of the industry becoming really profitable and widely productive, with greater attractions for both capital and labour, is the adoption, on a national basis, of massed purchases and sales.

Major Walter Elliot:—

Scottish agriculture, in common with agriculture in other parts of the United Kingdom, is passing through a time of difficulty. It is, however, universally agreed that the agricultural industry of Scotland is standing the strain better than that of England. I think it will continue to do so. How has this position been secured?

Firstly, agriculture in Scotland partakes more universally of the character of mixed farming than is the case farther south. Secondly, Scottish agriculture has not on the whole exaggerated the importance of grain as an economic sheet-anchor of the farm. Thirdly, the Scottish farmer and the farm worker have spent an infinite amount both of personal thought and personal labour on the land.

A survey of the statistics of food consumption in this country, particularly the statistics of imports, shows quite clearly that the great economic market lies in livestock and livestock products. Roughly speaking, of every £5 we pay abroad for food we pay £4 for livestock products, and this although we buy four-fifths of our bread from overseas. We should spare no pains upon livestock and livestock problems since the market there is practically unlimited and, in some directions at least—such as sheep, eggs and milk—is still profitable. Granted that production along certain lines may be profitable, problems of production arise, and of these the two chief are food and disease. The great livestock food is grass, and we are fortunate that this island is a natural grass country. There are few if any places in the world where natural grass can be used as food for longer periods of the year or under better conditions. The grass problem is therefore of importance—to get it growing earlier, to make it grow more evenly and more continuously, and to keep it growing later in the year. The skilled handling of a grass crop requires the highest degree of farming knowledge and management. What is more, it requires, in certain directions at least, not a reduction but an increase in the amount of labour to be employed.

The problems of disease amongst livestock need only be mentioned, for all practical men know that, say, tuberculosis amongst a high-grade dairy herd or " sickness " in sheep stocks will make all the difference between success and failure. We are gradually realising, however, that this is closely bound up with the previous question, that of food; and that disease cannot be examined apart from resistance to disease, which in its turn depends very largely upon feeding. " There's jist the ae disease," said a shepherd friend of my father, " that is—poverty." He was right.

The future prospects of agriculture in Scotland are closely bound up with these two problems. They are further vitally affected by the distributor and the consumer. There are certain articles (such as wool) where the preference of the consumer cannot be greatly affected by anything that the producer can do or say. The case is different in certain other agricultural products, notably in the case of milk. Producers have not fully grasped the importance of modern advertising, and the necessity and desirability of keeping one's products before the public. The Empire Marketing Board has done much for the home farmer both in its milk-publicity campaign and in the grant for the milk-feeding tests in Scottish schools, which have awakened so great an interest in the matter. They have indeed opened up the possibility of a new mass-market for milk. This possibility should be extended by further advertising campaigns based on local figures and local knowledge.

Finally comes the question of distribution. The costs of distribution are perhaps the greatest single factor in the future prosperity of Scottish agriculture. Here we, as farmers, have been remiss and have not followed the most promising line. It is of no use to complain against the profits of the middleman, or the costs of distribution in the abstract. The only useful criticism is to show that somebody else can do it better or cheaper. If it is true that milk can be distributed in Canada and the United States for sixpence a gallon (with high-paid labour) as against one shilling a gallon here, it is our business first of all to discover (1) under what conditions this is true, and (2) how they do it. At the Empire Marketing Board we started such an enquiry into the comparative cost of milk distribution in the principal European cities and in certain American cities. These results should be to hand before very long. This is a reflection not on the distributor, not on Government Departments nor on anyone else, but on us—the farmers—that we should have waited so long and gone such a roundabout way to do this.

To sum up, I should say that certain fundamental factors of which nothing can deprive us, water, grass, climate, markets, are still there and are still to be taken advantage of. In the better use of these I think there are still good prospects for the future of Scottish agriculture.

Mr. Joseph Duncan:—

Sheep breeders have had fat years for a long time, milk producers have been reasonably remunerated most of the time, but crop growers and feeders have had a lean time for the past three years. If we consider why the differences between these classes are so great, we may estimate the prospects for all. Sheep breeders have been supplying a market short of supplies; milk producers have been working on regulated prices, and have begun to control the surplus to prevent the market being over supplied; crops and fat cattle have been sold on an overstocked market. On the productive side there is nothing to give the advantage to the sheep breeders or the milk producers; it is the market side that makes the difference.

The prospects are promising if we keep abreast of changing circumstances. We have to improve our breeding for beef if we are to keep the advantage of selling a better article than the Argentine sends us; we have to give as much attention to quality as we have given to quantity in potatoes; and we have to keep pegging away at the elimination of animal diseases. But on the whole there is nothing wrong with our farming; it is as good as farming anywhere. If we had kept our marketing abreast of our production the prospects would have been more alluring.

The beginning has been made in marketing, and the prospects of agriculture in Scotland for the next few years depend on the extent to which farmers support the selling agencies already in existence and organise others to handle potatoes, grain and meat. Marketing is now so specialised a business that the old small scale dealing which characterises Scottish marketing is quite out of date. The margins are too narrow for that method now. If farmers will stick to their business, which is farming, and develop their own selling agencies for the marketing side, the prospects for agriculture are quite good.

Mr. J. C. Henderson:—

For a year or two after the war, markets were bare of supplies, and arable, as well as sheep farmers, were rewarded with enhanced prices for their various products. Efforts to cultivate were made on even a larger scale than during the war, as an increased supply of labour was found obtainable. This, however, proved merely a transition period. As transport was gradually being placed at the disposal of our colonies and various foreign exporting countries, food supplies of all kinds increased in volume each year, causing the arable farmer to reduce his acreage of cultivation, as he found his costs increasing and his receipts rapidly diminishing.

The gradually increasing stagnation in marketing farm produce, such as grain and potatoes, is causing the gravest concern to all. Many arable farmers find themselves left with no alternative but to accept any uneconomic figure in order to meet wages and other liabilities.

Foreign agricultural produce is put on our market at low prices because of a lower wage and longer working hour basis, and in certain cases by the aid of a bounty and low freightage. These factors are overwhelming the British arable farmer, as he is unable to compete on such unequal terms, and he is compelled to lay his land down in grass. If nothing is done to remedy this state of affairs we will shortly be wholly dependent for our supplies from overseas. Such a condition would have dire consequences in the event of a national emergency.

Unless some new policy is immediately adopted the future of Scottish agriculture seems doomed, so far as the cultivation of the soil is concerned, as the various palliatives which have been suggested are quite unfitted to reach the root of the evil. The foreigner seems able to strike us harder every year, and the ability of the British farmer to hold his own is gradually weakening. The majority of farm premises are greatly in need of renovation and modernisation, but the landowner, already impoverished owing to overwhelming taxation and decreasing rentals, is generally unable to meet the necessary outlay. Wreckage lies ahead unless the nation realises the true position and applies an immediate remedy to prevent the denuding of the countryside of its virile stock, which in the past has supplied the best material for its defence.

Professor J. Hendrick:—

There will be little difference of opinion as to the present position of agriculture in Scotland. There, as elsewhere, it is bad, and farmers generally, if not losing money, are not making much. The more interesting question concerns its future prospects. If we take a sufficiently long view there are excellent reasons for believing that conditions will improve. The population of the world is increasing, the standards of living are being raised in great and populous countries everywhere, and the fertile parts of the earth are rapidly being settled, so that if no great catastrophe occurs meantime, it seems almost certain that the competition for food and other agricultural products will increase. Again the indications are that the community is becoming impatient of the profits made by middlemen to the detriment of consumers and producers, and already public action begins to be taken to control the distributors of food. In time such action will probably benefit producers. These things, however, are poor comfort to the harassed farmer of the present, for they merely indicate that better conditions will arise in an indefinite future, and that his sons and grandsons may find farming a more profitable occupation than he does.

But the farmer can meantime do a great deal to help himself, and that is likely to work more quickly than waiting on slow economic changes or equally dilatory political action. Agriculture, like other industries, can be helped by organisation, by education and by science. The farmer can at once help in getting all these for himself. As at present conducted, Agricultural Societies are out of date. They ought to be centres of agricultural organisation. Manufacturers, distributors and workmen all combine. The individual farmer is a small producer who is helpless by himself; he has to learn to combine and to support his combination loyally. If he is to have the outlook necessary to improve his position in the world he must be well-educated. That does not mean attendance at a few technical lectures or the acquisition of a few recipes for manures or feeding stuffs, but the real education which enlarges vision and trains people to think for themselves. He must also give his support and interest to science, which organises and increases knowledge, which gives him power over nature. Agriculture in Scotland is governed by our soil and climate. The main crops which we grow are those suitable for a cool humid climate and an acid soil. We need to improve our knowledge of what we can do with our soil and how we can best make use of it. The old type of manuring experiment played a useful part at one time, but that time is past, and we need a soil research station properly equipped to supply accurate information such as is being widely distributed to our competitors in other countries. The most fundamental agricultural research is soil research, and in Scotland no station or institute yet exists to supply this.

Mr. J. H. Milne Home:—

It is generally agreed that the two years 1927 and 1928 were difficult and trying for agriculture, resulting in considerable loss to many farmers. The main reasons were excessive rainfall and lack of warmth. The harvest of 1928 was, in some parts of the South of Scotland, one of the latest in living memory; 1929, on the other hand, has been an exceptionally favourable year yielding an abundant harvest. Unfortunately the expected benefit from good crops has not materialised owing to the low prices obtained for grain, potatoes and meat. Many stock farmers have sustained considerable losses from disease in the two wet seasons and are still suffering from the after effects.

In taking a broad view of the condition of agriculture in all its branches, there is one fact which stands out prominently. In almost every saleable product of the farm there is a very wide difference between the average price of the commodity as received by the producer, and the average price of the same commodity as it reaches the consumer. Even when full allowance has been made for transport charges, and all legitimate handling and retailing costs, the gap seems too large. Moreover, in perishable food stuffs, such as milk and meat, there are periods of glut and scarcity which occasion waste and loss. Investigation of this subject of marketing must lead any unprejudiced enquirer to the conclusion that the producers can best meet the problem of low prices by concentrating far more closely upon grading and marketing in a systematic manner. By doing so they will obtain a higher return for their produce without necessarily raising the price to the consumer. Grading in many cases is of special importance. Much can also be done by the purchase of feeding stuffs, manures, &c. in combination.

The investigation of disease in animals and plants is another problem of the highest importance. The waste and the loss caused by preventable disease in live stock are very considerable. Every reduction in the average death-rate means increased profit to the stock owner. These are two lines upon which agriculturists should concentrate with all their energy.

The average standard of housing for rural workers has not, in the past half century, kept pace with the rising standard of the towns. In many districts the bothy system is still the rule, and there is a great scarcity of houses for married men. It is very desirable that this leeway should be made up if the best men are to be retained in agricultural occupations. The Housing (Rural Workers) Act, 1926, has provided a very valuable and practical means of dealing with this problem. A good deal has already been accomplished in some counties, but others have made less progress. The Act meanwhile has a five years' currency, but its operation has already been so beneficial that the extension for a further period of at least five years is much to be desired in the interest of all agricultural workers.

Lt.-Col. W. T. R. Houldsworth:—

Whatever the causes may be for the depression from which the agricultural industry is suffering at the present time, and these are no doubt many, varied and world-wide, and whatever the remedies may be that, if and when adopted, will lead to the ultimate salvation of agriculture, the obvious fact that faces us to-day is that, speaking generally, the ordinary farmer is unable to find ready at hand a remunerative market for his produce; or in other words, that prices for agricultural produce are too low compared with the costs of production.

The importation of foreign food-stuffs depresses the price of home-grown produce, and while some measure of limited protection might possibly be applied, at least in respect of imported bounty-fed foreign produce, protective duties of any kind are unpopular with the consuming public.

The marking of home-grown produce, and the education of the public to purchase home-grown in preference to foreign produce, might go some way towards alleviating the present situation, but the farmer must produce the very best, and by grading and other methods be taught and assisted to place his goods on the market in the most saleable and attractive form.

While Government may be able to accomplish much for the agriculturist by generous grants towards the work of research and scientific instruction, by drainage grants, by improvement of transport and credit facilities, by assisting the farmer to a more scientific system of marketing, the real remedy in the end lies with the farmers themselves, who, by adopting to a far greater extent the principle of combination and co-operation, would be able to obtain for their produce a price more commensurate with the cost of production, and a price more in proportion, than is the case at present, with the price paid by the consumer.

As so large a portion of the profit on agricultural produce is absorbed to-day by the middleman or distributor, or is lost by faulty marketing methods, and therefore fails to reach the producer, only by combination and by giving 100 per cent. support to co-operative movements within their own ranks can farmers hope to oppose the force of other interests and to obtain a fair share of the profit that is their due.

Major Keith:—

Agriculture in Scotland was never in a better position than it is to-day. At no time have there been keener, more intelligent, or better educated farmers, ready to adopt any plan or scheme which will better their business, and I think they are backed by as willing and intelligent workers as can be found in any industry or in any country. But they are up against the rock of low prices, and their produce will not pay for the cost of its production.

As to the future, a careful study of the prices at which farm produce of every kind is imported into this country will show that there is small hope of any serious help to be got from marketing and grading schemes, except for a limited amount of the very highest qualities. At the same time all the marketing and grading schemes now on foot are in the right direction, and should have the loyal co-operation of every farmer to the full extent of his powers; but they do not go to the root of the trouble, which is that the basic price of all farm produce is too low in relation to things which the farmer has to pay for.

As no Government, whatever its political complexion, is likely to make any serious attempt to deal with the situation till they have at least 2,000,000 unemployed on their hands, are completely stranded for cash, and are driven into finding remunerative employment instead of distributing the public money on doles, or on more or less unremunerative public works, it is up to the farmer to continue to do as he is doing, adjust his business to circumstances, quite regardless of the social effect of, say, replacing cultivation by sheep.

So long as the town population is determined to have cheap food, regardless of every other consideration, and is prepared to foot the bill for the resulting unemployment, then the farmer's course is perfectly clear, and judging from what I see going on all around me he is not being very slow in taking it.

Mr. J. A. Lennox:—

The nearest comparison to the present position in modern times was in the eighties and nineties of last century. In 1895 wheat fell to 27*s*. 10*d*. and oats to 16*s*. per quarter, potatoes to 28*s*. and hay to 50*s*. per ton, not much different from present prices, but the loss to-day is much heavier through the enormously increased cost of production. In 1895 the foreman on this farm had £30 per annum with his perquisites; to-day with similar allowances he is paid £104. Horse shoeing in 1895 cost 3*s*. 6*d*. per set, to-day 11*s*. 6*d*., and all tradesmen's prices may be estimated on the same basis. Rates to the occupying owner have risen 600 per cent., but the Derating Act will alter this.

These figures are sufficient to show that the present débacle is without precedent in its intensity, and it seems obvious that past measures of amelioration will be inadequate to deal with it.

There is also in the present position a unique feature which the public should note. All classes of farming suffered fairly equally in the eighties and nineties. There was little inducement to lay land down to grass because the cost of handling pasture and stock was not so much less than that of cultivating the land, and the prospect of profit was little better. From cultivation a little profit could be earned partly, perhaps mainly, through the unremitting toil and miserable wages of the cultivators and their families. Twelve shillings a week was not a living wage even then. To-day there is every inducement to lay down land to grass; prairie farming is paying in Scotland. The ploughman must go unless we stabilise prices at an economic level. But the land and the farmer will remain.

I am no pessimist. Many of us farmers cannot stand the breeze till the grass grows and the ewes lamb, but the young and the capable will change with the times and reach prosperity again. The way out is obvious; to reduce commitments, lengthen the rotation, and feed home-bred stock with home-grown products. I was at the burying of an old farmer recently who left a large fortune. One of his sayings was : "Aye be selling and dinna buy, and our ferm will pey." That should be the present motto, and the prospect is good. Breeding has always been the saviour of our agriculture. The Empire agricultural policy will change and possibly quickly, but grass increases soil wealth, and the change from grass to grain or potatoes only needs one year.

The canker apparent in the present position of agriculture will not kill the farmer, but if uncured will weaken the life of the nation.

Mr. John Mackie :—

The present condition of agriculture is not such as to encourage the average countryman to remain on the land or to stimulate the return to the land of any of our city dwellers. Dairy farmers and sheep farmers are doing fairly well, but the arable farmers who rely mainly on the rearing and feeding of cattle and the growing of grain have been losing money steadily for the last five years. As the latter class of farmer gives employment to the great bulk of our rural population, it is of the utmost importance, not only to the individual but to the country, that a strong endeavour should be made to put arable farming on a prosperous foundation.

Governments will not do much to help unless the farmers themselves can formulate recommendations and press for their adoption with a united front.

One cannot see much hope of prices increasing substantially in the near future under present conditions, and therefore it would appear essential that the cost of production must be reduced by taking every advantage of scientific knowledge. By keeping a record of all transactions one is able, by closely studying results, to discover which enterprises are most profitable, and to organise the management accordingly.

A fuller appreciation of the value of such studies, and of the necessity for reorganisation in many branches of the industry, is evidenced by the steady increase in the membership and the greater interest taken in the work of the Farmers' Union, the Milk Pool and the Wool Growers' Association. The support which has been given to the recently introduced system of marking home-killed beef, and the great interest being taken in it by the agricultural community generally, is further evidence of the growing recognition of the necessity for adopting every modern business method in order to combat the great competition farmers meet with from abroad.

Greater interest, too, is being taken by farmers in the work of our Agricultural Colleges, still it has to be admitted that the great proportion of practical farmers do not interest themselves in these matters, and do little or nothing to help forward the common good.

It would be fair to surmise that an intelligent form of rural education would pave the way to a more enlightened, more enterprising and more public-spirited country population. The whole idea of education is to improve the individual and not his business. When the farmer or farm worker has improved as an independent thinking individual then the improvement of other conditions will naturally follow.

So far as agriculture is concerned, the raising of the school age can be helpful only if the children, during the latter years of attendance at school, get such forms of instruction as will enable them at the outset to take a really intelligent interest in their work, and make them more readily adaptable to the ever-changing circumstances of present-day life. I consider that the greatest hope for the future of agriculture lies in the intelligent training of the youth of the country on proper lines.

Mr. A. W. Montgomerie :—

The position of Scottish agriculture and the prospects for the future as far as cropping, grain growing and feeding are concerned do not look very bright at the present time. Potatoes, grain and fat cattle are fetching prices much lower than the cost of production. With so much foreign competition it is difficult to see any signs of betterment. Naturally the result will be less cropping and more land put down to grass.

The prices paid for milk and dairy produce have not been too remunerative either, but the tendency towards lower prices for feeding stuffs should relieve the situation considerably, and the better organisation of the milk trade and the great results shown by the addition of a little milk to the diet of school children should tend to a much larger consumption. Also the introduction of a Bill to give school children milk will necessitate a much greater output, and the prospects for production seem much brighter.

The demand for good sound young dairy animals passing the tuberculin test has been exceptionally good and very remunerative prices have been paid for them. The prospect of Government assistance in clearing the country of tuberculosis will cause the demand for that class of animal to continue. Let all breeders at once isolate the young cattle. The brightest spot in the whole situation is the good enquiry and keen demand for high-class dairy cows and young animals for all countries.

Unfortunately foot-and-mouth disease outbreaks hold up that trade occasionally. The prospect for a real good trade when the ports are again opened up was never brighter, and I can see more hope for the Scottish farmer specialising in the production of really high-class cattle than in any other department.

We have the world for a market, but only the best class of animal is required.

Principal Paterson:—

The main cause of the present depression would seem to be high production costs without an adequate return. The position appears the more grievous to the farmer on account of his demanding, like other members of society, a higher standard of living.

Pastoral farmers are in the happiest position, having experienced a fairly long spell of good years, except in areas where diseases such as fluke, lamb dysentery, louping-ill, braxy, scrapie, &c. are widespread and have taken a heavy toll of the flocks.

In the case of the dairy farmer, while the price of milk to the consumer has been fairly high, the return to the producer, unless he is also the retailer, has often left only a very small margin after meeting production costs. The same holds true for the cheese farmer.

The position of the arable farmer has been becoming steadily worse until at the present time the staple crops—potatoes and grain—are unmarketable at an economic price. The situation with regard to potatoes seems to be due partly to lowered consumption, to a large yield per acre, and to the reversion in the last two years from sugar beet back to potatoes; in the case of grain there is the menace from imported " bounty fed " oats.

Future prospects for agriculture are likely to depend more on the knowledge, the initiative and the organising capabilities of the farmer than on any other factors. He must be prepared to alter his methods, to cope with changed conditions and to overcome difficulties. Those who have had a thorough training —practical and scientific—are going to be in a much stronger position than those who rely on purely empirical methods.

In every branch of farming our ideal should be maximum economic production, and quality second to none. We are continually in competition with graded produce from other countries which send to us only their best. If under the present fiscal policy we are to meet successfully the competition of imported produce, more attention must be paid to the production of first-class quality in the main agricultural products such as beef, bacon, potatoes and cheese, and the elimination from the market of secondary grades. The unfavourable comparison between the home and the imported article would then be unjustified.

An increase in milk consumption, apart from the benefit to the nation, would provide a great stimulus to Scottish agriculture. With Government assistance in the stamping out of tuberculosis, coupled with vigorous propaganda for greater milk consumption, there should be no difficulty in increasing consumption by a quarter pint per head per day. To meet such an increase we would require approximately 100,000 additional cows, and these, with the young stock necessary to maintain the herds, would give employment to at least 10,000 people, irrespective of those required in connection with the distribution of milk.

In research the greatest immediate benefit is likely to accrue from fostering research into animal diseases. The eradication or control of disease would have effects of incalculable benefit to the farmer and the community. On the arable side the same holds true, as the reduction in yield on account of disease is frequently very heavy and the value of the produce is much reduced.

De-rating, extension of the aid for drainage, a greater measure of co-operation will prove helpful, but are more in the nature of palliatives and do not materially affect the root cause of the trouble.

Professor E. Shearer :—

The continued agricultural depression has resulted in an anxious and increasingly difficult situation in Scottish agriculture. Only the reserve of resources established during the war period has prevented its already becoming acute.

It is not altogether surprising that the areas most highly organised for intensive production have felt the ill effects most severely, for not only is the characteristic farming system costly in labour, but the products are of a kind most susceptible to world competition. Over a period of years the fattening of sheep has shown a fairly consistent profit. Otherwise the record is most disheartening.

The areas devoted to more typically mixed farming are faring substantially better. The smaller farmer, in particular, is, at any rate, earning wages if he is not getting much return on his capital. Side lines, such as pigs and poultry, in many cases have helped to improve the situation.

Sheep farming, fortunate in the price levels which mutton and wool have maintained, hitherto has had little to complain of.

In the industry, generally, the position is aggravated by an unorganised marketing system which results in a disproportion between producers' and consumers' prices.

With regard to future prospects there are solid grounds for optimism. While faced with world-wide competition which improved transport tends to make increasingly intensive, there are important factors in our favour. Improvement in world conditions of industry and commerce will be accompanied by increased agricultural prosperity. Expansion of areas devoted to the production of breadstuffs and meat is reaching its limit, and growing populations in Europe and America will extend the demand. We have natural conditions favourable to the production of our native commodities, an excellent market at our doors; an energetic and enterprising agricultural community capable of adapting systems and methods to changing conditions. If, in addition, we develop our general and technical education on sound lines, extend the field of investigation, revise our marketing system and improve the conditions of rural life, we can face the future with a reasonable measure of confidence.

Major Sprot:—

It hardly seems necessary to dilate on the present situation of agriculture in Scotland, as anyone who is a farmer, a landowner or a farm worker is only too painfully aware of the present conditions.

As to future prospects, I firmly believe that the future lies in the hands of the industry itself. Subsidies are insidious makeshifts. " Protection " is outwith the scope of practical politics, and I do not place faith in political " cure-alls," for after all the most well-meaning politician is neither omniscient nor omnipotent.

What the industry wants is more money—more business—increased production. Under existing conditions there seems little chance of the industry getting these.

Sectionally and technically we are tolerably well organised in agriculture. Nationally and commercially we are to all intents and purposes entirely unorganised. It is true that extemporised deputations are convened to complain of German oats—*after* the market is broken, and joint committees set up to consider what can be done as regards potatoes—*after* the price has fallen to a farcical figure. But we have no machinery whereby these unfortunate situations, mostly of outside origin, can be anticipated, guarded against and countered.

Increased business seems possible only at the expense of the foreign competitor. I think we should just make up our minds to accept this as a fundamental truth and concentrate upon (1) actively attacking foreign competition in our own markets and also in the markets abroad, and sparing no pains to " boost " the British product at the expense of the foreign. The Empire Marketing Board propaganda is quite inadequate. (2) Intensively and insistently canvassing and cultivating the preference of the consumer for the home grown product until its consumption becomes a second nature and impressing upon him the great national benefits which will accrue in many other directions from such a policy. (3) Safeguarding our efforts under (1) and (2) by ensuring that those engaged in agriculture are duly cognisant of the vital importance of their grading up the quality of their output and of marketing it in accordance with the predilections of the consumer.

A big national movement on the part of the agricultural industry on these lines would have, apart from its material results, a valuable moral effect at home and abroad. I would urge all those connected with the land, and especially their representative bodies, to give this matter their earnest and immediate consideration.

On one point there will be general agreement—we cannot go on under existing conditions.

Mr. J. P. Ross Taylor:—

Of recent times much has been written of the present conditions of Scottish agriculture, but it is not so much the present that concerns the agriculturalist. He has to live at least a year ahead. Our Immortal Bard has put it thus:—

> "Still thou art blest, compar'd wi' me;
> The present only toucheth thee;
> But oh! I backward cast my e'e,
> On prospects drear!
> An' forward, tho' I canna see,
> I guess an' fear!"

Therein lies the popular belief in the farmer's tendency to meet trouble half-way. It is the unknown and very uncertain outlook which is crippling one side of the industry at the present time. On the one hand the pastoralist has enjoyed a succession of years of level remunerative prices, while his arable confrère has had to contend against an over-supplied and falling market for most, if not all, of his products, while out-goings are much in excess of what the industry can afford.

That arable farming to-day is in a most serious position requires no argument. A glance at the weekly Market Returns will convince anyone of the truth of the proposition.

The economic position of the industry is, of course, similar to that of several other national industries. But the people have been told that agriculture must have special regard as it is essential to the life of the nation. The people, however, do not seem to take this statement seriously, nor do our legislators.

Enterprise in the spread of scientific research and knowledge admittedly improves matters at home and abroad and opens up avenues for progress, but thereby, in the case of the tillage farmer, provides a super-abundance of the crops most suited to the climate of this country and most difficult to market at a price which will cover the cost of production. Then the outlet has been much restricted. Take oats for example—the partial disappearance of the horse from the streets and the use of electricity in place of the pony in the coal mines materially reduce the demand for oats.

Numerous palliatives have been offered and many expedients suggested, but there has emerged no short and certain remedy. The position is nearing the point of being critical, and the country will shortly have to decide for or against the continuance of arable farming. Of course, the farmer himself has his own way out. Should his conditions of tenancy permit—he can lay his land down to grass and thus seek "safety first." What then of our countryside and rural population? Are they to be deprived of the opportunity of earning a livelihood and be added to the already congested ranks of the unemployed in the cities? Can this country afford to go on importing more and more foodstuffs, the growing of which could provide work for many more than are at present employed on the land concurrently with allied industries? Is it sound policy to assist industry by providing the cheapest possible food when the system leads to the point where there is imminent danger of strangling the agriculture of the country?

Agriculturalists do not expect any grandiose scheme of protection or subsidies. They ask and require the first claim on the support of the citizens of the country and fair play in our home markets. The importation of grain and grain products under fiscal systems such as are in force in several Continental countries means the direct subsidisation of these imports into this country, with resultant chaos in our home markets.

The potato crop employs more labour than any other. We can grow all and more than the population wishes to consume. Why, then, cannot our home markets be reserved for the home product so long as its cost to the consumer does not exceed what is determined as a fair price?

Farmers themselves are not without fault in their attitude to enlightened ideas. Their individualistic outlook must give way to a disposition to work in conjunction and closer co-operation with their neighbours. For sooner or later they have to realise that the modern conception of industry is to serve the community, not the individual.

Mr. J. Harling Turner:—

If I ask myself—"Is Scottish agriculture at the moment really in a bad way?" I answer that question as follows:—

Sheep farming—No.
Dairy farming—Moderate.
Arable farming—Yes.

I see no reason why sheep farmers, especially those who were in possession of their farms prior to 1914, should not continue to make a good return out of the capital invested.

With regard to dairy farmers, if they will only remove from their herds such cows as do not come up to a certain standard, and pay special attention to rationing, dairy farming has every chance of being carried on successfully. Milk records, if correctly taken, would quickly show which cows are non-profitable.

I would try to impress on dairy farmers the necessity, not only in their own interests but in the interests of the nation, to do all in their power to eradicate tuberculosis from their herds. If they would only do so, then the prospects of the overseas trade would be bright.

It is difficult at the moment to forecast the future of arable farming, but we have seen depression in the past, and let us hope that we may have seen the worst of it, and that there are brighter times in store for those splendid tillers of the soil who "practise with science." Scotland has every reason to be proud of the skill with which the arable farmers manage their lands and the stock breeders their herds.

Those farmers who keep a large head of cattle might with advantage carry out experiments in regard to the intensive manuring and rotational grazing of their grass lands. From my own knowledge, the work that has been carried out by some of our Agricultural Colleges in that direction has been, and is, proving of the greatest value.

I would most strongly advise the Government, through their Departments of Agriculture, to give large grants for, *inter alia* :—

(1) *Education and Research.*—I firmly believe that the future of British agriculture depends largely on the education of those who are to make their living out of the land, and on research in connection with the diseases of animals, improvement of crop and pasture, plants, feeding of stock, dairying, analysis of soil, &c.

(2) *Draining.*—If some scheme could only be devised, then I think it would be of the utmost use for the Government to lend the monies required for redraining. There are thousands of acres in Scotland which if redrained could produce "two blades of grass where one grows to-day." A very large sum, no doubt running into millions, would be required, not only for new draining but for the redraining of the lands which were drained 40 to 60 years ago. In the first instance I would rather encourage redraining than undertake the draining of land in which a tile has never been laid. The cleaning out and opening of new open drains on sheep farms I include under this head.

(3) *Buildings.*—Loans on generous terms should be given to owners of farms towards the expenses of improvement of their buildings, and proprietors should be encouraged to take advantage of the Rural Housing Act and improve their workmen's cottages.

(4) *Agricultural Colleges and Experimental Stations.*—I would urge the Government to support in a much fuller way than they do at present our agricultural training centres. How often do the College Authorities find that owing to the want of funds they are hampered in their teaching, and are not able to carry out investigations which might prove of the greatest value to agriculture?

I would most strongly encourage say the West of Scotland Agricultural College to co-operate with the Education Authorities within its district to have a school for boys and girls of 14 and over, situated at Auchincruive, with hostels, where not only would students continue their ordinary education, but where they would spend at least half their time in learning the practical side of agriculture, dairying, horticulture, poultry or bee-keeping.

Finally, I would ask my agricultural friends to remember that, no matter what the State may do for them, they must

" practise with science," and also recollect that " Heaven helps those who help themselves."

Professor J. A. Scott Watson :—

The last fundamental reconstruction of Scottish agriculture was carried through more than a hundred years ago. At that time ordinary agricultural land in the low country was letting at £2 or £3 an acre, grain prices were about 50 per cent. higher than they are to-day, and a man's wage was 10*s*. a week.

After many experiments a system of farming was worked out that proved remarkably efficient and successful under the prevailing conditions. Indeed Scotland won the reputation of the best farmed country in the world. The system was one of diversified farmings, combining a variety of crops and stock and aiming at a high output per acre. The pair of heavy horses was adopted as the most economical power unit, and a three- or four-pair farm, divided into a dozen or more fields, was found to be in general the most economical type of holding. There were, of course, variations necessitated by local conditions.

Until quite lately it has been found possible to adapt and improve this old system, in order to keep it abreast of the times, without altering its general framework. But during the last few years economic conditions—particularly the relative level of wages and agricultural prices—have made profitable farming along the old lines impossible. I have so far inclined to the view that these conditions must be temporary, for it has been hard to believe that arable farmers in any part of the world could long survive at the prices they have been getting for their produce. Indeed it is true that the present agricultural distress is very widespread. But it begins to look as if some of our overseas competitors would outlast ourselves.

Broadly speaking these overseas competitors fall into two classes. On the one hand are the peasant farmers of Europe who pay wages very much lower than we pay, and themselves accept a standard of living lower than that of our wage earners. There are doubtless many lessons that we can learn from them; but they cannot show us what we particularly seek, namely, a way of farming that will pay what we regard as an adequate wage to the worker and leave a competence for the farmer himself.

Our other chief competitors are the big farmers in the new countries who are applying mechanical power, elaborate machinery, and mass production methods generally to the business of food production. They are paying higher wages than we pay, and yet seem to be in a stronger and more prosperous condition. It may be objected that they have cheap land, but our own is no longer dear. I believe it is to them that we must look for guidance through our present difficulties. We must aim at a bigger output per man, whatever this may mean in terms of output per acre.

SURPLUS POTATOES.

I.—THE USE OF POTATOES AND OATS AS FEEDINGSTUFFS.

From the Duthie Experimental Stock Farm, Rowett Institute, Aberdeen.

Potatoes and oats have a high value as feedingstuffs, and on farms carrying stock it is being found that at present prices it is more profitable to feed these to stock than to sell them. These notes have been drawn up to show the composition and feeding value of these home-produced feedingstuffs, and to give the results of tests done to demonstrate that they can be used to a large extent in making up the ration for pigs and cattle, provided the rest of the ration is suitable.

The following table compares the composition of potatoes and oats with swedes, turnips, barley, maize, sharps and soya bean cake, which are representative of feedingstuffs commonly used either direct or in combination in the form of cakes and meals.

	Potatoes.	Swedes.	Turnips.	Oats.	Barley.	Maize.	Sharps.	Soya Bean Cake.
	%	%	%	%	%	%	%	%
Moisture	76·2	88·5	91·5	13·3	14·9	13·0	13·5	14·5
Dry Matter ...	23·8	11·5	8·5	86·7	85·1	87·0	86·5	85·5
Protein	2·1	1·3	1·0	10·3	8·6	9·9	16·4	42·4
Oil	0·1	0·2	0·2	4·8	1·5	4·4	5·0	7·0
Carbohydrates ...	19·7	8·1	5·7	58·2	67·9	69·2	56·2	25·8
Fibre	0·9	1·2	0·9	10·3	4·5	2·2	5·3	5·0
Ash	1·0	0·7	0·7	3·1	2·6	1·3	3·6	5·3
Food Units, per ton	20·2	10·8	6·9	75·0	82·4	92·3	92·0	126·1

It will be seen from the table that weight for weight potatoes have about twice as much dry matter as swedes, about two and a half times as much as turnips, and about one quarter as much as cereals. These ratios are reflected in their feeding value. Thus the food units per ton of potatoes are about twice that of swedes and about one quarter that of cereals. The composition of the protein-rich soya bean cake is given, as it was used in feeding tests referred to below.

Out of 23·8 per cent. dry matter of the potato 19·7 consists of carbohydrates, mainly starch. The percentages of protein and mineral matter are both low. Further, the material classed as protein includes a good deal of nitrogenous material believed to be of little nutritive value. For intensive feeding therefore, either for rapid growth or milk production, potatoes must be supplemented by concentrates rich in protein and mineral matter.

Potatoes contain an alkaloid called solanin which is considered to be injurious to stock. This substance is present to the greatest extent in green potatoes and in the sprouts which are apt to grow when the potatoes are stored in clamps. In feeding potatoes therefore, the sprouts should be broken off and discarded and green potatoes should not be used. Water in which potatoes have been boiled should be rejected as likely to contain much of this bitter principal.

Potatoes may be fed either raw or cooked. As will be seen later, they can be fully utilised in the raw state by cattle, but the percentage utilised by pigs is much higher after boiling or steaming.

The special feature about oats as compared with other cereals is the high percentage of fibre. On account of this its feeding value per ton is rather lower than other cereals. This high percentage of fibre has to be taken into account in feeding it to young pigs.

Potatoes for Pigs.—Of all countries, Germany has developed the feeding of potatoes to the greatest extent. The method now used extensively in that country is one worked out by Professor Lehmann of Gottingen. This method, which has since been adopted in several other countries, is as follows :—A meal mixture is used as a supplement to the potatoes. This supplement is fed without change in composition or in amount throughout the whole feeding period from approximately 40 lbs. to 220 lbs. live weight. The amount of the supplement used is, in the English system of weights, approximately 2¼ lbs. per head per day. One of the simplest supplements used consists of 7 parts barley meal and 3 parts fish meal, the fish meal providing the protein and mineral matter deficient in the potatoes and barley meal. Other cereals can be used to replace the barley, and fish meal can be replaced by any protein-rich substance such as meat meal, dried yeast or soya bean meal, provided that care be taken to supply the necessary mineral elements.

In a typical case of this method of feeding in which barley, fish meal and meat meal were used as the supplements, the foods consumed per pig for a live weight gain of 196 lb. were 231 lb. barley, 31 lb. fish meal and 59 lb. meat meal. There was thus a gain of 196 lb. live weight for 321 lb. of meals plus potatoes. As it takes about 800 lb. of meals, if fed alone, for a 200 lb. increase in weight, the potatoes used replaced between 400 and 500 lb. of meal in the feeding of each pig.

A number of tests have been made to determine what weight of potatoes are required to replace a given weight of meal. At Wisconsin it was found that 442 lb. of potatoes replaced 100 lb. of maize, and at Copenhagen that 400 lb. of potatoes replaced 100 lb. of mixed meals. These results compare fairly closely with the feeding value calculated from the chemical composition shown in the above table.

In this country potatoes have not been fed to the same extent, though " chats " normally go into the pig tub. The necessity for boiling has not, however, always been fully realised. The following figures relating to an experiment already reported from Cambridge may be quoted to emphasise the necessity of boiling potatoes for pigs. Two groups of pigs were fed on raw and boiled potatoes respectively. Those fed on boiled potatoes all the time were finished in very good condition, and only required 3·76 lb. of dry matter per 1 lb. live weight gain. The second group did so badly that at the end of 34 days they had only gained 18 lb. live weight and had taken 6·36 lb. of dry matter for each 1 lb. of gain. They were then put on to boiled potatoes and the gain per day rose to 1·49 lb., while the food consumption fell to 3·80 lb. per 1 lb. gain. These results serve to confirm a large number of similar results reported from other countries. There is no doubt that if potatoes be fed to pigs in considerable amounts, it pays to cook them either by steaming or boiling.

The feeding of oats to pigs is not such a common practice in this country as it might profitably be. If the proper precautions be taken in balancing up the ration, oats can be used up to one-third of the total dry matter of the ration even in the case of young pigs. Owing to the high percentage of fibre contained in the husks, however, higher proportions are not as a rule advisable, except in the case of sows or other animals over 200 lb. live weight.

The value of oats as a food for pigs has been demonstrated by a series of trials organised by the Irish Department of Agriculture in 1927. Tests were carried out at twelve centres, at each of which two groups of 56 pigs were fed on the following rations :—

Group I.		*Group II.*	
Maize meal ...	2 parts.	Maize meal ...	1 part.
Sharps	1 part.	Crushed oats ...	1 part.
		Sharps	1 part.

Fish meal or separated milk, which supplied first-class protein and mineral matter, were fed as supplements in all the tests. The average age at the beginning of the experiment was 12 weeks and the feeding period lasted for 84 days. The results were as follows :—

	Average weight at beginning.	Average weight at end.	Average gain.	Average daily gain.	Lbs. of meal equivalent to produce 1 lb. live-weight gain.
	lb.	lb.	lb.	lb.	lb.
Group I (no oats)	73	210	137	1·63	3·59
Group II (oats replacing part of maize)	73	211	138	1·64	3·57

In view of the number of animals under observation these results can be considered very reliable. The high rate of gain indicates that under proper management maximum gains can be made with oats forming up to one-third of the ration.

The factor which limits the proportion of oats which can

be fed in the ration of young pigs is the high percentage of fibre. American feeding trials show that more of the grain can be consumed and greater live weight gains obtained by removing the husk before feeding. An experiment was carried out on this farm to give further information on this point. Oats in the three forms of (1) crushed oats, (2) husked oats, and (3) oatmeal were fed, in conjunction with the same basal ration, to three groups of pigs. The results are shown in the following table :—

	Average gain per lb. per day.	Food consumed per 1 lb. gain.	Cost per 1 lb. gain.
	lb.	lb.	
Group I : Basal + crushed oats ...	1·11	3·80	3·38*d.*
Group II : Basal + husked oats ...	1·05	3·55	3·89*d.*
Group III : Basal + oatmeal ...	1·10	3·48	3·89*d.*

It will be seen that the food consumed per lb. gain decreased in proportion to the amount of the fibre removed. On the other hand, when the cost of the husking and grinding was taken into account, it was found that the most economic gain was made with the crushed oats.

It has been shown that in the feeding of crushed oats up to one-third of the ration, the fibre has no harmful effect. The question as to whether it would be profitable to have the oats husked to decrease the food consumption per lb. live weight gain, and to enable a higher proportion of oats to be fed, is one which could be decided only after careful consideration of the cost of husking and other circumstances, which would vary on different farms.

For the purpose of this paper it was decided to make some special short feeding trials with very young pigs, to demonstrate that so long as reasonable amounts are fed, and the ration is well balanced, no trouble is caused either by the fibre of the oats or by the bulky nature of the potatoes. A further test was carried out to demonstrate the possibility of using nothing but oats and potatoes for the fattening of animals such as sows and pigs from the ordinary Wiltshire bacon weights.

In the experiment with young pigs, two rations containing a high proportion of oats and boiled potatoes were tested against a standard ration which is in common use in this country for all classes of pigs, and particularly for young ones. One of the rations with oats and potatoes had its protein and mineral content increased by separated milk and a mineral mixture, and the other by extracted soya bean cake and a mineral mixture. All the groups received small quantities of green food, and the animals had access to coal ashes.

The following table gives the composition of the rations and the result. The test ran from 6th November to 26th December, 1929.

Young Pigs.

	Group I.	Group II.	Group III.
Rations fed (*ad lib*) ...	pts. Barley meal 65 Sharps ... 25 Fish meal ... 10	pts. Barley meal ... 25 Sharps ... ... 20 Crushed oats 30 Boiled potatoes 60 Sep. milk 200 Min. mixture 2	pts. Barley meal ... 25 Sharps ... ... 20 Crushed oats 30 Boiled potatoes 60 Ex. soya bean cake ... ... 13 Min. mixture 3
No. in group	12	12	6
Average weight, 6th November 1929 ...	47·33 lb.	47·33 lb.	47·50 lb.
Average weight, 26th December 1929 ...	100·0 ,,	104·17 ,,	99·33 ,,
Average gain per head per day	1·05 ,,	1·14 ,,	1·04 ,,
Lbs. S.E. per 1 lb. gain	2·25 ,,	2·11 ,,	2·13 ,,
Feed cost per 1 lb. gain	3·34*d.*	2·76*d.*	2·79*d.*

The rate of gain was highest in the ration containing the separated milk—an indication of the well known high value of milk for growing animals. In Group III in which oats and potatoes were substituted for the greater part of the barley meal and part of the sharps and soya bean cake plus mineral mixture for the fish meal, the rate of gain is practically the same as for the standard ration of Group I, and the starch equivalent per lb. gain is rather less. A calculation of the food costs per lb. gain with oats at 6*s.* per cwt., potatoes at 1*s.* 4*d.* per cwt. and separated milk at 2*d.* per gallon, shows that both rations containing the high proportion of oats and potatoes are much more economical than the standard widely used ration of barley meal, sharps and fish meal.

Incidentally it may be noted that the results of Group III, in which animal protein is replaced by a vegetable protein, suitably supplemented with the mineral mixture, gives as good results as the ration with fish meal. This confirms extensive results carried out in a series of joint experiments between this Institute, the Nutrition Institute, Cambridge, Harper Adams, and the Department of Agriculture, Northern Ireland.

In a test with a few older pigs of about 200 lb. live weight and culled sows being fattened, a ration consisting of crushed oats 2 parts and boiled potatoes 8 parts was fed with a little green food, and access to coal ashes. Gains in weight varied from 1·23 to 1·90 lb. per day. The starch equivalent per lb. gain was 3·26 lb. in the case of the 200 lb. pigs and 3·36 in the case of the sows, and cost per lb. gain 3·16*d.* and 3·15*d.* respectively. The results show that for fattening animals, past the rapid growing stage when a high proportion of protein and mineral matter is no longer so necessary, oats and potatoes can be used without being supplemented by more expensive foodstuffs.

Potatoes for Cattle.—There is not such an amount of experimental data on the feeding of potatoes to cattle as there is for pig feeding. Good results are, however, reported in the case of cows and fattening cattle fed potatoes in reasonable quantities with suitable supplies of fodder and concentrates. In feeding tests in Massachusetts, U.S.A., amounts up to 25 lb. per day of raw tubers are reported to have been fed to cows without any unfavourable effect on the yield of milk or the health of the animal. Similar results have been obtained in tests on the Continent.

There is a risk of an objectionable flavour and odour to the milk if the potatoes be fed in large quantities. This risk is, however, minimised if the potatoes be fed after milking.

Contrary to what occurs in the case of pigs, raw potatoes, according to a report of feeding tests done in Vermont, U.S.A., appear to be more valuable for cattle than cooked potatoes.

Oats are largely used in the feeding of cattle. As the digestive organs of the ruminant are adapted to dealing with fibrous foodstuffs, the amount of fibre present in oats is not such a disadvantage as in the case of pigs.

Feeding Tests with Dairy Cows with Rations Containing Potatoes and a High Percentage of Oats.

For the purpose of this paper, a series of short tests was done with milk cows to determine whether an increase in the proportion of oats in the production ration and the substitution of potatoes for turnips or silage in the maintenance ration of milk cows would affect the milk yield.

A well balanced ration containing ground peas, bran, oats, fish meal and a composite cake, oats constituting about 23 per cent. of the production ration, was tested against a ration of oats, soya bean meal and a mineral mixture, in which oats constituted 75 per cent. of the total production ration. The basal maintenance ration consisted of 20 lb. turnips, 30 lb. silage and 8 lb. oat straw. In one group 12 lb. potatoes were substituted for 20 lb. turnips and in the other group 30 lb. of silage and 2 lb. oat straw were replaced by 12 lb. potatoes, 5 lb. hay and 30 lb. turnips.

The animals had not previously been accustomed to potatoes, and 12 lb. was the maximum quantity which they would eat readily.

Results.—The change over from the composite ration containing the low percentage of oats to that containing 75 per cent. oats and 25 per cent. soya cake meal was accompanied in each case by an increase in milk yield, the natural decline being for a short period actually changed into an increase. In the change over from silage to potatoes there was no alteration in the milk curve, but when potatoes were substituted for turnips there was a slight decrease in the rate of fall, indicating that for these short tests at least the 12 lb. of potatoes were of more value for milk production than 20 lb. turnips. No definite effect of any of the experimental rations on the percentage butter-fat or on the flavour of the milk was observed.

The mixed production ration cost 1·07*d*. per lb. as compared with 0·83*d*. per lb. for the oats and soya cake meal ration. As both were fed at the same rate, viz. 4 lb. per gallon of milk produced, the high percentage oats ration was both cheaper and better. It can be calculated from the results that if turnips cost £1 per ton, silage £2, hay £4, straw £1, potatoes at about 35*s*. a ton can be used profitably for replacing turnips and at a lower figure for replacing silage.

Summary.—Weight for weight potatoes have from two to two and a quarter times the feeding value of swedes and about a fourth of the feeding value of cereals.

Potatoes are poor in protein and mineral matter, and for intensive feeding with young animals or milk cows should be supplemented by foodstuffs rich in these.

For cattle, potatoes can be fully utilised raw, but for pigs the percentage utilisation is increased by cooking.

Oats, on account of their high percentage of fibre, have a rather lower food value than the average for other cereals. The large percentage of fibre limits the amounts which can be profitably used for the feeding of young pigs.

For young pigs, crushed oats can be used up to one-third of the ration without harmful effects. The results of tests given above show that for young pigs, rations containing a high proportion of oats and boiled potatoes give as good gains and are more economical than rations with certain other commonly used feedingstuffs.

For milk cows oats, if balanced up with a protein rich feedingstuff and a mineral mixture, can be fed up to 75 per cent. of the production ration.

Potatoes can be used up to 12 lb. per head per day with beneficial results. In other tests larger quantities have been used without detriment to health or milk yield.

Costs of rations are given showing that the substitution of potatoes and oats for commonly used cakes and meals is, at present prices, an economical procedure.

In conclusion, it may be stated that at the moment on this farm all cattle and pigs which are not on special experimental diets are being fed oats and potatoes to the amounts indicated in the tests referred to. It is considered that at present prices, oats for feeding purposes are worth about £7, 5*s*. per ton and potatoes for pigs about £2 per ton, and for cows about 35*s*. per ton.

II.—INDUSTRIAL USES, GENERAL POLICY AND MARKETING.

T. P. M'INTOSH, B.Sc., Ph.D.

THE potato industry suffers, often disastrously, from recurrent surpluses. The demand for many commodities increases with a fall in prices, but for the potato, which is used almost entirely for human consumption in Britain, the demand is more or less constant, hence cheap potatoes do not create a greatly extended market, and a surplus, if it is not to rot in the pits, must be disposed of otherwise.

The average annual production of potatoes on agricultural holdings in Great Britain during the years 1923 to 1927 was 3,769,000 tons. In 1928 it was 4,545,000 tons. The 1929 crop was estimated at 3,588,000 tons for England and Wales and 1,155,000 tons for Scotland, hence it exceeded that of 1928 by about 200,000 tons and was the largest since 1922. The estimated total supply, including imports, except those of Northern Ireland, averaged between the years 1923 to 1928, was 4,180,000 tons per annum. Thus one may assume that including imports there is a fairly large surplus for the season 1929-30.

The Nature of the Surplus.—In order to comprehend fully the problem with which we are confronted the nature of the surplus must be understoood. In Great Britain the surplus is a casual one: it fluctuates in quantity, actually disappearing in some years, and it arises mainly from over-planting, a favourable season, or a combination of both of these.

During the eight months September to April imports vary considerably; they decrease in years of high and increase in years of low production, and they are always greatest in years of high prices. Imports during the four months May to August show less variation, but the bulk of these is new potatoes which arrive before the current early British crop is marketed freely. In a year of over-abundant supply, the whole imports of maincrop potatoes may be regarded as surplus; so also may part of the early imports, as increased importation during the months May to August frequently results in part of the British early crop being throw into the late market. Moreover, very early imports, particularly those from Spain, are increasing, with the result that the period of marketing our maincrop (i.e. the maincrop of the previous year) is being cut down. This contraction in our market is of great significance.

Apart from the augmentation of the surplus by imports, it is undoubtedly true that British prices may be affected by production abroad: the average cost of producing a ton of potatoes in most continental countries is less than in Great Britain, and these countries are potential sources of supply immediately prices in this country reach a certain level, a level which is always lowest at times of over-production abroad.

The Feeding of Potatoes to Stock.—The starch equivalent of the potato is 18 and its feeding value is estimated at about £2 per ton. Provided they do not figure too largely in a ration, potatoes are suitable food for live stock; stock-feeding is, in consequence, a natural and simple method of using a surplus. It should be noted, however, that when the root crop is good, potatoes must be used in limited quantities, hence this method can deal solely with part of a large surplus.

Industrial and other Products of the Potato.—The potato is used in many countries for purposes other than direct consumption as food. Indeed, the crop is often grown remuneratively for industrial products alone. Were it possible, therefore, to send our surplus to the factory and withdraw it from the open market, remunerative prices might be obtained for table potatoes. The most important industrial products are: alcohol, farina and dried potatoes. An industry for the manufacture of acetic acid is now in process of formation, the acid being required for the preparation of artificial silk. On the continent potatoes are often converted into silage.

Alcohol.—Alcohol can be manufactured from all substances containing fermentable sugar or starchy material capable of being converted into fermentable sugar. Potato alcohol has been extensively produced on the Continent, especially in Germany.

The process of manufacture is roughly as follows: the potatoes are thoroughly washed and steam-cooked; they are then saccharified with green malt and fermented with yeast, and finally they are distilled. Only the starch is used in the process and the remainder of the potato forms a pulp suitable as a cattle food. The alcohol thus obtained is used for heating, power, and chemical and industrial purposes.

To compete with petrol and paraffin for lighting and power purposes, potato alcohol would require to be sold at a similar or lower price. One ton of potatoes produces 20 gallons of 95 per cent. alcohol, hence every £1 in the price of a ton of potatoes is equivalent to one shilling on the gallon. It is clear that the producer of alcohol could not offer the grower as much as £1 per ton for his potatoes. The success of potato alcohol in Germany has been due largely to a form of subsidy. A further difficulty is the fact that no large industry could be satisfactorily established on fluctuating supplies of raw material.

Starch (Farina).—Potato starch is a fine, white, glistening powder, consisting mainly of unchanged starch grains, and is used chiefly in connection with textile industry for sizing yarns and for finishing purposes. In addition, it is employed in the manufacture of glucose, dextrine and gums, in the laundry industry, and in various food preparations.

In the process of manufacture the tubers are first washed and reduced to a fine state by milling machines; the starch is then extracted by water and purified by many washings; finally, it is dried at a low temperature, to prevent conversion of starch into dextrine, and milled into a fine powder. Potatoes rich in starch and with large starch grains are preferred for the purpose, the process of extraction depending to some extent on the size of the individual grains. The larger the grain, the better is the quality of starch produced. The pulp left after the removal of the starch still contains 10 to 20 per cent. of the starch originally present in the potatoes in addition to the nitrogenous matter, cellulose and ash, and, when dried, forms a suitable food for stock.

The annual importation into Britain of farina and dextrine is estimated as equivalent to between 400,000 and 500,000 tons of potatoes.

The present price of Dutch farina is about £13, 10*s*. per ton. It takes ten tons of potatoes to produce one ton of farina. As farina is not manufactured in Britain at present, precise working costs are not available, but it is apparent from the above that, making allowance for the price of offal, the grower could not expect much more than £1 per ton for potatoes consigned to a farina factory.

Dried Potatoes.—These are the simplest of potato products, and they contain all the ingredients originally present in the tubers with the exception of water. Because of their dry nature, they may be stored indefinitely without deterioration. In preparation the tubers are first washed, they are then sliced or shredded and finally dried.

Experiments in drying have been carried out at the Peterborough factory of the Central Sugar Company, Limited, at the Eynsham factory, and by the Second Anglo-Scottish Sugar Beet Company, Cupar, Fife. At the Scottish factory 2,700 tons were sliced and dried during the last year. The charge for drying at Cupar is 25*s*. per ton of dried material, and it is estimated that five tons of raw potatoes are required to produce one ton of dried potatoes. In Germany dried potatoes are used to replace barley meal, and they are assumed to have approximately the same feeding value. Dried potatoes are composed largely of starch, and they may be compared with other foods on the basis of starch equivalents. Keller [1] gives 68·8 as the starch equivalent of dried potatoes and 73·6 as that for barley meal, hence the latter has not a substantially greater feeding value than the former. Barley meal at present costs about £9, 7*s*. per ton. The Cupar material does not obtain a greater price than £6 per ton in the open market, but it must be remembered than any new and untried food seldom realises its full value in the initial years of its sale. Assuming the feeding value to be about £8, 5*s*. per ton, the grower will obtain £7 for his five tons of potatoes; he will, however, require to make deductions for transport costs.

Acetic Acid.—An experimental factory for the manufacture of acetic acid has been erected at Peterborough. In the preparation of the acid all kinds of vegetable matter may be used, hence the industry is not dependent on potatoes and could find other raw material when there was no potato surplus. It is probable that the grower would not receive much more than 20*s*. per ton for potatoes consigned to an acetic acid factory.

[1] O. Keller, *The Scientific Feeding of Animals*, 1909.

Silage.—Potato silage is very often made on the Continent. There are two general methods of preparation. In one, the tubers are cooked and packed tightly in a pit silo. The loss here in the stock-feeding value is estimated at less than 5 per cent., and, thus stored, the potatoes will keep in good condition for a prolonged period. The other, which is commonly adopted in Holland and which is easier than the first, consists of making a stack silo with alternate layers of green grass and potatoes: a layer of about one ton of grass is laid on the ground and covered with a layer of about half a ton of potatoes; this is repeated until the silo is completed, carts being used for pressure if necessary; finally, the stack is covered with 9 in. to 1 foot of earth. The second method is now being investigated at the Agricultural Institute, Kirton, Lincolnshire.

The Possibilities of Increasing the Demand for Home-Grown Potatoes.—*General Policy.*—It is perhaps pertinent to question here whether some of the policies pursued by the potato industry have been advantageous to trade. Since the war it has been a *sine qua non* that each new variety must be an exceptionally high yielder; increased production has been encouraged without a corresponding stimulus to the demand; and table quality has not been a marked characteristic of some recent introductions. Apart from table quality, however, there has been a tendency for these newer varieties to produce often unattractive, over-size tubers. It would undoubtedly have been wiser had those concerned in raising and marketing new varieties given more consideration to table quality and less to yielding capacity. Fortunately there are indications that during 1929 the cooking quality of seedlings was more seriously considered. The combination of quality, such as is found in Golden Wonder, with the productivity of, say, Arran Banner, is probably impossible to obtain. Golden Wonder does not crop well on poor land, the percentage of ware being very small, hence it is not suited for universal cultivation; this is due to a large extent to the general infection of the variety with mosaic diseases. There is no reason to assume that new varieties combining Golden Wonder cooking quality and fairly good yielding capacity could not be raised as readily as high-yielding varieties. Mealy potatoes are not universally popular; in some districts waxy varieties are preferred. It would therefore be advantageous were the question of quality investigated and authoritative information placed at the disposal of those concerned. The presentation to the market of even-sized, attractive tubers that cook well could not fail in a degree to increase consumption; moreover, by the growing of such varieties over-production would be lessened.

Extension of the Time during which Maincrop Potatoes are eaten.—During the years 1923 to 1928 the average annual importation of potatoes into the United Kingdom from September to April was about 137,000 tons; from May to August approximately double that quantity was introduced, viz. 274,000 tons. It is clear, therefore, that we consume a very considerable amount of early potatoes, and if part of these could be displaced by the home-grown maincrop, the surplus would be lessened. New potatoes contain less dry matter than old potatoes and are in consequence of less feeding value; moreover, they frequently cost several times as much as the maincrop, hence their popularity is due entirely to their novel taste. Towards the end of spring old potatoes sprout in the pits to a greater or less extent, are thus depleted of part of their foodstuffs, and consequently deteriorate in cooking quality. This need not always happen, however; some varieties keep better than others, and it is certain that potato breeders could, given the inducement, produce varieties which would keep well into early summer. There can be no doubt that old potatoes of good cooking quality would sell well in April and May, and possibly also June, in Scotland, especially if supported by judicious and scientific propaganda.

Exports.—Information concerning foreign markets is obtained at present only by the most progressive farmers and merchants, hence the initiation of some form of intelligence service would be valuable.

The best seed potatoes in the world are grown in Scotland, yet quite frequently both seed and ware are allowed to rot in the pits. In other parts of the world potatoes degenerate rapidly, thus necessitating a continual demand for fresh seed; the whole of the Mediterranean area, including Italy, Spain, France, Greece and Malta, South Africa and South America, and parts of Germany, Austria and North America, are in this category. A good intelligence service would not only find out new markets for seed and ware, but also provide information concerning varieties, competition and best methods of packing. Personal investigation of such potential markets by a competent potato authority, the dissemination at home of the information obtained, and propaganda in the countries concerned would undoubtedly lead to increased trade.

Marketing.—That the present system of marketing could be improved is undoubted. But the problem is not a simple one. Having in view the historical development of the industry, and the outlook of the individuals concerned in it, much may be said in favour of State as opposed to trade control. It should be pointed out, however, that it would not be impossible for the trade itself to solve some of its difficulties.

Grading.—Up to the present good and bad samples of potatoes have been marketed under the same description; the general adoption of a standard grade would therefore assist in securing a better market for superior samples and help to eliminate inferior material. Under the powers conferred on them by the Agricultural Produce (Grading and Marking) Act, 1928, the Department of Agriculture for Scotland have now in operation a scheme for the grading and marking of ware potatoes in Scotland. In the preparation of this scheme the Department had the assistance of the various trade associations and agricultural bodies. The scheme involves the use of a national mark, and while it cannot be claimed that it will effect a cure for recurrent surpluses, it is believed that it will alleviate the situation to some extent. The Ministry of Agriculture and Fisheries, acting under the same authority, have prepared draft regulations for voluntary application in the trade, without, however, the use of a national mark. It would also assist the export trade if, in addition to the present system of inspection, some definite system of packing suitable for the various foreign countries were introduced. Moreover, these countries demand health certificates only, whereas it frequently happens that ill-dressed, wet and dirty consignments are exported which are neither a credit to the home country nor an invitation to the foreigner to purchase more. The grading of Scotch seed for health and the adoption of the National Mark for high-grade seed would undoubtedly help in the English trade.

Organisation.—It is clear that during years when there is a surplus, foreign produce, with the possible exception of part of the early imports, is unnecessary, and if it were excluded part of the surplus would vanish. It is the presence of foreign potatoes that makes it impossible to deal with the question fundamentally. Should the home surplus be disposed of and an economic price be obtained for the remaining crop, foreign importations will immediately increase and reduce that price, but probably not to such a low figure as is prevalent when there are large quantities of unused home surplus. The only method of disposing of the home produce is to divert the surplus into other channels than for human food. On the other hand, markets are frequently flooded unnecessarily and prices reduced abnormally. A better utilisation of marketing intelligence is obviously necessary. How control can be best brought about is a matter for thorough investigation, but it is obvious that in times of surplus it would pay the grower to utilise a percentage of his crop for feeding or industrial purposes, even if no profit were thus made, as the increased price for the remaining crop would be sufficient to make potato growing remunerative.

Summary.—1. In Britain the potato surplus is a casual one, and it arises as much from the effect of season as from overplanting.

2. The importation of foreign potatoes creates a difficulty and makes it impossible to deal with the question fundamentally.

3. There are, however, numerous ways of preventing undue loss of the home surplus.

4. The simplest method of using unsaleable potatoes is to feed them to stock in either the raw or the dried condition.

5. Potato silage may be a useful stock food. Its use and the methods of preparation should be investigated.

6. In the past insufficient attention has been paid to increasing the demand.

7. The demand might be increased in various ways, e.g. by concentrating on cooking quality rather than yield of new varieties; by increasing exports, especially of seed; and by

marketing, in early summer, maincrop potatoes in good condition and displacing some of the imported early crop.

8. Scientific propaganda would be valuable in increasing the demand.

9. The grading of seed and ware may not only increase the demand, but in years of surplus will tend to keep inferior material from coming on the market.

10. Marketing organisation and co-operation can be effective only if carried out on a large scale. These form suitable subjects for investigation.

MILKING MACHINES.

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MILKING by hand is a laborious process, and the expenditure for it is the largest single item in the labour bill for milk production. Consequently many attempts have been made to lighten this burden, and the result has been the evolution of the modern milking machine. In 1924 the West of Scotland Agricultural College, at the request of the Board, now the Department, of Agriculture for Scotland, started some investigations on the relative efficiency of machine milking. It is proposed to give here a very brief outline of the history of the development of the milking machine and discuss the position of the milking machine in Scotland at the present time. Then from the trials conducted and from the results of work elsewhere a review will be given of the possibilities of the milking machine and of the methods which should be employed in handling it.

History.—Over 100 years ago attempts were being made at the development of milking machines and American records on the subject go back to 1819, though it was not until 1840 or later that the results began to be of any practical importance. The number of machines brought out since then is probably well over 100, though the majority have disappeared after but a brief existence, while the good points of others were developed and incorporated in later machines.

Perhaps the earliest attempts at overcoming the labour of hand milking were through adaptations of the milking tube, which is inserted into the teat. It is quite generally believed that milking machines based on this principle disappeared long ago, but they are still to be found on the market in this country and elsewhere, though they are prohibited by law in certain countries. Such machines may cause injury to the udder, and where complete sterility is not obtained in the milking tubes there is grave danger of spreading udder infection.

Soon attempts were made to get through mechanical means the effect of the pressure of the hand on the teat in milking. Many complicated devices were brought out, but were never really successful. These machines were generally unreliable in action and too complicated for ordinary farm operation, while there was also difficulty in getting them to fit the various sizes and shapes of udders and teats, and they generally irritated the cow.

The modern tendency in milking machines has been to make use of a partial vacuum, or, as it is popularly called, suction. This is effected by lowering the atmospheric pressure within the machine, thus inducing the milk to flow to the centre of low pressure. There have been two main steps in the development of the vacuum milker.

As early as 1860 efforts were made to develop a milking machine dependent solely on continuous suction for its action, but there was one great drawback to this. The continuous suction tended to interfere with the blood circulation and caused congestion in the teats and lower parts of the udder. Consequently further improvement—through the introduction of a make and break in the vacuum—had to take place.

It is for the development of milking machines actuated by an intermittent vacuum that Scottish workers have been noted, and this country deserves credit for the introduction of the first milker of this tpye. The late Mr. John Speir of Newton worked on a vacuum milker from 1875 to 1881, and then the Murchland machine was introduced by Mr. William Murchland, Kilmarnock, in 1890. Shortly afterwards Messrs. Gray and Nicholson of Stranraer brought out a machine of similar type, and in 1895 Dr. Shields, of Glasgow, invented the Thistle mechanical milker. This was the first milking machine making use of an intermittent vacuum and was a great advance on all previous attempts. All modern machines are founded on the principle used in its development.

In 1902 Messrs. Lawrence and Kennedy of Glasgow brought out their machine, which was the first with a pneumatic pulsator on the lid of the unit. This machine, further developed and put on the market in 1905 by Burrell of New York, became the first modern American milking machine. Another Scottish machine, the Wallace, was brought out by Messrs Wallace of Castle Douglas in 1907.

Present Position in Scotland.—Milking machines probably increased gradually in number up to the time of the world war and then received a great impetus through the scarcity of labour. Since the return to a labour supply nearer to the normal there has been a very considerable decrease in the number of machines in use. Through the courtesy and co-operation of the Scottish Milk Records Association a survey was made of the conditions in the 708 milk-recorded herds in Scotland in 1929 and some very interesting results were obtained.

Taking the country as a whole it was found that 13 per cent. of the herds, with an average of 64 cows each, were being milked by machine, while an additional 12 per cent. of the herds, averaging 55 cows, have milking machines which are not in use. These latter represent in the great majority of cases herds in which the machine was introduced when labour was scarce. When labour became more plentiful the use of the machine was discontinued. The remaining 75 per cent. of the herds have always been hand milked, and on the average contain only 35 cows each.

Though these general figures are interesting, even more notable results are obtained when the country is divided into districts. In Dumfries and Galloway 28 per cent. of the herds, averaging 68 cows, are machine milked, while an additional 21 per cent., with an average of 61 cows, have machines which are not in use. The 51 per cent. of the herds which have always been hand milked average 50 cows per herd.

Ayrshire has been considered alone, and here it is found that only 4 per cent. of the herds, with an average of 37 cows, are machine milked, while 11 per cent. of the herds, averaging 47 cows, have machines not in use, and the remaining 85 per cent. of the herds, with an average of 33 cows each, have always been hand milked. Here the smallest herds are hand milked and the medium sized herds machine milked, while the largest herds have machines which are not in use. This is quite different from what occurs in Dumfries and Galloway.

The explanation probably lies in the fact that a much larger proportion of the herds are worked by the farmer and his family without hired labour than is the case in Dumfries and Galloway. Machines were introduced when labour was scarce, then when more labour became available those depending on hired help deserted the machines as they probably considered machine milking less economical than hand milking. On the other hand those who managed their herds with only the assistance of their families retained the machines to reduce the work for the family without giving too great consideration to the question of costs.

The five counties, Lanark, Stirling, Renfrew, Dumbarton and Bute, have been grouped together as the Clyde Valley. Here the herds average only 29 cows, as compared with 36 in Ayrshire, and 57 in Dumfries and Galloway. Only 2 per cent. of the herds in this district, with an average of 39 cows, are machine milked, and 4 per cent., with 45 cows each, have machines which are not in use. The remaining 94 per cent., averaging 29 cows per herd, have always been hand milked. The milking machine has never been an important item in the dairy industry of this district, and the possible explanation for the changes in the numbers of machines in use is the same as that given for conditions in Ayrshire.

The remaining regions of Scotland do not direct much attention to dairying and so need not be considered in this short study. From the figures given one point would appear to be fairly clear. In Dumfries and Galloway, where wages are relatively low, the machine is used mainly in herds of over 60 cows, whereas in Ayrshire and the Clyde Valley, where wages are higher, the average size of the machine milked herds is about 40 cows.

Effects of Machine Milking.—There are many points to be considered in arriving at a general conclusion as to the relative merits of hand and machine milking, and the more important of these will now be given consideration.

Milk Yield.—Where the milking machine is carefully operated, quite satisfactory and consistent milk yields are obtained, and the results compare favourably with those secured with hand milking. With inefficient operation, however, the milk records of the cows will be markedly depressed.

Fat Percentage.—Where careful attention is not given to machine milking there may be a fall in the fat percentage, due to inefficient milking throughout and a shortening of the lactation. With efficient operation there should be no great difference between the fat content of the milk obtained by machine milking and that of the milk obtained by hand milking.

Persistency.—It is sometimes stated that where the milking machine is used the cows tend to dry off earlier than they otherwise would. With careless operation this does undoubtedly occur, and leads not only to a decreased milk yield but also to a lowered fat percentage. With proper handling of the machine, however, the lactation will be of normal length. In this connection it must also be remembered that as cows mature they tend to have a shorter lactation than in their earlier years.

Age of Cows.—Young cows in their first lactation are generally believed to take more kindly to the milking machine than do old cows which have been accustomed to hand milking in their earlier years. This is probably correct. Heifers generally give no bother with the machine, while many old cows do not take to the milking machine when it is first used.

Rate of Milking.—There is no great difference in the time employed by hand and machine milking. The most important factors affecting this are the yield of milk and the individuality of the cow; the larger the yield of milk the more milk will be obtained per minute, but the longer is the total time required to milk the cow. Some cows naturally take longer to milk than others, no matter which method is employed.

Effect on Udder and Teats.—No deleterious effects on the udder and teats occur when the machine is efficiently operated. If, however, a milking unit is left on a cow too long—that is, after she has been milked out—congestion of the teats and lower parts of the udder may be induced. On the other hand it should be remembered that in the case of practically all newly calved cows there is more or less congestion of the udder, and the action of the machine has a beneficial effect in reducing this. It is even more beneficial than hand milking. The machine should not be used so long as the colostrum is thick as it is then very difficult to get the machine properly cleaned. But as soon as this stage is passed the machine should be used as its action will be found to be beneficial to the udder.

Milking Machine Practice.—Success in milking by either hand or machine can be attained only by attention to detail and the variations in conditions from cow to cow. Carefulness and cleanliness are essential in either case.

Operation of the Machine.—Before the machine is attached to the cow the first few streams of fore-milk should be drawn from the cow and discarded. This is required if clean milk is desired since the fore-milk contains large numbers of bacteria. This milk should be drawn, not on to the floor, but into a bucket. Drawing on to the floor tends to contaminate the byre and is an excellent aid to the spread of contagious mammitis. While the fore-milk is being drawn, the operator should see that all quarters are correct and that the milk flow is started from each teat. The cups of the unit are then attached to the teats.

In those machines where the pulsators can be controlled the pulsator will be adjusted to suit the individual cow. It is widely recommended by milking machine agents that the speed of the pulsator be about 40 beats per minute, but it has been found that better results will frequently be obtained with a 25 to 50 per cent. greater pulsation rate, depending on the individuality of the cow, stage of lactation, and so on.

The operator has now time to attend to other units. When the flow of milk is past he returns, massages the udder to ensure complete milking, and removes the unit. It need hardly be mentioned that cleanliness and quietness are just as essential with the machine as with hand milking.

Stripping.—The necessity of stripping after the milking machine is very frequently debated. In many cases it is essential for the reason that on occasion some cows which normally give all their milk to the machine may retain a portion of it. Then sometimes a teat may inadvertently be doubled up when the teat-cup is put on and so it cannot be milked.

On the other hand, where there is an experienced operator who massages the udder as recommended, stripping is not essential—in fact in some cases it may be detrimental, as cows which have been in the habit of being completely milked out by the machine, may, after a time, tend to retain some of it for the stripper.

Where cows have uneven udders with greatly varying milk yields in the different quarters, stripping is necessary as the milking machine should be removed when the lighter quarters are milked out, otherwise congestion may be produced in those quarters. The heavier quarters must then be finished by hand.

Cleaning the Machine.—The attention given to the care of the machine is the most important factor in the production of clean milk by machine milking, and its importance is becoming even greater as the necessity for clean milk is increasingly recognised. The methods employed in cleaning milking machines vary greatly, and are being continuously altered and improved, but an outline may be given here of a simple routine which will produce satisfactory results, and for which facilities are available on every dairy farm. These operations may be divided into two groups—those carried out at each milking, and those employed at longer intervals.

Cleaning at each Milking.—Immediately after milking, at least two gallons of clean cold water are drawn through each unit, and this is followed by a strong solution of washing soda in tepid water. Next boiling water is used, and then all parts which come in contact with the milk are immersed in boiling water, or better still, subjected to the action of steam in a steriliser if one be available.

Before the next milking is started a small quantity of boiling water, followed by cold water, is drawn through the unit, and this puts it in condition for work.

Additional attention.—At intervals of two to seven days each unit should be dismantled. All rubber parts are washed with a brush in a strong soda solution, and the metal parts which come in contact with the milk are also thoroughly washed with soda. Then all parts which come in contact with the milk are put in the steriliser, or immersed in boiling water for three minutes if steam is not available. In re-assembling the units care must be taken that all rubber is in good condition and that the teat-cup linings are taut when fixed in position. The teat-cup linings should be renewed frequently, as when they become worn or pitted they form excellent harbours for bacteria, and the worn rubber also loses its elasticity and the speed of milking is thereby lowered.

At regular intervals the pipe line must be washed out with a warm soda solution, followed by a rinsing of warm water drawn through by the vacuum pump. All moisture should be thoroughly drained from the line by turning on the drain and stall cocks.

Cleanliness in Machine Milking.—In addition to the care of the machine itself there are a few points in connection with the management of the cows and the handling of the machine and the milk which have a great influence on the cleanliness of the product.

Care of the Cows.—For the best results in the production of clean milk through the use of the milking machine the udders of the cows must be clipped, as this is a great aid in preventing hairs and dirt from entering the machine. Then the cows should be groomed daily. It is not possible to produce clean milk with dirty cows.

Immediately before milking the udders should be wiped with a cloth just damp with a solution of some mild disinfectant and then dried. Of course udders which are dirty from any cause must first of all be washed. Attention to those points aids greatly in the production of clean milk.

Handling the Machine.—With careless operation the teat-cups, when being attached to, or removed from, the teats, are sometimes allowed to come in contact with the bedding, or even to fall on the floor. This is to be guarded against, as is the falling of the cups during milking. Otherwise large quantities of dirt find access to the milk.

Removal of the Milk.—The milk should be removed from the byre as soon as drawn, without being poured from the cans of the milking machine to carrying cans. Through the use of a lid which is placed on the can as soon as the milking of a cow is completed, and the unit removed, the possibility of the contamination of the milk by the air of the byre is reduced to a minimum.

Where these precautions regarding the cleaning of the machine and the general cleanliness of the cows and working conditions are taken, it is easily possible to produce milk with machine milking which compares very favourably with hand drawn milk so far as general cleanliness and bacterial content are concerned. If, however, any of these precautions be neglected, milk showing a high bacterial count will be produced.

The cleaning of the machine is very important in this connection, since, when improperly cleaned, the rubbers and other parts coming in contact with the milk form a breeding place for bacteria. Then the bacteria which accumulate while the machine is not in use are washed into the can by the first milk drawn through, and so ultimately when mixing takes place they are distributed through the general bulk of the milk.

Economics of Machine Milking.—The relative efficiency and cost of machine milking as compared with hand milking are the main factors in determining whether or not the milking machine should be used in preference to hand milking on the average dairy farm. The factors affecting these can only be briefly outlined.

Cost.—The items constituting the cost of machine milking include interest and depreciation, the upkeep of the units, the running expenses of the engine, and labour. These costs have been worked out for herds of 20 to 60 cows. Two wage levels have been included—a higher of 50*s*. per week for men and 20*s*. for boys, and a lower of 40*s*. per week for men and 15*s*. for boys.

The total cost of all items in connection with the milking machine except labour works out at £2, 8*s*. 3*d*. per cow per year for a 20 cow herd, £1, 8*s*. 2*d*. for a 40 cow herd, and £1, 1*s*. 5*d*. for a 60 cow herd, while the labour costs per cow per year for the same sized herds are £1, 9*s*. 3*d*., £1, 0*s*. 6*d*. and 17*s*. 7*d*. where high wages are figured, and £1, 3*s*. 5*d*., 16*s*. 7*d*. and 14*s*. 4*d*. where the wages are low. This gives a total cost for machine milking in 20, 40 and 60 cow herds of £3, 17*s*. 6*d*., £2, 8*s*. 8*d*. and £1, 19*s*. per cow per year with high wages, and £3, 11*s*. 8*d*., £2, 4*s*. 9*d*. and £1, 15*s*. 9*d*. per cow per year with low wages. It is evident from this that the size of the herd is one of the most important factors in determining the cost of machine milking, while the labour costs are relatively unimportant.

Efficiency.—In addition to cost, the efficiency of machine milking must be taken into consideration before it can be determined whether or not machine milking is as economical as hand milking. With a good machine operator the yield of milk and butter fat can be maintained satisfactorily, but the reliability of the machine is also important.

The milking units seldom break down. The most serious difficulties which occur generally arise from the engine. Fortunately, however, paraffin and petrol engines are now very common, are relatively free from breakdowns, and repairs are generally easily obtained. In spite of this a breakdown with the milking machine engine on a large farm creates rather a serious situation, though it is generally of brief duration.

Against this drawback to machine milking must be stated the fact that really good milkers are becoming scarce, and it is sometimes difficult to obtain sufficient of them to meet the needs of a large farm. On the whole, machine milking may be regarded as equal in efficiency to the average of hand milking.

Economy.—The costs of machine milking must now be compared with those of hand milking. The wages levels considered here for milking are 10*s.* and 6*s.* per week per milker. An additional allowance is also made for washing up as in the case of machine milking, while the number of milkers is reduced when the majority of the cows are dry in the same way as the time required for machine milking was reduced.

It was found that the average costs of hand milking per cow per year were £2, 13*s.* 10*d.*, £2, 12*s.* 6*d.* and £2, 12*s.* 1*d.* for 20, 40 and 60 cow herds with high wages, and £1, 12*s.* 10*d.*, £1, 11*s.* 6*d.* and £1, 11*s.* 1*d.* for the same herds with low wages. It is apparent from this that the size of the herd has little influence on the labour costs of milking per cow where hand milking is employed; the main factor in determining the cost here is the rate of wages. On the other hand it was the size of the herd rather than the rate of wages which was the factor of greatest importance in determining the cost per cow per year for machine milking.

Where high wages are paid the cost per cow of milking in herds of under 40 cows is greater with the machine than with hand milking, but for herds of 40 cows and over hand milking is the more expensive, though the difference is not great in the case of a 40 cow herd. Where low wages are paid hand milking is in all cases cheaper than machine milking, though with a 60 cow herd the costs per cow per year are tending to reach the same level.

The modern milking machine is efficient and dependable and gives good results when carefully handled. The question of its installation is largely one of relative economy. Where milkers are scarce and wages relatively high a machine can be profitably installed with a 40 cow herd, but where milkers are plentiful and wages low the herd must be over 60 cows before the purchase of a machine will be justified.

THE APPLICATION OF MOLE DRAINING TO SCOTTISH SOILS.

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In the course of extensive field work among the soils of the south-west of Scotland we have been much impressed by the extent of arable and pasture land in which drainage is deficient. Over many broad stretches of Ayrshire and Lanarkshire, in particular, many tens of thousands of acres are entirely water-logged, while hundreds of thousands of acres are sour and sodden for most of the year. "There is probably no improvement of which land in Scotland, both arable and grazing, is at present so urgently in need as drainage, and to no purpose could money be devoted that would yield a better return in increased food production." [1]

Lack of free arterial drainage is responsible in some areas for the wet condition of quite large tracts of land. Subsidence due to collapse of mineral workings may wreck the drainage system in many districts. These two influences combine to hinder the drainage of hundreds of acres in the Kelvin valley. In Renfrewshire the tidal flow up the estuary of the Clyde hinders drainage towards the main arteries of Cart and Gryfe. But in addition to the areas where obstacles of this kind are encountered, there are extensive tracts lying undrained or under-drained where an easy outlet for excess water can readily be obtained. On such lands lime and manures are being thrown away, pastures are of little value, cultivation is difficult, and a state of affairs exists which tends to frustrate the best efforts of the farmer. He is driving his car with the brakes on.

During the last decade some of this land has been drained through assistance afforded by Government grants. But the cost of the work is high, being rarely under £20 per acre and usually over this figure. The drain tiles alone may cost £10 per acre. There is little wonder that landowners and factors shrink from undertaking schemes of land drainage beyond the work which is absolutely essential. This being so, we turn with interest to examine the claims of mole draining, which is said to cost about £2, 10*s*. per acre, and can be carried out at the high speed of two to three acres per day. The mole draining plough works best in the heaviest classes of land, just that type which is most in need of draining in Scotland to-day and which is usually most expensive to drain.

The central idea of the mole plough is by no means new. Draining machines of this kind have been in use for many generations in England, while, in the United States of America, Gopher plows, working on the same principle, were successfully used about the middle of last century.

At the present time a considerable amount of mole draining is

[1] *Report of the Scottish Conference on Agricultural Policy.*

being carried out in England, heavy machines operated by steam engines being used. In Scotland this method of land drainage has not received the attention it deserves, partly because of the cost and cumbersome nature of the plant, and because it was believed that the soil and size of fields in this country were unsuitable. These criticisms do not apply to a mole-draining outfit, designed and perfected by an Ayrshire engineer, which is the most useful mole-draining plant known to the writer and is proving singularly effective in solving drainage problems in Scotland.

In this article we propose to give a general description of the outfit with an account of some tests arranged for it by the writer in Ayrshire and Renfrewshire, and a summary of the soil and subsoil conditions under which it is likely to work to best advantage. In such a case as this it seems proper that the soil survey worker should co-operate with the engineer in "speeding up" the application of a useful and promising invention on behalf of agriculture.

The Ayrshire mole-draining plant (Fig. 1) consists of a Fordson tractor of 24 h.p. The front wheels are of motor car type and are fitted with pneumatic tyres; the rear wheels are of the usual tractor design. To the rear end of the tractor is fitted a patent Maybet winch driven by belt and pulley from the engine shaft and working on a reduction gear of 30 to 1. The winch drum, 8 inches in diameter, carries a steel rope which may be payed out to any length up to 200 yards. This rope has a breaking strain of over 6 tons, and the winch is capable of registering a pull of over 6,000 lbs. on the dynamometer. The free end of the rope is securely fixed to the forward end of the mole plough, which may be drawn through the soil by the pull on the wire rope, the tractor being secured from running backwards by a field-gun spade attachment let down on a pivot behind the rear wheels.

The mole-draining plough (Fig. 2) is a two-wheeled carriage made of heavy steel angle-iron, the wheels being fitted with pneumatic tyres. Its portability is such that, although weighing some 7 cwt., it can be fixed by one bolt to the rear of a motor car and towed at 20 miles per hour. The essential parts of this plough are (1) a steel frame, fully 6 feet long, which, when the drain is being cut, slides along the surface of the ground and keeps the line of the tunnel parallel to the surface. This strongly constructed frame can be lifted and controlled by a wire rope round a windlass on the top of the machine. (2) A broad and powerful steel coulter sharpened in front and making a cut in soil and subsoil about ¾ inch wide. This knife is not arranged vertically, but has a forward rake like the share of a plough. At its lowest extremity is rigidly attached (3) the torpedo shaped steel "mole," which when the machine is in action lies parallel with the surface. Behind the "mole" and fixed to it by a link is (4) a solid steel ball which enlarges and polishes the mole tunnel. At the forward end of the cradle is set vertically (5) a sharp circular knife, which revolves

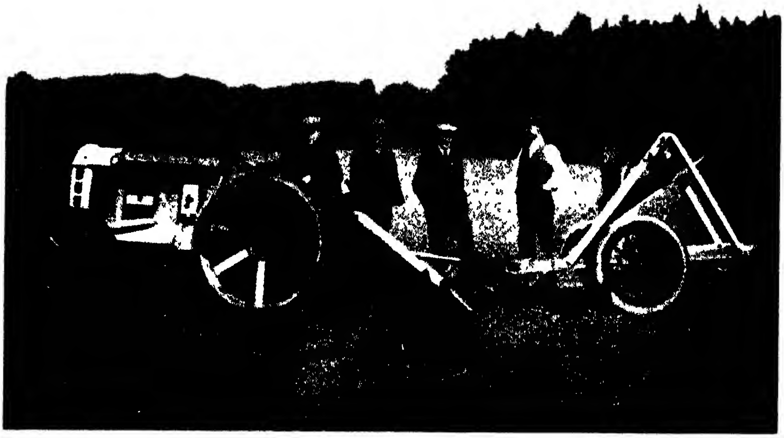

Fig. 1.

(1) Maybet winch at rear of tractor; (2) spade attachment for holding tractor firmly in place when hauling plough; (3) mole plough slung on steel carriage.

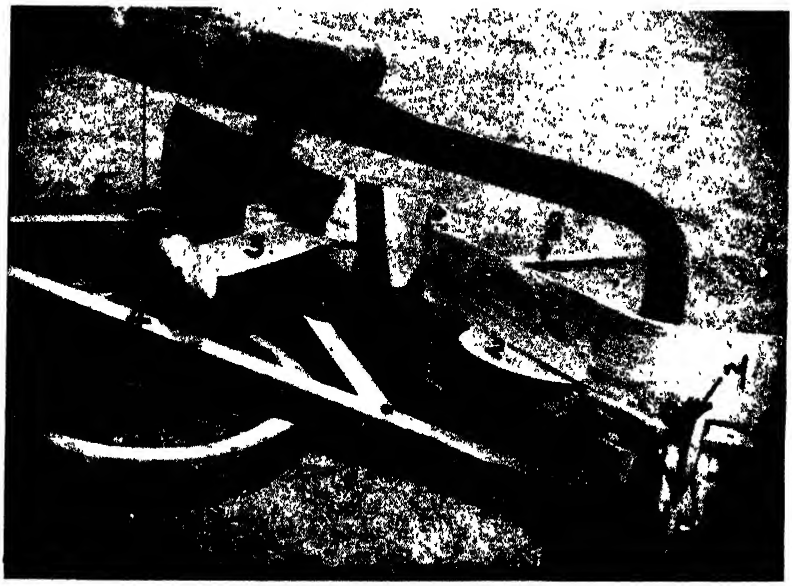

Fig. 2.

Shows the mole draining plough turned over to expose (1) a long steel frame, which slides along the surface of the ground when the plough is working and carries the cutting tools; (2) the circular knife for slicing the turf and upper soil; (3) the slicing coulter to which is rigidly attached (4) the torpedo shaped mole, and (5) a steel ball linked to a swivel at the rear of the mole. The plough is slung on a steel carriage (6) borne on two motor car wheels with pneumatic tyres. The haulage rope is attached to a swivel coupling (7). The tubular steel steering rod (8) is seen in the rear.

Fig. 4.

Shows (1) surface marking left by mole plough; (2) slight deflections caused by cutting old stone drain.

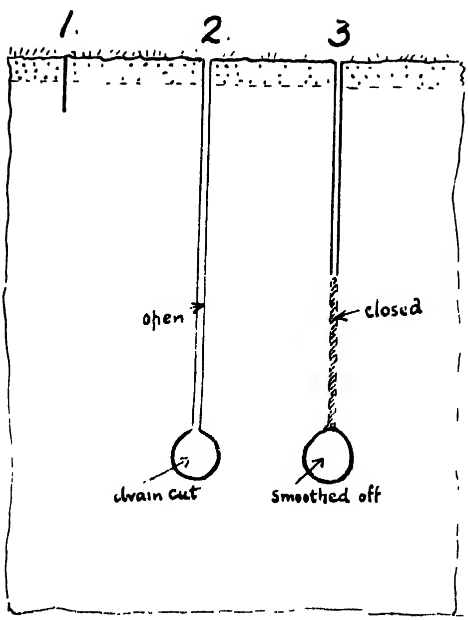

Fig. 3.

1. Turf cut by circular knife.
2. Vertical open cut and tunnel made by knife and mole.
3. Vertical cut partially closed by following ball.

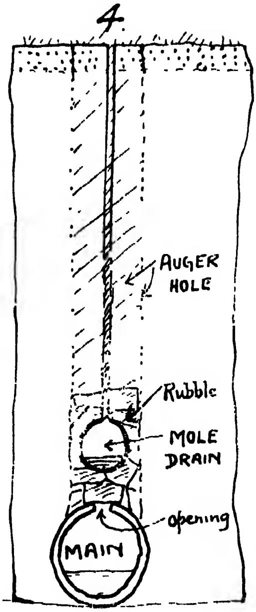

Fig. 5.

Showing large auger hole from surface through mole drain to main drain—lower part filled with sandstone rubble and upper with silt clods.

as the machine glides forward and cuts a slice some 4 inches deep in the turf and upper soil.

The work done by the various parts of the mole plough is shown in Fig. 3. First comes the circular knife which leaves cut as at (1), then the heavy coulter and mole cut a vertical slot leading down to a tunnel of circular cross section, and finally the steel ball which enlarges the passage, closes the vertical slot for some inches, and leaves the path of the steel " mole " with walls compressed and as smooth as the interior of a teacup. The depth and direction of the " mole " while the plough is in motion may be rapidly altered by the combined use of the overhead windlass and a long steel rudder which is fixed vertically in a socket at the rear of the cradle. With such control the plough may be made to travel forwards on its tyred wheels, then the cradle is slowly lowered, and the mole moves downwards until it reaches its lowest level in the soil when the surface of the cradle touches the turf. When a boulder is encountered the rudder is used to steer round it and ease it up or to bring the " mole " to the surface to avoid straining the rope. After the mole plough has passed over the ground the only surface trace of its operations is a narrow slot. In pasture land the grass soon knits across this and removes all traces of the work.

This mole plough can draw a drain of 6 to 8 inches in diameter at all depths up to quite 30 inches. Main drains may be cut with it, but the designers prefer to employ it only for minor drains of 3 or 4 inches in diameter which are led direct into (1) an open ditch, or (2) a tiled main drain.

In order to test the mole plough over an interesting range of soils, the writer recently arranged a trial in a field kindly provided by Mr. C. M. Collins of Barochan, Renfrewshire. The field contained a sandstone island, partly covered by pasty sandstone drift, rising out of a flat of silt. In cutting a drain the plough had to pass through a succession of soils ranging from free sandy loam and shading gradually into tough compact silt. The soil best adapted for mole draining in this field is the silt, which is a fine-grained laminated, clay-like deposit of estuarine mud and practically free from stones. It is composed of clay, fine siliceous silt and white mica in a fine state of division—probably one of the stickiest and most tenacious soils in the west of Scotland. By working the mole plough across these soil zones it was possible to obtain mole drains cut in a wide range of soil types. These drains will be kept under observation so that records may be secured of the " life " of machine-cut tunnels in subsoils of varying texture. The drains were cut at depths of 16 to 18 inches and 3 to 6 yards apart.

Where minor drains are cut in heavy soil at close intervals a large number of junctions with the main drain are rendered necessary. In order to expedite this work, the writer made use of the following method of leading in the minors. The mole drain was led right across the top of the main and clearing it by 9 to 12 inches. The path of the main drain was marked by pegs on the surface, while that of the mole drain was indicated by the surface cut (Fig. 4). At the intersection a 6 inch auger hole was drilled, with the Standard Earth auger, until the mole drain was cut across and the tile of the main drain was revealed. The latter was pierced with a triangular pointed bit with triple longitudinal grooves. The auger hole was then filled with sandstone rubble to a point above the mole drain, then with soil to the surface (Fig. 5).

The trial at Barochan was attended by a large company of farmers and others. The flexibility and capacity of the plough for doing " fancy work " was shown by the cutting of drains in " herring bone " fashion, by cutting an intercepting drain round a knoll, and by slipping out the mole to the surface to avoid an old stone drain.

After the company had seen the machine at work, a discussion took place, when the following facts were elicited from the drainage experts as the result of their experience with the mole plough in draining over 1,000 acres in the midland area of Scotland. Mole drains cut in boulder clay in 1918 are still running. Mole draining has been successful in land of the carse type near Alloa, where the most experienced farmers request drains of 4 inches diameter, with 14 inches of cover and 3 or 4 yards apart. The rate of working is two to three acres per day; in this connection much depends upon the size and shape of the field as affecting the length of mole drain. Where the land is laid up in ridges, 5 yards wide, with derelict drains below the furrows, the mole drains are run above the old tile drains. The Endeavour plough works very well in heavy boulder clay and does not suffer so much from obstructions as might be expected; in one of the Ayrshire examples near Auchinleck the writer noted that the mole plough had been forced to the surface once per 160 yards of run, and this in heavy boulder clay over coal measures. When the mole encounters a boulder, say 2 feet in diameter, the operator sees the turf rising up, and at once slips the mole round the obstacle and up to the surface. The boulder, already loosened, is removed and the mole reinserted, the gap in the mole drain being bridged with a tile. Land, really in need of draining, usually doubles its value the first year after the operation. The cost of draining averaged £2, 6*s*. 8*d*. per acre. This figure seems low, but as the owner of the draining outfit advertises that he is willing to take contracts on this basis and is actually doing so, we leave it unquestioned. It seems proper to point out, however, that there are some additional charges, such as the cost of boarding two men, the cost of connecting up the mole drains to the mains, and the outlay on tiles for repairing breaks in the mole drains and for lining outlets. In practice the men are usually boarded at the farm free of charge; the connections to main drains are cheaply and quickly made if carried out as described above; the tiles required for mole drain outlets or repairs should not cost more than £1 per acre. The total cost, additional to the contractor's fee of £2, 6*s*. 8*d*. per acre, we would estimate as not exceeding £2, 5*s*. per acre. Mole draining has been found effective with the limited fall of 1 in 100 in carse land. The mole plough has been successfully used in breaking hardpan, although the duration of this work is not known, probably ten years. Hardpan is common in ferruginous soils in the west of Scotland, with a thickness of 2 to 6 inches and at a depth of 10 to 18 inches.

The following are soil types in central Scotland where the mole plough will prove of most value. The carse clays of Stirling and the Forth valley; Carse of Cree in Wigtownshire and in the Carse of Gowrie; the lake clays of the western Blane valley and Gartness area; the estuarine silts and clays of Renfrew and Dumbarton; dry lake flats on heavy blue and red clays on the carboniferous and old red sandstone of Ayrshire, Lanark, West Lothian, Fife and Forfar; some of the heavier alluvial soils; rainwash clays in flats and slopes among the igneous rocks of Renfrewshire and Ayrshire; the deeper boulder clays over carboniferous rocks in Ayrshire, Fife, the Lothians and Lanarkshire; the red sandy drifts of south Ayrshire are liable to contain a large proportion of granite and greywacké boulders which would obstruct the mole plough; some of the old red sandstone drifts in Stirlingshire, parts of Perth and Lanark.

Mole draining is likely to have a limited application on the stony silurian boulder clays of Dumfries, Kirkcudbright and Wigtown, among such subsoils as the Galloway shepherd knew when he remarked that he always carried a pickaxe when he went to plant potatoes! In the West Highlands the soils are usually too stony and open for this type of drainage. This applies to Coll, Tiree, Mull, Islay, Arran and Bute, where the only suitable soils occur in small patches as local alluvium and rainwash on slopes. In Kintyre, some of the close grained alluvium near Machrihanish and occasional patches of drift might prove suitable. In Cowal the subsoil conditions are similar to those in Kintyre.

Generally speaking, the mole plough is likely to be of most value in draining lands in the midland valley of Scotland—in Ayr, Lanark, Fife and the Lothians, in the heavier drifts of the carboniferous and old red sandstone, and in the soil types mentioned above.

With regard to the drainage of sandy loams, loams and the lighter classes of land, the designers of the Ayrshire mole plough are experimenting with mole-tile drainage, and have succeeded in drawing in a string of tiles, 50 yards long, into a suitable mole tunnel. This method is expected to halve the cost of draining by tiles.

The further development of mole draining and mole-tile draining is certain to give a great stimulus to land drainage in this country. Given a greater demand for tiles than exists at present, the tile manufacturers could produce these at a much cheaper rate. Skilled drainers, who are drifting away to other occupations, would find abundant employment in co-operating with the draining machine, and openings would also be provided for unskilled labour.

These considerations indicate that this economical method of draining tracts of land at present unsuitable for agricultural purposes is worthy of development, and that a more extensive use of the mole plough would prove of benefit to Scottish agriculture.

INSECT PESTS.—No. VII.

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

MOTHS—*continued.*

IN addition to the species of *Noctuidæ* or Owlet Moths described in the October number of the JOURNAL, three other species of this large family may be mentioned either because of commonness or because of some outstanding characteristic.

The Cabbage Moth (*Mamestra brassicæ*).—The caterpillars of this moth are enemies not only of the cabbage and allied crucifers, but also of the smaller fruit plants and garden flowers. When attack is on the cabbage, the caterpillars eat their way into the heart and spoil the head with their moist excrement; on other plants they feed more exposed.

The moths, gloomy grey-brown with dark and light markings, have a wing expanse of 1¾ inches; they are on the wing throughout the summer. They are active at nightfall and at night, and rest in the daytime on flowers, on tree trunks and palings, and sometimes nestled against the sides of clods and stones in fields.

Eggs are laid on the various food plants. The caterpillars on hatching are pale green, but as they grow show great colour-variation. While some remain green, others become greyish-green, and still others may become very dark on the upper and more exposed parts; there are greyish or yellowish side lines; the spiracles are white encircled with black. Legs 16. The full grown caterpillar measures 1¼ inch.

The caterpillar feeds for over a month, and when full-fed leaves the food plant and enters the soil for pupation. The pupa is shining chestnut brown with two small spines at the hind end.

The Silver Y Moth (*Plusia gamma*).—This is a common moth in summer and autumn and is a migrating species. On summer and autumn nights one finds it coming to sugar or treacle baits. The front wings are satiny brown or grey-brown or purplish brown, and each has on it a distinct white or yellow-white Y resembling the Greek letter gamma. The caterpillar is a general feeder—it cannot be called a pest—on garden and herbaceous plants. The caterpillar has only twelve legs, the pairs on joints 7 and 8 found in the great majority of Noctuid caterpillars being absent in the Silver Y. The body of the caterpillar tapers somewhat towards the front end; the colour is green, with six wavy yellowish-white lines down the body; between the lines are white dots each bearing a bristle. Pupation is above ground, e.g. under cover of leaves; the pupa is black, and lies in a thin, whitish, spun cocoon.

The Antler or Grass Moth (*Charæas graminis*).—This moth, measuring 1¼ inch in spread of wings, gets its common name Antler Moth from the pale branched line which, when the wings are extended, is seen to run, in each front wing, half-way across the wing; the general colour of the front wings is grey-brown or brown-grey; the hind wings are paler. The caterpillar has the body round, with the joints distinct; colour dingy grey-brown with paler line down back and sides; spiracles black; a horny shield is present on the upper surface of the first and last joints of the body.

The moths are found in flight in July, August and September, and chiefly in the mornings and forenoons. Eggs are dropped among the grasses as the moths fly. The winter is probably passed in the caterpillar stage in shelter places. The caterpillars, only partly grown, come from these shelter places in April and continue feeding till June, when pupation takes place in the soil.

In different localities examples of the Antler Moth can be found every year, but periodically, when the environment has been exceptionally favourable, the insect appears in impressive numbers. Various writers have referred to the spectacle of thousands of the moths in active flight during a restricted period of the morning or forenoon; then a sudden disappearance, followed by mass reappearance the next morning. In the south of Scotland 1830, 1836, 1885 and 1894 were plague years as regards the Antler Moth. The upland pastures of Ettrick and Yarrow were greatly damaged, and in 1894 hill pasture suffered severely over a very large area extending from Roxburghshire right across to Ayrshire. In 1917, in June and July, caterpillars, pupæ and moths came to me from Westmoreland, Cheshire and Yorkshire. In these counties the pest was in overwhelming numbers.

Continental records indicate that the Antler Moth caterpillars can be serious enemies of wheat, rye and barley. Our British records, however, do not contain any exact account of destruction to cereals. In keeping with the fact that the caterpillars are found typically in upland and mountain pasture, the plants attacked include some of the coarser grasses and also some sedges and rushes. For example, in the Antler Moth plague in Dumfriesshire and Kirkcudbrightshire the late Mr. Service named as the plants most commonly taken by the caterpillars Bent Grass (*Agrostis vulgaris*), Mat Grass, Purple Molinia, Tussock Grass (*Aira cæspitosa*), Yorkshire Fog, Rough Stalked Meadow Grass; the sedges Deer's Hair and Cotton Grass, and of rushes the sharp-flowered Jointed Rush (*Juncus articulatus*) and the Heath Rush (*J. squarrosus*). In the 1917 outbreak in Yorkshire in addition to several of the above, Sweet Vernal, Sheeps Fescue, and the Wood Rush were eaten.

THE FAMILY *Geometridæ*.

The Geometer Family is a very large one; most of the species are night fliers, and a number is attracted by bright lights; sweet baits are of little avail as many, in absence of functional mouth parts, do not feed. A common attitude in rest is with the wings spread out and flat. The caterpillars are known as Geometers (measurers of the earth) or Loopers, from their mode of progression. Generally speaking a moth caterpillar has 16 legs, of which the hind five pairs are known as claspers or prolegs or abdominal legs. Most Geometer caterpillars have only two pairs of prolegs, the front three pairs being absent (rudiments may be present but they are of little or no use). (Fig. 1.) When moving the caterpillar takes hold by the thoracic or front legs and then draws up the hind part of the body, forming a sort of arch; then with the prolegs holding on, the front legs are pushed forward and so on, so that the caterpillar appears to be measuring out the twig or leaf. While resting on the food plant the caterpillars often rest with body extended, and in this position can easily be mistaken for small twigs, especially as their colour matches the colour of their surroundings. In such a position the caterpillar holds on to its support by the claspers.

In some species the females are wingless, or they may be just rudiments of wings.

For us here the family has importance because of the species that attack fruit plants and trees, and of these we shall describe the Magpie or Currant Moth and the Winter Moths.

The Magpie Moth (*Abraxas grossulariata*) (Fig. 2), with its black and white and yellow spots and patches, is a well enough known species. There is considerable variation in the colouration and shade, very pale varieties and very dark varieties being found. The moths fly in July and August and not again until the next late summer. The females lay their eggs singly or in small groups on the leaves, and in favouring conditions the eggs hatch in a fortnight. The newly hatched caterpillars are dark in colour, but on renewing their feeding after hibernation they are cream-coloured with a row of squarish, black, velvety spots down the middle of the back; the spiracles are black; above and below the spiracular line are rows of black spots. The legs are 10 in number, and the caterpillar is a looper or spanner. Above, the geometer or looper caterpillars have been stated to receive protection by their resemblance to twigs. The Magpie caterpillar is a marked exception, for it remains very conspicuous (Fig. 3), a good example of what is known as "warning colouration." The caterpillars are distasteful to insect-eating birds. The conspicuously coloured insect (Fig. 3) associated with some quality that makes it unpalatable to the bird or other enemy, assures itself of being readily recognised and therefore spared. However post-mortem examination of stomach contents of the cuckoo has proved that this bird takes Magpie caterpillars.

Gooseberry and currant (black currant is preferred to red

FIG. 1.
Caterpillar of Mottled Umber Moth.
From Nature. Enlarged.

FIG. 2.
Magpie Moth.

FIG. 3.
Magpie Moth. Adult at rest; caterpillar; and pupa removed from cocoon.

currant) are favourite food plants, but the caterpillars also feed on apricot and plum and blackthorn; there are records of attack on hazel and euonymus, and I have recorded a case where couch-grass growing under infested gooseberry bushes was being eaten.

The details of the life-history should be carefully noted. The young caterpillars hatching in July and August feed till autumn. At this time they are only partly grown and they go into winter quarters, taking shelter in fallen leaves that may be rolled together, or in soil litter or in the soil under or adjoining the food plant, or among moss and lichen on the bushes or—in the case of bushes against walls—in cracks in the wall. When spring comes round, the caterpillars come from their hibernating places at the time the food plants are coming into leaf. The caterpillars feed greedily in order to complete their growth, and the attacked plants, defoliated or partly defoliated, are weakened and fail to produce a crop of fruit.

The caterpillar is full grown in June and pupates under cover of a slight cocoon. The cocoons with their enclosed pupæ are found hanging on the foodplant from leaf and branch, or on walls, or on fences near at hand. The actual pupa is shining black and has a series of complete and incomplete yellow rings. By a month the new adults are ready to issue.

Control.—Destroy the young caterpillars in autumn by an arsenate of lead spray, 1 lb. arsenate of lead paste to 20 gallons of water; the under sides of the leaves should receive the spray. Examine the bushes after the leaves have fallen and collect any loose leaves that may contain sheltering caterpillars.

Watch for the appearance of the caterpillars on the plants in spring; hand-pick the caterpillars or poison them with an arsenate of lead spray. Arsenate of lead is a stomach poison; the poisonous arsenate is left on the leaf and when the caterpillar eats it is poisoned. This spring spray with arsenate of lead should be done as soon as the leaves have opened out and before the flowers are ready for visit from bees. The arsenate of lead spray is poisonous for bees. An alternative spray is hellebore powder, viz. hellebore powder 2 lbs., soft soap 1 lb., water 10 gallons. This hellebore spray can be safely used any time up to a month before the picking of the berries. Hellebore does not dissolve in the water, and therefore the spray fluid should be kept agitated.

The Magpie Moth is partly held in check by parasites. I have bred from the caterpillars both Tachinid and Ichneumonid parasites.

Winter Moths.

It may seem strange to some to hear that there are species of moth which appear for the first time in winter, and which are found flying and at work only in winter. Thus the Smaller Winter Moth (*Cheimatobia brumata*) and the Larger Winter Moth or Mottled Umber (*Hybernia defoliaria*) come from the pupal state in and from October or November to February;

further, the March Moth (*Anisopteryx æscularia*) appears in February and March.

The caterpillars of these winter moths are general feeders on fruit trees and a number of other broad-leaved trees. They are early feeders, hatching in spring from eggs laid in winter and early spring, and destroying buds, leaves and young fruits.

A feature of these three winter moths is that the females are unable to fly. Fig. 4 shows the female of each of the three species. Distinction is easy. The Cheimatobia females have rudimentary wings useless for flying. The Mottled Umber female is larger and quite wingless; she looks spider-like with her long legs; the body is yellow-brown in colour and there are two dark spots on the upper surface of the joints. The March female is wingless and also spider-like; she is recognisable by a tuft of hair at the tail-end.

The Cheimatobia male measures up to 1¼ inch in spread of

(*a*) Female of Cheimatobia brumata. (*b*) Female of Mottled Umber. (*c*) Female of March Moth.

FIG. 4.

All three enlarged. From Nature.

forewings, which are grey-brown with darker wavy lines; hind wings plain pale-grey. The Mottled Umber male is nearly twice as large as Cheimatobia; his front wings are brown or brown-yellow, with two dark bands; the hind wings are paler.

The March Moth male measures up to 1½ inch in spread of forewings; the forewings are brown or yellow-brown, with transverse bands; hind wings pale grey with a darker zigzag line across them. The caterpillars of all three moths are loopers with ten legs; the body behind the head consists of twelve visible joints; joints 1, 2, 3, 9 and 12 carry each a pair of legs.

The Cheimatobia caterpillar measures about ¾ inch when full grown; body somewhat thinner at the two ends; the colour varies with the stage of the caterpillar; the newly hatched caterpillar is greyish with the head dark; the older caterpillar is green, with a dark line along the middle of the back; on each side are three yellowish or white lines; in the final stage of the caterpillar the head is brown or green-brown, the body is greenish yellow with the spiracles dark.

The caterpillar of the Mottled Umber (Fig. 1) measures 1¼ inch when full grown; the back is brown or chestnut brown with a dark wavy line on each side; the sides are yellow; spiracles white with a ring of black; head and last joint brown-red.

The March Moth caterpillar in addition to the ten functional legs has an extra pair of legs on joint 8, too small, however, to be of service (these rudimentary legs do not show until the caterpillar has made some growth). The body does not thin out at the two ends; colour greenish-white or yellow-green, with the line of division between joint and joint a more pronounced yellow; the line down the middle of the upper surface is dark and edged with white; the side lines are greyish-white to yellow.

Life-history.—The Cheimatobia Moths come from the pupæ in the soil from October onwards. The females, unable to fly, have to crawl up the trees for their egg-laying. The eggs are laid beside the buds, on pruned surfaces and in bark crevices. Up to 200 eggs may be laid by one female. The eggs hatch in spring. The young caterpillars feed for a time in buds or under cover of spun-together leaves and flowers; later they feed exposed. Buds, blossom, leaves, young fruit are all eaten. The caterpillars have the power of spinning and can let themselves down on spun threads to a lower level or lower plants. The caterpillars are full grown in May and June, when they enter the soil under the trees or fruit bushes for pupation. The pupa is under cover of a silken cocoon to which are attached particles of soil.

The Mottled Umber Moth has a similar life-history, but the caterpillars feed exposed on the tree throughout their life.

The March Moth issues from the pupæ in the soil about March. The wingless females lay their eggs in bands or parallel rows round the twigs. Mixed with the eggs are hairs from the paint-brush like tuft at the hind end of the female (Fig. 4).

The caterpillars of these three moths are general feeders; they are harmful on rosaceous fruit trees—apple, cherry, plum—and on currant and gooseberry bushes that may be growing under these trees; in addition they play their part in the defoliation of other broad-leaved trees. The March Moth does not seem to be found in Scotland north of Perthshire, but the other two winter moths are found still further north.

Control.—Place bands of grease-proof paper round the trees in autumn. The bands should be from 7 to 9 inches wide, and should be fixed 3 to 5 feet from the ground, secured—an inch from the top and bottom—by a string. These bands should be kept catchy till the following April. Any females attempting the ascent of the stems for egg-laying will be caught on the sticky bands; eggs will probably be laid below the bands, but the caterpillars from these will be caught in their turn.

Bush trees that cannot be banded satisfactorily and trees not banded should be sprayed early in spring, before appearance of flowers, with arsenate of lead, viz. 4 to 5 lb. arsenate of lead paste to 100 gallons of water.

FAMILY *Liparidæ*.

This family contains some of the most destructive forest and orchard species in Europe; some are indeed notorious for the damage they cause, but for Scotland the species have little or no economic importance. One of the species is the Vapourer Moth (*Orgyia antiqua*). The moth is interesting because the female (Fig. 4) is quite unable to fly, her wings being reduced to mere stumps. The male has an active, whirling, jerky flight and flies by day. The caterpillar (Fig. 5), a handsome one, is a general feeder, feeding on the leafage of many different trees, including conifers, also on fruit and garden plants and on such plants as heather and blaeberry. It is the caterpillar of this moth which is sometimes so troublesome in the London parks. Troops of voluntary scouts have more than once assembled for a raid on the Vapourer Moth cocoons. In Scotland I have recorded the species as sometimes destructive to heather.

FIG. 5.
Caterpillar of Orgyia antiqua.
From Nature. Enlarged.

Another member of the family is the Brown Tail Moth (*Euproctis* or *Liparis chrysorrhœa*). The caterpillars are general feeders on a number of trees. On the Continent the Brown Tail is a forest pest of importance; in South Britain it ranks as a harmful orchard enemy—apple, pear, plum—but it seems to be a disappearing species. In 1897 an appeal was made to British entomologists to refrain from collecting the species so that it might recover its numbers. At the very same time thousands of dollars were being spent in the East United States (later also in Canada) in fighting this insect, which had been accidentally introduced into the United States from Europe. The caterpillars (Fig. 6), which in Britain hatch in August, spend the winter, only partly grown, in a nest or tent of spun-together leaves. A number of such nests of caterpillars chanced to be carried to the United States in a consignment of shrubs; in their new home the introduced caterpillars throve, and now the species—new at that time to America—has become a pest against which there is repressive legislation. In Britain the damage by the caterpillar has been chiefly to southern orchards. The Brown Tail has been recorded from Scotland, but not once in all my experience has the species ever come to me from Scotland.

Another Tent caterpillar of a closely allied family is the Lackey (*Clisiocampa neustria*). The female moths lay their eggs in ring clusters; the cluster of eggs fits round the twig as a ring fits on a finger. The eggs are laid in July and August, and

FIG. 6.
Eggs, caterpillar and pupa of Brown Tail Moth.
From specimen in Dr. MacDougall's Collection.

remain unhatched the winter through exposed to all the rigours of the winter weather. The eggs hatch in the next late spring. The caterpillars are gregarious; they spin together leaves to make a nest or tent in which they rest at night and take shelter against unfavourable weather. In England the caterpillars are harmful to the leafage of fruit plants. The name Lackey for the moth is due to the gay appearance of the caterpillars. The species is not found in Scotland.

A CHEVIOT FLOCK ON EXMOOR FOREST.

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THERE are in Britain a very large number of perfectly distinct breeds of sheep, some few of which are well known over the whole of the country, or are found, at any rate, over large districts. The majority of the breeds, however, are restricted to their own localities, from which they frequently take their name. Even though Scotch hill sheep and their half-breds, for example, are a usual sight on the Midland grazing farms of England, and the Down breeds are found in the Border counties, this change of environment is associated almost entirely either with the practice of fattening store sheep from the hills on the richer pastures of the vales, or with that of crossing the mountain breeds and their half-breds with the heavier and better quality Down sheep in order to produce a better quality store sheep. The breeding and the feeding of sheep are in the majority of cases two distinct functions—the now fast diminishing Down flock-master being the most notable exception. The tendency in the organisation of the sheep industry has been to use the poorest land purely for the breeding of sheep, and to fatten out the progeny on the richer lowland pastures. The great sheep fairs for the sale of draft ewes and store lambs, up and down the country, are too well known to need emphasis, and the annual importation of stores into the better pasture districts is a universal custom.

Even at the present day, which has seen the disappearance of so many local prejudices, the local breed, for breeding purposes, generally speaking still holds its own in its locality. There is more than prejudice here, for empirical knowledge has generally produced an animal peculiarly suited to its environment, and experiments in maintaining a non-native flock have led, usually, to loss of quality, reduction in fecundity, and so forth. Mountain sheep will not stand the rich food of lowland pastures, and lowland sheep are incapable of enduring the rigours of climatic conditions in the hills. It is true that recent years have seen a great increase in the number of flocks of Cheviot and Cheviot-Border Leicester crosses in the South Country, but these flocks are not, as a rule, kept pure, being used for crossing with local or Down breeds, the ewe flock being regularly replenished with pure stock, or at most with ewe lambs of the first cross.

Considerable interest, therefore, attaches itself to any early experiment in the acclimatisation of a Cheviot flock in the South of England, more particularly since it has long ceased to be an experiment and has passed into the realm of well-established practice. The results of this venture, which was started sixty years ago, can be seen to-day, and not only has the flock maintained its type and quality, but it has also proved itself better suited to its new district than the still popular local breed.

The Forest of Exmoor, in Somerset, was disafforested in 1818, and sold by the Crown to John Knight, a Worcestershire landowner and ironmaster, for development as an agricultural and mineral estate. The amazing story of how, in one lifetime, the bleak and uninhabited moor was enclosed, drained and converted largely into agricultural land supporting a thriving community, has only recently been told.[1] It stands as a monument

[1] C. S. Orwin, *The Reclamation of Exmoor Forest.* Oxford University Press. 1929.

to enterprise and tenacity of purpose even if the financial results were unsatisfactory to those concerned. Many mistakes were made and farming systems quite unsuited to the district were tried. Experiments were made with many breeds of stock, with results not always successful, as witness the experiment with Highland cattle, which were imported from Scotland, but proved so fierce and wild in their new environment that no one could handle them, and they became a menace to public security. Before the Forest was enclosed, all that it provided was a scanty living for a few ponies and the small local sheep which were depastured there by those who claimed common rights and others by virtue of payment. The winter climate was too rigorous to maintain the flocks, but during the summer great droves from the surrounding country were driven up on the moor. At the time of the enclosure it is on record that the 20,000 acres of the Forest provided grazing for some 30,000 sheep during the summer. In those days the flockmaster's objective was wool, and as long as the animal could be kept alive its age or mutton qualities were of no moment.

John Knight was quick to realise the great drawback of relying upon a breed which, in his day, was not only very small in size and poor in quality, but also one which was extremely slow in maturing and incapable of getting a living on the Forest during the winter. Exmoor lies between 1,200 and 1,700 feet above sea level, and its severe climate and great altitude induced him, after a brief essay with the local Exmoor Horn or Porlock breed, to make a trial of some Scotch Cheviots. This first venture proved a failure, owing to a lack of understanding on the part of the local shepherds, and no further attempt was made to import a new type of animal until the 'sixties, by which time John Knight was dead, and the management of the great estate had passed to his son, Frederick Knight. With the initial failure of his father before him, Frederick Knight decided that if Scottish sheep were to be established successfully he would have to import not only sheep, but also shepherds who thoroughly understood their management. He acted on this presumption with the wholehearted enthusiasm which characterised all his actions, and not only did he go himself to Scotland for his breeding stock but also for his shepherds and their dogs. Two of the shepherds brought down at this time are living on the Forest to-day, and their descendants of the first and second generation are now at work with the flock. At first both Cheviots and Blackfaced sheep were brought down, by boat, to Lynmouth, but the Blackfaces were gradually replaced by Cheviots, the last large purchase of which arrived by train to Bristol in 1871, and were then driven through Somerset on to the Forest.

Frederick Knight died in 1897, and the property with all the stock passed to Earl Fortescue. The Cheviot flock numbered at this time 5,300, but the numbers to-day have been reduced to about 4,500 owing to the letting of some of the land. Though it is very nearly sixty years since any Scotch ewes have been imported, it is claimed that there has been no loss of character or type, and that the Exmoor Cheviots would stand as good a chance of winning at Hawick as any of the native-bred animals shown there.

The system of managing the Cheviot flock is very similar to that which is followed in its native home. The whole flock is divided up into seven herdings (the equivalent of the Scottish "hirsels"), and it is through the head shepherd's herding that the only new blood is introduced. Every two or three years some rams are bought at Hawick and run with this herding, from which rams are bred for the other herdings, and in this way the new blood is distributed over the entire flock in the course of time. In all, about one hundred rams are used in the flock; they are turned out in November and the ewes start lambing at the beginning of April. In the autumn, the wether lambs are sold out to up-country farmers, and ewe lambs are taken away from the Forest and wintered on better land to the south. Culled ewes are put with a Shropshire ram on the best Forest pasture, and are fattened off with their next season's lambs on rape and improved grass in the following summer. No lambs remain on the Forest during the winter. Under the Knight management, large areas of winter keep had to be secured in lower lying land near by for wintering the ewe lambs, but Earl Fortescue is much better placed in having his own properties to the south of Exmoor, which provide excellent keep for theaves, during their first winter, until they are turned up to the moor again in the following spring. The ewe flock remains on the moor throughout the winter, and very rarely gets any hand feeding, for it is only in the severest weather that some rough hay has to be fed to it. The number of sheep which the Forest can maintain is determined by the amount of April keep, for in this month there is less food than at any other time of the year.

Such, very briefly, is the story of this interesting flock. As a manifestation of sheep-farming, it must be one of the largest enterprises of its kind in England; as a successful venture in the acclimatisation of a breed it is probably unique. It is regretted that data for comparison of Cheviots in their own country with this Exmoor flock are not available. For more than twenty years the register of Earl Fortescue's Cheviots has been maintained, but enquiries in Scotland have failed to produce anything comparable to it. The tables which follow have been abstracted from it, and are published with his permission.

The average size of the flock from 1911 to 1929 was about 4,800 breeding ewes and rams. It was at its maximum in 1911, numbering 5,934, and reached its minimum in 1924 with 4,167 sheep. Table I shows the percentage of lambs born to the flock for eighteen years, and also the losses of ewes and lambs together for seventeen years. In this flock register no lambs is "booked in" until June 1st, and consequently the lambing percentages are rather low in comparison with figures based on every lamb born alive. It will be seen that there is little relation between the success of the lambing season and the death-rate of ewes and lambs together. In some years (e.g. 1912) a low production of lambs is accompanied by a very low death-rate, but in 1918, when the death-rate was phenomenally high, the lambing records were below the average.

TABLE I.

Fall of Lambs, and losses of Ewes and Lambs, 1911 to 1928.

Year.	*Per cent. of Lambs born and living on June 1st.*	*Per cent. of losses of Ewes and Lambs.*
1911	95·0	...
1912	90·5	7·2
1913	93·5	10·5
1914	90·7	10·0
1915	96·7	8·5
1916	89·3	8·5
1917	91·0	9·5
1918	88·0	8·5
1919	93·0	14·8
1920	92·8	9·0
1921	95·3	8·2
1922	92·0	9·8
1923	96·7	9·0
1924	96·7	10·2
1925	102·4	8·4
1926	100·0	8·7
1927	97·5	8·7
1928	96·3	8·5
Maximum ...	102·4 %	14·8 %
Minimum ...	88 %	7·2 %
Average ...	94·6 % (18 years)	9·3 % (17 years)

TABLE II.

Analysis of losses of Ewes and Lambs, 1904 to 1913.

Year.	*Per cent. of Ewes lost.*	*Per cent. of Lambs lost.*
1904–5	4·6	3·2
1905–6	4·7	4·2
1906–7	5·5	3·8
1907–8	5·1	3·7
1908–9	4·1	3·7
1909–10	4·8	3·5
1910–11	5·2	3·5
1911–12	6·0	5·3
1912–13	3·9	4·5
1913–14	5·1	4·3
Maximum	6·0 %	5·3 %
Minimum	3·9 %	3·2 %
Average of 10 years ...	4·93 %	3·97 %

This is well illustrated by Table II, which shows for ten years the percentage losses of ewes and lambs separately. In 1906-7 the ewe losses were unusually high, whilst the losses amongst the lambs was under the average of the period, and in 1911-12 the death-rate of both ewes and lambs was high, in fact the maximum in either case for the period. Taking the ten year period it will be seen that the average death-rate of the ewes exceeded that of the lambs by 1 per cent.

An examination of the percentage losses of ewes month by month in each year during the same ten year period shows that in eight of these years by far the greatest loss, running up to so much as 40 per cent. of the total annual deaths, was experienced in May, in one year in June, and in one year in April and June. Naturally May is the month of greatest risk to the ewes; lambing is in full swing, and the late spring at these altitudes makes keep very short. From July to the following April the losses are inconsiderable compared with the losses incurred from April to July, and the winter accounts for only about 10 to 15 per cent. of the total annual losses. Although severe weather is frequently experienced during this season on Exmoor, it is no worse than that to which the Cheviots are accustomed on their native hills, and with plenty of keep still available, and no mouths but their own to feed, the toll taken is low.

THE BIOLOGIST on the FARM.—No. XXXVI.

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Peculiar Teeth in Rabbits.—Professor W. C. M'Intosh, the honoured doyen of British zoologists, is to be congratulated on his recent memoir on irregular dentition in rabbits and other mammals, an achievment surely unique for a man over ninety. It is with respect as great as our admiration that we offer him from these pages our tribute. Although his extraordinarily productive life has been mainly devoted to the study of marine zoology, he has always had a warm heart to the Natural History of the Farm.

In a stately paper of over sixty pages there is description after description of abnormal teeth in mammals, especially in the rabbit; and the first-glance impression of the plain man must be that Nature is after all not free from the charge of clumsy workmanship. Yet this is a triple fallacy. In the first place we have Professor M'Intosh's own statement that in the course of many years of random scrutiny he did not find among thousands of specimens of skulls of wild rabbits more than *one* case of abnormal teeth. It is not inconsistent with this remarkable statement (1923), that another naturalist should happen to find half a dozen abnormalities in as many years, it being understood that neither the Professor nor the other naturalist was preoccupied with the inquiry, but was only looking into the question as a by-play. There is much fortuitousness in the detection of the fortuitous.

In the second place, we must discriminate between abnormal variations in Wild Nature, where they tend to be quickly nipped in the bud, and abnormal variations among tame animals (in this case tame rabbits were included) where man's protective ægis permits the survival of abnormalities which would have short shrift in natural conditions. This is not so relevant in the case of tame rabbits' dentition as in some other cases, such as short-billed pigeons; for the keeper of tame rabbits does not tolerate the survival of monstrosities.

In the third place, there is the Biologist's contribution to the perennial problem of the Origin of Evil. If evolution is to go on, there must be variability, but the tax on variability is that some of the new departures may be monstrous, or pathological, or on the minus side. The last is naturally the most frequent of the three possibilities of evil. The very perfection of organic adaptations makes the possibility of some rift in the lute more probable. Against this, however, there seems to be a tendency in variations to be congruent with what has been already established, just as is the case when an architect adds a new wing to a house.

A rabbit has two pairs of upper incisors, the small second pair hidden behind the front pair. The two lower incisors bite up against the smaller pair of upper incisors. The front incisors above and the lower incisors below are very markedly chisel-edged, and this is obviously the most effective shape of tooth for gnawing animals. It is characteristic of Rodents, and it is brought about in a simple way by the fact that the enamel is either confined to the anterior surface of the tooth or is at most very thin behind. Thus the posterior part of the cutting surface of the tooth wears away more rapidly than the anterior margin, and a chisel-edge automatically results and is automatically kept sharp. The teeth are rootless and keep on growing as they are worn away. As the cutting surfaces of the lower incisors bite precisely in behind the anterior upper incisors, everything works well in the great majority of cases; but if there should be a failure to meet, the unworn incisors may continue growing till they prevent the normal action of the jaws. In one case known to us the rabbit could only eat by holding its head sideways in a very awkward, though life-saving, fashion. We see then that the perfection of the adaptiveness of the rodent's dentition opens up the possibility of something going badly wrong. Perhaps our surprise should be that things go agley so rarely. It should be remembered that Professor M'Intosh did not collect his instances without the help of numerous zoological friends, so that there is a fallacious impression of frequency.

The commonest abnormalities are in the front upper incisors, which sometimes come near to completing a circle in their growth. They may be symmetrically curved outwards, or they may be deflected to the right or to the left, or they may grow downward and inward into the mouth. Professor M'Intosh found little evidence in support of the widespread view that the abnormalities are induced by injuries in traps or from shot. The great majority seem to be referable to congenital or developmental disturbances, slight dislocations or disproportions, which keep the teeth from meeting one another in the normal fashion. Sometimes there is evidence of bone disease, more frequently in the lower jaw. Very striking are the records of cases where the animal was in good condition in spite of marked abnormality in the dentition. There is often extraordinary adjustability in life.

The Belief that Rabbits chew the Cud.—Not long ago we were asked by one of the ablest men of our acquaintance, a Fellow of the Royal Society and all that sort of thing, if rabbits chewed the cud. He seemed mildly surprised at the confidence with which we answered his question in the negative. We are reminded by Professor M'Intosh's memoir on rabbits' teeth that the belief is widespread and of long standing. It goes back to Gesner and Aldrovandus, and it is held by many country people to-day. Can the error be due to a misinterpretation of the munching movements characteristic of rodents? But some zoologists, Professor M'Intosh tells us, have promulgated the heresy because they found balls of food in the rabbit's stomach, which they could not account for except on the theory that the animals ruminated. It seems, however, that "rabbits, especially young rabbits, when hungry, will swallow the fæcal pellets, which may yield some nourishment after a second digestion." It is sometimes easier to show that a belief is erroneous, than to explain how it arose.

Control of Liver-Fluke.—In Britain the chief host of the young stages of the liver-fluke of sheep is the small freshwater snail, *Limnæa truncatula*, which is very common in ditches and the like. Like the land-snails it is hermaphrodite, each individual normally producing both egg-cells and sperm-cells; but it is somewhat unusual in being self-fertilising or autogamous. That is to say the eggs produced by an individual freshwater snail are fertilised by sperms from the same animal. This self-fertilising commonly occurs in flukes and tapeworms, but it is far from being usual in hermaphrodite animals. The point of practical importance is that a solitary representative of *Limnæa truncatula* could repopulate a ditch.

Messrs. C. L. Walton and W. Rees Wright pointed out some time ago that the laying of eggs begins in March and continues through the summer, that several masses are laid with an average of 15·7 eggs in a hundred counted masses, that the masses are in most cases roughly ellipsoidal when deposited on mud, but markedly flattened when placed on dead leaves and the like, that the masses are clear and gelatinous to start with, but soon become coated with mud and particles, and that the average period of development before hatching is three weeks.

In natural conditions the chief check is drought. This is fatal to adults and to eggs, but developing eggs can withstand 12 to 24 hours drying. Under laboratory conditions freezing seemed to have no effect on egg-masses, and the adults have also great natural resistance. Thus frost cannot be relied upon as an aid to the clearance of ditches or pastures. Copper sulphate, applied as a spray, as a dust, or scattered mixed with sand, is very effective in killing the freshwater snails. Even very dilute solutions are fatal to the egg-masses.

Venom of Dog-Tick.—One of the many advantages of living in a country like Scotland is that we are free from most of the poisonous pests which are common in more genial climates. Even our adder is now very much in the background, and our mosquitos have lost their malaria germs. We were thinking of this the other day when we read Dr. Stewart M'Kay's account of how his pet Airedale suffered from a tick (*Ixodes holocyclus*) which became attached during a runaway excursion near Sydney. The female tick fixes its mouth-parts and injects poison. This acts as a local anæsthetic and also keeps the blood from clotting. But the poison is carried to the vagus centre in the medulla oblongata of the brain, and this leads to irritation of the branches of the vagus going to the throat, lungs and heart. Later on there is paralysis of the muscles of swallowing, and irritation of the muscles of the stomach causing vomiting and retching. The heart action is seriously disturbed, there is a fall in blood pressure, breathing breaks down badly, there is unsteadiness on the legs and then a collapse, paralysis of the hind legs sets in, and then of the forelimbs. The animal lies on its side quite unable to move. Coma supervenes and then death. And all from a drop of neuroloxin, the use of which to the attached tick may be that it obtains a prolonged supply of blood during the period when it is producing its two thousand eggs. Children may also be bitten with equally serious effects.

Species and Chromosomes.—All but the simplest living creatures, whether plants or animals, are built up of hundreds or thousands or (usually) millions of minute cells, which form the tissues and organs. Each cell or " unit corpuscle of living matter " contains a spherical central nucleus, and each nucleus contains a definite number of minute rod-like bodies which stain easily with dyes and are therefore called chromosomes. These chromosomes carry the invisible, yet measurable, differences which are the initiatives or representatives of bodily characters that are independently heritable. The body-cells usually have these chromosomes in pairs, one of which came from the male parent and the other from the female parent. But in the ripe germ-cells which unite in fertilisation the normal number of chromosomes is reduced to half the normal number, otherwise there would be a doubling of the number of chromosomes at every fertilisation, which would be absurd.

Dr. C. C. Hurst has been studying the species of roses for many years, and he has convincingly worked out some conclusions which are of general interest. In the genus Rosa there are five fundamental species, each with two sets of seven chromosomes; but each set of seven (a septet) is peculiar in itself. They are conveniently called A, B, C, D, and E septets, differing from one another in the genes or initiatives of Mendelian features which they carry. But besides the five fundamental species with two septets in their body-cells, hence called diploids (14 chromosomes), there are other species of Rosa with 21, 28, 35, 42, and 56 chromosomes—all multiples of seven. Thus in this genus Rosa evolution has worked in permutations and combinations of sets of seven chromosomes.

Improvement of Rough Grazing Land.

THERE has recently been a greatly increased interest in problems connected with the improvement of rough pasture, and it is likely that in the near future more attention will be paid to devising ways and means whereby the poor hill pastures in this country can be improved. The following notes describe briefly a simple experiment carried out by an enterprising sheep farmer in the south-west of Scotland and the results obtained.

Some eight years ago this farmer began topdressing various small areas of hill land with basic slag, and observing an improvement in the herbage he decided to extend the work, so in addition to slagging he sowed some seed on portions of his poorest land. Beginning on a small scale he collected seed sweepings from his hay shed, and sowed them on land which had been slagged in the previous autumn. At this time a dressing of about 15 cwt. of slag was applied per acre, and the seeds were sown at the rate of some 80 lb. to the acre. The results of the slagging and seeding were so promising that in 1925 it was decided to begin in earnest to improve about 40 acres of the worst grazing land on the farm.

The land selected is fairly low lying, flat and mossy in nature, and before the experiment began was covered with a spongy mat of dead vegetation. The herbage consisted generally of nardus, poor heather, bog myrtle, mosses and other plants native to this class of land. Further, louping-ill and braxy were known to be specially virulent on this particular area. No hay had ever been cut, and the land was considered to be useless and dangerous for sheep.

In the autumn of 1925 a dressing of 6 cwt. per acre of 26 per cent. slag was applied by hand, and in May of the following year light seeds, discarded during seed cleaning operations, were sown at the rate of 100 lb. to the acre. These seeds were sown broadcast from a cart, the land being too rough and cut up by open surface drains for a broadcast sowing machine. A local seed merchant supplied the seeds, the cost to the farmer at the nearest railway station being 4*s*. per cwt.

By October 1927 it was apparent that the old herbage was disappearing and was being replaced by such grasses as Yorkshire fog, timothy, ryegrass, rough stalked meadow grass, and cocksfoot, and it was observed that a few plants of wild white and ordinary white clover had secured a footing. A cut of hay was taken that year, about 30 cwt. to the acre being secured. Sheep were wintered on the foggage and came off in good condition.

In November (1927) another dressing of 5 cwt. per acre 26 per cent. slag was given, and by the summer of 1928 the old herbage had completely disappeared, the new grasses had thickened up exceedingly well, and there had been a surprising increase in the number of wild white clover plants. About 200 blackface lambs were finished off on the foggage (August to September) and 60 hoggs wintered till the end of March, when they were removed for the sake of the hay crop. All these sheep subsisted solely on the grass, no other food being given them, and they wintered without a single casualty, while on the rest of the farm there was the usual death-rate, attributed to louping-ill and braxy, of about 12 per cent.

In February 1929 a very light dressing of farmyard manure was applied to as much of the area as the available supply would allow. In April it was seen that a further improvement had taken place, the most noticeable feature being the extraordinary increase in the amount of wild white clover. In fact the land was covered by a thick sole of this clover. An interesting and significant feature was an invasion of moles and earthworms, which had never ventured into this ground before the experiment began.

The experiment has undoubtedly been a complete success, as land which was formerly worthless now produces a crop of hay and provides good healthy grazing.

In the spring of 1927 an area extending to about 30 acres, similar in nature to that already experimented on, was sown out with light seeds at the rate of 100 lb. per acre, but in this case no slag was applied. The following summer it was seen that only in places had the new grasses become established and that no clover plants were present. These new grasses had caught only on the sides of surface drains and in wheel tracks, in fact only where the mat of old vegetation had been broken. It was plain that without manurial assistance there was no chance of the seeds becoming established, so the area having been reseeded in March 1928 at the usual rate, a dressing of 10 cwt. per acre of 30 per cent. slag was applied in November. Last April there was a considerable improvement, the young grasses were in a flourishing condition, and clover much in evidence. There is no reason to doubt that in two years this ground will also be good grazing land.

In spring of 1928 a further 25 acres of poor rough grazing land were given a dressing of 6 cwt. ground mineral phosphate and 6 cwt. kainit per acre and seeded with the light seeds. The following spring the fresh greenness of the young grasses was most noticeable, and it seems that here also the treatment is going to meet with success.

A farmer in Argyllshire has also experimented with this method of improving rough grazing land. In this case the subject is a deep peat, reported to extend to a depth of about 20 feet, the herbage consisting generally of bog myrtle, heather, nardus and moss. A dressing of 9 cwt. per acre of 32 per cent. slag was applied in March 1928, followed immediately by a seeding of light seeds at the rate of about 120 lb. to the acre. Last May the greenness of the pasture was very apparent compared with that on contiguous untreated land. Stock had shown a decided preference for the grazing on the slagged and seeded area, and it was observed that where the new grasses had come away they had been very closely eaten. A considerable number of these new plants were appearing and an odd clover plant had caught on. It is proposed to apply a further dressing of slag, 8 cwt. per acre, in November and to reseed again in March 1930.

It will be noted that in these experiments no expensive cultural operations were involved; the artificial manure was applied and the seed merely sown and allowed to germinate.

There are large areas of this type of grazing land in Scotland to which this treatment might be applied with success.

Probably the most important result of this experiment has been the definite decline in virulence of sheep diseases on the slagged land, and in view of the results of recent investigations carried out by the Rowett Research Institute, Aberdeen, on the incidence of diseases in stock subsisting on a diet deficient in minerals, the matter is worthy of serious consideration.

For years the rough grazings in Scotland have been depleted of their mineral content by repeated generations of sheep and cattle, and, if this deterioration is to be stopped, a policy of feeding the land, or the stock, or both with minerals must be adopted. Suitable small patches here and there throughout the grazings might be topdressed so that these patches would grow a mineral-rich herbage, which would help in some measure to balance up the surrounding mineral-poor grazing.

Notes from Agricultural Colleges.

Kilmarnock.

Silage Mixtures.—The growing of a suitable silage crop is now a regular part of the rotation of many farms, especially where the land is, on account of heaviness or infection from disease, unsuitable for the successful cultivation of a root crop.

The silage mixtures that are used vary to a very marked degree, and this variation does not appear in most instances to conform to difference in soil or climate or even from district to district. It is rather from farm to farm.

In order to compare some of the more common ingredients of the silage mixtures in general use a series of trials have been carried out at the College Farm during the past five seasons.

The results of the first trials indicated clearly the superiority of a grain-producing oat such as "Crown," "Record" or "Victory" to a straw-producing variety such as "Tam Finlay" or "Sandy"; the marked superiority of the Tasmanian Maple pea to the Dun or Grey variety and of Swedish vetches to either French or Russian, the latter of which is a close ally of the Hairy vetch.

In one instance where a quantity of native Scotch vetches were secured through the courtesy of a local firm of seed merchants the resulting crop was decidedly in favour of the vetch of home origin, but as the Scotch vetch is not widely grown and is seldom offered on the market, it is of little relative importance.

The Swedish vetch is much the larger seed and the plant grows a bigger and stronger foliage than either the English or Russian vetch.

The English vetch is intermediate in size of seed and is very often just the Swedish vetch once or twice grown, from which a fair proportion of the vigour of the original stock has departed.

The Russian vetch is much the smallest in size of seed, and the resulting plant is also more spindly and less bulky than either the English or Swedish. It is, however, much hardier, and where the silage crop is sown in autumn it is to be recommended in preference to either of the others on that account.

It should be noted here that while maximum production can be secured only by the inclusion of a fair proportion of vetches in the silage mixture, a too lavish profusion of these is undesirable as their trailing habit of growth tends to cause the whole crop to lodge unduly.

The Maple pea is a much larger seed than that of the Dun or Grey, and it appears to be more vigorous in growth, germinates more freely and, generally, competes more strongly for a due share of the available space; the haulm is stronger and drags less on the other plants growing alongside, thereby lessening the tendency of the crop to lodge.

The higher yield from the inclusion of a grain-producing oat for silage mixture as compared with a straw producer is probably due to the fact that the broader foliage of the grain variety, when cut immature, and the stiffer straw prevent to a greater degree lodgment of the vetches and peas.

For the purpose of the trials equal quantities of the cereal and the legume were used, seeding being at the rate of 240 lb. per acre of the mixture. The results were as undernoted :—

	Yield per acre.	
	Tons.	*Cwt.*
Tam Finlay oats and English vetches	10	16
Tam Finlay oats and Russian vetches	10	12
Tam Finlay oats and Swedish vetches	11	9

	Yield per acre. Tons.	Cwts.
Crown oats and English vetches ...	11	12
Crown oats and Russian vetches ...	11	8
Crown oats and Swedish vetches ...	12	10
Crown oats and Maple peas	13	10
Crown oats and Dun peas	11	5

Variations in the rate of seeding of the silage crop show very marked divergences, and would appear to range from as little as 150 lb. per acre to as much as 300 lb., the latter figure often being supplemented by the inclusion of a bushel of Italian ryegrass.

Some trials have been made to test the various rates of seeding while the proportions of the ingredients were kept constant. These were 4 parts (by weight) Crown oats, 2 parts beans, 1 part Swedish vetches and one part Maple peas. The rates of seeding and the resulting yields per acre were as follows :—

Rate of Seeding.	*Yield per acre.* *Tons.*	*Cwt.*
200 lb.	15	6
250 lb.	15	19
300 lb.	14	18

From the foregoing results it would appear as if approximately 250 lb. of the silage mixture is necessary for seeding in order to obtain the maximum yield, and that heavier seedings rather tend to depress the weight of the resulting crop. Many of the visitors who saw this trial expressed the view that the thick seeding had resulted in a " drawn " vegetation liable to lodge and difficult to harvest.

In the grading of oats for seed care should be taken to see that the large grains are selected for sowing, as trials at the College Farm show that a rigorous elimination of all but the large grains may increase the yield of the resulting crop by 3 or 4 cwt. of grain per acre in comparison with even normal seed.

In the trials the sowing was at the uniform rate of three million seeds per acre, and the seed for all the trial plots was drilled in.

The return from the " large grain " seeding was equivalent to a yield of almost 28 cwt. per acre as against a yield of rather under 24 cwt. per acre from the " normal " seeding, while the seeding of the " small grain " gave a yield of just over 20 cwt. per acre.

To effect a uniform seeding at the rate of three million seeds per acre with these different grades of seed the amounts required were as follows :—

Large seed	279 lb.
Normal seed	242 lb.
Small seed	154 lb.

From the foregoing it will be seen that after the extra seed required has been deducted, there is still a big difference in favour of the large grain seeding.

Craibstone.

Potato Experiments, 1929.—In a note last year attention was drawn to the use of large tubers for seed when ware is selling at a low price. The trial this year again showed that, when planted at the same distance apart in the drill, large seed produced a larger crop with a much larger proportion of "seed" size, whereas smaller seed produced more ware; it was also shown that the large seed planted whole produced a larger crop with more tubers of seed size than when they were cut.

The effect of the distance apart of the setts in the drill was tested with Kerr's Pink and Arran Banner, and the following results were obtained :—

27 in. drills.	2 ins.		2 ins. to 1½ ins.		Small.		Total.		Less Seed planted.		Nett Total.	
KERR'S PINK.	tons	cwt.	tons	cwt.	tons	cwt.	tons	cwt.	tons	cwt.	tons	cwt.
Medium, 12 ins. ...	11	18	2	6	0	8	14	12	1	11	13	1
Large, 12 ins. ...	12	1	6	3	0	8	18	12	4	4	14	8
,, 18 ins. ...	12	17	3	19	0	10	17	6	3	3	14	3
,, 24 ins. ...	10	8	3	10	0	9	14	7	2	2	12	5
ARRAN BANNER.												
Medium, 12 ins. ...	16	11	2	13	0	4	19	8	2	2	17	6
Large, whole, 18 ins.	17	16	2	11	0	5	20	12	3	3	17	9
,, cut in 2, 9 ins.	17	13	3	0	0	7	21	0	3	3	17	17
,, cut in 3, 6 ins.	16	16	4	13	0	10	21	19	3	3	18	16

In both cases the large seed produced a heavier crop than the medium-sized seed. As has been the case in many other trials, the results show that comparatively close planting gives a rather larger crop than wider planting, even when allowance is made for the extra seed necessary, and the increase is mainly in the seed size.

In the case of the trial with Arran Banner, the result is complicated by the operation of two factors known to give opposite effects, namely, cutting the seed into two and three parts respectively and planting correspondingly closer so that the same weight of seed per acre is planted in each case. The final result indicates that the increased crop, especially of seed size, due to the closer planting more than compensates for the decrease which would follow from cutting the seed. In order, therefore, to get more tubers of seed size it would appear as if it would be better to cut the large ones and plant them closer, rather than plant them whole at a wider distance apart.

In the variety trials attention may be drawn to the results obtained from two varieties recently registered by the Department of Agriculture for Scotland—Arran Crest and Arran Banner—compared with varieties of the same type, Epicure and Ally respectively.

	Over 2 ins.	Between 2 ins. and 1½ ins.	Small.	Total.
	tons cwt.	tons cwt.	tons cwt.	tons cwt.
Arran Crest	11 16	7 2	0 14	19 2
Epicure	9 3	5 18	3 0	18 1
Arran Banner	17 8	5 8	0 14	23 7
Ally...	12 5	8 0	1 6	21 11

Arran Crest formed tubers earlier than Epicure and produced an evener sample with much fewer small. Arran Banner produced the heaviest crop of all the varieties tested, Ally being next best. The former produced a nice sample of tubers with few small, and the quality was good.

The following results were obtained with Great Scot and Golden Wonder when planted at fortnightly intervals, half of the seed being sprouted and half unsprouted :—

	Sprouted.				Unsprouted.			
	2 ins.	2 ins. to 1½ ins.	Small.	Total.	2 ins.	2 ins. to 1½ ins.	Small.	Total.
GREAT SCOT.	tons cwt.	tons cwt.	tons cwt.	tons cwt.	tons cwt.	tons cwt.	tons cwt.	tons cwt.
March 16th ...	9 11	5 2	1 1	15 14	9 1	6 1	1 6	16 8
April 1st ...	10 15	5 10	1 7	17 12	5 12	6 19	3 5	15 6
April 16th ...	9 1	5 15	2 2	16 18	5 12	8 8	2 2	16 2
May 1st... ...	11 8	5 2	2 4	18 14	7 14	6 13	1 9	16 6
May 16th ..	11 3	6 0	1 16	18 19	7 9	7 4	2 9	17 2
June 1st ...	8 10	5 0	1 6	14 16	5 12	5 10	2 2	13 4
June 16th ...	8 13	3 14	1 3	13 10	1 14	3 8	1 1	5 15
GOLDEN WONDER.								
March 16th ...	5 8	10 17	2 4	18 9	3 5	8 8	3 5	14 18
April 1st ...	5 10	8 19	2 11	17 0	2 12	9 1	2 15	14 8
April 16th ..	5 7	8 8	2 18	16 13	1 13	7 9	4 6	13 8
May 1st ...	4 6	10 1	3 2	17 9	1 17	9 1	3 9	14 7
May 16th ...	2 12	8 15	5 2	16 9	1 12	7 7	4 4	13 3
June 1st ...	2 9	7 15	2 18	13 2	0 5	3 8	4 1	7 14
June 16th ...	1 3	4 6	4 6	9 15	.	2 9	4 4	6 13

The March planting of Golden Wonder was best, but there was comparatively little difference between the April and May plantings, the latter being fully better than the former in the case of Great Scot. This is due to the fact that there was heavy rain a day or two before the April plantings so that the soil was not in so good condition as in May. The date of planting had not much influence on the amount of seed produced, except that there was least in the case of those planted late.

The sprouting, as usual, gave a good increase, especially in the case of Golden Wonder, and the increase was mainly in the case of the ware tubers. The amount of seed size obtained is interesting. When sprouted, the amount of seed of Great Scot is consistently reduced, whereas with Golden Wonder there was fully more seed size when the tubers were sprouted.

One effect of the sprouting that does not seem to be fully appreciated is its effect on quality, especially in the case of late varieties. The more mature potatoes are, the better is the quality. The crop from well sprouted seed has always a better chance of being mature than those that are unsprouted. The unsprouted, late planted Golden Wonder was of very poor quality.

The selection of healthy stocks (free from mosaic) of the chief varieties of potatoes which has been going on for the past few years is showing a rather interesting feature in the case of several varieties. The following case will serve as an example :—

1st year.—Several healthy plants (say 10) were selected.

2nd year.—Ten tubers from each plant (100 plants) were planted and all were found to be healthy.

3rd year.—Ten tubers of each were again planted (1,000 plants). All the produce of seven (700 plants) of the original plants was healthy. In No. 8, half (50 plants from five plants of 2nd year) was healthy, the other half (50 plants) was affected. In No. 9, the produce of one plant of the 2nd year (10 plants) had mosaic, while the remainder was entirely healthy. In No. 10, the produce of eight plants of 2nd year (80 plants) was healthy. In the other two (10 plants each), five of one and one of the other had mosaic. In two plants of the above, one stalk had mosaic while the other four or five stalks were entirely healthy. These were not cases of infection, as there were no plants with mosaic near, and in any case there is very little infection at Craibstone. During the past few years there have been plots where Langworthy with and without mosaic were planted alternatively in the drill, and so far there has been no case of infection seen.

Complaints are usually made regarding the cropping power of Golden Wonder, but in view of the comparatively high price obtained for it this year more attention will doubtless be paid to it next season. Attention has been drawn in previous years to the reasons for the poor crop obtained. These are summarised in the results of a trial given in the following table :—

	Per acre.							
	Over 2 ins.		Between 2 ins and 1¼ ins.		Small.		Total.	
	tons	cwt.	tons	cwt.	tons	cwt.	tons	cwt.
Good treatment— Without mosaic ... Sprouted .. ... Well manured ...	7	17	8	17	1	2	17	16
Poor treatment— With mosaic ... Unsprouted ... Poorly manured ...	2	11	7	17	0	18	11	6

A healthy stock, well sprouted and well manured, produced a good and profitable crop.

Several trials with manures were carried out. In the meantime attention may be drawn to one where the manures were applied at different times. Many allotment holders and some farmers think that it is a benefit to apply part of the manure when earthing up. In the trial the treatments and results were as follows :—

Variety—*British Queen.*

No dung applied.

Mixture used :—2 cwt. sulphate of ammonia.
4 cwt. superphosphate.
2 cwt. sulphate of potash.

	Applied.	Per acre. tons	Per acre. cwt.
1.	No manure	8	15
2.	When planted	13	13
3.	Half when planted ... Half when earthed up ...	10	7
4.	When earthed up ...	9	3

The reason for this result evidently is that the late application caused too late a growth, so that the plants formed shaws rather than tubers. It is also interesting to note that the quality of the tubers from Plots 4 and 3 was poorer than from Plot 2.

Agricultural Produce (Grading and Marking) Act, 1928.

THIS Act, which came into force in August 1928, is designed to foster a demand for home-produced agricultural and horticultural produce. To this end the Department are empowered to make regulations prescribing grade designations to indicate the quality of any articles of Scottish agricultural produce, together with a National Mark by means of which such graded produce may readily be identified. During 1929 the Department have, after consultation with the respective interests concerned, applied the provisions of the Act to the following articles of Scottish produce :—

(1) *Eggs.*—Three grade designations, viz. "Specials," "Standards" and "Mediums," together with a National Mark, have been prescribed. The quality is the same in each grade, viz. the highest; the only difference between the grades is one of weight. Authority to use the National Mark has been granted to 48 registered packers of Scottish hen eggs; the orders for National Mark labels during a period of six months represent an output of over 1½ million dozen eggs.

The relative regulations also require that, as from specified dates, all preserved eggs must be marked either "Preserved," "Chilled," "Cold Stored" or "Sterilised" as the case may be, and that premises used for the cold storage or chemical storage of eggs must be registered by the Local Authority. So far eight premises have been so registered.

(2) *Tomatoes.*—Four grade designations, viz. "Large AA," "AA," "Medium AA" and "Small AA," together with a National Mark have been prescribed. All graded tomatoes must be of first quality, the only difference between the grades relates to the number of fruits to the lb. During the year three growers were approved as registered packers under the National Mark scheme, and the Department have evidence that a much larger number will apply for registration in 1930.

(3) *Beef.*—Two grade designations, viz. "Select" and "Prime," together with a National Mark have been prescribed. "Select" grade beef is from choice young animals and is of exceptional tenderness, while "Prime" is, generally speaking, equal in quality to "Select" but from older animals. The National Mark scheme is experimental and limited in its operation meantime to Aberdeen, Inverurie and a few outlying centres in Aberdeenshire and Banffshire, whence the bulk of Scotch killed beef destined for the London market is consigned. The grading is done by official graders appointed by the Department. The scheme became operative in October, and the number of sides graded and marked has increased steadily from 537 during the first week to 1,958 during the week ended 21st December.

(4) *Malt Flour and Malt Extract.*—Grade designations together with a National Mark have been prescribed to represent the quality of Malt Flour, Pharmaceutical Malt Extract, Bakers' Malt Extract and Veterinary Malt Extract manufactured from grain produced in Scotland. The National Mark scheme was introduced towards the end of the year, and it is therefore not yet possible to say to what extent it will be taken advantage of by the trade.

(5) *Ware Potatoes.*—A grade designation "Scottish Standard" together with a National Mark has been prescribed to denote first quality ware potatoes of declared variety grown in Scotland. The National Mark scheme was introduced late in December, and already it is apparent that it will have a large measure of support from the trade.

Scottish Egg-Laying Test.

SINCE October 1924 an official egg-laying test has been conducted each year by the Department of Agriculture for Scotland at Seafield, Roslin, Midlothian. Each test lasts for 48 weeks, and the fifth of the series ended on 14th September 1929.

Space is provided for 100 pens of pullets, and it is found that in the five tests that have taken place White Leghorns have occupied from 32 to 39 pens, the average for the five tests being

35. Rhode Island Reds come next with an average of 19; then follow White Wyandottes 17, Black Leghorns 7, Buff Rocks and Light Sussex 4 each, Anconas 2, Barnvelders 1, &c.

In the Duck section space is provided for 19 pens, and the averages occupied in the five tests have been Khaki Campbells 7, White Runners 4, and Buff Orpingtons 1.

The total number of eggs laid by pullets in the tests has varied from 73,277 to 96,249, while the average number laid per bird of all breeds over the five tests has ranged from 182·46 to 193·67. So far as breeds are concerned, the average number of eggs per bird over the five tests has varied as follows :—

		Average.
White Leghorns	187·92 to 202·85	196
White Wyandottes ...	187·22 ,, 201·67	193
Rhode Island Reds ...	162·45 ,, 195·56	184
Black Leghorns	170·60 ,, 196·10	183
Buff Rocks	160·00 ,, 202·67	177
Light Sussex	149·12 ,, 181·18	163
Anconas	143·80 ,, 173·80	160

In the Duck section the lowest average number of eggs per bird has been 150·34 and the highest 210·85, with an average over all the tests of 175·6. For Khaki Campbells the average has been 187 and for White Runners 172.

So far as the winter period (mid-October to mid-January) is concerned, White Wyandottes take the lead with an average of 43·53 eggs per bird, Buff Rocks being next with an average of 40·97. Then follow White Leghorns, 39·33, and Rhode Island Reds, 35·06.

Review.

The Reclamation of Exmoor Forest. C. S. Orwin, Oxford University Press.—This account of the enclosure and settlement of 20,000 acres of high-lying land in the County of Somerset is not unlikely to become a classic of English agricultural literature. The story which it relates is one of absorbing interest, the presentation of it in form and style is of high literary quality, and the sanity and discretion of its judgments and opinions are impressive.

For centuries up to the year 1814 Exmoor Forest had been leased by the Crown to successive wardens and had been utilised mainly for the summer grazing of about 25,000 sheep from numerous farms in North Devon, a few cattle, and a stock of hill ponies. In that year the Commissioners of His Majesty's Woods and Forests recommended enclosure and division. An Act was passed to enable the enclosure to be carried through and allotment of the lands to various interested parties was duly made, the Crown's share being over 10,000 acres. The Crown portion was thereafter in 1818 put up for sale by public tender and was acquired by Mr. John Knight, an ironmaster of

Worcestershire, for £50,000. He afterwards purchased their lands from other proprietors and his total holding amounted by 1820 to 15,000 acres.

The story is then the account of the reclamation and settlement of the Forest by John Knight and his son Frederic, and its later ownership and management during the last thirty years by the Earl Fortescue.

The first stage was the actual enclosure of the Forest by a boundary wall twenty-nine miles long; the construction of twenty-two miles of good roads where had formerly been mere trackways; and the cutting of numerous drains. John Knight's original idea of reclamation was to utilise the land for farming on a large scale, and he proceeded to break up considerable areas, paring, burning, liming, and ploughing with bullock teams in yokes of six. Much advantage in the way of drainage was secured by subsoiling to break the moor-pan. About 2,500 acres were dealt with in this way, and an attempt was then made to farm on the four-course system and to grow barley and wheat and turnips; but the severe climatic conditions were too heavy a handicap for crop growing to be a success.

At the same time Knight enclosed and improved large areas for grazing purposes and sought to introduce and acclimatize high-class flocks and herds of sheep and cattle, the foundation stocks of which he travelled far and wide to secure. In one of his journeys in 1826 he came as far north as Falkirk and he gives a vivid picture of the famous Tryst—" A considerable plain covered with immense herds of cattle standing separately and tended mostly by persons in a variety of Highland dresses, and all kinds of music, but the bagpipe left the other but little chance of being heard. A long row of very large seats, full of whisky, divided in the middle of the plain the Highlanders from the Angus or Lowland cattle."

The Highland cattle did well on the improved grazings but " all were wild and some were wicked," and when some of them were being driven to market "they started in different directions all over the country, tossed and gored everybody they met, and were shot in fields all over the country."

He was more successful with his introduction of Cheviot sheep, and an account elsewhere in this issue of the JOURNAL of the flock still flourishing on the moor will be read with interest. It is to be noted, however, that success was not attained with the management of these until Scottish shepherds and their dogs were also installed.

Large scale farming did not prosper, and the second Knight was more successful in his operations when he adopted the plan of leasing out to tenants suitable areas of the Forest after these had been improved and equipped with farm steadings.

It is unnecessary to recount further this remarkable story, with its details of dairying and mixed farming, its evolution of a parish with village and church, its unsuccessful mining of iron-ore. It is safe to say, however, that anyone interested in the history of agriculture will find in Mr. Orwin's book a tale of courage and enthusiasm, of resource and enterprise worthy of the best pioneering spirit of our countrymen.

Essay Competition.

THE General Society of Cattle Breeders of Spain have decided to hold an essay competition in 1930, and the following note gives particulars of the subjects of the essays and the conditions of entry.

Theme 1. Contribution to the study of the increase of forage supplies in dry regions in thinly populated districts.

First prize : 1,000 pesetas and 1st medal.
Second prize : 300 pesetas and 2nd medal.

Theme 2. Influence of vitaminic factors in feeding, giving particulars ascertained from the writer's own experience.

First prize : 2,000 pesetas and 1st medal.
Second prize : 500 pesetas and 2nd medal.

Theme 3. Present position of information regarding epizootic abortion. Scheme of work and methods necessary for investigating this complaint. Means of ensuring efficacy of sera and vaccines and avoiding vaccination accidents, and compensating breeders for losses in experimentation in the event of there being any such accidents.

First prize : 2,000 pesetas and 1st medal.
Second prize : 500 pesetas and 2nd medal.

It is not necessary to develop both parts of the foregoing theme. It will be sufficient if the writer devotes his attention to one of them.

Theme 4. Supply of milk in large towns. Methods of effecting this service under the best conditions for producer and consumer.

First prize : 1,000 pesetas.
Second prize : 300 pesetas.

Themes 2 and 3 are of an international character, and investigators of all countries may transmit scientific works in their own language, although, in order to facilitate reading and interpretation, it would be preferable to send them in Spanish, French or English.

The works are to be original and those which gain prizes will remain the property of the Society. If published the latter will supply 200 copies to the author.

The works are to be transmitted in a sealed and registered envelope before April 1st, 1930, to the Asociacion General de Ganaderos, Huertas 30, Madrid, the work to be furnished with a title (lema) and in a separate envelope, with the same title written thereon, a card or slip bearing the name and address of the writer.

Labour on Scottish Farms.

THE Agricultural Returns collected on 4th June 1929 give the following numbers of workers employed on 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 ...	60,603	6,186
Do. under 21 years old ...	21,471	3,335
Total of Males	82,074	9,521
Women and girls	19,009	7,430
Total	101,083	16,951
Grand Total ...	118,034	

The grand total is 734 above that recorded in 1928, regular workers being more numerous by 520 and casual workers by 214. Of the regular workers, men over 21 have increased by 706, while males under 21 are fewer by 238. The total number of regular male workers is almost exactly the same as in 1921, the figure then being 82,099 and now 82,074. A considerable alteration has, however, taken place in the age distribution, men over 21 having increased in number by 1,791, while those under 21 are fewer by 1,816. Thus while farm staffs have been maintained almost unchanged, there has been a considerable falling off in the recruitment of youths, the deficiency averaging 227 per annum.

Women and girls regularly employed show an increase of 52, male casual workers an increase of 200, and female casual workers one of 14; none of these changes is of much significance.

Acreage under each Variety of Potatoes in 1929.

A STATEMENT is printed on p. 111 showing the acreages under certain varieties of potatoes in Scotland in 1929, as returned by growers of one acre or over. These returns cover 126,972 acres out of the total acreage of 144,770, 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 744 acres as compared with 1928, and the acreage included in the returns of varieties an increase of 77 acres.

The area under First Earlies, 15,144 acres, is greater by 85 acres than that returned in 1928. Epicure, with 7,939 acres, or 189 less than last year, accounts for 52½ per cent. of the total. Duke of York, with 2,408 acres, shows an increase of 558 acres, or 30 per cent., and now takes second place, while Sharpe's Express, with 1,954 acres, has increased by 615 acres, or nearly 47 per cent., and occupies the third place. Eclipse, which formerly had the second largest acreage, is now fourth with 1,794 acres, a decrease of 1,084 acres, or 35 per cent. These four varieties cover 93 per cent. of the whole area under First Earlies. The new immune variety Herald has increased from 38 to 132 acres.

Second Earlies, with a total acreage of 20,550, exceed that recorded in 1928 by 1,137 acres. Great Scot, with an increase of 1,490 acres, covers 13,777 acres. British Queen, with 3,530 acres, shows a very small decrease, while Ally, with 962 acres, has diminished by 580 acres, or 38 per cent., and is now not far above Royal Kidney, which has increased by 252 acres and now stands at 697. These four varieties account for 93 per cent. of the total.

The area under Maincrops, 91,278 acres, shows a decrease of 1,145 acres, which almost exactly balances the increase under Second Earlies. The supremacy of Kerr's Pink is still more marked this year. With an increase of 2,790 acres, it covers 47,329 acres, or 52 per cent. of the whole area under Maincrops. King Edward VII has recovered from last year's decrease to the extent of 2,014 acres, and remains in the second place with 15,324 acres. Majestic, Golden Wonder and Arran Chief follow with 7,537 acres, 6,716 acres and 5,812 acres respectively, the first two showing moderate decreases and the last a decrease of 2,531 acres, or 30 per cent., which has brought it down from third to fifth place. These five varieties account for 90½ per cent. of the Maincrop acreage. The Up-to-Date group shows a moderate increase, and the new variety Arran Banner now stands at 278 acres, more than three times last year's acreage. Arran Consul, on the other hand, which showed a very large increase last year, has gone back from 2,430 acres to 1,610. Every other variety except Early Market shows a diminished acreage, Field-Marshal and Rhoderick Dhu being conspicuous with decreases of 433 and 283 acres respectively.

Varieties immune from wart disease cover in all 83,005 acres, or 65·4 per cent. of the total area included in the return; non-immune varieties cover 43,131 acres, or 34 per cent.; while the varieties not specified in the returns account for only 836 acres, or less than 1 per cent. These totals and percentages show little difference from last year's, the increase in the proportion under immune varieties being this year very small.

Annual Estimates of the Produce of Crops. THE following statement regarding the produce of crops for 1929 was issued on 11th 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 1929, with COMPARISONS for 1928, and the AVERAGE YIELD PER ACRE of the Ten Years 1919-28.

CROPS.	Estimated Total Produce. 1929.	Estimated Total Produce. 1928.	Acreage. 1929.	Acreage. 1928	Average Estimated Yield per Acre. 1929.	Average Estimated Yield per Acre. 1928.	Average of the Ten Years 1919-1928.
Wheat ...	*Tons.* 58,000 *Quarters.* 263,000	*Tons.* 62,000 *Quarters.* 282,000	*Acres.* 50,730	*Acres.* 58,227	*Cwt.* 22·9 *Bushels* 41·5	*Cwt.* 21·2 *Bushels.* 38·7	*Cwt.* 21·0 *Bushels.* 38·5
Barley (including Bere) ...	*Tons.* 101,000 *Quarters.* 521,000	*Tons.* 103,000 *Quarters.* 532,000	100,549	111,924	*Cwt.* 20·1 *Bushels* 41·5	*Cwt.* 18·4 *Bushels* 38·1	*Cwt.* 17·5 *Bushels.* 36·5
Oats .	*Tons.* 755,000 *Quarters.* 5,058,000	*Tons* 704,000 *Quarters.* 4,797,000	888,731	878,436	*Cwt.* 17·0 *Bushels.* 45·5	*Cwt.* 16 0 *Bushels.* 43·7	*Cwt.* 14·6 *Bushels.* 40·1
Beans ..	*Tons.* 2,700 *Quarters.* 12,300	*Tons.* 3,000 *Quarters.* 13,300	2,833	3,151	*Cwt.* 19·3 *Bushels* 34·7	*Cwt.* 18·9 *Bushels.* 33·7	*Cwt.* 18·3 *Bushels.* 33·5
Hay from Rotation Grass	*Tons.* 681,000	*Tons.* 627,000	408,322	400,753	*Cwt.* 33·3	*Cwt.* 31·3	*Cwt.* 31·6
Hay from Permanent Grass ...	157,000	152,000	120,032	117,286	26·2	26 0	26·0
Hay from Timothy Meadows ...	112,000	105,000	47,836	49,014	47·0	42·8	42·5
Potatoes	1,155,000	1,032,000	144,770	144,026	*Tons.* 8·0	*Tons.* 7·2	*Tons.* 6·5
Turnips & Swedes	6,606,000	6,660,000	371,273	378,003	17·8	17·6	17·0
Mangolds ...	24,800	21,600	1,204	1,250	20·6	17·3	17·8

NOTE.—The total produce of wheat, 58,000 tons, is 4,000 tons less than that of 1928. The area under the crop has decreased by nearly 7,500 acres, but the average yield, 22·9 cwt. or 41·5 bushels, is nearly 2 cwt. above the ten years' average, and is the highest recorded since 1914. Barley with a total produce of 101,000 tons, shows a decrease of 2,000 tons. The area harvested is less than that of 1928 by 11,375 acres, but the average yield per acre, 20·1 cwt. or 41·5 bushels, is 2½ cwt. above the ten years' average, and is much the highest ever recorded; the highest previous figure was reached in 1898. The total produce of oats, 755,000 tons, is larger than last year's by 51,000 tons. The area shows an increase of nearly 10,300 acres, while the average yield per acre, 17 cwt. or 45·5 bushels, is, like that of barley, about 2½ cwt. above the ten years' average, and is also the highest on record. The total produce of beans amounts to 2,700 tons, or 300 less than in 1928; the average yield per acre is 1 cwt. above the ten years' average.

The total produce of hay of all kinds, 950,000 tons, is 66,000 tons over last year's total. Hay from rotation grass, with a total production of 681,000 tons, accounts for 54,000 tons of this increase. The area is larger than in 1928 by over 7,500 acres, while the yield per acre, 33·3 cwt., is 1·7 cwt. above the ten years' average. Timothy meadows, with the high average yield of 47 cwt., being 4½ cwt. above the ten years' average, produced 112,000 tons, or 7,000 more than last year, while other meadows, with an average yield of 26·2 cwt., produced 157,000 tons, exceeding last year's crop by 5,000 tons.

Potatoes, with practically the same average as in 1928, show a total produce of 1,155,000 tons, which exceeds last year's by 123,000 tons and is the largest recorded since 1922, when the acreage was considerably greater. The average yield per acre, 8 tons, is the highest on record; the best figure previously was 7·6 tons, in 1920 and 1922. Turnips and swedes, with a total produce of 6,606,000 tons, show a slight decrease. The area is less than in 1928 by 6,700 acres, while the average yield per acre, 17·8 tons, is 0·8 ton above the ten years' average. The total produce of mangolds, 24,800 tons, is 3,200 tons above last year's; the average yield per acre, 20·6 tons, exceeds the ten years' average by 2·8 tons.

Every crop shows a larger yield per acre than in 1928, and record yields of oats, barley and potatoes have been obtained. The total produce of oats, hay, potatoes and mangolds is larger than that of 1928, while wheat, barley, beans and turnips and swedes each show a smaller production owing to diminished acreage.

Agricultural Returns, 1929.

THE abstract of the Agricultural Returns printed on pp. 112-119 shows that the total area under all crops and grass amounts to 4,652,988 acres, a decrease of 12,474 acres as compared with 1928, the arable land being less by 27,952 acres, while the area under permanent grass is greater by 15,478 acres. The land under rye-grass and other rotation grasses and clover has decreased by 6,533 acres, the decrease in the area under other crops being thus 21,419 acres.

The total area under the cereal crops is 1,044,012 acres, being 9,044 acres less than in 1928. The area under wheat shows a decrease of 7,497 acres or 12·9 per cent. Barley has decreased by 11,375 acres or 10·2 per cent., but oats has increased by 10,295 acres or 1·2 per cent.

Beans show a decrease of 318 acres or 10·1 per cent. Potatoes have increased by 744 acres or 0·5 per cent., but turnips and swedes have decreased by 6,730 acres or 1·8 per cent., and mangolds by 46 acres or 3·7 per cent. The acreage under sugar beet continues to diminish, the area being 1,700 acres, or 73·5 per cent., less than last year. Cabbage shows a decrease of 187 acres or 4·3 per cent., and rape 2,870 acres or 24·6 per cent., while only 1 acre has been returned under flax. Vetches, tares, &c. for fodder have decreased by 899 acres or 7·6 per cent.

Rye-grass and other rotation grasses and clover show a gross decrease of 6,533 acres or 0·4 per cent., the area for hay being greater by 7,569 acres or 1·9 per cent., but that for pasture being less by 14,102 acres or 1·3 per cent. The area under permanent grass shows an increase of 15,478 acres or 1·0 per cent., the area for hay being greater by 1,568 acres or 0·9 per cent., and that for pasture by 13,910 acres or 1·0 per cent.

The area under wheat, barley, oats and potatoes, 1,184,780 acres, is 7,833 acres less than last year, and is the lowest aggregate recorded.

The live stock returns show that horses, sheep and pigs have decreased while cattle have increased. Horses used for agricultural purposes are less numerous by 2,507 and unbroken horses of one year and above by 1,522, but those under one year are greater by 401. "Other horses" have decreased by 1,105, the total decrease in all classes being thus 4,733 or 2·9 per cent. Cows in milk have decreased by 490 or 0·1 per cent., cows in calf by 4,041 or 8·0 per cent., heifers in calf by 945 or 1·8 per cent., and bulls by 40 or 0·2 per cent. Other cattle, two years and above, have increased by 21,502 or 11·1 per cent., and those of one year and under two by 10,751 or 3·7 per cent., but those under one year are less by 7,640 or 3·0 per cent. The total number of cattle has thus increased by 19,097 or 1·6 per cent. The total number of sheep show a decrease of 23,184 or 0·3 per cent. on last year's high total. Breeding ewes have increased by 5,922 or 0·2 per cent. Other sheep, one year and above, have decreased by 20,870 or 2·1 per cent. and those under one year are less by 8,244 or 0·3 per cent. The number of pigs, 142,217, is less than in 1928 by 53,287 or 27·3 per cent. Sows have decreased by 6,080 or 27·4 per cent., boars by 645 or 26·3 per cent., and other pigs by 46,562 or 27·2 per cent.

The acreage under rough grazings, 9,573,114 acres, is less than last year by 134,654 acres. This acreage includes 443,170 acres of deer forest land used for grazing 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 total figures for cattle and sheep in Scotland include 3,463 cattle and 91,039 sheep grazing in deer forests on 4th June. Of these 1,321 cattle and 58,212 sheep were also included in returns made by agricultural occupiers, and these particulars have been cancelled as duplications on Agricultural Returns and are now brought under the heading of deer forest stock. The remaining 2,142 cattle and 32,827 sheep were not included in any Agricultural Returns, and represent the stock pertaining to deer forests as such and prior to 1926 not returned on the Agricultural Returns.

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

The total area of land under crops and grass returned as owned by occupiers of holdings in 1929 amounts to 1,350,091 acres as compared with 1,318,859 acres in 1928, an increase of 31,232 acres. This area is 29·0 per cent. of the whole area of land under crops and grass; in 1928 the proportion was 28·3 per cent.

The poultry figures are as follows :—

Fowls hatched before 1929	2,638,351
Fowls hatched this year	3,004,964
Ducks hatched before 1929	135,976
Ducks hatched this year	82,503
Geese hatched before 1929	7,429
Geese hatched this year	16,490
Turkeys hatched before 1929	14,673
Turkeys hatched this year	71,341

The returns of labour employed on farms are summarised at page 86.

Agricultural Conditions in 1929.

Weather.—Throughout January the rainfall was light; but there were occasional falls of snow in most parts of the country, while severe frosts occurred frequently in practically all areas. During the first week of February the weather was mild and open in most districts, and some progress was made with outdoor work. Frost of unusual severity was, however, general for the remainder of the month, and there were heavy falls of snow in many areas, the roads being blocked in some districts. During March the weather was unusually dry and sunny, with an almost entire absence of rain. In some parts of the country there were severe night frosts, especially during the earlier part of the month. Ploughing and other outdoor work made excellent progress. The weather during the greater part of April was generally cold and dry, and night frosts were frequent in many districts, while towards the end of the month there were intermittent falls of snow. Throughout May and June conditions were generally favourable for all kinds of farm work and also for live stock; towards the end of June, however, the progress of crops was retarded to some extent by cold drying winds and low night temperatures in many districts. The weather throughout July was generally dry and sunny, especially in the south-western districts; a moderate rainfall towards the end of the month proved very beneficial. During August the weather was very unsettled in practically every district, with frequent heavy rain and little sunshine. Some damage was caused to crops and live stock by a violent thunderstorm in Central Aberdeen on the night of the 28th, and in several of the south-western districts thundery conditions also prevailed. Conditions improved during September, the weather being generally dry and sunny; in many areas the cereal harvest was completed in good order by the end of the month. In the northern counties and the Western Islands, however, the weather was generally wet throughout the month, and harvesting operations were seriously retarded. The weather throughout October varied considerably in different parts of the country; in the north-eastern districts and along the eastern seaboard generally the conditions were uniformly favourable for the completion of harvest operations and for autumn cultivation, but in Shetland and Orkney, the Western Islands and most of the northern districts the weather was generally wet throughout the month and outdoor work was delayed. In November conditions were generally favourable for autumn cultivation and winter sowing in the north-eastern districts and down the east coast generally, apart from some severe frost in the early part of the month; in Shetland and Orkney, however, and in most western districts the weather was wet and stormy, and very little progress was made in a number of areas with outside work.

Wheat.—During the first few weeks of the year the weather was generally unfavourable for the wheat crop, and the plants were rather thin and backward in growth. Where sown early the crop had a fresh healthy appearance, but much of the seeding was delayed, and in these cases the plants were only just showing above the ground at the end of January. The severe weather that prevailed during the greater part of February prevented much progress from being made; in most districts the crop was checked in growth and browned by frost, and at the end of the month no spring sowings had been accomplished. The crop showed a distinct improvement during March, but suffered a further set-back as a result of the inclement weather in April. Growth improved during the latter part of May, and by the end of June the crop was healthy and vigorous in most districts. Steady progress continued to be made throughout July and August, but in some areas, on carse lands, the crop was badly lodged by heavy rains; in some instances ripening was retarded by the same cause, and the crop was somewhat short in straw. Cutting began at the end of August in a few isolated cases, and was general by the middle of September. Progress was rapid as compared with last year, and in most districts the harvest was completed or practically completed before the end of September. There were no reports of disease or damage by insect pests except from South-East Perth, where wire-worm thinned out many fields in the early summer. The crop was secured in good condition and the yield was exceptionally good.

Barley.—Sowing was completed by the end of April in most districts. The crop germinated well, and made uninterrupted progress throughout the spring and summer in practically every district except the Lothians, where growth was seriously checked by drought during the early summer. By August the crop was generally very promising, despite a certain amount of lodging in several of the eastern areas; it ripened more rapidly than wheat, and in a number of districts a good beginning was made with cutting by the end of August. Harvest was completed by the third week in October except in a few outlying western areas, where the work was delayed by bad weather. The grain was of good average quality, and in most cases the crop was secured in good order. No damage was reported from disease or insect pests. Bere, which is grown mainly in the crofting counties, was also a good crop.

Oats.—By the end of March sowing was generally well advanced in the north-eastern and south-western districts, and was practically completed before the beginning of May in every district except Orkney and Lewis. The crop germinated well, and although progress was slow the braird in most districts was strong and regular. Early in the season, however, grub had begun to be troublesome, and by May this pest, and to a lesser extent wire-worm, was prevalent in most districts. The damage done by the former was most extensive in the north-eastern districts, where many fields were badly thinned, but the south-western areas were also affected to a greater or less extent. On the whole, however, in spite of these widespread attacks, the condition of the crop remained surprisingly good. There was no reference to any damage by grub in the reports received from Shetland, Orkney, Caithness, the Hebrides and Argyll. Another outstanding feature in connection with the oat crop was the exceptional prevalence of weeds, charlock being especially troublesome in some south-eastern districts and yarrow in the western counties. As the season advanced, however, the crop recovered from the various set-backs; by the end of August it was ripening quickly in the earlier districts and harvest was begun on some farms, but in a number of the later districts the crop was still green at that time. Damage from lodging proved to be less serious than had been anticipated. By the end of September the ingathering of the crop was completed or practically completed under favourable conditions in most districts.

In several northern and north-western areas, however, the work was interrupted by persistent wet weather, which proved detrimental to the crop, and in these localities the results of the harvest were disappointing.

Beans.—In most of the districts in which this crop is grown sowing was completed by the end of March. By May the crop had made good progress and was generally healthy and vigorous, except in a few areas, where it was somewhat backward and thin owing to frosting of the seeds. Later in the season, however, the reports were uniformly satisfactory; in every district in which the crop is grown it was podding well, and was strong and healthy. Harvesting was in progress before the end of August in some north-eastern districts. In most areas, when the harvest was completed, the yield proved to be a full average, but in Berwick it was somewhat below the normal.

Potatoes.—A good beginning was made with the planting of early varieties by the end of March in a number of areas, but in most of the eastern districts planting had not begun by that time. The most forward district was Ayr, where a considerable proportion of the main crop was planted by the beginning of April. Planting was completed or practically completed in most districts by the end of April; any arrears that were carried over into May were overtaken in unusually favourable conditions as regards both soil and weather. Where the crop was showing above the ground at that time the haulms were generally strong and vigorous. During June and July growth was checked by drought in certain areas, and some damage was caused by frost in a few northern districts. The rainfall at the end of July and during August, however, had a beneficial effect on the crop, and despite signs of blight in a number of districts towards the end of August, there was by that time every indication of a good yield. In a few isolated areas 10 per cent. or more of the crop was sprayed, but in most districts the proportion of the crop so treated appears to have been very small. In most districts three-quarters or more of the crop had been lifted at the end of October under favourable conditions; in some northern and north-western districts, however, the work was seriously retarded by wet and stormy weather, particularly in Skye, where much of the crop on low lying clayey soil rotted in the ground.

Turnips and Swedes.—The sowing of root crops was generally well advanced by the end of May; in a number of districts the sowing of swedes was completed by that time, but progress with the sowing of yellow turnips was much slower. Some re-sowing of turnips was necessary in a few north-eastern districts as the result of frost and attacks by fly, which caused some damage also in some south-western areas. During the early summer the crop suffered to a certain extent from lack of rain, especially in certain of the north-eastern districts, and weeds were unusually troublesome in several areas. Fair progress was made with singling in a number of districts by the end of June, but hoeing was somewhat in arrear at that time in several north-eastern areas. At the end of August the crop was generally reported to be healthy and promising well; finger-and-toe was, however, prevalent in a number of districts, but generally not to any serious extent. In September growth was somewhat retarded in certain areas owing to lack of moisture, and there was evidence of damage from mildew and dry rot in some south-eastern and south-western districts. On the whole, however, the reports indicated that the crop promised to be a good average. Lifting was completed or almost completed by the end of November in some of the north-western and south-western districts, but elsewhere little progress had generally been made by that time, owing in part to the sodden condition of many fields.

Mangolds were sown in good time and the crop made steady progress throughout the season. Some loss occurred in Roxburgh as a result of plants running to seed, and in Dumfries growth was checked by frost in June. In most cases, however, the crop was reported to be strong and healthy. Most of it was secured by the beginning of December, and good yields were reported from every district. In Berwick the crop is regarded as the best obtained for the last twenty years.

Sugar Beet.—There was a further and considerable diminution in the area sown as compared with last year. Growth was slow at first, especially in South Ayr, where the progress of the crop was checked by maggot, but later in the season the crop was reported to be generally healthy and vigorous. In Berwick, South-West Angus and North-East Fife, however, a considerable number of plants ran to seed. Most of the crop was lifted by the end of November under satisfactory conditions generally.

"Seeds" and Meadow Hay.—Grass and clover seeds generally promised well until February, when the frost checked growth more or less seriously. By April, however, the crop was for the most part fairly strong and healthy, and as the season advanced it recovered in most districts from its earlier set-back. Harvest was in progress in a number of districts by the end of June, but in most of the northern, north-eastern and south-western areas cutting had not then begun. Clover was reported to be less abundant than usual in many districts; in South-East Perth, however, it was stated to be almost strangling the grass in some fields. The estimates of yield of both "seeds" and meadow hay showed considerable variation, that of the former being from 5 to 10 per cent. below the normal in most of the north-eastern and south-eastern districts. By the end of July the cutting of hay was practically completed in excellent order in most districts; in Skye and the Outer Hebrides, however, the harvest was much interrupted by wet weather, and some loss occurred.

Cultivation.—Ploughing was fairly well forward by the end of October in most districts, but in Shetland, Orkney, the northern counties, the Western Isles and some south-western districts little or no progress had been made by that time and little more in many cases during November, operations having been delayed by the inclement weather. Wheat sowing generally made good progress during October and November; by the end of November it was completed or practically completed in Moray, Angus, Central and South-West Perth, North-East Fife, Berwick, Roxburgh and North-West Lanark; elsewhere the work was well in hand. The braird was showing at the beginning of December on early-sown fields in South-West Angus, Central Perth and Berwick.

Live Stock.—Pastures recovered rapidly from the set-back that occurred in the early spring, and throughout the grazing season their condition was generally satisfactory. Grazing cattle throve well throughout the autumn, despite the rain and lack of sunshine during August in many districts. It was reported that in a number of farms in Central Perth oats were being bruised and used for feeding. At the end of November practically all the cattle had been housed for the winter in most districts; in North Ayr those not housed at night had lost ground. Dairy cattle generally made good progress throughout the season. The milk yield was well maintained in most districts, but fell off to some extent in a few of the north-eastern areas during July, and some house-feeding was required in order to maintain it. In November, apart from the normal seasonal falling off in the milk yield, the supply was somewhat below even the average for the season in East Aberdeen, South-West Angus, South-East Lanark and Wigtown; the decrease in the last-named county was ascribed to the diminution in artificial feeding. The reports on sheep were generally satisfactory. Sheep on arable farms in Perth and Berwick suffered, however, to some extent from maggots and flies, while in Kirkcudbright a number of cases of lameness were reported. Foot-rot was also prevalent among a number of hill flocks in South-West Fife, Kinross, Clackmannan and Kincardine. Supplies of winter keep are ample for the requirements of stock in every district except the Western Islands; in a few cases there is a certain scarcity of hay.

Labour.—The supply of regular workers was generally adequate for requirements, but there was a certain scarcity of casual labour for harvesting and potato lifting in a number of districts. In Argyll female labour was short of requirements towards the end of the year, and the supply of dairy workers in Dumbarton and Renfrew did not meet the demand.

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, Department of Agriculture, York Buildings, Edinburgh.

CROPS AND SEEDS.

The Nutritive Value of Pasture: The Influence of the Intensity of Grazing on the Yield, Composition, and Nutritive Value of Pasture Herbage. Part II. *By H. E. Woodman, M.A., Ph.D., D.Sc., D. B. Norman, B.A., and J. W. Bee, B.A. Journal of Agricultural Science, Vol.* 19, *Part* 2, *April* 1929.—The investigations were made to ascertain the effects of lengthening the interval between successive cuttings to three weeks on the yield, composition and nutritive value of pasture herbage. It is hoped ultimately to be able to give a complete answer to the following questions:—

(1) At what stage in the growth of pasture grass does lignification, with consequent lowering of digestibility, set in?

(2) Is there a stage of growth prior to lignification when the food material in pasture grass is so balanced, in respect of digestible protein and non-protein constituents, as to render it more adapted to the requirements of grazing animals than is the case with grass grown under systems of weekly and fortnightly cuts?

(3) Under what system of cutting, or rotational grazing, does a pasture yield the maximum amount of starch equivalent in a season?

Under a system of three-weekly cuts, pasture grass never reaches the stage of growth at which lignification sets in, with consequent decline in the digestibility, not only of the fibrous component, but also of other organic constituents. The crude fibre of pasture herbage after three weeks' unchecked growth still consists mainly of digestible cellulose, unmixed with any appreciable proportion of the more carbonaceous and entirely indigestible lignocellulose. At the commencement of the trials in 1925 creeping bent was by no means conspicuous among the grasses of the plot. Frequent cutting favours the spreading and development of this creeping species. By the end of the 1925 trial, creeping bent had already established itself as one of the important species in the plot. Under conditions of close grazing, creeping bent approximates to grasses like perennial ryegrass in respect of composition, digestibility and nutritive value. The best results are to be obtained from pastures when the conditions are such as to permit of the herbage being grazed down *closely* at suitable intervals, as in rotational grazing practice.

The results obtained in the present investigation respecting the nutritive ratio of pasture grass cut at three-weekly intervals encourage the hope that grass grown under a system of monthly cuts, while retaining the high digestibility and nutritive value associated with concentrated foods, will also contain digestible protein and digestible non-protein constituents in such proportions as to render it more suited to form the sole diet of farm animals. Rotational close grazing possesses an important advantage over a system of non-rotational close grazing by producing a larger amount of dry-matter per acre over the season.

The productivity of pastures is controlled primarily by meteorological factors, of which the most important is the rainfall, in particular its distribution over the season. Other factors which have an effect on the productivity of the pastures are: (1) manurial constituents in the soil; (2) physical character of soil; (3) botanical character of herbage.

So far as digestibility is concerned there is little to distinguish grass grown under systems of weekly, fortnightly and three-weekly cuts. Under a system of three-weekly cuts pasture grass never reaches the stage at which lignification sets in.

The results obtained so far in the investigations refer to pasturage under unfertilised conditions.

An Investigation into West Australian Pastures. *By Eric John Underwood, B.Sc. (Agric.), University of Western Australia.*—The writer summarises his investigations as follows:—Twenty-six samples of pastures were collected from different parts of the agricultural areas of the State, and analysed with a view to finding what correlation existed between the proportion of the different constituents present and the reputed value of the pastures as food for stock.

It was found from a consideration of the analyses that:—

(1) Very little difference is apparent between the energy values of good and poor pastures in this State.

(2) Very large differences do occur in the proportions in which protein and phosphoric acid are present in different pastures.

(3) These differences correspond closely with the reputed value of the pasture to a stockman—a low protein and phosphoric acid content being associated with a low nutritive value, and a high protein and phosphoric acid content with a high nutritive value.

(4) Similar differences occur also in total ash and in silica-free ash, but not with the same consistency nor to the same extent as with protein and phosphoric acid. Lime is apparently abundant in almost every case.

(5) Dressings with superphosphate give, in the southern districts, quite large increases of protein and phosphoric acid in the herbage.

SOILS.

Studies in the Geology and Mineralogy of Soils. Part II. Soils of South-East Scotland. *By R. Hart. J. Agric. Sci., XIX*, 802 (1929).—In continuance of his previous work the author discusses in this paper the results of his study of soils from the district lying between the Forth and Tweed. A general account of the physiographical and geological occurrence of the soils is given, followed by mechanical and mineralogical analyses of thirty soils. The soils studied are developed on glacial drift, in most cases on boulder clay, and consequently as shown in the mechanical analyses the clay content is high. The mineralogical analyses show that the soils have a varied content of silicate minerals and that in most cases the minerals are comparatively fresh, that is, only slightly chemically altered. The soils can be grouped according to the minerals present, and this grouping seems to depend on the geology of the parent material. The results also suggest that the composition of the matrix of the glacial drift (boulder clay) is largely influenced by local bedrock. The distribution and classification of the soils can be materially aided by a mineralogical analysis.

Determination of Fertiliser Requirements of Soils. *J. König, Naturwissenschaften*, 17, 755 (1929).—The determination of fertiliser requirements necessitates the consideration of two factors: the kind of crop and the availability for the plant of the nutrients present in the soil and fertiliser. The citric acid (1 per cent. solution) extraction method is employed for the determination of the easily soluble nutrients. The amount of nutrient assimilable by the crop is calculated from these figures by means of a "percentage utilisation coefficient" which has been predetermined for the particular crop. The maximum plant requirement is also determined by means of crop analysis. The difference between these two sets of figures gives the amount of nutrient to be added artificially. The actual quantity of fertiliser necessary is obtained from the percentage utilisation coefficient for the particular crop with reference to the fertiliser to be used.

Influence of Soil Reaction on the Conversion of Different Forms of Nitrogen in the Soil and their Utilisation by Plants. *K. Nehring, Landw. Jahrb.*, 69, 105 (1929).—From the point of view of nitrification in the soil the physiological nature of fertilisers is of importance. Salts of potash are physiologically neutral, superphosphate is certainly not acid and basic slag definitely basic. At first urea and calcium cyanamide act as physiologically alkaline but later as acid fertilisers, the net result being that urea is physiologically acid and calcium cyanamide is alkaline. Both "Leunaphos" and "Nitrophoska" are acid fertilisers. A series of pot experiments were carried out to determine the soil reaction for optimum effect of the fertiliser. A sandy loam high in humus was used, the reaction being artificially adjusted. Nitrate of soda showed the optimum effect at pH 4-5; urea and calcium cyanamide at pH 6; urea at pH 7, and ammonium sulphate at pH 8. The result varies with the crop. Barley is acid sensitive, while oats are acid tolerant. Below a pH 6·5 nitrate nitrogen is a better plant food than sulphate of ammonia, while above that they are of equal value.

Physical and Chemical Investigations on Danish Heath Soils. *Fr. Weis, Det Kgl. Danske Videnskabernes Selskab. Biolog. Meddelelser, VII*, 9, *Copenhagen* (1929).—The object of the investigations was to classify and study the properties of the Danish heath soils with a view to their development for agricultural and forestry purposes.

It was found that the soils of lowest quality had the smallest content of fine materials, and the difference was most marked in samples from the hard pan layers of the various soils. Numerous acidity determinations were carried out, and it was found that the surface layer was extremely acid (pH 4 to 4·5), but at a depth of 24 to 32 ins. the acidity was considerably less (pH 5 to 5·5). The results of laboratory and field experiments indicated that large quantities of lime would be required to bring about a neutral reaction in the surface soil, but the author believes that this is unnecessary, and that the addition of small amounts of lime is decidedly beneficial even though it does not bring about much change in reaction. The hygroscopically bound water was determined and was found to be related chiefly to the amount and nature of the organic colloids and humus.

Investigations were also carried out on the organic substances and on the nitrogen content of these substances. The distribution of the organic substances in the different layers of the heath profile was studied, and the upper layer was found to contain considerable amounts of "raw humus," and the upper layer of the hard pan was rich in precipitated humus colloids. Considerable amounts of nitrogen were present in most of the heath soils examined, and it is pointed out that nitrogen starvation in newly cultivated heath soils is due to the fact that the nitrogen compounds are not in a form readily available to plants, but some of this nitrogen can be made available by the application of small amounts of lime.

The chemical analyses of the various layers of the soil profiles showed that heath soils are very poor in calcium, potassium, magnesium and phosphoric acid. It is essential therefore to add these substances in sufficient quantities if the soils are to be rendered fertile, and in the poorest classes of soils cultivation is necessary in order to bring back to the surface layer the colloidal substances which have been washed down to the hard pan layer. According to the author of this paper, if heath soils are treated on proper principles, their cultivation is economically sound.

DAIRYING.

Relative Values of High and Low Testing Milk for Cheese-making

P. O. Veale, Bull. No. 9, N.Z. Dept of Scientific and Industrial Research.— The author, who is research chemist to the Federation of Taranaki Co-operative Dairy Factories, Hawera, New Zealand, conducted an investigation under factory conditions on the cheese-making properties of the milk of typical herds of the three leading dairy breeds in New Zealand, the Ayrshire, Friesian and Jersey. The raw milk of each herd was made into cheese daily for a complete season of eight months under carefully controlled conditions. The Friesian herd, consisting of 70 cows, supplied 472,394 lb. milk with an average content of 3·55 per cent.; the 50 cows of the Ayrshire herd supplied 256,085 lb. milk of 3·85 per cent. butter fat; the Jersey herd gave 290,275 lb. milk of 4·75 per cent. butter fat. Records of the yield and quality of cheese made by each group are detailed in this important bulletin. The total amount of experimental cheeses made amounted to nearly 49 tons, so that the writer has ample material on which to base his conclusions. He found that the low testing milk gave a proportionately larger yield of cheese per pound of butter fat than the high testing milk, this difference in yield being caused by differences in the ratio of casein to fat, which was higher in the low testing milks. Yet during the majority of the spring and summer months, cheese made from the high testing milk showed to advantage in body and in texture. Towards the end of the season, however, the rich Jersey milk produced a cheese somewhat open and greasy. The author concludes that the higher limit for the economical utilisation of butter fat in cheese milk is from 4 to 4·5 per cent. Beyond this limit it appears to be difficult to produce a cheese with a uniform body. Cheese made from low testing milk contained on an average 3 per cent. more moisture than high testing milk. Complete data on the seasonal variations of the butter fat, casein, solids not fat, are given as well as the losses of fat and casein during manufacture. The yield of cheese from each herd throughout the season, the moisture content of the cheese prior to export, the behaviour of the cheese during transport overseas, and the reports of the expert graders in London are given in detail.

The author discusses the payment of cheese milk on a basis of the casein-fat ratio, and concludes a very excellent report by answering the self-imposed question: "Should the New Zealand Cheese-making industry continue in its present tendency to use year by year continually richer and richer milk for cheese-making? " by the emphatic declaration : " Certainly not."

The Taste of Milk. *C. L. Roadhouse and G. A. Koestler, Jour. Dairy Science*, 12 (6), 421-473.—A study of some factors affecting the flavour of milk enables the authors to conclude that the chloride-lactose relationship is one of the most important means of assessing the taste of milk. Samples of milk which have a relatively low chloride-lactose number usually have a better flavour than those of like origin which have a high chloride-lactose ratio. Investigation also showed that the primary taste of milk is associated principally with the finely dispersed easily dialysable ingredients, whereas the fat and protein (non-dialysable) have scarcely any influence. Food flavours, on the other hand, are primarily associated with the latter constituents, and not with the dialysable portion of the milk.

Pasteurisation of Milk and Undulant Fever. *Milk Plant Monthly*, 18 (9), 19-20.—Undulant or Malta Fever, similar in many of its symptoms to the ambulatory form of typhoid fever, has been traced to the Bang bacillus of contagious abortion which not infrequently occurs in raw market milk. This disease, which causes a disabling and long continued illness, appears to be rare in American cities where pasteurisation of the milk supply prevails. On the other hand, it is common in country districts, where it is communicated not only by raw milk but also by direct contact with infected animals.

Utility of Certain Tests in Grading Raw Milk. *M. J. Prucha, Proc. Amer. Dairy Science Assn.*, 1929.—As a practical method of grading raw milk, the well known methylene blue test has a definite value. In recent years another dye called Janus Green has been recommended, but the author after careful investigation has found it to have no special advantages over methylene blue. The average reduction time of Janus Green is from 30 to 60 minutes longer than methylene blue.

No closely correlated agreement can be established between the reduction time and the official plate count when individual determinations are compared. Only when large numbers of determinations are related is there perceptible agreement. This is probably because other factors than bacteria enter into play. Leucocytes seem to be concerned in the reduction time. The author has been able to predict the approximate time of reduction by microscopic examination of the milk for leucocytes. When present in numbers less than 4 million per c.c. leucocytes exert little apparent influence in the reduction time. Above this number they shorten the reduction test.

ANIMAL BREEDING.

Cattle.

The Effect on Lactation of the Length of the Preceding Calving Interval and its relation to Milking Capacity, to Age, and to other Factors of Influence. *By Lt.-Col. J. Matson.* 1929. *Jour. Agr. Sci., Vol. XIX, pp.* 553-562.—This paper is concerned with milk production in the tropics. The author draws his data from Indian dairy herds.

He finds that for Indian cattle whose yield capacity is 6,000 lb. there should be 420 days between calvings, and if the period is less than 335 days production is considerably diminished. The writer also finds that unrestricted access to the bull may prevent the real yield capacity of a cow from being discovered.

The writer suggests the follow law, " The optimum calving interval varies directly with milking capacity and inversely with age up to maturity."

Inbreeding in Cattle. *P. Lyczko*, 1928.—163 cases of inbreeding in the black and white cattle of Lorzendorf have been investigated, some of them being fairly closely inbred. It was found that inbreeding gave, on the whole, good results, and certainly no bad results were obtained. Inbred animals exhibited no weakened constitution or lower fertility, and they often show a higher milk and fat yield than their dams. Presumably the original stock was sound, and the inbreeding was selective to the best yielding lines.

Pigs.

Fertility in Pigs. *By I. Johansson.* 1929. *Ztschr. Tierzucht*, 15—49-86.—This study is based on the records of 464 sows with 2,589 litters over a period of 35 years. Length of gestation was found to be about 114 days. It seemed to be independent of age of sow, size of litter and season of the year. The size of litter tended to increase to the fourth and to decrease after the sixth. There appeared to be no relation between the interval between pregnancies and litter size. Infantile mortality showed no correlation with duration of pregnancy unless this was less than 112 days. It was found to be higher in winter than in summer, and to increase if the size of litter was above 12.

How many Ribs has a Pig? Variations in the Skeletal Structure of the Pig. *By A. M. Shaw.* 1929. *Sci. Agr., Vol. X, pp.* 23-27.—The author made counts of the ribs at various factories and carcase exhibitions. He discovered a direct correlation between the number of the ribs and the "placing" of the carcases, provided that the quality was equal in every other respect. In this paper he presents nearly 4,000 records from as many as 17 different breeds and their crosses. He found that the number of ribs varies from 13 to 17 pairs inclusive, and that variation in the number occurs in all breeds. Litter mates showed a higher degree of uniformity than unrelated animals. The additional ribs are definitely associated with the larger breeds, particularly with those types known to possess a heavy bone. The cervical vertebræ are constant in number, and the thoracic vertebræ vary according to the number of ribs present. The usual variation in the lumbar vertebræ is from 6 to 7, only two specimens being found with 5. No correlation was found between sex and the number of ribs present. There appeared to be a distinct breed difference as to the number of ribs.

Work is at present in progress at the University of Saskatchewan with a view to testing out the economic importance of the additional ribs. The evidence already obtained supports the view that this is a point of economic importance. The question of developing a pure strain possessing uniformity of rib number is also receiving attention.

Poultry.

Hereditary Factors in Bacillary White Diarrhœa. *By Elmer Roberts and L. E. Card.* 1928-29. *Univ. Illinois Agric. Exp. Stat., p.* 112.—It may be possible to establish strains of chicks which are resistant to this malady, Survival among the selected resistant stock after it had been inoculated with the organism causing the disease was 83·6 per cent., while among a non-selected stock only 52·5 per cent. of the birds survived. These results are in accord with those of 1925, 1926 and 1927.

In addition, during 1928 matings were made between the stock selected for resistance and unselected stocks. Survival among the progeny of selected males and unselected females was 83 per cent., while the survival for progeny from stock of selected females and unselected males was 74·4 per cent. These results may indicate the existence of dominant hereditary factors for resistance, and may also show that sex-linked factors for resistance may be involved. A total of 2,081 chickens was used during 1928. In 1929 between 3,000 and 4,000 chicks were being used in this study.

General.

The Inheritance of Resistance to the Danysz Bacillus in the Rat. *By M. R. Irwin.* 1929. *Genetics, Vol.* 14, *pp.* 337-365.—There is considerable confusion concerning the meaning of the term of inherited resistance to disease which leads to the loose conception that certain diseases are inherited, whereas what is inherited is the resistance to the bacteria (or else the susceptibility to it). Previous to Pasteur's discovery of the role of micro-organisms as the causative agents of many diseases, it was quite generally recognised by the medical profession that there were individual and racial resistances and susceptibilities to disease.

Although this paper deals with a disease in the rat, it throws considerable light on the general problem of resistance to disease in larger animals. The technique of the work is beyond reproach, special care being taken that the virulence of the bacteria was the same over the eighteen months during which the experiment was conducted. The evidence clearly shows that by breeding from those animals which resisted the attacks of this disease, larger numbers of animals resistant to it were obtained in each succeeding generation. It would appear that the resistance to this bacillus is inherited in a complex manner and with a tendency towards dominance. Distinct differences between individuals in their ability to transmit resistance to their offspring were noticed. Weight of the animals appeared to make no difference, though decrease in size might have been associated with decrease in resistance. Certain stocks of rats showed a differential action in resistance between the sexes, but this requires further investigation.

INSECTS AND PESTS.

A new British Industry: The Breeding of Parasites.—Amongst the many activities of the Empire Marketing Board, one of the latest and most novel is the establishment of a laboratory for the breeding of insect parasites. The Board naturally breeds only insects which it takes to be useful to man, and specialises in those species parasitic on and destructive to other insects which are recognised pests. When the stock of any particular parasite has become large enough to afford a surplus, consignments are sent to areas throughout the Empire where its special pest flourishes. Thus to Canada have been sent parasites of the pine tortrix, the greenhouse whitefly, and a scale-insect; to New Zealand a parasite of the great wood wasp; to India and Kenya a parasite of American blight or woolly aphis; to New Zealand and Canada parasites of the earwig; and so on. (*Science*, 1929, p. 152.) The utilisation of imported parasites to deal with well-established pests is a comparatively recent development of entomology, and still much has to be learned about its ultimate effects. But it is safe to say that of all the animals which have been established for specific purposes in foreign lands, many have lived to cause more trouble than they were worth, and we wonder if the entomologist in making those hasty and seemingly promiscuous introductions has given due weight to the lessons of the past. If not, he may be laying up for future generations anxieties which he cannot visualise.

The Control of Warble Flies. *U.S. Dept. Agr. Farmers' Bulletin, No.* 1596, 1929.—The control of warbles, or as they are called in the United States "cattle grubs" or "heel flies," is one of the most important of the insect problems affecting cattle owners. The total loss caused by these pests in the United States is estimated at from 50,000,000 to 100,000,000 dollars a year—a loss which affects many branches of trade—stockmen, dairymen, feeders, butchers, hide-dealers, tanners and manufacturers of leather goods. The Bulletin referred to above gives an account of the life-histories and the methods and causes of the spread of the flies, and suggests means for combating the pest. Natural enemies seem to play an insignificant part in control, although it has been noted that some wild birds, poultry and small rodents eat warble grubs when they fall to the ground before pupation. Evil-smelling materials have been applied to the legs and lower portions of the body of cattle, where the flies lay their eggs, in the vain hope of causing them to desist. Fly sprays which kill the young grubs before they have burrowed into the skin, sheds for the shelter of the beasts from the flies, destruction of the eggs by creosote dips in wading tanks, have all been tried with varying success. The most efficient method is the old one of pressing the grubs from under the skin of infected cattle and killing them. This method, better adapted for the farm than the range, ought theoretically to stamp out warble flies in a single year, for if no grubs issue, no warble flies will be produced to carry on a new generation. But the ideal is as difficult to attain on the farm as in the sphere of morality.

STATISTICS.

PRICES of AGRICULTURAL PRODUCE, FEEDING STUFFS and FERTILISERS in September, October and November 1929.

LIVE STOCK : Monthly Averages of Prices at certain representative Scottish Markets.

(Compiled from Returns received from the Department'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. 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 ...	59 9	52 7	43 0	61 0	52 10	43 5	62 6	54 2	43 6
Cross-bred (Shorthorn)	55 3	47 9	37 4	54 6	47 2	37 3	56 5	49 1	39 2
Galloway	55 11	51 3	...	51 5	47 0	..	58 11	49 6	...
Ayrshire	51 3	40 9	32 0	50 10	40 7	30 5	51 3	41 3	30 3
Blue Grey	...	...	...	...	...	...	...	...	...
Highland	...	...	...	46 0	...	...	50 9	44 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	14	10	...	14½	10	...	14½	10	...
†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	14½	13	8¾	14	12¼	8½	13½	11¾	8½
Half-bred	14¼	13	8¾	13¾	12	8¼	13¼	12¼	8
Blackface	14	12¾	9	13¾	12	8¼	13½	12¼	8¼
Greyface	14¼	13	9¼	13¾	12½	8½	13¾	12½	8½
Down Cross	14¾	13¼	8¾	14	12	7¼	13¾	12¼	7
†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	13 5	12 10	...	13 3	12 7	...	13 3	12 7	...
Porkers	14 1	13 1	...	14 1	13 1	...	14 1	13 3	...

* Live weight. † Estimated dressed carcase weight.

Live Stock: Monthly Averages of Prices at certain representative Scottish Markets—(*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—									
Aberdeen-Angus :	Per head. £ s.	Per head. £ s.	Per head. £ s.	Per head. £ s.	Per head. £ s.	Per head. £ s.	Per head. £ s.	Per head. £ s.	Per head. £ s.
Yearlings	17 10	13 1	11 15	18 3	13 17	11 14	17 6	13 9	10 13
Two-year-olds ...	23 6	18 11	15 5	23 9	18 12	15 6	21 17	17 15	15 8
Cross-bred (Shorthorn):									
Yearlings	16 7	12 2	10 10	16 10	12 18	10 6	15 11	12 18	9 14
Two-year-olds ...	22 4	17 6	15 5	21 13	17 9	14 3	20 18	17 8	14 1
Galloway :									
Yearlings	15 0	...	...	15 3	12 0	...	14 4	...	...
Two-year-olds ...	25 10	20 0	...	23 12	17 7	...	19 0	15 10	...
Ayrshire :									
Yearlings	12 12	...	...	13 10	11 5	9 10	10 13	...	...
Two-year-olds ...	...	...	...	16 10	13 0	11 5	...	...	...
Blue Grey :									
Yearlings	...	...	...	12 10	...	...	...	9 0	...
Two-year-olds ...	...	...	...	21 10	...	...	...	11 5	9 5
Highland :									
Yearlings	...	8 2	...	9 9	7 6	5 16	10 3	8 7	6 13
Two-year-olds ...	13 13	12 15	10 10	14 12	11 7	9 6	15 5	11 1	9 15
Three-year-olds ...	20 0	17 10	...	18 13	15 1	11 15	17 10	15 3	12 8
DAIRY COWS—									
Ayrshire :									
In Milk	31 1	21 15	12 0	29 8	20 16	11 12	30 8	20 15	12 0
Calvers	29 16	22 2	14 18	29 0	21 2	14 4	29 6	21 5	15 5
Shorthorn Cross :									
In Milk	33 11	25 0	...	32 8	23 19	...	33 1	23 18	...
Calvers	32 4	22 10	17 9	30 19	22 10	18 17	31 14	22 19	19 8
SHEEP—	s. d.	s. d.	s. d.	s. d.	s. d.	s. d.	s. d.	s. d.	s. d.
Cheviot Hoggs ...	...	...	...	46 7	38 0	...	41 0	...	...
Half-bred Hoggs ...	...	...	...	71 0	...	...	52 0	44 6	...
Blackface Hoggs ...	...	...	...	41 7	27 0	...	31 1	24 8	...
Greyface Hoggs ...	40 0	...	...	46 2	36 0	...	47 2	38 0	...
Down Cross Hoggs	...	...	...	40 0	30 0	...	51 6	44 0	...
PIGS—									
(6 to 10 weeks old)	44 3	29 7	...	44 7	30 2	...	46 2	30 8	...

DEAD MEAT: Monthly Average Prices at Dundee, Edinburgh, and Glasgow.

(Compiled from Returns received from the Department's Market Reporters.)

Description.	Quality.	September. Dundee.	September. Edinburgh.	September. Glasgow.	October. Dundee.	October. Edinburgh.	October. Glasgow.	November. Dundee.	November. Edinburgh.	November. 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	8¾	8⅞	10½	8¾	8¼	10½	8¾	8¼	10½
	2	8⅝	...	9½	8½	7½	8¾	8½	...	8¾
Bull	1	7¾	7¼	7	7½	6⅝	6¾	7½	6½	6½
	2	6⅞	7	6½	7	6	6	7	...	6
Cow	1	6⅞	6¼	6⅝	6½	5⅜	6¼	6½	6	6
	2	6	...	5⅞	6	...	5¼	6	...	5
Irish—										
Bullock or Heifer ...	1	...	...	8¾	...	...	7⅞	...	...	7⅞
	2	...	...	8⅛	...	...	7¼	...	...	7¼
Argentine Frozen—										
Hind Quarters ...	1	5⅛	7½	6¾	6⅛	7¾	6¾	6⅝	7½	6¾
	2	...	5½	..	6	5⅞	...	...	6¼	...
Fore ,, ...	1	4¾	5	5	5	5¼	5	5¼	5⅝	5
	2	...	4½	...	...	4⅞	...	...	5	...
Argentine Chilled—										
Hind Quarters ...	1	8¼	8⅛	8	7½	7⅜	7¾	8¼	8	7½
	2	...	7⅞	7½	...	6⅞	7¼	8	7⅝	7⅛
Fore ,, ...	1	5⅛	5	5⅛	5¼	5	5	5½	5⅜	5⅜
	2	...	4¾	4⅞	5⅛	4½	4¾	..	5⅛	5⅛
Australian Frozen—										
Hind Quarters ...	1	...	...	6¾	...	...	6¾	...	...	6¾
	2	...	...	...	...	...	...	...	...	...
Crops	1	...	...	5¾	...	...	5¾	...	...	5⅝
	2	...	...	...	...	...	...	...	...	...
New Zealand Frozen—										
Hind Quarters ...	1	..	...	6¾	...	...	6¾	...	...	6¾
	2	...	...	...	...	...	...	...	...	...
Fore ,, ...	1	..	...	5	...	...	5	...	...	5
	2	...	...	...	...	...	...	...	...	...
MUTTON:—										
Hoggs, Blackface ...	under 60 lb.	13¾	11⅝	11½	13	10⅝	10¾	13	10⅜	10⅞
	60 lb. & over	12¾	...	10	12	...	9¾	12	...	10
,, Cross	under 60 lb.	13	11⅝	11½	13	10⅝	10¾	13	10⅜	10⅞
	60 lb. & over	12	...	10	12	...	9¾	12	...	10
Ewes, Cheviot	1	...	7¾	7⅞	...	6½	7⅛	...	6⅝	7
	2	...	...	7¼	...	...	6⅜	...	...	6
,, Blackface ...	1	10⅜	7¾	7⅝	9	6½	7⅛	9	6⅝	6⅞
	2	9⅜	...	7	8	...	6¼	8	...	6
,, Cross	1	7¾	7¾	7¼	7	6½	7	7	6⅝	6⅞
	2	6¾	...	6¼	6	...	6	6	...	6
Argentine Frozen ...	1	...	...	6	..	...	6	...	...	6
	2	...	...	...	...	...	...	...	..	...
Australian ,, ...	1	...	6½	5½	...	6	5½	...	6¼	5⅜
	2	...	5½	...	...	5	...	...	5½	5
New Zealand ,, ...	1	...	...	5½	...	...	5¼	...	..	5¾
	2	...	...	5	...	...	5	...	...	5
LAMB:—										
Home-fed	1	14	12½	12½	13	11⅜	12¼	...	11⅛	11¾
	2	...	...	11	...	...	11	...	...	11⅛
New Zealand Frozen ...	1	...	9	8½	...	9½	8½	...	9	8½
	2	...	7½	...	...	8⅜	...	...	8	...
Australian ,, ...	1	...	...	8	...	...	8	...	...	8
	2	...	...	...	...	...	...	...	...	...
Argentine ,, ...	1	...	...	7	...	...	7	...	...	7⅛
	2	...	...	...	...	...	...	...	...	...

Eggs: Monthly Average Wholesale Prices at Aberdeen and Glasgow. **Provisions: Monthly Average Wholesale Prices at Glasgow.**

(Compiled from Returns received from the Department's Market Reporters.)

Market.	Description.	Quality.	September.	October.	November.
			s. d.	s. d.	s. d.
Aberdeen.	Country ... ... per doz.	1	2 0	2 4	2 10
		2	1 10	2 3	2 9
	Duck .. ... ,,	1	2 1	2 6	3 0
		2	1 11	2 4	2 10
Glasgow.	Country .. ... per doz.	1	2 1	2 11	3 5
		2	2 0	2 10	3 4
	Irish ... ... per 120.	1	18 2	26 10	29 6
		2	16 2	21 5	26 0
	,, (Cold stored) ... ,,	1	...	16 6	16 7
		2	...	...	14 8
	,, Duck ... ... ,,	1	14 5	17 9	19 2
	Argentine ... ... ,,	1	...	16 9	17 0
	Australian ... ... ,,	1	...	19 3	18 11
		2	...	...	18 1
	Belgian ... ... ,,	1	15 5	19 1	22 6
		2	13 11	...	...
	,, (Pickled) ... ,,	1	..	...	17 8
	Canadian ... ... ,,	1	...	17 9	18 0
		2	...	...	17 6
	Chinese, Black ... ,,	1	11 1	12 3	13 6
	,, (Violet) ... ,,	1	...	14 4	14 3
	Danish ... ... ,,	1	15 9	20 0	23 5
		2	...	18 3	21 0
	,, (Pickled) ... ,,	1	...	14 9	14 6
	Dutch ... ... ,,	1	14 5	17 5	19 8
		2	14 0	...	...
	,, Duck ... ,,	1	...	14 0	14 8
	Polish (Blue) . ,,	1	11 5	13 4	13 11
		2	10 2	12 5	12 5
	,, (Red) ... ,,	1	9 8	12 3	12 2
	Russian ... ... ,,	1	...	14 5	15 6
		2	...	...	13 11
	Swedish ... ... ,,	1	15 1	17 10	21 0
		2	15 0	16 6	...

Description.	Quality.	September.	October.	November.
		s. d.	s. d.	s. d.
Butter:				
Irish Creamery ... ... per cwt.	1	181 3	183 7	178 9
,, ,, (Unsalted) ,,	1	185 3	186 0	180 9
Australian ... ... ,,	1	181 0	182 0	175 3
Danish ... ... ,,	1	194 0	203 10	193 3
,, (Unsalted) ... ,,	1	198 6	208 0	197 3
New Zealand ... ... ,,	1	185 9	189 5	182 9
,, (Unsalted) ... ,,	1	188 3	194 5	192 6
Siberian ... ... ,,	1	172 9	179 0	177 0
Swedish ... . ,,	1	186 3	195 0	185 9
Cheese:				
Cheddar ... ... ,,	1	98 2	101 6	110 6
	2	89 8	97 0	103 9
Cheddar (Loaf) .. ... ,,	1	114 6	116 10	119 6
Dunlop ... ... ,,	1	90 6	95 8	99 3
	2	82 3	90 6	92 6
Canadian... ... ... ,,	1	98 3	101 5	101 6
New Zealand (Coloured) ,,	1	99 0	99 5	99 0
,, (White) ,,	1	98 3	98 10	98 6
Hams:				
Irish (Smoked) ... ... ,,	1	212 0	200 0	177 0
	2	198 6	183 7	160 0
American, Long Cut (Green) ,,	1	112 9	108 5	106 6
American, Short Cut ... ,,	1	110 6	105 0	101 9
Bacon:				
Ayrshire (Rolled) ... ,,	1	153 6	147 7	145 6
Irish (Green) ... .. ,,	1	131 0	124 10	130 0
,, (Dried or Smoked) ,,	1	136 0	130 5	135 0
,, (Long Clear) ... ,,	1	145 6	140 0	135 6
Wiltshire (Green) ... ,,	1	132 6	130 10	131 0
,, (Dried or Smoked) ,,	1	138 3	136 5	137 0
Danish, Sides ... ... ,,	1	113 0	112 0	112 6
Dutch (Green, Wiltshire Style) ,,	1	106 6	109 0	108 6
American (Long Clear, Middles, Green) ,,	1	102 3	101 7	109 3
American (Short Clear Backs) ,,	1	102 3	101 0	106 0

FRUIT AND VEGETABLES: Monthly Average Wholesale Prices at Glasgow.

(Compiled from Returns received from the Department's Market Reporter.)

Description.		Quality.	SEPTEMBER.	OCTOBER.	NOVEMBER.
FRUIT:—					
Apples—			s. d.	s. d.	s. d.
British—					
Cooking ...	... per cwt.	1	19 4	...	...
Lord Derby...	... ,,	1	21 4	20 0	...
Other Dessert	... per 60 lb.	1	15 0	...	...
Imported—					
American ...	... per barrel.*	1	33 8	26 1	24 9
Nova Scotian	... ,, *	1	...	...	22 0
Other Canadian	... per case.**	1	17 0	16 0	18 0
Pears, Californian	... per case.†	1	18 6	...	...
Plums, Victoria...	... per lb.	1	0 5	...	...
VEGETABLES:—					
Beet	... per cwt.	1	6 0	5 5	5 3
Brussel Sprouts ...	... ,,	1	8 6§	27 0	23 6
Cabbage, Coleworts	... per doz.	1	1 4	1 4½	1 5
,, Red ...	... ,,	1	2 9	2 7½	2 5
,, Savoy ...	... ,,	1	...	2 4	2 1
Carrots	... per cwt.	1	6 0	6 0	5 3
Cauliflowers—					
Broccoli, *Cornish*	... per doz.	1	...	...	6 0
Other British	... ,,	1	3 0	4 1	6 0
French	... ,,	1	...	...	6 5
Celery	... per bunch.	1	2 5	2 4	2 5
Cucumbers ...	... per doz.	1	4 3	6 0	6 0
Greens	per doz. bunches.	1	...	9 0	9 0
Leeks	,,	1	2 8	2 6	2 6
Lettuce, Cos ...	... per doz.	1	1 6	1 8	2 0
,, Cabbage	... ,,	1	2 0	1 3	2 3
Onions, *Dutch* ...	... per cwt.	1	6 4	6 0	5 5
,, *Valencia*	.. per case.‡	1	8 5	9 10	9 5
,, *Spring* ...	... per bunch.	1	0 4	...	0 10
Parsley	... per cwt.	1	14 0	12 10	14 6
Parsnips	... ,,	1	13 0	12 0	10 3
Peas	... ,,	1	22 8	...	...
Radishes	per doz. bunches.	1	1 6	1 6	1 6
Rhubarb	... per cwt.	1	4 0	4 0	...
Spinach	... ,,	1	22 0	27 2	32 0
Tomatoes, *Scottish*	... per lb.	1	0 6½	0 7¾	0 10
,, *English*	... ,,	1	...	...	0 9
,, *Channel Islands*	,,	1	0 3½	0 5	0 7
,, *Canary*	... ,,	1	...	...	0 6½
Turnips	... per cwt.	1	2 8	2 5	2 3
Vegetable Marrow	... per dozen.	1	3 6	5 0	5 0

* 140 lb. (approx.). ** 40 lb. (approx.). † 72 pears. ‡ 9 stone. § per 40 lb.

POTATOES: Monthly Average Wholesale Prices at Aberdeen, Dundee, Edinburgh, and Glasgow.

(Compiled from Returns received from the Department'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. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.
SEPTEMBER.							
Aberdeen, per ton	1	...	3 10 0	...	...	...	...
Dundee ,,	1	...	3 5 0	...	...	...	4 0 0
Edinburgh ,,	1	3 3 4	3 10 0	...	...	...	...
Glasgow ,,	1	3 6 0	4 0 0	...	...	...	3 18 0
OCTOBER.							
Aberdeen ,,	1	...	...	...	...	5 0 0	2 16 0
Dundee ,,	1	...	2 15 0	...	...	...	2 10 0
Edinburgh ,,	1	3 0 0	...	..	...	...	...
Glasgow ,,	1	...	3 3 0	...	...	...	3 3 0
NOVEMBER.							
Aberdeen ,,	1	..	...	...	...	5 0 0	2 12 6
Dundee ,,	1	...	...	...	...	...	2 10 0
Edinburgh ,,	1	3 0 0	...	...	...	...	...
Glasgow ,,	1	...	2 13 9	6 10 0	...	5 15 0	2 18 9

ROOTS, HAY, STRAW, AND MOSS LITTER: Monthly Average Prices at Aberdeen, Dundee, Edinburgh, and Glasgow.

(Compiled from Returns received from the Department'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.										
* Aberdeen, per ton	1	...	...	...	74 5a	...	...	...	28 2	...
‖ Dundee ... ,,	1	...	19 0	...	140 0b	...	75 0	...	75 0	52 6§
					82 6c		...			
¶ Edinburgh ,,	1	...	...	...	105 0c	...	58 9	45 0	58 9	...
‖ Glasgow ,,	1	...	...	...	83 9	83 9	58 9	...	62 6	34 8§§
OCTOBER.										
* Aberdeen ,,	1	...	...	..	77 6a	...	...	...	31 3	...
‖ Dundee ... ,,	1	...	17 2	...	143 4b	...	79 0	70 0	79 0	52 6§
					101 3c					
¶ Edinburgh ,,	1	...	...	...	117 6b	...	57 0	41 0	56 0	...
					108 0c					
‖ Glasgow ,,	1	...	...	...	93 6	96 0	58 0	...	59 6	33 9§§
NOVEMBER.										
Aberdeen ,,	1	...	...	...	79 5†	...	...	...	34 5	...
‖ Dundee ... ,,	1	...	17 6	17 0	110 0b	...	77 6	70 0	77 6	52 6§
					100 0c					
¶ Edinburgh ,,	1	...	...	...	115 8b	...	60 0	45 0	60 0	...
					111 3c					
‖ Glasgow ,,	1	...	...	...	97 6	100 0	60 0	...	62 6	33 9§§

* Loose straw, ex stack.
§ Foreign, ex quay.
a Ex stack, baled.
¶ Bunched straw delivered.
† Ex stack, loose.
c Loose, delivered.
b Baled, delivered.
‖ Baled straw delivered.
§§ Home (in 1½ cwt. bales).

Feeding Stuffs : Monthly Average Prices at Glasgow and Leith.

(Compiled from Returns received from the Department's Market Reporters.)

Description.	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.
Linseed Cake—						
Home	14 1 3	13 16 3	14 3 3	13 10 0	13 8 2	12 17 6
Foreign	13 2 2	12 15 0	13 2 3	13 1 3	12 16 3	12 15 0
Decorticated Cotton Cake	11 15 0	...	11 14 0	...	11 11 3	...
Undecorticated do.—						
Bombay (Home-manufactured)...	7 17 6	7 10 8	7 11 9	7 5 0	7 5 0	6 16 3
Egyptian (do.)	8 6 3	...	8 2 0	...	7 11 7	...
Palmnut Kernel Cake	11 0 0	...	11 2 0	...	11 3 9	...
Soya Bean Cake ...	12 10 0	11 17 6	12 10 0	11 11 8	...	...
Coconut Cake ...	11 10 0	...	11 10 0	...	11 8 9	...
Groundnut Cake, Undecorticated—						
(36-37 per cent. Oil and Albuminoids)	9 10 0	9 15 0	9 10 0	9 9 0	9 6 3	8 17 6
(39-40 per cent. do.)	9 15 0	9 17 6	9 14 0	9 11 6	9 8 9	11 3 2
Maize Germ Cake—						
Home	11 12 2	...	11 1 0	...	10 18 9	...
Foreign	11 6 3	...	10 15 6	...	10 10 0	...
Maize Germ Cake Meal	10 5 0	..	9 15 6	...	9 8 9	...
Rice Meal	7 18 2	7 12 6	7 16 0	...	7 11 3	...
Bean Meal	11 4 5	11 14 5	10 17 6	11 7 6	10 12 6	11 5 0
Barley Meal ...	10 5 0	10 0 0	10 3 0	9 15 0	10 0 8	...
Fish Meal	19 5 0	18 10 0	19 5 0	18 8 0	19 5 0	18 10 0
Maize Meal—						
Home-Manufactured	10 15 8	10 10 0	10 8 6	9 17 0	9 18 9	9 3 2
South African—						
(Yellow) ...	9 14 5	...	9 8 0	9 5 0	8 15 11	8 17 6
(White) ...	10 0 0	...	9 10 0	9 15 0	8 17 10	...
Locust Bean Meal (Fine)	10 8 2	9 3 9	10 5 0	9 5 0	10 1 11	9 1 3
Maize Gluten Food (Paisley) ...	9 10 8	...	9 10 0	...	9 10 0	...
Maize—Plate ...	9 13 5	9 11 11	9 6 6	9 2 0	8 15 0	8 8 2
Do. African, Flat	...	...	...	...	9 0 10	...
Do. American ...	10 0 8	...	9 16 0	...	9 16 3	...
Oats—Home ...	9 9 1	8 15 0	9 2 6	7 14 0	8 3 9	7 9 5
Do. Plate ...	8 16 3	...	8 8 9	...	8 1 11	8 5 0
Do. Canadian No. 2	9 6 3	...	9 3 0	...	8 3 9	...
Barley Feeding (Home)	10 4 5	9 0 0	10 1 0	8 16 0	9 6 11	9 0 0
Do. Bran ...	10 0 0	...	9 18 0	...	9 8 9	...
Wheat—						
Home	12 5 8	10 13 9	11 8 6	9 18 0	10 7 6	9 18 2
Poultry	11 8 2	10 11 8	10 7 0	9 17 6	9 16 3	9 16 11
Imported... ...	10 8 2	...	10 3 0	...	9 17 6	...
Middlings (Fine Thirds or Parings)	9 0 4	8 12 6	8 9 9	8 2 0	8 5 4	7 9 4
Sharps (Common Thirds) ...	7 5 8	7 8 9	6 19 3	7 3 0	7 0 0	6 17 6
Bran (Medium) ...	7 3 2	7 1 3	6 19 3	6 18 0	7 1 3	6 16 3
,, (Broad) ...	7 5 8	7 16 3	7 1 6	7 13 0	7 3 9	7 11 3
Malt Culms... ...	7 17 2	7 12 6	7 15 0	6 15 0	7 7 6	6 5 0
Distillery Mixed Grains—Dried	...	9 7 6	9 15 0	9 9 0	...	9 2 6
Brewers' Grains—Dried	8 15 8	8 0 0	8 16 6	8 0 0	8 10 8	7 18 2
Distillery Malt Grains Dried	8 13 2	...	8 13 6	8 15 0	8 8 9	...
Crushed Linseed ...	24 2 6	...	26 6 0	...	26 10 0	...
Locust Beans, Kibbled and Stoned	9 10 0	8 17 6	9 7 6	8 17 6	9 3 2	8 15 8
Beans - China ...	9 17 10	...	9 13 9	...	9 11 7	10 0 0
Do. Sicilian ...	9 18 2	...	9 14 6	...	9 13 9	...
Pease, Calcutta (White)	15 5 0	...	15 2 0	...	15 0 0	...
Feeding Treacle ...	7 1 7	7 5 0	7 0 0	7 5 0	7 0 0	7 5 0
Linseed Oil, per gall.	0 6 0	...	0 6 11	...	0 6 0	...

Fertilisers : Monthly Average Prices at Glasgow and Leith.

(Compiled from Returns received from the Department'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	9 9 0	9 9 0	9 11 0	9 11 0	9 14 0	9 14 0
Sulphate of Ammonia (Neutral and Granular) § ...	N. 20·6	9 9 0	9 9 0	9 11 0	9 11 0	9 14 0	9 14 0
Superphosphate ...	P.A. 13·7	...	.	a2 17 6	2 15 0	2 15 0	2 15 0
,, ...	,, 16·0	...	...	a3 3 9	3 1 3	3 1 3	3 1 3
,, ...	,, 17·4	...	...	a3 8 9	...	3 6 3	...
,, ...	,, 18·3	..	...	...	3 7 6	...	3 7 6
Ground Mineral Phosphate d ...	P.A. 26	...	...	a2 6 6	...	2 6 6	...
,, ,, ,, e ...	,, 26	a2 6 6	2 6 6	...	2 6 2	...	2 5 0
,, ,, ,, f ...	,, 26	a2 9 0	2 9 0	a2 9 0	2 8 11	...	2 7 6
,, ,, ,, e ...	,, 34	...	3 11 6	...	3 9 3	...	3 7 6
,, ,, ,, f ...	,, 34	...	3 14 0	...	3 11 9	...	3 10 0
Kainit (in bags) ...	Pot. 14	3 5 9	3 2 6	3 5 9	3 2 6	c3 6 3	3 2 6
Calcium Cyanamide†	N. 20·6	8 12 0	...	8 14 0	...	8 16 6	...
Potash Salts ...	Pot. 20	3 15 6	3 10 0	b3 15 6	3 10 0	c3 16 3	3 10 0
,, ,, ...	Pot. 30	5 2 0	4 17 6	b5 2 0	4 17 6	c5 2 9	4 17 6
Muriate of Potash... (on basis of 80 per cent. purity)	Pot. 50	9 6 0	...	b9 6 0	8 15 0	c9 7 6	8 15 0
Sulphate of Potash (on basis of 90 per cent. purity)	Pot. 48·6	11 6 9	...	b11 6 9	10 17 6	c11 8 9	10 17 6
Steamed Bone Flour	N. 0·8/1·0 P.A. 27·5/30	...	...	a6 0 0	5 12 6	5 15 0	5 12 6
Bone Meal (Indian)	N. 4·12 P.A. 22·9	...	...	...	...	9 0 0	...
,, ,, ,,	N. 3·75 P.A. 22·9	...	...	...	8 15 0	...	8 15 0
Basic Slag ...	P.A. 14	§2 12 6	...	...	...	2 7 6	...
,, ,, ...	,, 15·75	...	2 12 6	..	2 13 5	..	...

Abbreviations :—N. = nitrogen ; P.A. = Phosphoric Acid ; Pot. = Potash.

§ Carriage paid in 6-ton lots. † Carriage paid in 4-ton lots. *a* F.o.r.
b F.o.r. in 4-ton lots, or F.o.r. ex store, less 5*s.* 6*d.* per ton lifted at quay.
c Less 5*s.* 6*d.* per ton ex quay. *d* 75 per cent. fineness through prescribed mesh sieve.
e 80 per cent. fineness through standard 100-mesh sieve.
f 85 ,, ,, ,,

Statement showing the Acreage under each Variety of Potatoes in Scotland in 1929.

Variety.	Acres.
A. First Earlies.	
1. *Arran Rose	26
2. *Dargill Early	67
3. *Di Vernon	39
4. *Herald †	132
5. *Immune Ashleaf ...	53
6. *Snowdrop (including Witch Hill)	46
7. Beauty of Hebron (including Puritan) ...	96
8. Duke of York (including Midlothian Early and Victory)	2,408
9. Eclipse (including Sir John Llewelyn) ...	1,794
10. Epicure	7,939
11. May Queen	317
12. Ninetyfold	189
13. Sharpe's Express ...	1,954
14. Sharpe's Victor	32
15. Other First Earlies not specified above ...	52
Total First Earlies ...	15,144
B. Second Earlies.	
16. *Ally	962
17. *Arran Comrade	404
18. *Catriona	163
19. *Edzell Blue	319
20. *Great Scot	13,777
21. *Katie Glover	36
22. *King George V.... ...	436
23. British Queen (including Pioneer, Macpherson, Maid of Auchterarder, Scottish Standard, English Beauty, &c.) ...	3,530
24. Royal Kidney (including Queen Mary)	697
25. Other Second Earlies not specified above ...	226
Total Second Earlies	20,550
C. Maincrops.	
26. *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.)	765
27. *Arran Banner †	278
28. *Arran Consul †	1,610
29. *Arran Victory	457
30. *Bishop	94
31. *Champion	608
32. *Crusader...	89
33. *Early Market	55
34. *Golden Wonder (including Peacemaker) ...	6,716
35. *Irish Queen	343
36. *Kerr's Pink	47,329
37. *Langworthy (including Maincrop and What's Wanted)	255
38. *Lochar	62
39. *Majestic	7,537
40. *Rhoderick Dhu	412
41. *Tinwald Perfection ...	417
42. Arran Chief	5,812
43. Evergood	83
44. Field-Marshal	479
45. General	58
46. King Edward VII. (including Red King) ...	15,324
47. Northern Star (including Ajax, Allies and Aeroplanes)	86
48. President (including Iron Duke and Scottish Farmer)	194
49. Up-to-Date (including Dalhousie, Factor, Glamis Beauty, Scottish Triumph, Stephen, Table Talk, Laing's Imperial, &c.)	1,657
50. Other Maincrops not specified above ...	558
Total Maincrops ...	91,278
Total Area Classified, ...	126,972
Acreage Not Included, ...	17,798
Total Acreage Grown, ...	144,770

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
(4) Varieties marked thus † have been registered by the Department of Agriculture for Scotland as new varieties.

ABSTRACT OF AGRICULTURAL RETURNS FOR SCOTLAND, 1929.

Collected 4th June 1929 (and comparison with 1928).

CROPS.

Distribution.	1929.	1928.	Increase.		Decrease.	
	Acres	*Acres.*	*Acres.*	*Per Cent.*	*Acres.*	*Per Cent.*
Total Area (excluding Water)	19,069,503	19,069,503	..	..	..	..
Mountain and Heath Land used for Grazing (*b*)	9,573,114	9,707,768	..	..	134,654	1·4
Total Acreage under Crops and Grass..	4,652,988	4,665,462	..	..	12,474	0·3
Arable Land	3,105,478	3,133,430	..	..	27,952	0·9
Permanent Grass (*a*) — For Hay ..	167,868	166 300	1,568	0·9	..	..
Permanent Grass (*a*) — Not for Hay ..	1,379,642	1,365,732	13,910	1·0	..	..
Permanent Grass (*a*) — Total ..	1,547,510	1,532,032	15,478	1·0	..	..
Wheat	50,730	58,227	..	..	7,497	12·9
Barley (including Bere)	100,549	111,924	..	..	11,375	10·2
Oats	888,731	878,436	10,295	1·2	..	..
Mixed Grain	1,169	1,338	..	..	169	12·6
Rye..	2,833	3,131	..	..	298	9·5
Beans (to be harvested as Corn)	2,833	3,151	..	..	318	10·1
Peas	387	346	41	11·9	..	..
Potatoes	144,770	144,026	744	0·5	..	..
Turnips and Swedes	371,278	378,008	..	..	6,730	1·8
Mangolds	1,204	1,250	..	..	46	3·7
Sugar Beet	613	2,313	..	..	1,700	73·5
Cabbage	4,132	4,319	..	..	187	4·3
Rape	8,820	11,690	..	..	2,870	24·6
Vetches or Tares, for Seed	121	142	..	..	21	14·8
Vetches, Tares, Beans, Peas, Mashlum, etc., for Fodder	10,980	11,879	..	..	899	7·6
Carrots	351	370	..	..	19	5·1
Onions	159	133	26	19·5	..	..
Flax	1	3	..	..	2	66·7
Small Fruit	7,927	8.006	..	..	79	1·0
Rye-grass and other Rotation Grasses and Clover — For Hay	408,322	400,753	7,569	1·9	..	..
Rye-grass and other Rotation Grasses and Clover — Not for Hay .	1,091,414	1,105,516	..	..	14,102	1·3
Rye-grass and other Rotation Grasses and Clover — Total	1,499,736	1,506,269	..	..	6,533	0·4
Other Crops	2,670	2,675	..	..	5	0·2
Bare Fallow	5,489	5,799	..	..	310	5·3
Orchards (*a*)	1,019	1,103	..	..	84	7·6

LIVE STOCK.

	No.	*No.*	*No.*	*Per Cent.*	*No.*	*Per Cent.*
Horses used for Agricultural purposes (including Mares for Breeding)	123,357	125,864	..	..	2,507	2·0
Unbroken Horses (including Stallions) — One year and above ..	14,969	16,491	..	..	1,522	9·2
Unbroken Horses (including Stallions) — Under one year ..	5,494	5,093	401	7·9	..	..
Total	143,820	147,448	..	..	3,628	2·5
Other Horses	17,185	18,290	..	..	1,105	6·0
Total of Horses	161,005	165,738	..	..	4,733	2·9
Cows in Milk	355,631	356,121	..	..	490	0·1
Cows in Calf, but not in Milk	46,771	50,812	..	..	4,041	8·0
Heifers in Calf	51,339	52,284	..	..	945	1·8
Bulls being used for Service	16,991	17,031	..	..	40	0·2
Other Cattle :—Two years and above ..	215,578	194,076	21,502	11·1	..	..
" " One year and under two ..	301,234	290,483	10,751	3·7	..	..
" " Under one year	245,401	253,041	..	..	7,640	3·0
Total of Cattle	1,232,945	1,213,848	19,097	1 6	..	..
Ewes kept for Breeding	3,281,087	3,275,165	5,922	0·2	..	..
Rams to be used for Service in 1929	90,525	90,517	8	..	..	..
Other Sheep :—One year and above	974,877	905,747	..	..	20,870	2·1
" " Under one year	3,209,031	3,217,275	..	..	8,244	0·3
Total of Sheep	7,555,520	7,578,704	..	..	23,184	0·3
Sows kept for Breeding	16,130	22,210	..	..	6,080	27·4
Boars being used for Service	1,812	2,457	..	..	645	26·3
Other Pigs	124,275	170 837	..	..	46,562	27·2
Total of Pigs	142,217	195.504	..	..	53,287	27·2

(*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 1929, with COMPARISON for 1928.

COUNTIES.	Wheat.		Barley (including Bere).		Oats.	
	1929.	1928.	1929.	1928.	1929.	1928.
	Acres.	*Acres.*	*Acres.*	*Acres.*	*Acres.*	*Acres.*
ABERDEEN ...	10	12	9,580	11,394	179,080	177,869
ANGUS	10,737	12,027	10,967	12,048	56,795	55,280
ARGYLL	...	2	771	814	14,767	14,924
AYR	674	1,324	21	77	35,834	34,533
BANFF	...	14	6,168	6,645	44,410	44,181
BERWICK	1,604	1,671	10,337	11,776	26,146	25,320
BUTE	3	9	6	7	4,240	4,336
CAITHNESS ...	...	...	455	533	26,677	27,018
CLACKMANNAN ...	162	236	88	94	2,657	2,843
DUMBARTON ...	314	363	...	5	6,176	6,153
DUMFRIES ...	20	50	39	63	33,507	33,834
EAST LOTHIAN ...	4,736	5,170	11,945	12,931	15,086	14,608
FIFE	11,237	12,310	9,892	11,094	42,717	40,461
INVERNESS ...	33	27	3,550	3,723	29,715	28,218
KINCARDINE ...	868	949	5,358	6,121	31,374	30,880
KINROSS	194	267	110	99	6,224	6,179
KIRKCUDBRIGHT...	18	53	27	53	19,258	19,691
LANARK	1,750	1,945	41	74	34,333	34,344
MIDLOTHIAN ...	4,783	5,227	2,976	3,453	19,359	19,119
MORAY	661	915	7,785	8,117	24,009	23,590
NAIRN	...	...	1,705	1,937	6,508	6,278
ORKNEY	...	...	3,397	3,364	30,406	30,931
PEEBLES	2	...	33	59	5,353	5,239
PERTH	6,800	7,787	1,651	2,442	63,825	62,939
RENFREW ...	1,386	1,722	...	4	8,826	8,697
ROSS & CROMARTY	535	1,030	5,486	5,721	32,473	31,561
ROXBURGH ...	804	1,120	5,910	6,690	21,982	21,886
SELKIRK	...	5	141	141	3,103	3,306
SHETLAND ...	...	...	516	553	5,952	6,037
STIRLING	1,091	1,483	314	393	16,514	16,472
SUTHERLAND ...	...	...	199	215	6,794	7,014
WEST LOTHIAN ...	2,308	2,485	1,033	1,194	10,185	10,200
WIGTOWN	...	24	48	90	24,446	24,495
TOTAL ...	50,730	58,227	100,549	111,924	888,731	878,436

ACREAGE under POTATOES, TURNIPS and SWEDES and SUGAR BEET in each COUNTY on 4th June 1929, with COMPARISON for 1928.

Counties.	Potatoes.		Turnips and Swedes.		Sugar Beet.	
	1929.	1928.	1929.	1928.	1929.	1928.
	Acres.	*Acres.*	*Acres.*	*Acres.*	*Acres.*	*Acres.*
ABERDEEN ...	7,759	7,827	77,306	78,591	2	42
ANGUS	19,382	18,650	28,745	29,550	53	112
ARGYLL	2,632	2,714	4,644	4,750	...	...
AYR	8,674	8,628	6,727	6,608	1	...
BANFF	1,891	1,892	18,675	19,087	5	12
BERWICK	2,315	2,464	18,466	18,710	30	125
BUTE	970	1,012	1,210	1,161	...	...
CAITHNESS ...	1,082	1,091	10,243	10,427	...	...
CLACKMANNAN ...	372	376	704	706	...	...
DUMBARTON ...	2,109	2,260	1,311	1,358	...	...
DUMFRIES ...	3,066	3,319	13,812	13,960	...	...
EAST LOTHIAN ...	8,473	8,017	11,814	11,634	54	445
FIFE	16,876	16,525	20,102	20,387	379	1,230
INVERNESS ...	4,855	5,019	8,472	8,594	...	...
KINCARDINE ...	4,154	4,246	14,655	14,950	3	34
KINROSS	1,193	1,161	2,159	2,246	...	...
KIRKCUDBRIGHT	1,367	1,356	8,348	8,560	...	1
LANARK	6,122	6,175	8,930	8,999	...	1
MIDLOTHIAN ...	6,486	6,285	8,924	9,040	11	48
MORAY	1,704	1,708	12,774	13,164	11	68
NAIRN	259	275	3,578	3,740	...	10
ORKNEY	2,177	2,253	12,457	12,644	...	...
PEEBLES	358	331	2,467	2,631	...	...
PERTH	18,299	18,277	22,177	22,866	34	132
RENFREW	3,222	3,372	1,858	1,853	...	...
ROSS & CROMARTY	7,176	6,916	13,187	13,410	...	...
ROXBURGH ...	1,218	1,220	15,098	15,445	4	27
SELKIRK	135	131	1,784	1,883	...	...
SHETLAND ...	1,966	1,994	981	980	...	...
STIRLING	3,292	3,363	3,447	3,488	...	...
SUTHERLAND ...	1,023	1,047	2,465	2,518	...	...
WEST LOTHIAN ...	2,589	2,537	3,018	3,061	...	11
WIGTOWN	1,574	1,585	10,735	10,802	26	15
TOTAL	144,770	144,026	371,273	378,003	613	2,313

ACREAGE under RYE-GRASS and other ROTATION GRASSES and CLOVER, and under PERMANENT GRASS in each COUNTY on 4th June 1929, with COMPARISON for 1928.

Counties.	Rye-grass and other Rotation Grasses and Clover.				Permanent Grass.			
	For Hay.		Not for Hay.		For Hay.		Not for Hay.	
	1929.	1928.	1929.	1928.	1929.	1928.	1929.	1928.
	Acres.	*Acres.*	*Acres.*	*Acres.*	*Acres.*	*Acres.*	*Acres.*	*Acres.*
ABERDEEN	51,387	50,719	243,982	245,162	1,755	1,520	48,242	47,136
ANGUS	23,425	21,950	60,435	61,972	1,406	1,023	28,991	28,475
ARGYLL	11,592	11,928	15,610	15,785	14,964	15,714	50,864	52,059
AYR . .	26,697	26,508	45,942	47,563	22,190	22,799	157,469	157,351
BANFF	10,425	10,406	61,814	61,320	356	547	12,169	11,835
BERWICK .	12,221	11,536	52,026	52,727	2,548	3,020	61,235	59,869
BUTE	2,264	2,413	6,103	5,457	501	580	9,479	9,767
CAITHNESS ..	9,908	10,353	31,008	29,998	728	1,058	23,128	23,181
CLACKMANNAN	1,212	1,161	1,418	1,361	1,305	1,379	6,768	6,564
DUMBARTON .	5,015	4,986	5,018	5,162	2,502	2,555	22,290	22,157
DUMFRIES ...	20,228	20,505	49,269	47,710	19,493	19,484	101,994	101,885
EAST LOTHIAN	9,129	8,726	16,655	17,834	1,484	1,563	26,018	24,751
FIFE	25,645	25,263	29,053	30,356	5,060	4,053	74,386	73,591
INVERNESS .	11,918	11,131	23,280	21,739	8,715	9,640	55,960	59,749
KINCARDINE ..	13,054	12,618	35,684	35,739	291	468	11,448	11,050
KINROSS .	2,917	2,864	7,882	8,025	538	643	12,297	12,316
KIRCUDBRIGHT	11,170	10,647	40,619	41,072	14,375	13,075	84,595	84,961
LANARK ...	30,345	29,720	33,519	34,960	13,621	14,774	107,042	104,884
MIDLOTHIAN ...	10,810	11,226	16,692	17,640	1,898	1,527	42,631	41,593
MORAY	5,856	5,713	35,046	35,418	394	118	8,012	7,846
NAIRN	1,646	1,617	9,236	9,453	96	108	2,025	1,774
ORKNEY ...	11,316	10,920	31,475	31,418	1,294	966	15,094	14,774
PEEBLES ..	2,389	2,474	9,597	10,223	1,474	1,364	28,730	27,972
PERTH	32,880	31,996	58,972	61,018	11,787	11,838	97,988	94,549
RENFREW ...	8,210	7,943	6,362	7,215	6,413	6,103	43,778	43,517
ROSS AND CROMARTY ...	12,935	13,166	35,276	35,179	3,328	2,878	26,076	26,292
ROXBURGH ...	10,459	10,262	48,527	51,851	7,928	6,243	61,443	57,968
SELKIRK ...	1,535	1,409	7,237	7,239	1,989	1,984	14,034	13,489
SHETLAND ...	1,562	1,527	528	471	2,002	2,094	11,815	11,213
STIRLING ...	10,696	10,011	9,814	9,734	8,389	9,059	54,152	53,703
SUTHERLAND ...	4,553	4,612	6,219	6,120	1,607	1,550	7,763	7,985
WEST LOTHIAN	6,478	6,373	4,892	5,052	1,355	1,068	21,857	22,377
WIGTOWN ...	8,445	8,070	52,224	53,540	6,082	5,505	49,869	49,099
TOTAL ...	408,322	400,753	1,091,414	1,105,516	167,868	166,300	1,379,642	1,365,732

NUMBER of HORSES, CATTLE, SHEEP and PIGS in each COUNTY on 4th June 1929, with COMPARISON for 1928.

COUNTIES.	Horses.*		Cattle.		Sheep.		Pigs.	
	1929.	1928.	1929.†	1928.†	1929.†	1928.†	1929.	1928.
	No.	No.	No.	No.	No.	No.	No.	No.
†ABERDEEN ...	22,652	23,070	181,770	175,198	343,695	326,989	17,508	22,588
†ANGUS	7,678	7,934	50,100	46,341	194,757	196,788	6,093	8,414
†ARGYLL ...	4,325	4,380	54,483	56,073	733,233	747,666	3,058	4,525
AYR	7,112	7,150	111,154	110,328	388,644	399,236	9,443	13,896
†BANFF	6,663	6,662	43,661	42,550	95,601	94,314	4,740	6,681
BERWICK ...	3,734	3,865	25,451	24,893	391,566	382,351	3,744	5,260
BUTE	964	986	8,822	8,787	42,623	43,149	494	747
†CAITHNESS ...	4,421	4,413	20,535	20,104	187,697	176,768	1,313	2,147
CLACKMANNAN	474	488	4,005	3,507	12,833	13,750	318	756
†DUMBARTON ...	1,290	1,389	12,732	13,342	67,696	71,012	695	1,132
DUMFRIES ...	5,355	5,424	68,999	70,018	575,774	591,050	8,424	12,623
EAST LOTHIAN	2,896	3,097	15,485	13,907	159,302	157,348	4,220	5,794
FIFE	7,322	7,471	46,495	44,765	134,587	132,670	5,152	8,172
†INVERNESS ...	6,363	6,798	47,892	48,846	511,019	515,771	1,514	2,236
†KINCARDINE ...	3,817	3,925	27,573	26,457	62,890	65,106	2,379	3,440
KINROSS ...	878	898	5,711	6,044	33,084	33,821	607	1,036
†KIRKCUDBRIGHT	3,694	3,831	58,708	59,130	387,662	392,564	11,023	13,926
LANARK ...	5,981	6,128	70,175	70,047	236,717	246,358	7,269	10,084
MIDLOTHIAN ...	2,847	2,896	17,876	16,612	190,167	190,864	13,400	15,316
MORAY	3,872	3,935	25,253	23,878	50,943	52,965	3,313	4,741
NAIRN	1,063	1,055	7,180	6,933	13,654	12,755	627	849
ORKNEY ...	5,306	5,387	35,306	33,649	54,507	49,404	1,694	2,668
PEEBLES ...	717	747	7,194	6,919	211,985	214,214	825	1,187
†PERTH	9,739	10,189	69,721	69,137	654,502	654,304	7,605	10,688
RENFREW ..	2,049	2,118	24,021	24,396	43,565	46,574	3,609	4,564
†ROSS AND CROMARTY ...	5,722	5,613	39,411	38,383	325,875	323,313	2,563	4,088
ROXBURGH ...	3,199	3,303	24,890	25,359	587,367	584,336	2,785	4,178
SELKIRK ...	503	486	4,005	4,022	193,346	194,075	345	589
SHETLAND ...	2,114	2,411	11,440	11,376	165,728	163,823	155	298
STIRLING ...	3,179	3,336	32,274	33,314	121,095	124,965	1,963	3,288
†SUTHERLAND ...	1,768	1,847	9,246	9,549	226,026	218,266	500	669
WEST LOTHIAN	1,709	1,768	11,855	11,065	22,790	23,876	1,507	2,583
WIGTOWN ...	4,414	4,448	59,522	58,919	134,590	138,259	13,332	16,401
TOTAL ...	143,820	147,448	1,232,945	1,213,848	7,555,520	7,578,704	142,217	195,504

* 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. 112.

† 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 1929.

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.
ABERDEEN	Aberdeen	..	2,879	18,209	1,864	9,272	1	7,342	25,958	160	4,809	2,618	21,115	18,576	4,667
	Alford	..	369	15,627	304	7,305	..	5,027	22,039	363	6,458	2,018	15,322	53,070	736
	Deer	8	1,217	40,464	2,211	15,916	..	12,475	49,468	496	9,403	5,033	41,641	55,270	3,789
	Deeside	2	889	14,718	526	6,755	..	5,788	18,354	168	6,249	2,021	15,073	57,451	1,134
	Ellon	..	1,062	26,498	948	11,610	..	7,673	37,961	220	5,371	2,896	27,306	51,257	2,021
	Garioch	..	1,318	22,970	678	10,202	1	5,762	31,277	107	6,630	3,003	23,995	27,596	1,583
	Huntly	..	457	14,016	362	5,697	.	2,501	22,938	198	6,610	1,847	12,244	47,496	1,027
	Turriff	..	1,389	26,579	866	10,549	..	4,819	35,987	48	3,212	3,217	24,474	32,979	2,561
ANGUS	Arbroath	2,715	3,876	10,396	4,491	6,032	2	4,335	10,120	360	3,789	1,614	9,544	8,517	1,124
	Brechin	2,570	8,638	18,464	4,510	9,061	14	7,259	19,957	395	7,572	2,245	15,179	74,080	1,608
	Dundee	3,046	1,352	10,142	4,824	5,506	6	4,733	10,689	323	3,814	1,535	10,068	20,470	1,607
	Forfar	2,406	2,101	17,793	5,557	8,146	31	6,598	19,669	328	13,816	2,284	15,319	91,690	1,759
ARGYLL	Ardnamurchan	..	..	412	199	47	..	488	128	1,144	1,399	158	3,389	63,612	31
	Cowal	..	..	1,183	201	390	..	1,055	819	1,458	6,888	296	4,005	129,607	140
	Islay	..	11	3,567	513	1,137	..	2,794	2,642	1,642	14,871	868	9,902	70,787	430
	Kintyre	..	223	4,409	369	1,958	..	1,751	9,537	1,389	11,583	1,094	13,883	127,919	1,708
	Lorn	..	3	1,795	545	481	..	2,429	967	3,997	6,060	633	8,768	168,253	272
	Mid-Argyll	..	..	1,585	310	419		1,589	1,079	2,564	6,809	487	6,712	101,091	266
	Mull	..	534	1,866	495	212		1,486	438	2,770	3,814	789	7,824	71,964	211
AYR	Ayr	112	7	9,360	1,737	1,726	..	7,340	12,960	6,399	41,547	1,765	29,099	112,667	2,699
	Carrick	34	13	8,459	3,422	2,665	1	5,293	11,984	3,867	35,408	1,838	24,100	196,446	2,951
	Kilmarnock	304	1	8,949	1,193	1,115	..	7,428	10,979	6,583	42,873	1,778	31,511	35,210	2,664
	Northern	224	..	9,066	2,322	1,221	.	6,636	10,019	5,341	38,141	1,736	26,444	44,321	1,129
BANFF	Banff	..	5,615	25,545	1,404	11,478	5	5,996	35,372	65	2,652	3,923	27,765	31,721	3.492
	Keith	..	553	18,865	487	7,197	..	4,429	26,492	291	9,517	2,740	15,896	63,880	1,248
BERWICK	Eastern	523	3,710	8,306	1,047	6,138	20	3,960	14,766	655	19,983	1,251	8,795	107,009	1,250
	Middle	984	5,506	9,091	903	7,017	4	5,418	15,436	728	21,670	1,499	9,606	135,148	1,771
	Western	97	1,121	8,749	365	5,311	6	2,843	21,824	1,165	19,582	984	7,050	149,409	723
BUTE	Arran	..	4	2,051	592	408	.	1,106	2,499	270	4,466	510	4,008	32,246	226
	Bute and Cumbrae	3	2	2,189	388	802	.	1,158	3,604	231	5,013	454	4,514	10,377	262
CAITHNESS (not divided)		..	455	26,677	1,082	10,243	.	9,908	31,008	728	23,128	4,421	20,535	187,697	1,313
CLACKMANNAN (not divided)		162	88	2,657	372	704	.	1,212	1418	1,305	6,768	474	4,005	12,833	318
DUMBARTON	Eastern	244	..	3,152	1,088	596	.	2,617	2,223	1,311	9,817	654	5,654	12,723	518
	Western	70	..	3,024	1,021	715		2,398	2,795	1,191	12,473	636	7,078	54,973	177

* See Note on p. 116.

† Including Stock grazed on Deer Forests.

ACREAGE of CROPS and NUMBER of LIVE STOCK in each COUNTY DISTRICT of SCOTLAND on 4th June 1929.

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.
DUMFRIES	Annan	..	..	10,971	979	4,548	.	6,010	18,153	2,999	18.670	1,591	16,024	55,121	1,839
	Dumfries	17	17	8,034	1,042	3,173	..	4,380	11,934	2,105	15,780	1,155	14,133	60,296	2,532
	Langholm	..	..	2,111	141	953	..	1,352	3,390	3,108	8,320	410	5,004	125,577	308
	Lockerbie	..	17	7,293	529	3,098	.	4,697	13,679	6,268	25,080	1,281	18.168	146,266	1,257
	Thornhill	3	5	5,098	375	2,040	.	3,789	7,113	5,013	34,144	918	15,670	188,514	2,488
EAST LOTHIAN	Eastern	1,267	4,967	4,716	3,584	4,361	13	3,147	6,578	575	10,213	1,089	5,325	75,420	788
	Western	3,469	6,978	10,370	4,889	7,453	41	5,982	10,077	909	15,805	1,807	10,160	83,882	3,432
FIFE	Cupar . ..	3,713	3,302	14,113	6,073	7,157	125	7,478	12,399	1,247	16,189	2,159	12,624	50,328	1,499
	Dunfermline	1,040	396	7,291	1,804	2,418	7	4,303	3,019	1,175	23.242	1,170	9,126	26,676	973
	Kirkcaldy	2,287	1.744	9,593	3.485	3,977	78	6,071	5,655	991	15,692	1,735	10,761	23.263	1,402
	St. Andrews	4,197	4,450	11,720	5,514	6,550	169	7,793	7,980	1,647	19,263	2,258	13,984	34,320	1,278
INVERNESS	Inverness	19	1,347	6,846	419	3,949	..	3,083	11,432	136	4,481	1,239	7,375	40,719	836
	Aird	14	37	5,268	436	2,361	.	2,786	6,003	348	5,556	867	6,041	41,114	391
	Badenoch	..	24	3,524	146	1,475	..	2,033	4,221	989	10,452	651	4,567	97,357	154
	Lochaber	..	5	945	387	191	.	1,220	274	2,037	2,875	327	5,084	139,940	105
	Skye	..	2	5,079	1,370	369	..	2,073	836	3,474	5,276	925	10,733	124,967	7
	Harris, N. & S. Uist ..	.	2,135	8,053	2,097	127	..	723	514	1,731	27,820	2,354	14,092	66,922	21
KINCARDINE	Laurencekirk	251	873	9,800	1,441	4,030	3	3,318	9,476	86	3,032	968	6,784	21,537	693
	Lower Deeside	..	544	3,613	775	1,709		1,913	3,982	16	670	533	3,463	2,121	632
	St Cyrus	509	1,213	6,001	873	2,888	.	2,563	6,182	38	2,346	713	4,342	13,546	326
	Stonehaven	108	1,722	8,155	815	4,011	..	3,658	10,162	97	3,713	1,009	8,610	17,847	497
	Upper Deeside .. .	.	1,006	3,805	250	2,017		1,602	5,881	54	1,687	594	4,374	7,839	231
KINROSS (not divided)		194	110	6,224	1,193	2,159		2,917	7,882	538	12,297	878	5,711	33,084	607
KIRKCUDBRIGHT	Eastern	5	24	7,822	952	3,287	..	4,704	13,900	4,459	27,748	1,396	20,702	75,037	3,869
	Northern	..	..	1,475	108	617	.	923	3,424	2,863	10,296	406	5.337	143,302	642
	Southern	13	2	8,201	236	2,765	.	4,549	20,790	5,230	35,589	1,572	27,002	86,252	6,125
	Western	..	1	1,760	71	679	..	994	2,505	1,823	10,962	320	5,667	83,071	387
LANARK	Lower Ward	653	8	3,488	1,877	551	..	2,587	1.319	2.463	6,836	647	4,599	1,270	4,236
	Middle Ward . ..	1,058	18	15,022	2,458	3,040	.	16,113	11,015	7,071	52,744	2,841	35,944	32,815	1,992
	Upper Ward	39	15	15,823	2,287	5,339	..	11,645	21,185	4,087	47,462	2,493	29,632	202,632	1.041
MIDLOTHIAN	Calder	1,393	340	5,666	1,751	1.683	..	3,562	1,671	560	13,875	788	5,552	38,729	3,302
	Gala-Water	250	905	4,842	435	3,277	.	1,761	10,703	376	15,399	589	4,383	103,831	406
	Lasswade	1,402	1,363	5,798	2,123	2,922	10	3,392	4,074	633	9,368	884	5,015	40,183	1,960
	Suburban	1,732	368	3,053	2,177	1,037	1	2,095	244	329	3,989	586	2,976	7,424	7,732
MORAY (not divided)		661	7,785	24,009	1,704	12,774	11	5,856	35,046	394	8,012	3,872	25,253	50,943	3,313
NAIRN (not divided)		..	1,705	6,508	259	3,578	.	1,646	9,236	96	2,025	1,063	7,180	13,654	627

* See Note on p. 116.

† Including stock grazed on Deer Forests.

Acreage of Crops and Number of Live Stock in each County District of Scotland on 4th June 1929.

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	..	1,001	16,646	1,182	6,287	..	6,311	17,410	963	7,831	2,905	18,723	24,301	854
	North Isles	..	2,109	9,261	687	4,435	..	3,394	10,240	254	5,849	1,715	12,075	22,531	639
	S. Ronaldshay & Walls	..	287	4,499	308	1,735	..	1,611	3,825	77	1,414	686	4,508	7,675	201
Peebles (not divided)		2	33	5,353	358	2,467	..	2,389	9,597	1,474	28,730	717	7,194	211,985	825
Perth	Blairgowrie	2,319	616	14,893	5,740	5,836	13	7,028	14,993	462	14,369	2,078	13,898	60,995	2,008
	Central	443	134	13,928	3,420	4,344	..	7,067	13,944	1,582	19,225	2,062	13,513	130,871	1,475
	Highland	6	33	5,945	745	2,326	..	4,450	5,938	2,535	15,028	1,117	8,799	204,614	1,102
	Perth	3,770	769	19,967	6,631	7,685	21	9,444	16,654	1,867	29,763	2,811	21,025	70,000	2,550
	Western	262	99	9,072	1,763	1,986	..	4,891	7,443	5,341	19,598	1,671	12,486	188,022	475
Renfrew	First or Upper	795	..	3,713	1,129	816	..	3,762	1,939	4,010	22,772	931	11,485	20,009	2,170
	Second or Lower	591	..	5,113	2,093	1,042	..	4,448	4,423	2,493	21,006	1,118	12,536	23,556	1,439
Ross & Cromarty	Black Isle	49	1,915	6,561	798	3,872	..	3,223	9,565	170	2,068	1,160	6,536	15,871	689
	Easter Ross	457	1,003	9,305	1,803	4,912	..	3,918	14,149	240	6,757	1,551	9,962	80,521	1,264
	Mid Ross	29	563	8,737	710	3,852	.	4,023	10,946	454	7,184	1,476	9,338	82,083	557
	S.-W. and Western	..	12	1,742	585	172	.	1.422	380	1,557	2,574	322	4,269	72,313	42
	Lewis	..	1,993	5,828	3,280	379	.	349	236	907	7,493	1,213	9,306	75,087	11
Roxburgh	Hawick & Liddesdale	2	15	2,634	149	1,620	.	1,400	5,565	3,643	12,190	497	5,846	185,453	340
	Jedburgh	78	1,044	6,637	236	4,340	.	3,133	15,423	2,514	18,923	994	7,039	168,918	624
	Kelso	667	4,220	7,815	658	6.191	4	3,870	17,555	807	14,830	1,124	7,820	154,898	1,289
	Melrose	57	631	4,896	175	2,947	..	2,056	9,984	964	15,500	584	4,185	78,103	532
Selkirk (not divided)		.	141	3,103	135	1,734	..	1,535	7,237	1,989	14,034	503	4,005	193,346	345
Shetland	Mainland	..	509	4,883	1,577	854	..	1,190	411	1,421	8,353	1,398	8,770	126,499	136
	North Isles	.	7	1,069	389	127	..	372	117	581	3,462	716	2.670	39,229	19
Stirling	Central	526	55	6,748	1,385	1,446	..	3,584	3,721	4,904	18,455	1,344	12,763	42,960	785
	Eastern	482	249	5,619	841	1,048	..	3,839	2,735	1,919	16,537	1,011	9,043	6,496	635
	Western	83	10	4,147	1,066	953	..	3,273	3,358	1,566	19,160	824	10,468	71,639	543
Sutherland (not divided)		..	199	6,794	1,023	2,465	..	4,553	6,219	1,607	7,763	1.768	9,246	226,026	500
West Lothian	Bathgate	254	95	4,919	692	1,185		3,231	2,610	875	12,629	847	6,321	9,452	284
	Linlithgow	2,054	938	5,266	1,897	1.833	..	3,247	2,282	480	9,228	862	5,534	13,332	1,223
Wigtown	Machars	..	43	9,040	315	3,770	23	5,088	19,212	4,438	32,783	1,963	27,525	74,796	3,255
	Rhins	..	5	15,406	1,259	6,965	3	3,357	33,012	1,644	17,086	2,451	31,997	59,792	10,077

* See Note on p. 116.

† Including stock grazed on Deer Forests.

Department of Agriculture for Scotland,
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RECLAMATION AND CULTIVATION OF PEAT LAND IN LEWIS.

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Undeveloped Land in Scotland. — The reclamation or improvement of the great area of uncultivated land in Scotland is a problem of national importance. More than half the land surface of the country consists of mountain and heath land used for grazing and the total area of arable land amounts to about 3¼ million acres, which is less than one-sixth of the total land surface. There are also about 1½ million acres of permanent grass.

Most of the mountain and heath land can be divided into three main groups :—

1. Mineral soil on steep slopes—usually shallow and often stony or rocky;
2. Heath land with a thin covering of acid peat;
3. Moorland with acid peat varying in thickness from a foot to 20 feet or more.

In addition there are small areas of "downwash" material in hollows and at the bottoms of slopes; alluvial stretches along streams and patches of slightly acid or even alkaline peat, sometimes fairly pure and sometimes with a considerable admixture of mineral material; and also throughout the country considerable areas of swampy mineral soil which are uncultivated because of lack of drainage.

The grazing value of much of the land classed as "mountain and heath" is extremely low. In the case of the mineral soils this may be attributed largely to the high rainfall, which tends to leach out the plant nutrients and to leave the soils in a very acid condition. In the heath and moorland types the surface consists of peat of varying thickness, but all are extremely acid and very deficient in lime, phosphate, potash, and even in available nitrogen. Drainage is also a matter of the greatest importance in peat land and, unless there is a satisfactory system of drainage, improvements in other directions are practically impossible. Recent methods of reclamation and improvement of peat land have been discussed in a previous contribution.[1]

The problem of land improvement in Lewis.—In the island of Lewis some of the conditions already described are seen at their worst. The island has a total area of 683 square miles, of which 18½ square miles or 2·7 per cent. is arable, and there is a rural population of about 24,000. The surface of Lewis is rather featureless, except for the hilly parish of Uig in the south-west and part of Lochs parish in the south-east, and the greater part of the island has an altitude of less than 300 feet. The climate is mild and humid and the annual rainfall is about 50 inches. There is not much frost or snow, but the amount of sunshine is low and gales are frequent.

Most of the arable land is situated along the coast in stretches one to two miles wide and as a rule is either light sandy soil, which is frequently calcareous, or loamy soil of moorland type derived chiefly from "skinned land," i.e. land from which a former layer of peat has been removed more or less completely for fuel. Apart from small areas of rocky mineral soil in the hilly regions, the remainder of the island consists of moorland, heathland, and considerable areas of uncultivated skinned land. The peat of the heath and moorland varies in thickness from a few inches to 15 feet or more, and in consistency from very soft wet bogs to fairly dry firm peat. The surface is smooth in places and extremely eroded in others and the vegetation consists of Heather (chiefly *Calluna vulgaris*), Deer's-hair grass (*Scirpus cæspitosus*), Cotton grass (*Eriophorum vaginatum*), Matgrass (*Nardus stricta*), Blaeberry (*Vaccinium Myrtillus*), Crossleaved heath (*Erica Tetralix*), Bog Asphodel (*Narthecium ossifragum*), Cinquefoil (*Potentilla reptans*), various mosses (*Rhacomitrium*, *Sphagnum*, *Polytrichum sp.*), &c. The surface layer of the peat is frequently brown, fibrous and undecomposed, and remains of trees are often found buried in the peat, although at the present time the island is practically treeless. Botanical descriptions of the peat have been given by F. J. Lewis.[2]

The vegetation is sparse and affords poor grazing for the "Black-faced" sheep kept by the crofters. Along the sides of the numerous lakes and streams on the island, however, the peat is often silty and bears much better pasture. The skinned land, apart from small cultivated areas round the crofts, is in an extremely unsatisfactory condition. Peat cutting appears to be more or less unregulated; in some places the peat is completely removed right down to the rock or boulder clay, while in other places banks of peat are left here and there in a haphazard fashion. Much of the skinned land is therefore useless as pasture at the present time, and will be very difficult to reclaim

[1] Reclamation of Peat Land in Northern Europe, W. G. Ogg. *Scottish Journal of Agriculture*, xii (1929).

[2] The Plant Remains in the Scottish Peat Mosses, Trans. Roy. Soc. Edin., xlvi, i, 45 (1907).

on account of the irregular condition of the surface. There is urgent need for peat-cutting regulations such as have been adopted in most of the northern countries of Europe.

Agricultural conditions in the island are in a very backward state. The farming community is composed almost entirely of crofters who cultivate two to five acres of land and share a stretch of moorland as common grazing. The small arable patches are sometimes quite well farmed, but largely by hand labour, and in many cases even the arable land is unfenced. Some attempt is made at regulating the number of sheep allowed on the common grazing, but little or no effort has been made by the crofters to improve it or to increase the area under cultivation. This may be due partly to the Crofters' Act, which, while giving security of tenure, has tended to continue conditions exactly as they were at the time the Act was passed.

Experiments in reclamation were made many years ago by Sir James Matheson, and stretches of land which were drained and improved by him are to be found at Lochganvich. This land has reverted to a great extent, but is still somewhat drier and better pasture than the adjoining moor.

In recent years attempts at reclamation were made by Lord Leverhulme on deep peat at Arnish Moor and on a shallow moor at Gress. An account of these experiments has been given in this Journal by Mr. D. H. Thompson,[1] who was in charge of the work. At Arnish an area of five acres was drained by means of turf drains. Small plots were cultivated by spade and dressed with basic slag in one part and superphosphate in another; half of the number of plots was sown with rye and winter vetches and half with rape and rye. The experiment was given up before it was shown whether or not it was likely to prove successful.

The whole question of the improvement of the Lewis moorland has been reopened by Mr. T. B. Macaulay of Montreal, whose ancestors came from Lewis, and who desires to improve the conditions of the rural population of the island. Mr. Macaulay has generously provided the means for the establishment of a Soil Research Institute at Aberdeen and a Demonstration Farm in the island of Lewis, besides encouraging better farming of the existing arable land by offering prizes for the best farmed crofts and in various other ways.

Site of the Demonstration Farm and nature of the peat.—The farm has been established at Arnish Moor, where the Leverhulme experiment was commenced. The moor adjoins a main road and is three miles south of Stornoway. It is about 100 feet above sea level and is typical of much of the peat land in Lewis. An area of 147 acres was acquired consisting partly of shallow peat of the heath type and partly of very wet moorland with deep peat. A small stream separates these types and along its sides the peat is silty. The surface layers are brownish in colour and very tough, fibrous and undecomposed. The natural vegetation,

[1] Reclamation of Peat Moss on the Island of Lewis, *Scottish Journal of Agriculture*, iv, 199 (1921).

consisting of sedges, cotton grass, heather, &c., is very sparse and its grazing value negligible.

A representative sample taken from various spots in the deep peat area to a depth of one foot gave the following analysis :—

Moisture (wet sample)	89·70	per cent.
Moisture (air dried)	13·31	,,
Ash in wet sample	0·27	,,
Nitrogen in wet sample	0·15	,,
Phosphoric acid (P_2O_5) in wet sample	0·01	,,
Potash (K_2O) in wet sample	0·01	,,
Lime (CaO) in wet sample	0·04	,,
pH	4·20	

From tests made in various parts of the island, it appears that the peat is mostly strongly acid, the pH ranging from 4 to 5 in uncultivated land, and from 5 to the neutral figure 7 in cultivated land.

The peat from the new demonstration farm is strongly acid and contains a very small amount of lime, phosphoric acid and potash.

Pot Experiments.—A series of tests by Mitscherlich's method [1] were carried out on peat from the farm in order to obtain an estimate of the manurial requirements. In this method oats are grown in pots; one set of pots receives a complete dressing of artificials, and in other three sets nitrogen, phosphate and potash are omitted in turn. The detailed results will be published elsewhere, but some idea of the differences obtained is conveyed by the accompanying photographs (Figs. 3 and 4). They show that without the addition of phosphate, nitrogen and potash, growth is very poor. According to the chemical analysis a considerable amount of nitrogen is present, but very little appears to be available to plants. The most striking result was obtained by omitting phosphate; this reduced the yield by eleven-twelfths, and the resultant growth was no better than in the unmanured peat. The omission of nitrogen reduced the yield by two-thirds and the omission of potash almost as much.

Experiments with different kinds of phosphates showed that superphosphate or basic slag gave by far the best results—at any rate in the first year. The application of shell sand without fertilisers produced an increased but very small yield, and ground lime gave no increase over the untreated pots. Neither shell sand nor ground lime gave any increase in the pots which received a full dressing of artificials. It must be borne in mind, however, that the plants grown were oats and that the artificials included an abnormally heavy dressing of superphosphate, so that even without applying lime there would be no lack of available calcium. This must not be taken to mean that liming is unnecessary under field conditions even for oats.

[1] For description of the method see The Manurial Requirements of Soils, R. Stewart, *Scottish Journal of Agriculture*, xii, 3 (1929).

A field test on the same lines was carried out in quadruplicate on virgin peat. The plots each measured 1 yard by 7 yards and the crop was oats. No weighings were done, as the plots were damaged by rabbits, but from observation it was quite clear that in the absence of phosphate, nitrogen, potash and lime had no effect. Nitrogen appeared to be next in importance and then potash. These plots confirmed in a striking manner the results obtained from the pot experiments.

Draining.—This was commenced on 4th January 1929 and was carried out under the supervision of Mr. W. G. Coles, formerly Chief Surveyor of the Department of Agriculture for Scotland. The stream running through the farm was cleaned and deepened and an area of about 50 to 60 acres of the somewhat sloping ground drained by means of parallel leaders 100 yards apart, into which run secondary drains in herring-bone fashion 22 yards apart. Instead of tiles, creosoted wooden boxes 6 feet long, 4 inches wide and 4 inches deep were laid in the secondary drains. The main drains have been left open, but the secondary drains had to be filled in in order to allow cultivation to be carried out. The drains are not running very freely, but improvement should be seen as the peat decomposes under cultivation. It is too early yet to judge whether this system of draining is satisfactory or whether modifications and additional drains will be required. The portion already drained includes a considerable area of shallow peat with a good slope, but much of the undrained portion is flatter and consists of deeper peat. Various systems will be tried on other parts of the farm.

Liming.—There are no limestone deposits on the island, but extensive deposits of shell sand are found at various places along the coast. Arrangements were made for this material, which contains from 40 per cent. to 50 per cent. of calcium carbonate, to be delivered at the farm at 6*s*. per ton, and a dressing of 8 tons per acre was applied to 19 acres. Smaller areas were treated with various amounts of shell sand, ground lime, and mixtures of shell sand and ground lime, and an area was left untreated.

On account of the softness of the ground considerable difficulty was experienced in applying the lime, but this was eventually overcome by loading the lime on a sledge drawn by a wide-wheeled tractor.

Cultivation.—The softness of the ground made it impossible to use horses, and, owing to the uneven nature of the surface and the tough fibrous character of the peat, ordinary implements were not satisfactory. Two implements specially designed for peat work were therefore purchased on the Continent—a "Bulldog" tractor fitted with very wide wheels, made by Lanz of Mannheim, and a Lanz Fräse or moor cultivator. The latter was purchased from the Swedish Peat Society and had been used in the development of that society's new experimental farm at Gisselås. It works on the rotary plough principle, weighs 6 tons, and is drawn by an 80 H.P. petrol engine. The wheels are fitted with broad drum-shaped attachments which prevent the machine from sinking, and cultivation is carried out by means of a rapidly revolving horizontal cylinder studded with bent steel knives.

Cultivation had previously been attempted by means of a plough drawn by the Lanz tractor, but without much success. The moor cultivator, however, was used successfully, but it too, notwithstanding its wide wheels, frequently sank in the soft peat. As the summer of 1929 was very wet and the draining had scarcely been completed when cultivation was attempted, conditions could not be regarded as favourable or even normal; but despite these conditions and numerous delays caused by mechanical troubles with the second-hand cultivator, 25 acres received a single cultivation to a depth of 8 inches during June and July. Owing to softness of the ground and the occurrence of numerous very soft boggy spots, it was impossible to give the usual second cultivation to a depth of 16 inches. The very wet autumn rendered the cultivation of further areas out of the question, and this was postponed until 1930.

Buildings and fencing. — The primary object of the Macaulay farm is to ascertain the possibilities of peatland reclamation in Lewis and to demonstrate the latest methods of peatland farming. It is also intended to encourage vegetable growing, better methods of milk production, and to be used as a centre to test the breeds of cattle, pigs and poultry most suitable for the island.

The buildings erected on the farm consist of a dwelling-house for the grieve or manager, a large corrugated iron machinery shed, a modern byre for twelve cows, a dairy with all the necessary equipment for the production of certified milk, and a stable for two horses. The byre windows are glazed with vita glass and an electric lighting plant has been installed. These houses were built on a rocky outcrop beside the Stornoway road, and a belt of trees has been planted for some distance along the roadside. A stout fence has been erected round the farm, but the various fields have not yet been fenced off.

Preliminary Experiments.—A comprehensive scheme of experiments was drawn up and it was intended to lay down considerable areas in oats, potatoes, pasture and mashlum in 1929. Owing to the wetness of the ground and the lack of cultivating machinery the programme had to be very much curtailed, but small areas of potatoes, oats, mashlum, turnips and vegetables were laid down, and in July nearly 8 acres were sown out with rye and grass seeds. Much of the work had to done by hand, and it was not possible to give constant close supervision. The idea of properly replicated experiments had, therefore, to be abandoned for the first year, and plots were laid out for demonstration purposes and for the purpose of obtaining some indication as to the suitability of certain crops and manures. Where possible, the yields were weighed, but too much stress must not be laid on the results from trials of this kind.

The weather during 1929 was distinctly abnormal. The first four months of the year were very dry and sunny with a rainfall of 6·06 ins., compared with an average of about 16 inches for that period. The summer and autumn, however, were exceptionally wet, and there were only eight dry days during the months of August and September. Conditions were, therefore, very unfavourable for working peatland and for ripening crops.

Potato tests.—Two series of experiments were carried out on potatoes.

I. In the first the area, slightly less than two-thirds of an acre and consisting chiefly of old peat banks which had been filled in with peat turf, was in a very rough condition. The peat was broken up and levelled by hand labour, consolidated by means of the broad-wheeled tractor, and dressed with shell sand at the rate of 8 tons per acre. The following mixture of artificial manures was applied :—

$$\left.\begin{array}{l}10\tfrac{1}{2}\text{ cwt. superphosphate } (18\%\ P_2O_5)\\ 4\text{ cwt. sulphate of potash}\\ 3\text{ cwt. sulphate of ammonia}\end{array}\right\}\text{per acre.}$$

In addition to the above dressing, part of the area was treated with seaweed at the rate of 15 tons per acre.

Drills were made by spade and from 11th to 14th May the potatoes were dibbled in the drills. They appeared above ground on 13th June, and the first sample of the Great Scot variety was tried on 16th August and proved of satisfactory quality.

On account of the heavy autumn rains it was not considered advisable to leave the potatoes in the ground later than the month of September. They were not fully matured and the proportion of seed and chats was fairly large.

The results obtained were as follows :—

Variety and Manuring.	Cwt. per acre.		
	Ware.	Seed.	Chats.
Great Scot—with seaweed and artificials	87¼	21	26
Great Scot—with artificials only ...	87⅛	24	10
Kerr's Pink—with seaweed and artificials	81	16	15¾
Kerr's Pink—with artificials only	87½	21½	21½
Arran Consul—with seaweed and artificials	90¾	24	12
Arran Consul—with artificials only	81	18¾	8

The total yield over the whole area was at the rate of 6 tons per acre and the average yield of wares was 86 cwt. In view of the state of the ground at planting time—it was too soft for horse work—the difficulty of breaking up the peat by hand, the lateness of planting, and the fact that the crop was not mature at lifting time, the yield must be considered very satisfactory and has exceeded expectations. The seaweed did not produce any definite increase in yield.

The quality of the Great Scot and Kerr's Pink varieties was very good and they sold readily in the island for 7*s*. to 8*s*. per cwt. Arran Consul was rather soft and immature, but there was no difficulty in disposing of the crop.

II. Another potato test was carried out on an area where the peat was particularly wet, fibrous and undecomposed, and the vegetation chiefly Scirpus. Shell sand was applied at the rate of 8 tons per acre and the land was hand dug, but nothing approaching a good tilth was secured. Five plots each measuring one-twentieth acre were laid out; one of these plots was divided into two, one half receiving farmyard manure and the other half seaweed in addition to artificials. The remaining plots were designed to compare various forms of phosphates.

The following table gives the treatments and yields :—

$\frac{1}{20}$th acre Plots.	Manuring per acre.	Yield in lb.			Total Yield per acre.
		Ware.	Seed.	Chats.	
					cwt.
1 (*a*).	3 cwt. superphosphate ... ... 4 ,, ground mineral phosphate 1 ,, sulphate of ammonia ... 15 tons seaweed	112	32	56	55¾
1 (*b*).	Artificials do. ... ... 15 tons farmyard manure ...	45			31¾
2.	3 cwt. superphosphate ... ... 4 ,, ground mineral phosphate 3 ,, sulphate of ammonia ... 4 ,, sulphate of potash ...	133	30	25	33½
3.	10½ ,, basic slag (18 % P_2O_5) ... 3 ,, sulphate of ammonia ... 4 ,, sulphate of potash ...	110	22	27	28½
4.	5 ,, ground mineral phosphate 3 ,, sulphate of ammonia ... 4 ,, sulphate of potash ...	79	15	13	19⅛
5.	10½ ,, superphosphate ... ... 3 ,, sulphate of ammonia ... 4 ,, sulphate of potash ...	60	20	15	17

The potatoes were not planted until 20th May, and as the ground became water-logged during the late summer and early autumn, growth was seriously checked and the yields are much less than would otherwise have been the case. There was also considerable damage by rooks after planting, especially on the farmyard manure plot. Throughout the season, however, the plots which received seaweed and farmyard manure looked considerably better than the others, which indicates that organic manures are particularly useful on raw undecomposed peat.

Oats and Mashlum.—The peat received shell sand at the rate of 8 tons per acre and the following dressing of artificials :—

2 cwt. sulphate of ammonia
4 cwt. 30 per cent. potash salts
2 cwt. superphosphate (18 % P_2O_5)
3 cwt. ground mineral phosphate
per acre.

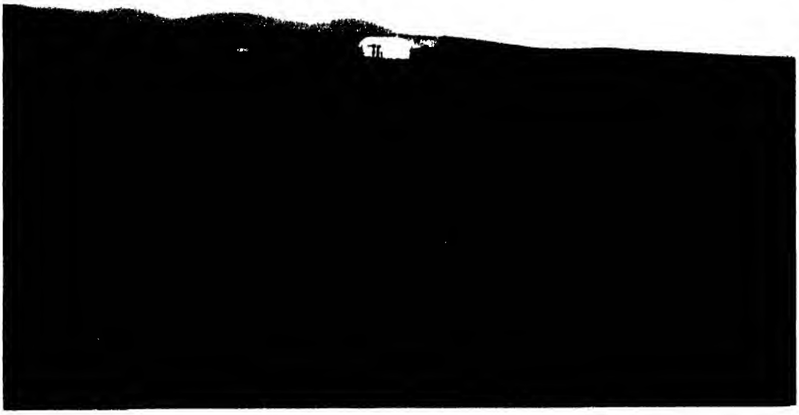

FIG. 1.
The Macaulay Demonstration Farm, shewing the buildings in the distance.

FIG. 2.
The Moor Cultivator.

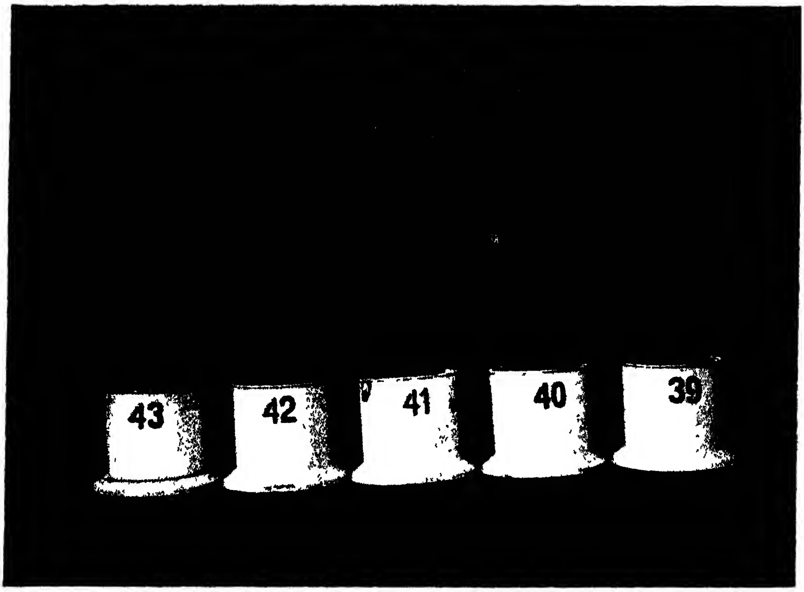

FIG. 3.

Mitscherlich Pot Experiments—

No. 39 untreated; 40 shell sand; 41 half shell sand half ground lime; 42 ground lime; 43 complete artificials, no lime.

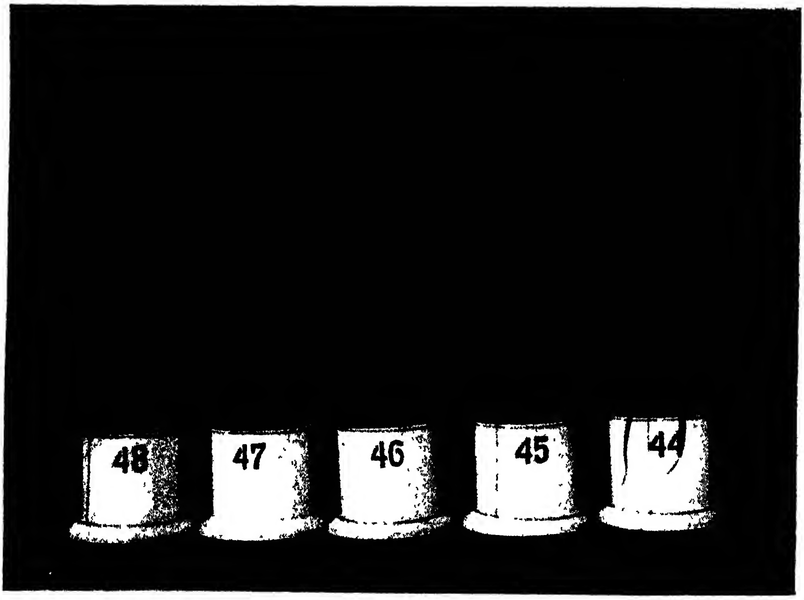

FIG. 4.

Mitscherlich Pot Experiments—

No. 44 complete artificials and ground lime; 45 complete artificials and shell sand; 46 like No. 45, but no nitrogen; 47 like No. 45, but no phosphate; 48 like No. 45, but no potash.

Four varieties of oats, viz. Sandy, Strigosa, Castleton Potato and Black Tartarian, were sown on 12th June on one-sixteenth acre plots. Owing to the lateness of sowing and to the difficulty of covering the seed properly in peat, rooks caused considerable damage and greatly thinned the seeding. Black Tartarian was a failure, although at first it appeared promising; Castleton Potato was thin owing to damage by rooks but gave a fair crop of straw; Strigosa gave a close, fairly good crop of straw; and Sandy gave the best result of all, probably owing to its good tillering properties. None of the varieties ripened.

Plots of Mashlum consisting of the following mixture were sown on various dates from 5th May. The manuring and liming were the same as on the oat plots.

3 bushels oats (Sandy).
2 bushels tares.
3 lb. alsike.
2 lb. broad-leaved red clover.
12 lb. Italian rye grass.

The plants germinated well and made promising progress at first, but most of the leguminous plants stopped growing or died out at an early stage. The oats made a good healthy growth, and the rye grass also made fair progress. The crop was cut green and fed to cattle.

There was great variation in growth in both the oat and the mashlum tests. The peat in this area contained numerous soft spots which became increasingly wet during the summer and autumn. The drains did not appear to affect these patches, which showed a very poor growth and gave the whole crop an uneven appearance.

An interesting point was noted in regard to cultivation. Certain parts were cultivated by the Lanz cultivator early in April when the ground was fairly dry, and a good tilth was obtained to a depth of 9 or 10 inches; other parts were cultivated by hand and the tilth on these places was poor. It was observed that, where the peat had been well cultivated by the machine, the crop was good and quite comparable with a cereal crop on good mineral soil.

Turnips, Vegetables, &c.—About one-twentieth of an acre was sown with Challenger and Balmoral Green-Top Yellow turnips. They received the same manuring and liming treatment as the cereals and both varieties gave a fair yield—approximately 8 tons per acre, and were entirely free from disease.

Carrots appeared to make a healthy growth and were free from pests, but were not more than 2 or 3 inches long and about 1 or 2 inches in diameter.

Marrow-stem kale gave a moderate crop. Growth was fairly close but the stems were somewhat thin. Cabbages were quite healthy but remained rather small.

It seems probable that the limiting factor in most of these crops was the depth of tillage. Roots did not appear to penetrate below the depth of cultivation, which was necessarily shallow, and development was arrested at an early stage. It is likely, however, that with better tilth and suitable manuring many crops could be grown successfully on Lewis peat.

Pasture.—Although it is realised that it would be advantageous to crop land of this kind for some time before laying it down to grass, it was necessary to provide pasture for the dairy herd as soon as possible. An area of 7¾ acres of the thin peat on the north side of the stream was therefore cultivated by the Lanz machine in July. Owing to the softness of the ground at the time of cultivation it was not possible to go over it a second time. Prior to cultivation the field was limed in strips, each strip being 150 feet wide and running from the top of the field to the small stream. Commencing with the strip nearest the steading, lime and sand were applied as follows :—

Plot	*Area.*	*Dressing.*
1.	1·15 acres.	4 tons shell sand per acre.
2.	1·15 ,,	4 tons shell sand per acre. 1 ton ground lime
3.	1·3 ,,	2 tons lime per acre.
4.	1·3 ,,	1 ton lime per acre.
5.	1·45 ,,	½ ton lime per acre.
6.	1·45 ,,	No lime.

The following dressing of artificial manures was applied over all the plots :—

2½ cwt. sulphate of ammonia.
5 ,, potash salts.
2 ,, superphosphate (18 % P_2O_5).
4 ,, ground mineral phosphate.

Five different mixtures of grass and clover seeds were sown on 18th July in strips parallel to the stream and across the limed plots, No. 1 mixture being at the top of the field and No. 5 adjoining the stream, and rye was sown as a nurse crop on 16th July.

The mixtures per acre were as follows :—

	I.	II.	III.	IV.	V.
White clover	5¼	1	...	...	...
Wild white	...	1	1	1	1
Red clover (L.F.)	1¾	3	...	...	2
Cornish marl	...	...	2	4	...
Dorset marl	...	...	2	...	...
Alsike	...	...	1	...	2
Bird's foot trefoil	...	1	1	...	2
Smooth stalked meadow grass	1¾	4	...	...	...
Rough stalked meadow grass	1¾	2	1½	...	2
Timothy	2½	5	5	5	8
Meadow fescue	5¼	3	...	6	...
Tall fescue	...	3	...	4	...
Perennial rye grass	13	8	12	4	8
Italian rye grass	1¾	3	4	4	5
Cocksfoot	1¾	6	8	6	6
Meadow foxtail	...	...	..	...	4

The rye made little progress, but the grasses and clovers germinated well and look clean and healthy. So far the various mixtures have not shown any noticeable differences. Clovers are still healthy and vigorous on the limed and sanded plots, but they are also to be seen on the unlimed plot. The clover seeds were inoculated before sowing and nodules are present on the roots.

Numerous wet patches have appeared during the winter and an attempt has been made to drain them by open ditches. The field as a whole looks promising.

American Cranberries, Rhododendrons, and Osiers.—Two varieties of American cranberries have been planted in a bed near the stream. Some of the cuttings were planted on a layer of sand 3 inches thick overlying the peat, and others were placed in the pure peat after the turf had been removed. The latter did not survive, but the plants on the sanded area appear to be thriving.

A bed of Dutch rhododendrons planted in early spring blossomed during the summer and made very satisfactory progress until the beginning of winter. Since then the severe gales have caused considerable damage, many of the plants having been stripped of their leaves and some uprooted. An osier bed has been laid out in a wet corner of the farm and at present appears to be in a satisfactory condition.

Experiment on skinned land.—Three main types of skinned land may be distinguished :—

> *Green type.*—This usually consists of boulder clay from which the overlying peat has been more or less completely removed. It is frequently very stony, but has a fairly uniform surface vegetation of sedges, marsh grasses, and occasionally a little heather. This green turf is often stripped off by crofters for a variety of purposes, and extremely stony, bare areas are left. When land of this type is cleared of stones it gives a brown loamy or gravelly soil.
>
> *Black type.*—As much as 2 feet of peat is sometimes left on this type. The vegetation consists chiefly of heather and bog plants, but bare patches are frequent. When drained and cultivated this type gives a dark peaty soil.
>
> *Stony type.*—Stones and rock outcrops are so abundant that cultivation is practically impossible, but the land might be improved for grazing.

An experiment on skinned land of the first type was laid down near the township of Sandwick. The area measured 28 by 38 yards and consisted of poor, hard, stony clay land with about 3 inches of peat on the surface. The herbage was extremely poor, and the object of the test was to compare various methods of improving it as pasture.

This area was divided into four equal plots running roughly north and south and these were cultivated as follows :—

Plot 1 was trenched to a depth of 12 inches, sown with oats, grass and clover seeds, harrowed and rolled.

Plot 2 was lightly dug, sown in the same way as plot 1, chain harrowed and rolled.

Plot 3 was roughly levelled, sown with grass and clover seeds, and chain harrowed.

Plot 4 was left in its original state, but the bare patches were sown with grass and clover seeds.

The area was sub-divided into thirteen strips running east and west across the four plots. These strips were manured with various mixtures of artificials with and without shell sand, lime, farmyard manure and seaweed, and two control plots were left untreated. It was thus possible to compare the effects of the various treatments on skinned land which had received different amounts of cultivation.

The oat yields from the different strips on plots 1 and 2 were weighed, but owing to the very wet condition of the crop at the time of harvesting and to the damage caused by rabbits on some of the best strips the figures obtained do not accurately represent the differences. It was found that plot 1, which was trenched, produced a much better crop than plot 2, which was lightly dug. On both plot 1 and plot 2 striking differences were observed between the manured and unmanured strips. On the control (untreated) strips, the seeds germinated but growth stopped at an early stage, and the plots which received shell sand or lime appeared, without artificials, to be equally poor. The manured plots receiving dung or seaweed in addition to moderate quantities of phosphate and nitrogen were much superior to those receiving heavy all-round dressings of artificials. Shell sand gave increased yields where applied in addition to artificials, while the plots receiving ground lime were more attractive to rabbits than any of the others.

Interesting differences were observed in the pasture on plots 3 and 4. Plot 3, which was roughly levelled, sown with grass and clover seeds and harrowed, was distinctly superior to plot 4, which received no cultivation. On the unmanured strips of these plots, however, growth was extremely poor, and, although fenced off, these strips were not appreciably different from the area outside the fence open to cattle and sheep. The strips which received shell sand were slightly better in growth and colour and contained some clover. The manured strips on both plots 3 and 4 showed a marked improvement, especially those treated with farmyard manure or seaweed with moderate additions of nitrogen and superphosphate or ground mineral phosphate.

Comparing plots 1 and 2 with 3 and 4 it was observed that the pasture on plots 1 and 2 which had received cultivation was superior to that on plots 3 and 4, but cultivation without seeding and manuring produced no improvement.

Without the use of suitable machinery cultivation would be expensive, but the experiment indicates that there are distinct possibilities of greatly improving land of this type simply by roughly levelling it and applying suitable manures and seeds, in some cases perhaps with the addition of shell sand.

Before definite conclusions are reached, however, the experiment must be continued for several years and extended to other localities.

AGRICULTURE AND THE FOOD SUPPLY.

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(The following is the substance of a Lecture delivered at Dundee University College to a City audience on February 1, 1930.)

The problem of agriculture and the food supply, which is one of the pressing national problems of the day, can be stated quite briefly. On the one hand we want to ensure to our home consumers an adequate supply of cheap and good food; on the other we want to see our home food producers, our farmers and farm workers alike, in a position of economic security, able to live in reasonable comfort and able to cherish reasonable ambitions. The question is how these two objects are to be reconciled.

It is matter of common knowledge that for the past nine years a large proportion of our farmers have been making severe and repeated losses, and that the financial position of many is becoming desperate; also that severe unemployment among farm workers appears to be imminent. These statements do not apply to all districts or to all kinds of farms. There are some quite notable exceptions. The unfortunate feature is that the farmers who have been making the heaviest losses are those who have been employing the most labour and have been extracting from the land the largest quantities of human food. The mountain sheep farmer, whose output may be reckoned as two or three pounds of wool and two or three ordinary joints of mutton to the acre and who employs a man to perhaps a thousand acres, has been making profits. The arable farmer growing a ton of corn or seven tons of potatoes to the acre, and employing a man on every thirty acres has been, and is to-day, selling his produce far below cost.

The present depression is in part a world depression, due largely to causes connected with currency. It has been the usual experience in the past that periods of deflation, periods when the amount of money in circulation has declined, have been periods of great difficulty for the farmer. The prices of the commodities that he produces decline more rapidly than his costs, and so long as the process of deflation lasts he makes losses. But there are, it seems, other causes of a different nature, affecting different countries in different ways, and likely to be permanent in their operation. It is impossible to understand the situation fully unless we begin by looking round and looking back—by comparing the past history of this business of food production in our own and other countries.

If we go back, in our own land, to the middle of the eighteenth century—that is to say before the industrial revolution—we find that food production was the main concern of the great bulk of the population. The towns were small; Dundee, for example, although reckoned an important place even then, contained less than 10,000 inhabitants. Most country tradesmen farmed a bit of land, or at least helped out the local farmers during their busy seasons. Even the towns had considerable areas of land, and many townsmen were farmers on a small scale. With all this agricultural activity one might suppose that Scotland produced a surplus of food; there was, it is true, an export of store cattle, and in good years there was some grain to spare. But on the whole our ancestors exported little, and themselves fared but poorly. Fresh meat, except in autumn, was a luxury of the rich; wheaten bread was eaten by the plain man only on special occasions. In bad years Scotland had to import food, and with a succession of poor harvests there was little wherewith to pay for imports, and the population starved. It is hard for us to-day to think of real famine at home, except in connection with war. Yet as late as the sixteen nineties a very considerable number of the people of Scotland died of want. Even later, in 1783 for example, great organised efforts were necessary to prevent famine. The picture that we start with is of a population consisting mainly of small farmers and cottars occupying most of their time in trying to produce the bare necessities of life; and, taking one year with another, only just succeeding.

Now in Britain we had, between 1760 and 1820, a great change in the economic framework of society—the industrial revolution and the agrarian revolution. We shall have to consider that presently. But meantime we must observe that in many other countries the industrial revolution had very little meaning, and an agrarian revolution, in our sense, can hardly be said to have occurred. Over the greater part of continental Europe the main features of the old agricultural system have persisted till the present day. The small family farms, mainly in the hands of peasant proprietors, remain. The peasants still, to a large extent, live on the produce of their own holdings and they have an economic outlook peculiar to themselves. They do not farm for money profits, but for a living. They suffer, of course, from certain obvious disadvantages. They cannot afford a modern scientific training. They are, unless they organise on co-operative lines, weak sellers and uneconomical buyers. They cannot introduce costly labour-saving machines, for the scale of their enterprise makes these uneconomical. Nevertheless they survive—indeed the greater part of the world's food supply is still produced by them.

If we investigate the small holder's costs and his income we generally find that his business, judged from the ordinary business point of view, is unsound. He normally works twelve hours a day or more; his wife works on the farm; his children probably work as well. If we reckon this labour at ordinary wage rates, and add the ordinary interest on the capital invested in the holding, we may get a figure of perhaps £5 a week. On the other side the family income, allowing for the consumption of home produce, is probably £3 or £4 per week. The farm is losing £50 or £100 a year, or at the rate of probably 10 or 20 per cent. per annum on the capital investment. It may go on doing so indefinitely. This is not a fanciful picture. Careful investigations have shown that the state of affairs described is so common as to be almost normal. A man who can thus manage to live upon his losses is a difficult man to put out of business. Also, it is important to note, he reacts to farming depression in a peculiar way. The manufacturer who finds himself making losses can shut down his factory; a big capitalist farmer can change his system, can employ fewer hands, can cut his expenses in various ways. But the small farmer cannot do these things. A less intensive system would only throw himself and his family idle. He may not produce less, because if he did so he could not live. Actually he responds by working harder, thus producing more, and he lives more sparingly, thus setting free more of his produce for sale. Up to a point then, low prices have the effect of stimulating rather than of checking production. In the end, of course, the peasant may give up his holding and become a labourer, but that means for him a loss of status and the loss of his land, which he usually values above everything else.

There is, of course, a brighter side to the picture. A good deal can be done for the peasant by teaching him to specialise in those market products that are most suitable to his circumstances —poultry, pigs, dairying, vegetable culture, and so forth, industries in which it is no particular advantage to work on a large scale. A good deal can be done to make good his deficiencies as a manager by supplying him with expert advice, a scheme that has proved very successful in Denmark. He can be taught to buy co-operatively, and also to grade and market his produce on co-operative lines. Some of his peculiar difficulties —e.g. that of improving his live stock—can be met by State-aided schemes. But however well these matters are organised his disadvantages in the production of the big staples—grain, beef, mutton, &c., are very serious.

Let us return to our own country and outline the history of our agriculture since the old days of subsistence farming. After 1750 Scotland began to make rapid strides in trade and industry, and before the end of the century was in the midst of the industrial revolution. The spinning wheel disappeared from the farm kitchen. The weaver left his country cottage for a factory where his loom was driven for him first by water power and later by steam. The farmer ceased to dig his fuel from the local moss, and turned to coal. Iron, shipbuilding, fisheries and other industries made rapid progress. Overseas trade increased. The population began to grow rapidly, but the increase was wholly confined to the towns—actually the country districts lost people. Agriculture was faced with a new problem; it had to organise with a view to feeding the towns. It had to begin producing for the town market instead of for home or local consumption. Naturally there was a process of specialisation. One man took to milk, another to sheep, another to grain and beef production. The farmer and his family lost their spare time jobs, their home industries that had kept them employed in seasons when no farm work was available. The supply of casual labour largely disappeared. The farmer had to work out a new system of commercial farming aiming at money profits. Also he had to meet a growing demand for wheat, meat and dairy produce. Very rapidly, or so it seems as we look back on it now, the farming industry was revolutionised. A vast amount of capital, in relation to the total wealth of the people, was sunk in the land, in enclosing, draining, liming, building and so forth. The small tenants and bonnet lairds disappeared. Farms were consolidated and combined into bigger units, adapted to the more wholesale scheme of production. In many districts the whole aspect of the countryside was changed. Bleak moorlands became cornfields, old worn-out arable land was turned into good pasture. The increased amount of stock and the introduction of clover and turnips restored the fertility of the soil, and led to greatly increased yields of grain. By the end of the Napoleonic wars Britain was the best farmed country in the world, and Scotland the best farmed part of Britain. The picture that we now have is of a country of carefully organised commercial farms, so arranged and managed as to provide regular employment for the staff of men and horses, and so farmed as to produce nearly the maximum amount of food that was possible with the existing means.

If now we glance aside from agriculture to the other staple industries and look at their subsequent history we find an almost constant tendency in one direction. There has been a steady increase in specialisation of industry and of workers and a constant growth in the size of the individual undertakings. Factories became too big for individuals to own, and the individual capitalist gave place to the Joint Stock Company. Small companies have become big companies, and lately these have been uniting into huge combines and cartels. The final result, it appears, is likely to be what we call rationalisation of whole industries under centralised control. Throughout there has been a steady growth in the application of mechanical power and a progressive replacement of men by machines. This process has, of course, from time to time led to serious unemployment and distress. But broadly it has led to shorter hours and higher pay for workers, larger profits and greater security to capital, and more abundant and cheaper supplies of manufactured articles to the consumer.

Now in the interval agriculture has not stood still. Great progress has been made in the sciences of manuring and feeding. Plant breeders have produced improved varieties of crops, animal breeders improved breeds of stock. At the same time there has been a continuous effort to apply machinery and power to agricultural operations with on the whole a considerable measure of success. But it has been difficult to introduce in farming the principles of specialisation of labour or the displacement of men by machines. Most farming operations are seasonal, and a given worker has to switch over from one operation to another week by week and sometimes day by day. If the farmer attempts to specialise in a particular crop he may find that his labour staff has to be augmented at one season and perhaps thrown idle at another. Again a specialized machine, like a corn drill or a binder, can be employed at the best for only three or four weeks in the year. For these and for other reasons the tendency has been, in this country, to build up a fairly complex system of mixed crop-and-stock farming; and with this system it has been clearly shown that there is a limit to the economical size of the individual farm. If we compare the three- or four-hundred acre mixed farm with one of a few thousand acres, we find that the latter offers but little more opportunity for specialization of labour, while the disadvantages of extra transport costs soon begin to outweigh the advantages to be gained through the use of larger machines.

Our land then, in the main, continues to be farmed by individual tenant farmers employing a few thousand pounds of capital and employing typically about half a dozen wage earners. It will be clear that although our comparatively large scale farming is in many ways more economical than the peasant system of Continental Europe, the capitalist farmer, employing paid labour, is in the same position as any ordinary business man. He grows produce to sell and he cannot live on losses. Hence when we get a long period of depression like the present he is more easily broken than the small holder. He may show a 10 per cent. loss and the peasant a 20 per cent. loss; but the peasant can struggle on indefinitely while the capitalist farmer, however hard he works or lives, is doomed to bankruptcy within a definite period of time.

The third main type of agricultural organisation is that of the new countries, like Canada and Australia. In these countries there are large areas of cheap land of easy cultivation, on which the modern tendency is to apply mechanical power and mass production methods to the production of single crops. It is a system that gets comparatively little out of an acre of land, but means a large output per man employed. The colonial farmer has had the advantage of freedom to develop the land in the most profitable way under modern conditions. He is unhampered by obsolete plant and buildings, by small fields or by old traditions. It is the custom to regard this system as one of exploiting virgin land rather than as a scheme of permanent agriculture.

But the more thorough understanding of the business that is being acquired is making it possible to continue the system over much longer periods than has been found possible in the past. Moreover there are still great tracts of land untouched by the plough. We must reckon with the competition of this type of farming for an indefinite period.

Let us now frankly face this question. Supposing that the British farmer is to be left (as the common phrase puts it) to work out his own salvation, what is he going to do? It seems that he must carefully consider the probable incidence of overseas competition and must concentrate on the production of those commodities with regard to which he can, in the long run, hold his own. Let us see what that means, with regard to a few of the more important of our products :—

Wheat.—It cannot be denied that countries like Canada have large areas of better wheat land than we possess. They have far more reliable harvest weather. They can produce samples that command, one year with another, substantially higher prices than our home-grown wheats. They have high wages, but wheat and other cereals present an easy problem to the engineer. Power ploughing, power drilling, combine harvesting and a system of elevators reduce the man labour per bushel to a very low figure. There is every reason to expect that if our markets are left open to free competition our wheat area will continue to shrink rapidly.

Barley.—Barley is grown chiefly for malting, and malting quality depends largely on harvest weather. In good years our best barley districts can still produce choicer samples than any other country in the world. But for these very choice samples there is but a limited demand, and their production is in any case largely a matter of luck. Meantime countries like California can produce large and regular supplies of good ordinary quality—good enough for distilling or for the brewing of the plain man's beer. Barley will remain an important crop locally, for example in Norfolk or wherever the home farmer can definitely beat his overseas competitors on quality; but over the greater part of our arable areas it cannot hope to regain its old importance.

Oats.—Scotland and the moister areas of England can produce the heaviest yields and the best quality of oats that are anywhere to be found. Unfortunately the market for oats is rapidly shrinking. Street horses are disappearing; pit ponies will soon be only a memory. As a human food the oat is of small and declining importance. If cultivation of the crop is to continue on the present scale increasing amounts will have to be consumed on the farm by the farmer's own stock. For this purpose it will have to compete with a whole array of imported feeding stuffs.

Potatoes.—This country could still easily produce all our home requirements of potatoes. The small but formerly lucrative business of early potato production is, however, being killed because countries like Jersey, France, Spain and the Canaries have at last come to realise the advantage of their early spring. As regards main crop sorts there is no hope of an increased consumption; moreover we have, just across the North Sea, large areas of good potato land, with the advantage to the grower of cheap hand labour. The invention of really efficient machinery for lifting the crop may help us to keep our present position in the main crop market. We can hope for nothing more.

Sugar Beet.—The present position is entirely artificial, and the future of the industry, if the subsidy is withdrawn as intended, is obscure. That it will maintain its present proportions is hardly conceivable.

Live Stock.—On the live stock side the outlook is far better. Our home mutton, lamb and beef still command a substantial premium over anything that we import. With regard to milk we have practically a monopoly of a slowly expanding market. The same applies to pork. Our home eggs and poultry, when properly graded and marketed (as they are being to an increasing extent), are preferred to the corresponding commodities from overseas. As regards costs we have the advantage of large supplies of imported feedingstuffs—milling offals, oil seed residues and the like, at low prices.

It seems that there is little doubt as to which way farmers will turn if they are left to solve the economic problem that confronts them. They are already turning, and turning rapidly, wherever the conditions render the change easy of accomplishment. For example the county of Northumberland in 1920 grew 38,000 acres of barley; in 1928, 15,000. In 1920, 8,000 acres of wheat; in 1928, 3,000 acres. In 1920, 46,000 acres of oats; in 1928, 34,000 acres. In 1920, 32,000 acres of turnips and swedes; in 1928, 18,000 acres. On the other side cattle have increased from 127,000 to 155,000, and sheep from 978,000 to 1,157,000. Statistics for other counties are, indeed, not so alarming, but where they are least alarming the economic crisis is most acute. Nobody can go from Norfolk to Northumberland and from Northumberland to Angus without reaching the conclusion that the Northumbrian farmer is the one who has succeeded to the greatest extent in dodging the present depression. Northumberland is continuing to proceed in the same direction, and its example is being followed, or must soon be followed elsewhere. A grave degree of unemployment will be the inevitable result.

Rural depopulation—in the sense of a declining proportion of the population engaged in agriculture—is an inevitable thing. Material progress means largely this, that fewer and fewer people are required to produce the bare necessaries of life and more and more are set free to produce its luxuries and improve its amenities. So long as the process takes place slowly, so long as it is only the young people that drift to the towns, so long as the towns can support the increasing numbers, provide them with decent houses and so forth, it need be a matter for no very great regret. But when the process becomes rapid, when the older workers are thrown out of employment, the matter becomes one for serious thought. For old and middle-aged people trained to agriculture and accustomed to a country life will be neither useful nor happy in town occupations.

I need hardly say that a decline in corn growing and arable farming will place our country in a much weaker position in the event of a national emergency such as faced us fifteen years ago. Land under grass can be quickly ploughed up again for cropping so long as the skilled men and proper equipment can be found to do it, but after a few years these will be very hard to find.

It is not for an agriculturist, with all an agriculturist's prejudices, to say whether it is worth our while, as a nation, to try to maintain either our output of food or our numbers of rural workers. What seems quite certain is that nothing short of protection or subsidies will achieve such an end.

We began by asking the question whether it is possible to have world prices for food and a prosperous home agriculture. The answer depends on what we mean by the last phrase. If we mean merely an agriculture that will return reasonable profits to the farmer and enable him to pay reasonable wages to his workers, we can answer that a way will be found. But if we mean a home agriculture producing anything like the present quantity of food or employing anything like the present number of men, we must answer in the opposite sense.

Even if the country decides against a permanent policy of protection, it is immediately important that something should be done to mitigate the economic forces that are bearing so hardly upon the farmer. It is worth some sacrifice to avoid the wholesale bankruptcy of a large class of people and the loss of employment by a very large number of workers who will be difficult to absorb elsewhere.

THE FARM COTTAGE IN SCOTLAND.

JOSEPH F. DUNCAN,

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THERE is an unworked mine of agricultural history in Scotland for the past century and a half from which it is to be hoped someone will give us a history of the industry one day. The Statistical Acounts, the County Surveys, the Transactions of the Highland Society, and the official Reports of the last fifty years constitute a record which few countries can show, but the material has never been reduced to a readable compass for the ordinary reader. In this article I propose to present a few of the facts about one aspect of the industry which does not provide matter for pride, but which has more than a historical interest—the housing of the workers. If the farm cottages of Scotland are not all they should be, and on that point, if on no other, there is general agreement, it cannot be said we have erred in ignorance. The facts have always been known and there has never been any lack of remedies provided.

Farm cottages as part of the equipment of the farms were a necessary result of the enclosures and improvements which began in the last half of the eighteenth century, and which continued in the Northern counties down almost to our own day in the combination of small farms into larger units. As the cottars disappeared and the growth of power industry drew the craftsmen from the countryside to the towns, farmers could no longer depend for their labour supply on outside sources and had to provide housing for their workers. The enclosures made most rapid progress in the Lothians and Borders, and before the beginning of the nineteenth century the cottars had disappeared. Further north the enclosures came later, and in Fife, Perth and Forfar when the need for housing became urgent the bothy system was resorted to as the cheaper and easier method of meeting the need. In the north-east and along the Moray Firth the small farm held out much longer, and the improving leases provided a plentiful supply of cottars long after they had disappeared in the rest of Scotland, and it is interesting to note that the married farm worker in that area is still known as a cottar although he is housed on the farm.

When Sir John Sinclair wrote his General Report of the Agricultural State and Political Circumstances of Scotland in 1813, based on the County Surveys, he reports on the housing of farm workers as follows :—

> " In the southern counties of Scotland, and particularly in Berwickshire and the Lothians, the cottages attached to farms are now generally constructed from 18 to 20 feet in length and 16 in breadth, divided into two apartments, the first of which may be called the living room, and the other the store or lumber room, where meal, potatoes, coals, &c. are kept.
>
> The height of the side-wall is usually from 7 to 8 feet, and they have rarely more than one floor, being considered when of that construction to be warmer, and less liable to have the roofs damaged by the violent winds so frequent in Scotland." [1]
>
> " Though some of them are on a proper construction, yet in too many instances they are far from being comfortable, having neither a floor except of earth, nor ceiling. The windows also are very small, which may admit a little light, but are rarely calculated for the admission of fresh air. When sickness therefore comes into the poor man's

[1] General Report, vol. i, p. 128.

family, the consequences are often fatal. At the same time from the great expense of keeping up cottages, farmers are never anxious to have more than what are barely sufficient to accommodate the labourers necessary for all the different operations of the farm." [1]

His description of the houses in the north-east shows an older type of house, the "auld clay biggin" erected by the cottars themselves for the most part, and not a part of the buildings erected by improving lairds. It is interesting to note that the "but an' ben" of the cottar was a more commodious house than the cottage built for the hinds, but we know from other sources that the hinds had a simple way of converting their single apartment into a "but an' ben" by erecting the box bed across the breadth of the room.

> "In the central district, and the north-east Lowlands, the accommodations given to the married farm-servants are of a different description. Their cottages are generally 12 feet wide, and from 24 to 36 feet long. They usually have two divisions or what they call a "but and a ben." In one of these divisions most commonly used (besides a bedstead for some of their children, and the kitchen furniture) there is a fireplace. In the other there is a bedstead for the cottager and his wife, or sometimes two bedsteads, if the children are young and numerous, and also a fireplace. These cottages have only an earthen floor below, and in general no more than two windows, one in each end. A few of them have three or four windows, and are ceiled above in one end with a plain coat of lime plaster, or covered with thin deals. In some places they are thatched commonly once in two years, which costs *5s.* to *10s.*, besides the cottager's trouble in putting on the thatch. More frequently they are stob-thatched or sewed, that is, covered with a coat of straw from 5 to 10 inches thick, which costs from £5 to £6, and lasts from 15 to 20 years.
>
> "The inferior kind of these cottages till within the last seven years cost only from £8 to £10, and the better sort or tradesmen's houses from £15 to £20; but from the great rise in the price of wood and labour, an artificer's house built with stone and clay, and pointed with lime on the outside of the walls, having a ceiled roof with a wooden floor in the best end or bedroom, and stob-thatched with straw, costs from £30 to £40." [2]

Sir John Sinclair was not content, however, to describe things as they were. He was, as usual, prolific with suggestions as to what was the proper thing to do. His directions as to what a "proper built" cottage required are interesting as showing what the opinion of that day was as to the needs of farm workers' housing. It is a sad commentary that, more than a hundred

[1] General Report, vol. iii, p. 250. [2] Ibid, vol. i, p. 129.

years after he wrote, it is still difficult to convince many local authorities that it is necessary to have a plentiful supply of good water near the cottages.

> " A proper built cottage is always placed upon a dry spot, where all damp and water-runs can be completely drained off.
>
> " It is also essentially necessary to be near a plentiful supply of good water, and at a distance from stagnant pools or marshes.
>
> " The floors of cottages should be raised one foot above the surface; the walls built in the most compact manner, and close up to the covering of the roof. The roof, if not thatched, to be first lathed and plastered all over between the scantlings, and then lathed and plastered for the ceiling. The floors formed of any dry substance as a mixture of clay, brickdust, forge-ashes and lime, or common bricks laid on edge in zig-zag form, or pavement bricks, or dressed flag-stones, or deals; for all of which it is necessary that the area of the floor be first made dry by draining, have all the soil taken off to the depth of from one-half to two feet, and then covered with chips of stones, or dry gravel, which if mixed with lime, will be preferable." [1]

Sir John went further. He provided specifications and plans for cottages such as were usually erected in East Lothian and other arable counties. These were single apartment cottages, 18 × 15 feet, built in pairs at a cost ranging from £76 to £82 a pair. An " improved plan " gives a cottage of the same floor-space with the fireplace in the centre and two bed closets of 6′ 3″ × 9′ and a living room of $15\frac{1}{2}' \times 9'$, and a pantry, coal cellar, pig-stye and earth closet attached to the house. He proposed to fix an iron plate to the back of the fireplace, which could be removed from the living room fire to warm the bed closets, a proposal more ingenious than practicable. The cost of this " improved " cottage was £64, 10*s*.[2]

I am afraid Sir John Sinclair did not carry very much weight in his own day, however grateful students of history are to him for the great work he did in carrying through the Statistical Report and the County Surveys. His schemes were submitted to a generation of agriculturists struggling with the legacy of problems, financial and otherwise, of a European War, and a fellow-feeling ought to make us sympathetic, so we shall not judge too harshly their failure to respond even when an improved cottage could be had for £64. There were not many improvements made, and the period from the 'twenties to the 'forties is the leanest period in farming literature and the time of least public effort in the industry during the last century. With the 'forties, however, comes the new Statistical Account, and the Journal of Agriculture, while the Transactions of the Highland

[1] General Report, vol. iv, pp. 271-2.
[2] Ibid, vol. iv, p. 273 et seq.

Society show an awakening interest in many problems. We can imagine how the farm worker has fared in the interval.

The approach of the Highland Society to the problem is interesting and moderate.

> "Many years ago the Society, with a view of improving the conditions of the poorer classes, and of removing the reproach which our southern neighbours had long cast on the peasantry of Scotland of being deficient in habits of order and cleanliness, proposed to give premiums under certain regulations to a limited number of parishes for the best kept cottages and gardens. As it was assumed that landed proprietors would gladly avail themselves of the Society's premiums, it was resolved that they should be offered in turn to every county in Scotland; certain counties being selected from the north and an equal number from the south. This plan was pursued for several years, but was ultimately changed, as some districts seemed indifferent about the premiums, and others frankly avowed that the cottages were not in a condition to derive benefit from them—their houses being so bad as to preclude them from joining the competition with any hope of success. It was therefore considered advisable to discontinue the premiums to the counties, and to allow any parish, wherever situated, to compete, provided a guarantee was given by the parties applying for the premiums to contribute one-half of the amount offered. This it was hoped would have had the effect of interesting proprietors and other influential persons in the different parishes, and of leading them personally to superintend and stimulate the competitions. The change seemed at first to promise well; for on looking back to reports made some years ago, not only was the number of competing parishes allowed by the rules complete, but many more applications were made than could be complied with in any one year. This zeal, however, on the part of proprietors was more apparent than real; for in many instances, parishes applied for and obtained the right to premiums, but never held a competition, nor sent in a report. The committee regret to say that for several years there has been a falling off in the number of applications; and it has been suggested, notwithstanding the pains which the directors have always taken to publish the premiums and to invite competition, that this may be owing to landed proprietors not being in the habit of reading the lists, and to their being subsequently unaware of the benefit offered."
>
> "The efforts of the Society with regard to cottages were for some time exclusively directed to improve the mode in which the dwellings of the poor were kept by their inmates, but it soon became apparent from the various reports received from year to year that almost everywhere cottages were deficient both in accommodation and repair; and attention was at length turned to the improvement of the buildings

themselves, which indeed should have been the first step in the process.

"On the suggestion of a nobleman who takes a great interest in this branch of rural economy, premiums were offered also for the improvement of existing cottages. The committee regret that as yet only one candidate has claimed the prize." [1]

We can understand the difficulty the Highland Society had in finding competitors for its prizes for the best kept cottages and gardens from a general description of the farm cottages written in the same year as the Society was reporting upon. The reference to the uncertain tenure of the cottages placed alongside the efforts the Society was making to reform the system of Hiring Markets, is a reminder that the problem of the migration of farm workers is at least one hundred years old, and this fact ought not to be forgotten in connection with the housing problem.

"The houses now inhabited by married farm servants present in general a better appearance externally than they did at the times about which I write; but as yet they are anything but comfortable inside. Turf and thatch have in most cases given place to grey slates. Better materials being used for roofing render them dry above, and I believe that none require a system of surface drainage such as I have mentioned; but as few of them are either ceiled, plastered, lofted, or have anything in the shape of joiner work except the outer door and the windows, in frosty weather the cold is keenly felt by the inmates. To make up as far as possible for the want of partitions, the inhabitants arrange their furniture so as to procure the greatest possible degree of warmth; and were it not for the uncertain tenure by which they retain their holdings, my belief is that they would at their own expense render them far more comfortable, as the necessary improvements could be made at a cost of a few shillings." [2]

In various ways the Highland and Agricultural Society showed its interest in the question of improved cottages. Reports appeared in the Transactions during the 'forties of improvements which had been effected on certain estates, and premiums were offered to proprietors who showed enterprise in building new cottages or in improving existing ones. Premiums were also offered for essays on the Bothy System and for essays on Cottages. If the results were disappointing, the fault did not lie with the Society. It endeavoured to stimulate action by the force of example as well as by the provision of precept.

From a prize essay by James Black, factor on the Ellon Estate, we have a description of the "but an' ben" as it

[1] H. and A. Transactions, 1848, Series III, vol. 3, pp. 203 et seq.
[2] *Journal of Agriculture*, July 1847, p. 2 et seq.

existed in Aberdeenshire in 1851. He gives a drawing of a cottage and a plan and describes it as follows :—

"The cottage is at present occupied by three families, and is a fair average specimen of the accommodation with which a crofter or tradesman of the humbler class or a married farm servant is generally provided. The side walls are scarcely 5 feet in height. The door, at the one side of which are piled up irregular blocks of stone to form a buttress to the wall to prevent it from falling, is so low that an ordinary sized person on entering requires to bend considerably to the ground; and the gables, considerably above the level of the side-walls, are built with turf, and do not even at the apex exceed the height of the side walls above 4 feet. The whole mason work is composed of undressed surface stones and mortar. An entire absence of every idea of comfort in the occupants is shown by the carelessness which has allowed the walls to be deprived to a great extent through the influence of the drought and wind of their cementing mortar, which at the first gave them a degree of compactness and a power of resistance to the weather; but they are now quite open, and almost permeable by the wind in every part.

"The roof of the house is covered with turfs, which are overlaid with straw; and above all may be observed quantities of grassweeds growing up through the straw, and forming by their decomposition a very convenient receptacle for the lodgment of the rain from heaven.

"The floor is depressed below the level of the surrounding ground, and is exactly the same material as the sub-soil of the surrounding area on which the structure is raised. It is full of inequalities, arising from the nature of its composition, from defective drainage, from heaps of circumjacent refuse, and from the slovenly habits of the inmates. It is therefore frequently damp, and thus serves to augment the general discomfort. There are two small windows in front, each containing four small panes of glass.

"There is no ceiling. You see immediately above you from the floor the rafters and turfs, densely covered with soot, and in damp and rainy weather giving off to the furniture below a copious covering. Nor is any attempt made at separate apartments by regular partitions. One or two bedsteads placed in the middle divide the building into two portions, familiarly denominated a but and a ben; in the one of which being used as a kitchen, and for this reason the more comfortable of the two, the whole family sit and eat and converse together." [1]

It was in the 'fifties that the limelight was turned on the housing conditions of the farm workers. Sheriff Watson in

[1] H. and A. Transactions, 1851, Series III, vol. 5, p. 92.

Aberdeenshire had been waging a campaign, the Free Church discussed the problem at an Assembly, and several Synods of the Churches appointed committees to consider the question. One of the most interesting reports was by a committee of the Synod of Angus and Mearns :—

> " According to the report from the parish of —— (and it is a fair sample of the state of matters in the great majority of our parishes) ' the house of an agricultural labourer usually consists of two small apartments, with a dark niche between called a pantry. It is generally damp and unventilated (unless in those cases where the hand of time has made ghastly fissures) and unlathed. We are in possession of evidence proving that many live in single rooms barely 6 feet high, the floor being of clay full of holes, the roof of rotten thatch, through which rain often pours, and the walls of stones, turf or earth, pervious to every wind. To see, as we have often seen, a husband, wife and several children living in such a miserable crib is repugnant to every right notion of what is due to a human being; and we are indignant when contrasting it with the superior accommodation provided for cattle and horses. The bothy accommodation is often still more objectionable than that provided for the married labourer. As there are comfortable cottages, so are there no doubt comfortable bothies, but of those the number is notoriously small.' The minister of —— has furnished us with a sketch of those in his parish, and with a fidelity which cannot be disputed. ' On entering, four bare walls, never plastered, present themselves. Casting the eye upwards, you can generally see the sky through the slates, if it be fair above, otherwise you may also feel its influences. Floor there is none. On the earth where the floor should be, is most commonly a hack stock, an axe, and a quantity, sometimes a large one, of hag or brushwood, which is the fuel used. Two or three rude forms or long narrow stools, a meal-chest or two, a brose-cap, milk-flagon, and spoon constitute the entire furniture. The beds, bare, black and hard-looking, are the most uninviting couches one could well conceive. The bed-clothes in colour very much resemble the potato-sacks I have seen in the field.' " [1]

The outstanding figure of the time, however, was the Rev. Harry Stuart, of Oathlaw in Angus. He was not content with exposing the conditions in his own county but set himself to provide a remedy. Mainly as a result of his exertions there was created an Association for Promoting Improvement in the Dwellings and Domestic Condition of Agricultural Labourers in Scotland. Its Patron was Prince Albert, its President the Duke of Buccleuch, and it had one Duke and five Earls as Vice-Presidents. The list of Extraordinary Directors and Ordinary

[1] *Journal of Agriculture*, July 1856, p. 399 et seq.

Directors makes a most imposing array, but with Mr. Stuart as honorary secretary it had an active and useful career of six years. How long it continued in existence I have not been able to discover. The last report I have is the Sixth in 1860. It prepared plans for cottages which had a considerable sale amongst proprietors, and the reports note with pride that the sale has not been confined to Scotland, but that a considerable sale had been effected in England and even in France.

In the Third Report in 1857 there is an interesting sketch by the Architect of the development of the farm cottage in Scotland. The general plan to begin with was the single apartment cottage described by Sir John Sinclair which was divided by running the beds across the room. The Architect notes with regret that cottages of this description are still being erected in some parts of Scotland in 1857. Then followed the living room with bed closets entering off it. These were found too small, and if they were erected in accordance with Sir John's plan we can agree. Then came the room-and-kitchen house, with sleeping accommodation in the garrets. Another plan which may be said to have become the standard in farm cottages was the "but an' ben with a mid closet." The association in its plans adhered to one general principle "that three separate apartments are the minimum accommodation for a labourer's family." It was a modest ideal, but we have not yet—seventy years later—reduced it to practice.

Farming had now entered upon its prosperous period. Rents were rising and landowners could no longer plead inability to face the cost of cottage building. There had been the difficulty, too, that the Court of Session had decided that building houses for working men did not constitute an improvement for which an estate could be burdened, which throws an interesting light upon the view which had been taken of the responsibility of the owner for the housing of the workers.

In the Fourth Report of the Commission on the Employment of Children, Young Persons, and Women in Agriculture, 1867, we get a survey of the condition of the cottages in Scotland as a whole. There were five Assistant Commissioners each with an area on which to report. Mr. Culley, who took from Perth to the Borders in the East, reports :—

> "There is probably no district in Scotland where the improvement in cottage accommodation has made so much progress as in the south-eastern counties, an improvement becoming everywhere more marked as you travel from the north to the south of my district. As a whole farm labourers are now better housed in the lowland part of my district than in any of the south-midland counties of England, and I know no county in England where the average cottage accommodation is so good as in Berwickshire; a remark which would also apply to part of Roxburghshire and East Lothian." [1]

[1] Report, p. 19.

Mr. Culley adds :—" There is indeed still great room for improvement in Scotland both as to quality and quantity of cottage accommodation." [1]

Mr. Norman, who reported on Forfar to Nairn, says " few of the old turf houses are now to be seen," but that the cottages " are substantialy built of stone, with either slated or thatched roofs," but that " drainage and ventilation are still but little attended to, and as a general rule the cottages are totally insufficient in number." Mr. Campion, who took the counties from Inverness to the North, as may be expected lacks nothing in colour when dealing with the crofting districts. In the arable districts he notes " general complaints of the scarcity of cottage accommodation," although a great improvement has taken place yet " many cottages of a late date possess very insufficient accommodation." Mr. Boyle, who reported on Lanark, Renfrew, and Argyll, says he " never hears in Scotland any question of building cottages with three bedrooms, in fact there are few with two bedrooms, and it is a very common thing to find cottages of only a single room even in the Lowlands." He goes on to pass strictures on the crowding into a single room. " The cottages are almost stifling, the windows seldom unfastened, and the kitchen seldom gives on to the open air. . . . The number of cottages is very scanty but on the increase." [2]

Mr. Tremenheere gives a vivid report of Ayr, Dumfries and Galloway. In Dumfries large sums have been spent by the larger proprietors. In the ten years previous the Duke of Buccleuch had spent £50,000 on farm cottages, yet some of the worst cottages he had met with were in that county. Of Ayrshire he says :—" In no county in Scotland can the wants and comforts of the rural population be more disregarded. Not only are cottages not built, but the old ones are permitted to fall into decay and ruin and no disposition is shown to replace them." In Kirkcudbrightshire improvements are being made, and in Wigtown " the old one-room hovel is gradually disappearing." But even more illuminating are the two opinions quoted by Mr. Culley. A landlord told him :—" On my farms the cottages are excellent, almost all have two apartments," while a minister said :—" I do not see any necessity for a farm labourer's cottage containing more than two apartments, and for perhaps one-third of the whole number on a farm one room of good size would be sufficient." [3]

The Royal Commission on Agriculture, generally known as the Richmond Commission, which reported in 1881, gives the reports of the Sub-Commissioners Mr. Jas. Hope of East Barns and Mr. G. J. Walker of Aberdeen, but they do not give us much information about cottages. Mr. Hope, whose district was the Midlands and South of Scotland, reported generally that they had been much improved, while Mr. Walker for the Northern district reports that they are generally insufficient in

[1] Report, p. 19. [2] Ibid, p. 118. [3] Ibid, p. 78.

number. But neither Commissioner seems to have given very much attention to the question.

It is different when we come to the Royal Commission on Labour, 1893. There were four Assistant Commissioners and they gave a mass of information about the cottages. It is difficult to summarise because there are a large number of reports, but the Commissioners were not allocated contiguous areas and no attempt was made to give a general survey of the whole country. One of the Commissioners gives an epitome of the evidence of farmers on the cottages in Fife, Kinross, and East Lothian which with few exceptions shows that the farmers were of opinion that the cottages were good and sufficient. He gives no epitome of the evidence of farm workers. There is an interesting paragraph, however, in his report on the Lothian cottages :—

> "Between the years 1855 and 1870 a great reformation appears to have been effected in the cottages of the Lothians. The old structures were pulled down, and entirely new ones took their place. In the early days of cottage improvement, the number of rooms was, as a rule, confined to two, a kitchen with box-beds and a good sized bedroom; between the two and just opposite to the entry door was an apartment generally used as a 'hold-all,' a store, larder and lumber-room in one. Sculleries were not then thought necessary. Viewed in the light of present opinion, the cottages built 30 to 35 years ago were faulty in several ways. The ceilings were too low, the bedrooms not sufficient in number for grown-up families, the absence of a scullery a decided drawback, and the tile roofing liable to leak and get out of order. Although, no doubt, these objections are justifiable, nevertheless, the cottages built between 1855 and 1860 were comfortable and well suited to the tastes and circumstances of the labourers at the time. I am of opinion that, except on a few wealthy estates, where much building has been done in recent years, the majority of the labourers' cottages date back to 'the Reformation.' They have in many cases been altered and added to, not so much because of complaints lodged by the occupants or tenants of the farms, but spontaneously by the proprietors." [1]

Another Commissioner gives summaries of the evidence of landlords, factors, farmers, workers, and a few other witnesses such as ministers and schoolmasters. The evidence of landlords and factors appears to vary according to their experience of the estates they know, and it is not an unfair inference that they are likely to be those who have least reason to object to investigation. The balance of evidence from the farmers is that the number of cottages is insufficient and the quality is not good. The farm workers, as may be expected, are most critical both as to number and habitable condition, and the independent witnesses generally agreed with them.

[1] C. —6894 —XVI, p. 112, par. 96.

The prevailing complaint is that cottages are damp, and one Commissioner is constantly referring to the number of cottages set against a bank without the earth being removed from the walls. Room and kitchen is the type of house most frequently met in the southern districts, and in the north kitchen and closet. There are still a few of the old single apartment dwellings converted into a "but an' ben" by the beds. The older houses are without any storage accommodation and without outhouses. "Inferior cottages are too often to be found," and "too often there is reason for complaint about distance from water." Except in Fife, the Lothians, and the Borders, there is general complaint that there are not sufficient cottages.

The most complete survey we have had of farm cottages was that undertaken by the Royal Commission on Housing in Scotland, 1912-1917. The remit made "special reference in the rural districts to the Housing of Miners and Agricultural Labourers," an indication that the housing conditions of these two classes of workers had become a matter of special concern. The Commission heard evidence from all classes of witnesses and visited most of the districts in Scotland and made personal inspection of the houses. Two reports were presented, but while the Majority and Minority differed as to the remedies to be proposed, there was practical agreement as to the facts. I do not propose here to do more than indicate the findings of the Commission as to the condition of farm cottages.[1]

The common type of cottage to be found in Scotland to-day is the old "but and ben" with the room and kitchen entering right and left from the door, and a small closet or pantry let in between the two rooms. The site has too often been selected not for its suitability as a site but for economy of land and the convenience of farm work. The result is that the site is often a contributing factor in the prevailing dampness of the houses and aggravates the difficulties of water supply and drainage. Such houses as have been built in recent years include a larger proportion of three and four room houses, and some estates, although they are in a small minority, have made a praiseworthy effort to increase the accommodation and to improve the conveniences.

> "The majority of the houses occupied by farm servants in Scotland are houses of the older type of structure, which have been improved by renovations in several directions. The walls have been heightened and better roofs put on; efforts have been made to drain the sites, and to mitigate the worst effects of the bad foundations by providing ventilation under the floors. Walls have been lined on the inside with wood, and in some cases strapped and lathed and plastered. Windows that did not open or that contained only a single opening pane, have been replaced by sash windows, though many of the older type remain. In many cases rhones have been provided. In many cases, too, another

[1] Cd. 8731, pp. 161 et seq.

room has been added. While a great deal has been done in this way to make the best of old houses so defective in essential matters, it cannot be said that the improvements have been, on the whole, more than a slight mitigation of the evils of such defects in site and structure. All that can be said is that efforts have been made to make the best of bad conditions, but it has been possible only to stave off for a time the work of displacing these older houses by others more adapted to modern requirements." [1]

The complaint most prevalent is that the houses are damp. "The evidence submitted to us is conclusive that, in a majority of cases, it is so pronounced in farm cottages as to be injurious to health, and it may fairly be regarded as a factor in the promotion of chronic rheumatism common amongst farm workers." Other defects of structure are deficient lighting and ventilation and defective chimneys. There is a general absence of sanitary accommodation and conveniences; sculleries are provided in a minority of cases, and washhouses are rarely provided. "Those who have no intimate knowledge of the conditions of farm cottages in Scotland will scarcely credit the statement that in the twentieth century houses are provided for workmen and their families without any sanitary provision whatever, but the evidence submitted to us is conclusive. Our own visits confirmed that evidence. We found that the complete absence of any provision is only too common." [2]

Another frequent cause of complaint is the absence of a proper water supply and the distance water has to be carried. "Cases of water having to be carried 150 yards are quite common."

The finishings and fittings of the interiors are summed up in two paragraphs of the Report :—

"Press or cupboard accommodation is generally deficient, and where provided is of the most primitive character. Grates are of the simplest and frequently of the most wasteful pattern. Ranges or ovens are rarely provided. The mid-room or closet may be fitted with rough shelves and used as a pantry, and may have a window. Often, however, it is not ventilated at all and may be merely a large press. It is frequently used as a lumber-room or coal-cellar, and in most cases is not fit to be classed as a room. Yet probably it is everywhere included as a room in the census enumeration. This has a very important bearing on the estimate of house accommodation and shortage.

"Altogether it may be said quite fairly that the interior finishing of the best of the typical houses of the farm-servants provides rooms of four walls, with floors and ceilings and a minimum of other fittings. Such conveniences as are required to make the rooms habitable have to be found by the occupants themselves, who have also to do all the

[1] Cd. 8731, p. 165, pars. 1064 and 1065. [2] Ibid, p. 167, par. 1086.

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papering and painting of the walls. They must provide the storage for clothes, and often for food and household utensils. Even where the structure is satisfactory, the houses lack comfort and convenience, because no skill has been expended on designing or planning the interiors. A little more expenditure on fittings and on the storage accommodation would have gone far to make the houses more habitable.'' [1]

In the absence of a complete survey which would be necessary before any definite statement could be made as to the shortage of houses, the Commissioners could only report that there was general agreement as to the lack of sufficient houses of a reasonable standard. The most acute shortage was to be found in the north-eastern counties and in Ayrshire, while in the counties on the east and south of the Forth the supply appeared to be adequate.

Since the Royal Commission on Housing reported, the general position has not changed. The existing cottages are fifteen years older, with all that means in wear and tear, because during the war and since, even the minimum of maintenance repairs which used to be done has ceased. As against that we have the renovations of existing cottages carried out under the Housing (Rural Workers) Act, 1926. With the exception of East Lothian, where the Act has been used to enable the cottages on a large number of farms to be renovated, such action as has been taken throughout Scotland does not overtake the arrears of ordinary maintenance repairs which have accrued since the Royal Commission reported.

PURE MILK PRODUCTION.

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SINCE 1926 the Bacteriology Department and County Staff of the West of Scotland Agricultural College have been actively engaged in pure milk advisory work among the farmers in the college area. At first the work was carried out by means of clean milk competitions, and during the years 1926, 1927 and 1928 these were held in Renfrewshire (50 farms), West Stirlingshire (7 farms), West Perthshire (18 farms), the Craigie and Symington district of Ayrshire (28 farms), Renfrewshire (22 farms), and Dumbartonshire (36 farms).

Clean milk competitions undoubtedly serve a useful purpose in focussing the attention of farmers and the general public on the pure milk problem; but many farmers dislike the competitive element and therefore refuse to participate. Moreover,

[1] Cd. 8731, p. 165. pars. 1069 and 1070.

such competitions are costly to run, owing to the expenses entailed in the collection of milk samples, most of which must necessarily be taken by a member of the college staff and not by the competitors. Also competitions are of limited duration. They last only for a few months or at most for one year. During that period a farmer may have attained a high standard in the production of pure milk, and may even have won a prize, but there is a possibility that at the conclusion of the tests he may not make the continuous effort necessary to maintain that standard. His success in the competition may have been due largely to his workers. The latter, having made an effort during the progress of the test, may return to their old methods, or they may have been replaced by inexperienced or less careful persons. Again, where two competitors are retailing milk in the same district, there is always a risk that the sales of the less successful competitor may be adversely affected, in spite of the fact that the slight difference in marks may have been due to factors over which he had no control, e.g. variations in atmospheric temperature at time of sampling.

In order to overcome such disadvantages in pure milk advisory work, a scheme was started in 1927 to enable farmers to have milk tested at frequent intervals. A specially low fee was charged to bring the tests within the means of even the smallest farmer, and tests were made monthly. Extra tests were made free of charge when the farmer was in difficulties, e.g. in regard to tainted or bad-keeping milk or butter, and cows suffering from mastitis or "weed." Many farmers who refused to enter clean milk competitions were quite willing to take advantage of this scheme. Where such competitions had been held an endeavour was made at their termination to persuade all the competitors to join the scheme. In our estimation the success of the competition lay not so much in the actual results as in the willingness of the farmers to continue having tests carried out.

The scheme of periodic tests has been remarkably successful. At the beginning of 1929 about 300 farmers were submitting samples monthly for analysis; at the end of the year the number had increased to over 800. Taking the average herd as consisting of thirty cows, each giving 700 gallons of milk per lactation, approximately 17,000,000 gallons of milk are being produced annually under the guidance and advice of the staff of the West of Scotland Agricultural College. This involves the testing of about 10,000 samples per annum. Not only are these farmers having milk tested periodically at their own expense, but in many cases, if not most, they are endeavouring to carry into effect the instructions of the college staff in regard to improvements in method and equipment necessary to ensure the production of pure milk.

Many farmers do not care to have such tests made. They are of the opinion that they have sufficient worries at present without adding to them by the discovery that their milk is not of a very high standard of purity, and that alterations are therefore necessary in their methods or equipment. In many cases their buildings are only second rate, and they are in difficulties with their workers. The latter may not be willing to alter their methods or to take greater care in their work. If such farmers, however, are persuaded to begin these tests, they generally become interested in them and remain in the college scheme.

Such periodic bacterial and fat tests are of great benefit both to the milk producers and to the consumers. They give the farmers information regarding the quality and purity of their milk and stimulate their interest in the production of high grade milk. It is important that farmers should have this information. The fact that several large dairy companies have set up their own bacteriological laboratories, not only shows that they appreciate the benefits to be derived from a knowledge of the condition and quality of the milk with which they are dealing, but also renders it desirable for farmers and farmers' associations supplying such dairies to have this information. The tests enable farmers to compare their milk with the standards required for graded milk and assist them to qualify for licences to sell graded milk. They also enable farmers to demonstrate to the Public Health Authority and to the general public that they are endeavouring to put pure milk on the market. In Britain the consumption of milk by the community is not as great as it should be, owing partly to the fact that the general public has heard so much in recent years of the dangers of contaminated or infected milk (i.e. the risks of infection with disease-producing bacteria that may occur in it) that it has become "suspect." The question of milk surplus and low prices can be solved by increasing the consumption. One step in this direction is to gain the confidence of the milk consumers by convincing them that only wholesome milk is being put on the market. Moreover, there is a growing movement towards increasing the price of milk which contains few bacteria and has a high fat content. Such periodic tests supply the farmer with the evidence required to support his claim for an increased price per gallon. The tests for butter fat afford a check on the general management, and limit the chance of the fat falling below the legal standard.

It has been found that such monthly bacterial tests are of inestimable value, not only as a check on the work and the methods, but also as an encouragement to the workers, many of whom become keenly interested in the results of the tests. In the case of those farms which have been submitting samples for a number of years there has generally been a marked improvement in the purity of the milk produced. In such cases the tests have proved not only of great educational value to the farmer and his workers, but also of financial benefit, owing to the reduction of the loss through bad-keeping or tainted milk. They have also made possible the production of butter and cheese of much higher quality.

The purity and quality of milk is ascertained by means of tests to determine :—

1. Total number of bacteria per cubic centimetre.

2. Whether coliform or intestinal bacteria are present in 1/10, 1/100 or 1/1000 cubic centimetre.

3. The type of fermentation produced on keeping the milk at 37°C. or 100°F. (about blood heat) for 48 hours.

4. The fat percentage.

1. The total number of bacteria per cubic centimetre varies widely according to the conditions under which the milk has been produced. The greater the contamination of the milk the higher the bacterial content, but milk produced even under the cleanest possible conditions may contain one thousand or more bacteria per cubic centimetre, due chiefly to the fact that bacteria occur normally in the udder. Provided the udder is healthy, such bacteria are harmless and not likely to give rise to taints, especially in the case of cooled milk.

A high bacterial content is most frequently due to one or more of the following causes :—

(*a*) The utensils, including strainer and cooler, not being properly washed, sterilised and drained.

(*b*) The cows not being properly cleaned before milking.

(*c*) Dust arising from dried particles of dung and dirt, or from inferior fodder and bedding, gaining access to the milk from the air of the byre.

(*d*) Dirt and bacteria from the milkers' hands getting into the milk, especially if the milkers do not wash their hands before milking each cow, and also if dirty milking stools are in use.

(*e*) The fore or first drawn milk being included.

(*f*) A contaminated straining cloth.

(*g*) Contamination of the utensils or the milk through the agencies of flies.

(*h*) The milk not being cooled soon after it is drawn.

(*i*) The milk being old, so that even if only slightly contaminated with bacteria they have had time to grow and multiply in it.

(*j*) The addition of milk from a previous milking.

(*k*) The presence of " weeded " or " gargety " milk and " salty " milk.

(*l*) A contaminated water supply.

In most cases there is a marked reduction in the bacterial content of the milk from farms for which clean milk tests have been made over a period of more than two years. This is evident when the results of a series of tests for a group of farms are examined. For example in the first Craigie and Symington series of tests (28 farms) 54 per cent. of the samples had bacterial counts of less than 30,000 germs per cubic centimetre, in the second series 63 per cent. In the first Lugton series of tests (25 farms), 48 per cent. of the samples had lower counts than 30,000 germs per cubic centimetre, in the second 65 per cent. In the Renfrew clean milk competition 76 per cent. of the samples had lower counts than 30,000 germs per cubic centimetre, and only 7 per cent. of the samples had higher counts than 100,000 germs per cubic centimetre.

In the case of many farms the samples had a much higher bacterial content, and therefore were of a much lower standard of purity during the summer months than during the rest of the year. In this connection temperature undoubtedly plays an important part, as is clearly indicated by graphs 1, 2, 3 and 4 (see pages 159-162). This increase in the bacterial content is due to one or more of the following causes :—

(*a*) The milk may not be cooled sufficiently at the farm and may not be stored in a cool room. (On many farms it is not possible to cool the milk as there is not a proper or adequate supply of water.)

(*b*) The utensils, including strainer and cooler, after use may not be properly washed, sterilised, and drained free from moisture. The bacteria still occurring on them grow and multiply rapidly at the high air temperature prevailing, so that when the utensils are used again the milk becomes highly contaminated. During the cold weather bacteria do not grow and multiply so rapidly, and thus lack of thorough washing and steaming has not such a marked effect. Sterilisation of milk utensils can be efficiently carried out only by immersing them in boiling water for about 20 minutes or by steaming them until they are thoroughly heated up. It is impossible to sterilise a milk churn by merely rinsing it with pails of boiling water. A number of cases of sliminess last summer were traced to germs occurring on the utensils. When the cans were thoroughly washed and sterilised the trouble disappeared. It may not be possible to wash and sterilise the utensils efficiently owing to lack of proper water supply and equipment.

(*c*) The courtyards and fields, especially at the gates, may be in a muddy condition owing to heavy rainfall. The coats of cows become polluted with mud and dung and are therefore extremely difficult to clean prior to milking.

(*d*) During bad weather the cows may be brought into the byres in a wet condition, and if they are not dried before milking, water containing dung may fall from their coats into the milk pail and contaminate the milk. This is more likely to occur in the morning when the cows are brought into the byre just prior to milking.

2. Coliform bacteria are intestinal organisms, and always occur in animal excrements, byre dust, and in water contaminated with dung or sewage. Their presence in milk is due chiefly to its being contaminated directly or indirectly with animal excrements and byre dust. Most of the factors already mentioned as causing milk to have a high bacterial content are also responsible for the presence of coliform bacteria in it.

The percentage of samples containing coliform bacteria in 1/10 cubic centimetre varies greatly in the case of different competitions and series of tests. In the Renfrew competition it was as low as 25 per cent., while in a competition held in another district it was as high as 64 per cent. Here again the best results were obtained in the case of farms which had been having milk tested for a number of years, e.g. in the first Craigie and Symington series of tests 34 per cent. of the samples were coliform negative and in the second series 52 per cent. In the first Lugton series of tests 42 per cent. of the samples were coliform negative and in the second series 54 per cent. In the last Renfrew competition 75 per cent. of the samples were coliform negative. A number of farms which has been sending in milk for several years seldom has coliform bacteria in the samples except in the summer months.

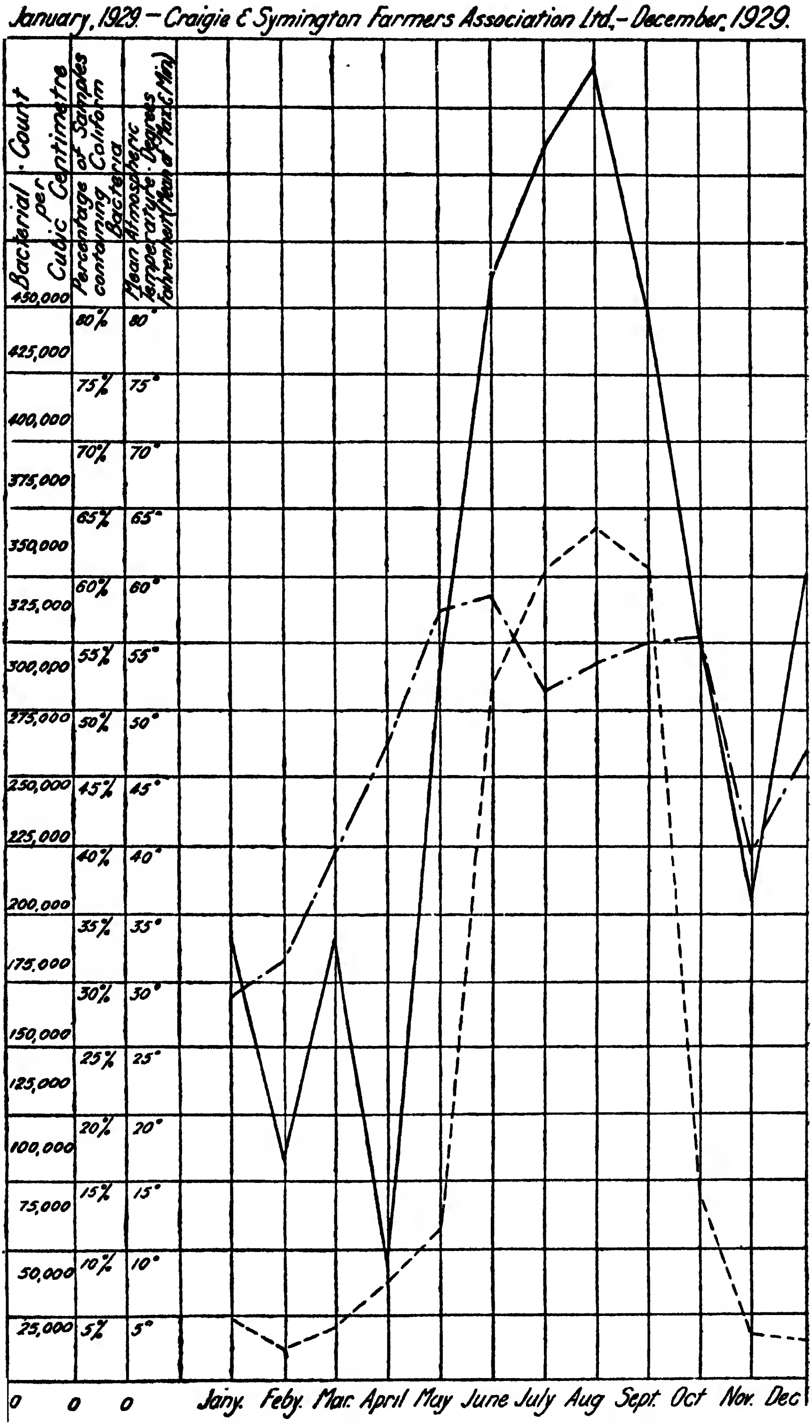
The percentage of samples containing coliform bacteria varies greatly according to the time of year, as is indicated by the graphs 1, 2, 3 and 4 (see pages 159-162). The percentage is much higher in summer than during the rest of the year owing to the causes already mentioned in connection with bacterial content.

The coliform positive samples have generally a much higher bacterial count than the coliform negative. This is clearly shown by the graphs, there being a remarkable correlation between the curves for results of bacterial content tests and coliform tests. This is also shown by the following table :—

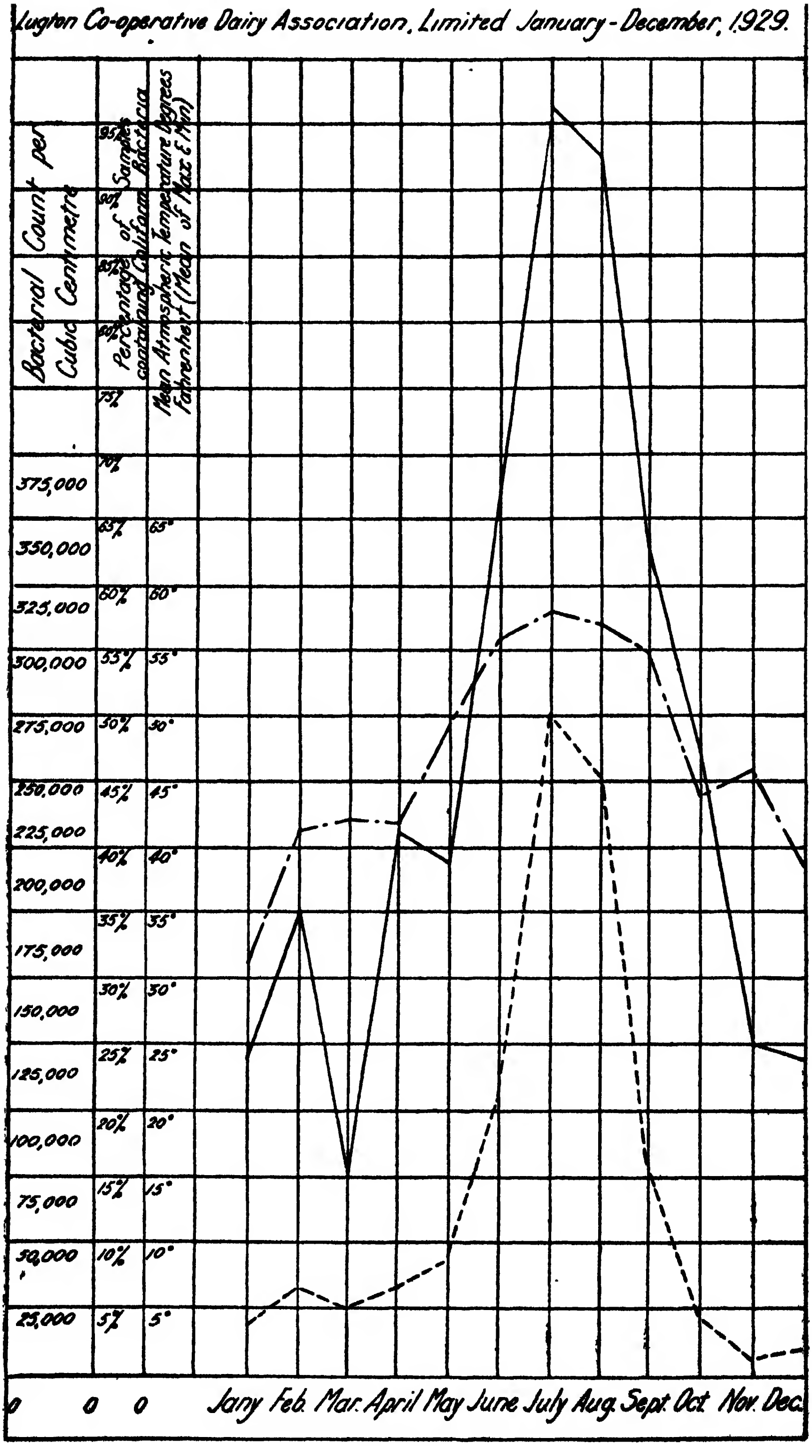
Competition or Series of Tests.	No. of Samples.	Average Bacterial Content of Samples which are :— Coliform − (1).	Coliform + (2).	Ratio of (1) to (2).
West Perthshire	72	13,021	150,551	1 : 12 approx.
Dumbarton	250	27,133	95,235	1 : 4 do.
Renfrew	175	31,688	53,395	1 : 2 do.
First Craigie and Symington	140	42,049	74,381	1 : 2 do.
Second do.	207	24,874	250,732	1 : 10 do.
First Lugton	156	25,195	94,946	1 : 3·5 do.
United Dairies (Scotland) Ltd.	966	31,436	140,132	1 : 4·5 do.
Clydebank Co-operative Society, Ltd.	765	18,009	157,855	1 : 9 do.
Dunlop	570	19,430	115,857	1 : 6 do.
Second Lugton	354	24,684	144,554	1 : 6 do.
Dalry	528	25,847	122,003	1 : 5 do.
Thankerton	240	27,554	179,801	1 : 6 do.
Kilmaurs	603	25,006	145,366	1 : 6 do.

These results can be explained to some extent by the fact that milk containing coliform bacteria has generally been contaminated to a greater extent in its production. Moreover, it is possible that the flora of such milk is capable of growing and multiplying more rapidly than the flora of milk containing no coliform germs, especially if the milk is not cooled soon after it is drawn.

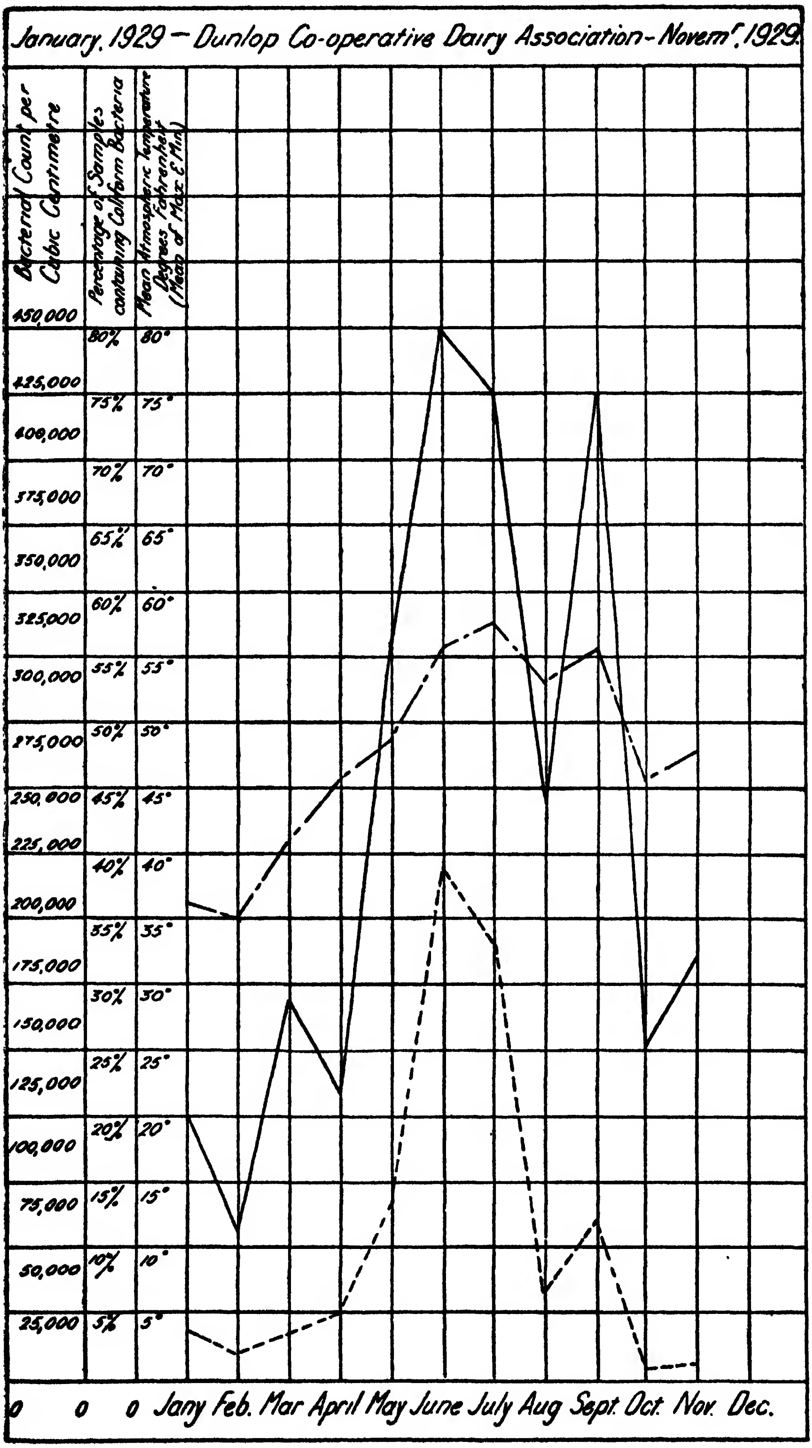
The above results emphasise the importance of the coliform


January, 1929 — Craigie & Symington Farmers Association Ltd.— December, 1929.
Bacterial Count per Cubic Centimetre
Percentage of Samples containing Coliform Bacteria
Mean Atmospheric Temperature. Degrees Fahrenheit (Mean of Max. & Min.)
450,000
425,000
400,000
375,000
350,000
325,000
300,000
275,000
250,000
225,000
200,000
175,000
150,000
125,000
100,000
75,000
50,000
25,000
0
80%
75%
70%
65%
60%
55%
50%
45%
40%
35%
30%
25%
20%
15%
10%
5%
0
80°
75°
70°
65°
60°
55°
50°
45°
40°
35°
30°
25°
20°
15°
10°
5°
0
Jany. Feby. Mar. April May June July Aug Sept. Oct Nov. Dec

GRAPH 1.


Lugton Co-operative Dairy Association, Limited January - December, 1929.
Bacterial Count per Cubic Centimetre
Percentage of Samples containing Coliform Bacteria
Mean Atmospheric Temperature Degrees Fahrenheit (Mean of Max & Min)
375,000
350,000
325,000
300,000
275,000
250,000
225,000
200,000
175,000
150,000
125,000
100,000
75,000
50,000
25,000
95%
90%
85%
80%
75%
70%
65%
60%
55%
50%
45%
40%
35%
30%
25%
20%
15%
10%
5%
65°
60°
55°
50°
45°
40°
35°
30°
25°
20°
15°
10°
5°
0 0 0
Jany Feb. Mar. April May June July Aug. Sept. Oct. Nov. Dec.

GRAPH 2.


January, 1929 — Dunlop Co-operative Dairy Association - Novemr. 1929.
Bacterial Count per Cubic Centimetre
Percentage of Samples containing Coliform Bacteria
Mean Atmospheric Temperature Degrees Fahrenheit (Mean of Max. & Min.)
450,000
425,000
400,000
375,000
350,000
325,000
300,000
275,000
250,000
225,000
200,000
175,000
150,000
125,000
100,000
75,000
50,000
25,000
0
80%
75%
70%
65%
60%
55%
50%
45%
40%
35%
30%
25%
20%
15%
10%
5%
0
80°
75°
70°
65°
60°
55°
50°
45°
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35°
30°
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20°
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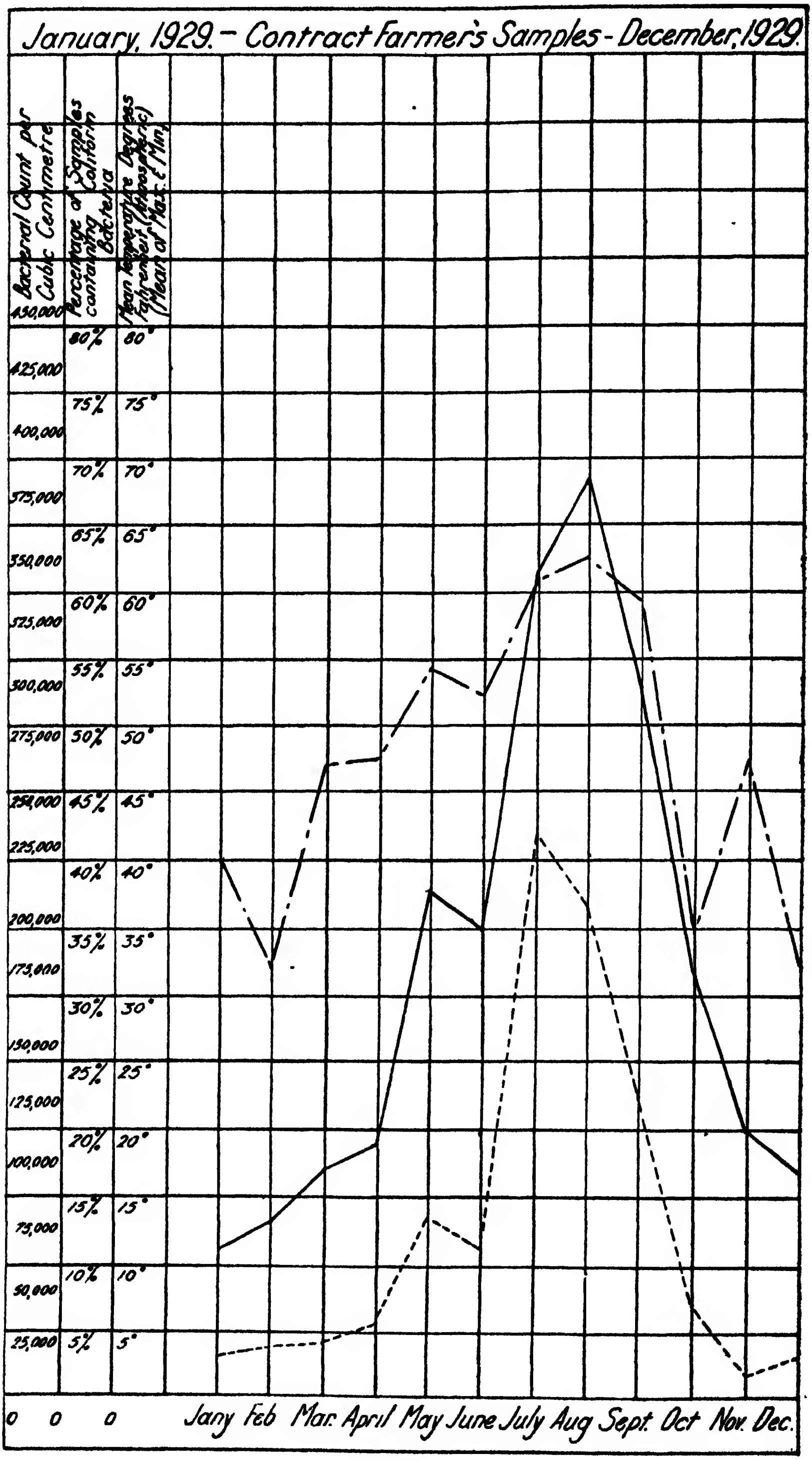
Graph 3.


January, 1929. – Contract Farmer's Samples - December, 1929.
Bacterial Count per Cubic Centimetre
Percentage of Samples containing Coliform Bacteria
Mean temperature Degrees Fahrenheit (Atmospheric) (Mean of Max. & Min.)
450,000 80% 80°
425,000
75% 75°
400,000
70% 70°
375,000
65% 65°
350,000
60% 60°
325,000
55% 55°
300,000
275,000 50% 50°
250,000 45% 45°
225,000
40% 40°
200,000
35% 35°
175,000
30% 30°
150,000
25% 25°
125,000
20% 20°
100,000
15% 15°
75,000
10% 10°
50,000
25,000 5% 5°
0 0 0
Jany Feb Mar. April May June July Aug Sept. Oct Nov. Dec.

GRAPH 4.

test for indicating the purity of milk. It is probably the most valuable test for drawing the line between clean and dirty milk.

3. The fermentation test gives a rough indication of the kinds of bacteria which predominate in milk. When clean milk ferments, it yields a smooth even curd free from gas bubbles and curd digestion, and unpleasant flavours and odours. The fermentation in this case is due chiefly to the " true " lactic bacteria, the germs which are used for " starters " in buttermaking and cheesemaking. When contaminated and " weeded " or " gargety " milk ferments, it develops undesirable properties, such as gassiness, curd digestion, and putrid or bitter flavours. It is our experience that the results of the test, in the case of milk containing coliform bacteria, may be fairly good. The curd in many cases is normal, except for the presence of a few bubbles of gas. In some cases no gas is evident. On the other hand, samples which do not contain coliform germs may undergo gassy fermentation due to the action of other bacteria and certain yeasts. This test is therefore of little or no value in determining whether milk has been contaminated with coliform or intestinal bacteria (and therefore with byre dust or dung). Its results may also be misleading in the case of very clean milk containing few or no lactic bacteria. Such milk may give very bad results by this test. Moreover, this test gives no indication of the bacterial content of milk. For example, in a series of tests (1000 samples) it was found that the proportion of good to bad fermentation tests did not vary whether the bacterial counts were over or under 30,000 germs per cubic centimetre. Its use, however, is justified in that it provides cheesemakers with useful information as to the cheesemaking properties of the milk.

A greater importance is being attached to a pure food supply owing to an increase in knowledge of the relationship of foods to the occurrence and spread of disease. In this connection the attention of the medical authorities and the general public has been focussed on the question of the milk supply, and as a result there is an ever-widening demand for pure milk. The clean milk movement is a serious effort on the part of the farmer, aided by the colleges, to put milk only of the highest grade of purity on the market and to prove to the general public that he is doing so. This movement is all the more to be commended in that it is a purely voluntary effort on the part of the farmer. In view of present day conditions and Government regulations he is finding that it is advantageous to have such tests made. The greater the number of farmers in this clean milk movement the greater is the weight of evidence that can be produced to prove to consumers that sound milk is being marketed. Farmers *can* obtain this evidence provided they adopt proper methods. A very high standard in the production of pure milk is attained by many farmers in the movement. Such a standard can be maintained only by continuous effort.

It has been suggested that the necessity for extremely low bacterial content is not so urgent in the case of milk that is to be pasteurised. Pasteurisation, however, is not a clearing process, and therefore it is quite as necessary that such milk should receive the same care in its production as milk sold unpasteurised. Pasteurisation can not be efficiently carried out in the case of highly contaminated milk. Under such circumstances many bacteria may survive the process and affect the wholesomeness and keeping properties of the pasteurised milk. This fact is recognised by large creameries, and therefore many of them, although they are pasteurising milk, are having bacterial tests made by the college. Pasteurisation should be regarded chiefly as a process whereby milk is rendered safe as regards infection from bacteria causing tuberculosis and mastitis ("weed").

The farmer has to overcome many difficulties in producing pure milk, and these difficulties are increased by the fact that the milk may not reach the consumer until twenty-four or forty-eight hours after milking. A great improvement in the purity of the milk leaving the farm may be effected by slight alterations in the existing methods and a little extra care on the part of the workers. In some cases it may be necessary to make alterations in equipment, and the farmer may be unwilling or unable to do this owing to the low returns obtained for milk. His buildings may be out of date and in need of repair, but this should not discourage him, as it is possible with proper care to produce clean milk even in an inferior type of byre. This has been demonstrated frequently in the results of clean milk competitions in the West of Scotland. There is no doubt that periodic bacterial and fat tests and the advisory work connected therewith act as a check on the work and are of great educational value not only to the farmer but also to his workers.

HISTORY AND DEVELOPMENT OF THE ROTHAMSTED AGRICULTURAL EXPERIMENT STATION.

ERNEST H. GODFREY, F.S.S.

THE present elaborate system for the conduct of scientific agricultural experiments at Rothamsted owes its origin to the life-long labours of Lawes and Gilbert, whose names will be honourably remembered for all time.

Establishment of the Experiments.—In 1822 John Bennet Lawes, then only eight years old, succeeded to the fine old ancestral manor of Rothamsted, near Harpenden in Hertfordshire. After education at Eton, and for a time at Brasenose College, Oxford, he studied in the chemical laboratory of Dr. Anthony Todd Thomson at University College, London, where he had for fellow-student Joseph Henry Gilbert, afterwards his life-long scientific partner. In 1834 he entered into possession at Rothamsted, and immediately began experiments with plants growing in pots, which were subsequently repeated on a field scale. An important early discovery was the high fertilising value of superphosphate of lime, which Lawes rendered soluble, and therefore immediately available as plant food, by treating bone meal with sulphuric acid. In 1842 he obtained a patent for this discovery and established a highly successful company for the sale of the new fertiliser, the business resulting in a considerable fortune for Lawes himself. In the following year (1843) Lawes established a chemical laboratory and engaged the services as chemist of his previous fellow-student, Dr. J. H. Gilbert, who at Giessen University had been a pupil of the great Liebig. The two worked together—Lawes the practical agriculturist, Gilbert the exact scientist—for nearly sixty years.

In 1847 Lawes contributed to the Journal of the Royal Agricultural Society his first paper on agricultural chemistry, whereby he definitely disproved the so-called mineral theory of Liebig, who claimed that field crops diminish or increase their yields in exact proportion to the mineral substances conveyed to them in manure. Liebig's theory had replaced the " humus theory " of Thaer, and now Lawes proved the importance of nitrogen as one of the most powerful elements of soil fertility.

Agricultural Appreciation.—Early testimony as to the practical value to farmers of these experiments was not wanting. In 1855, twelve years after their commencement in 1843, Mr. Denison, M.P., in a report on the agricultural section of the Paris Exhibition, stated that " English farmers have wisely accepted the teaching of Mr. Lawes, based on experiments on the accuracy of which full reliance might be placed, and the results of which were open to all." Public appreciation took more practical form when in the same year a laboratory at Rothamsted was erected by subscriptions amounting to £1,000 to replace the primitive barn-like structure till then in use. In 1882 Lawes was created a baronet in recognition of his services to agriculture; and in 1893 he and Dr. Gilbert celebrated the 50th anniversary of their fruitful partnership. Steps were then taken to give some adequate expression to the universal admiration felt for their splendid work and the gratitude due for the practical public benefits derived. The Prince of Wales (afterwards King Edward VII) headed the movement, and under an executive committee consisting of representatives of the Royal, the Royal Agricultural, the Chemical, the Linnean, the Highland and Agricultural and the Royal Dublin Societies, a fund of about £700 was raised, the subscribers numbering nearly 450 and including persons from all parts of the world. In addition to the presentation of illuminated addresses, it was arranged that his portrait in oils should be presented to Sir John Lawes, and that a piece of plate, suitably inscribed, should be presented to Dr. Gilbert. Hubert Herkomer, R.A., was commissioned to paint the portrait. In further permanent commemoration of the experiments, a monolithic granite boulder, quarried in Westmorland and weighing some eight tons, was erected in front of the Rothamsted Laboratory at Harpenden. Upon a polished panel in front of the boulder is an inscription stating that the stone was intended to commemorate the completion of fifty years of continuous experiments (the first of their kind) conducted at Rothamsted. The ceremony of presentation took place at Harpenden on Saturday, July 29, 1893, under the chairmanship of Mr. Herbert Gardner, M.P. (afterwards Lord Burghclere), President of the Board of Agriculture, and in the presence of a distinguished gathering of subscribers to the fund and others interested. The painting by Herkomer proved to be an excellent characteristic portrait of Sir John Lawes, and it is gratifying to state that this portrait, and also one of Dr. Gilbert, painted by Mr. Frank O. Salisbury, now adorn the walls of the present Rothamsted Laboratory buildings.

On August 11, 1893, Dr. Gilbert was knighted and thenceforward became known as Sir Henry Gilbert.

Life-Work of Lawes and Gilbert.—The scientific partnership, begun in 1843, was terminated 57 years afterwards by the death of Sir John Lawes on August 31, 1900. Sir Henry Gilbert died on December 23, 1901. Their experiments were unique in that they were conducted with such unfailing regularity and continuity over so long a period with the most meticulous attention to accuracy of detail and verification of results. Two main lines of inquiry were persistently followed, relating respectively to plants and to animals. For plants, the procedure consisted in growing the principal crops of a farm rotation, each separately year after year for many years in succession upon the same land without manure, with farmyard manure, and with a great variety of artificial manures. As a rule, the same description of manure was applied year after year upon the same plot. Rotation experiments without manure and with different manures were also made. The experimental crops included wheat, barley, oats, beans, clover and other leguminous plants, turnips, sugar beet, mangolds, potatoes and grass. In 1857 experiments were instituted to determine whether plants assimilate free or uncombined nitrogen, as well as various other collateral questions. Both leguminous and gramineous plants were thus grown. The conclusion arrived at was that our agricultural plants do not themselves directly assimilate the free nitrogen of the air by their leaves. But in 1886 Hellriegel and Wilfarth announced their important discovery of the part played by nodules on the roots of leguminous plants in the fixation of free nitrogen, and the whole question then assumed a different aspect. Gilbert, who had presided over the meeting at which Hellriegel first communicated the results of his famous investigations, at once appreciated the importance of the discovery; and a fresh series of experiments, conceived in its light, were undertaken at Rothamsted from 1888 to 1895. The results proved that when a soil growing leguminous plants is infected with the appropriate organisms there is a development of the root nodules with increased growth and gain of nitrogen. As a result of the knowledge thus acquired and confirmed, the inoculation of soil with the organisms necessary to promote the growth of leguminous plants has become a more or less regularly established agricultural practice.

The Broadbalk Field of 11 acres at Rothamsted, devoted to wheat experiments, has become famous amongst agricultural scientists the world over. Upon the plots in this field, wheat experiments have been continuously conducted since 1843 to the present time, a period of 87 years. Innumerable have been the practical agricultural lessons derived therefrom. One point brought out by these experiments was the fact that wheat may be successfully grown for many years in succession upon ordinary arable land, provided that suitable manure be applied and that the land be kept clean. Furthermore, the experiments showed that, even if unmanured, wheat could be grown with only a small annual diminution of yield. Begun in 1843, and allowing eight years for the exhaustion of original manurial applications, the annual average produce per acre of wheat upon the unmanured plot for the 46 years 1852 to 1897 was close to 13 bushels, a yield exceeding the annual average in 1900 of the whole of the United States and about equal to the average for the whole world. The latest figures of yield for this unmanured plot show an average in dressed grain of 11·8 bushels per acre for the 77 years 1852 to 1928. This yield is about equal to that of Canada in unfavourable years of drought, such as those of 1924 and 1929, when the average for the whole Dominion was 11·9 bushels in each case. The manured plots in this field have proved consistently the great value of farmyard manure, and also of the application, under proper conditions, of artificial manures, especially nitrogenous fertilisers. It is related that a visitor from beyond the Atlantic, talking to Sir John Lawes in Broadbalk Field, said : " Americans have learnt more from this field than from any other agricultural experiment in the world."

Other experiments have related to the mixed herbage of permanent meadows. Of 20 plots at Rothamsted, two were untreated, two received ordinary farmyard manure, and the remainder different artificial fertilisers. The effect of these varying treatments was very marked. Repeated analyses showed how greatly both the botanical constitution and the chemical composition of the mixed herbage varied according to the description of manure applied. They showed also how dominant was the influence of season, both as regards the proportions of the different species present and the conditions of development and maturity. As was stated in the Jubilee address from the Royal Agricultural Society, Sir John Lawes had " to the practical advantage of the farmer successfully employed readily available chemistry to modify at pleasure the entire character of the vegetation." The information supplied by these experiments is still being practically utilised for improving the yield and quality of hay and pasture, the beneficial effect of nitrogen having been first clearly demonstrated on these plots. They have also shown how to control herbage by varying the fertiliser and the reaction of the soil. The knowledge thus gained is being used to alter grass land and render it suitable for various purposes. It is being applied especially by the Golf Research Committee for the improvement of golf greens.

Incidentally, and mainly as part of the work carried on in the laboratory, the field experiments have elucidated a large range of scientific questions. Extensive sampling and analyses of soils, investigations respecting rainfall and the composition of drainage waters, the transpiration of water by plants and experiments on the assimilation of free nitrogen have been amongst the more important subsidiary questions thus studied and reported on.

In addition to their experiments with cereal and other crops, Lawes and Gilbert conducted almost equally famous investigations into the nutrition of animals. These included the consumption of food in relation to live weight; the proportion and development of organs or parts of different animals; the composition of animals under varying conditions of age and fatness; animal solid and liquid excreta; losses by respiration and cutaneous exhalation; and the influence of food upon the quantity and composition of milk. These experiments also produced classical contributions to knowledge on the sources of fat in the animal body, the characteristic demands of the animal body for nitrogenous or non-nitrogenous constituents; the influence of food in the exercise of force; and the comparative characteristics of animal and vegetable food in human dietaries. Sir John Lawes was the pioneer in establishing scientific bases for the valuation of unexhausted improvements under the Agricultural Holdings Acts, 1875 to 1923, and he presented to the Royal Agricultural Society his useful tables for estimating the dead weight and value of cattle from the live weight. So early as 1855, Lawes had in view the possibility of perpetuating the experiments after his death, and in 1889 he created the Lawes Agricultural Trust, with an endowment of £100,000, of certain areas of land and of the laboratory. This Trust, which is constituted of leading agricultural and scientific representatives, is the authority under which the Rothamsted experiments are still conducted.

Modern Developments.—After Gilbert's death in December, 1901, the Lawes Agricultural Trust appointed as Director of the Rothamsted Experimental Station Mr. (now Sir) Daniel Hall, then principal of the South Eastern Agricultural College at Wye, Kent. The new directorate, faced with peculiar difficulties in the efforts to bring up to date the work of an institution that had been conducted on fixed lines for so many years, and with financial resources limited to a comparatively small income from the Trust fund, decided that it was necessary in the first place to appeal to the public for further funds. This was done by the incorporation in 1904 of a "Society for Extending the Rothamsted Experiments," which still exists under the chairmanship of the present Duke of Devonshire. The appeal met at first with little response; but in 1906 the late James Mason, M.P., of Eynsham Hall, Oxfordshire, in memory of his father's interest in agricultural science, built the present Bacteriological Laboratory and provided the income for a Bacteriologist. Another munificent gift was made in 1907 when the Goldsmiths' Company provided an endowment of £10,000, the income of which, since augmented by the Company, is devoted to soil investigations. After his appointment as Development Commissioner, Mr. Hall found it necessary to resign the Rothamsted directorship. During his ten years' tenure of the office, Hall, on the scientific side, carried out important researches into the chemistry of the soil. He also did work of great value in popularizing and rendering intelligible to farmers the scientific results obtained. By his "Book of the Rothamsted Experiments" and other writings, he did much to change the attitude of farmers towards scientific inquiries, and to awaken in the rural community a more enlightened appreciation of the benefits of scientific investigations in all aspects of agricultural practice.

During the lifetime of Lawes and Gilbert the Rothamsted experiments were conducted at the cost of Sir John Lawes, and for some years afterwards they continued to be carried on solely by voluntary effort. With the establishment in 1909 of the Development Commission, Rothamsted, for the first time, came to be considered as eligible for the receipt of public grants, thus rendering possible the great recent expansion of the work. In 1912 Sir John Russell, the present Director, succeeded Mr. Hall. The work at first was continued upon the lines laid down by his predecessor, but it soon became evident that the increasing demands upon the Station would necessitate an expansion far beyond the limits then existing. At about this time, too, the old Testimonial Laboratory, erected in 1855, besides having become hopelessly out of date as regards facilities and equipment, began to show unmistakeable signs of subsidence and collapse. On the occasion of the centenary in 1915 and 1916 of the births of Lawes and Gilbert an appeal was issued for funds to rebuild the Laboratory. The Development Commission undertook to provide half of the amount required. Eventually, new laboratories for soil and plant nutrition investigations were completed in 1919, and in 1925 was opened a further block of laboratories for plant pathology. In 1926 the Station acquired the Experimental Station and Farm formerly conducted at Woburn in Bedfordshire by the Royal Agricultural Society, and thus became able to supplement the field experiments on the heavy soil at Rothamsted by similar experiments on the light land at Woburn. During recent years, also, local field experiments organised by the Rothamsted Station in different parts of the country have proved exceedingly helpful as part of the general scheme.

Present Organisation and Work.—The existing organisation of the Rothamsted Station is varied and complex, including numerous divisions and sub-divisions, but all subordinate to its fundamental purpose: the study of problems connected with soil fertility and plant nutrition. The Station consists of an Institute of Plant Nutrition with eight separate laboratories for bacteriology, botany, chemistry, fermentation work, insecticides and fungicides, general microbiology, physics, and statistics. Next is an Institute of Plant Pathology, with entomological and mycological laboratories. Separate departments exist for the field experiments and for the Station Farms. In addition to the Director (Sir John Russell), and the Assistant Director (Dr. B. A. Keen), who is head of the Physical Laboratory, there are altogether now on the permanent staff about 107 workers, in addition to post-graduate research and voluntary students from different parts of the world. The annual income of the Station is upwards of £30,000, which includes the Government grant of £27,000 through the Ministry of Agriculture, and £2,670, the income from the endowment provided by Sir John Lawes. In addition there is an annual income of variable amount received from subscribers to the Society for extending the Rothamsted experiments.

The Chemical Department is divided into three groups: (1) the soil; (2) fertilisers, and (3) the resulting plant. As regards the soil, the study is one of pure chemistry, and it includes the processes affecting the formation of the soil, and, especially as regards this country, the processes by which the soil has been modified through artificial conditions. This study is at present somewhat academic in character, but in this, and in other temperate countries, an outstanding feature is that a considerable amount of fertilising material has been washed out of the soil. In our country calcium carbonate is removed from the soil, whereas in drier countries, Canada for instance, nearly all the calcium carbonate is retained. By the washing out of calcium carbonate the soil tends to become acid, thus rendering important the study of soil acidity. Around Rothamsted, chalk, in days gone by, has been brought up from the subsoil and applied plentifully on the surface; but this process was not adopted for permanent grass lands.

Nitrogenous feeding of the plants is another form of investigation, and involves a study of the amount of nitrogen in rain water and in drainage waters. The manufacture of nitrogenous compounds with nitrogen obtained direct from the air has been a remarkable scientific achievement of the past 20 years, and has led to a great cheapening of nitrogenous fertilisers. Work at Rothamsted has been largely concerned with this discovery and its applications. Another line of investigation has been the manurial value of different basic slags, consequent upon changes in the processes of steel manufacture. Then there is the influence of soils and manures upon the composition of the plant, not merely in relation to yield but also as to quality. For instance, with regard to the newly-introduced sugar beet crop, there is not only the question of root yield, but also that of sugar content. With the potato there is the relative effect of chlorides and sulphates, and also the cooking quality and the composition of the tubers. The effect is being studied of the same manures on different classes of soil, as for instance on the heavy soils of Rothamsted and the light soils of Woburn. In co-operation with the Institute of Brewing, important experiments relating to the quality of malting barleys are being carried out at Rothamsted and at different outside centres.

In the James Mason Bacteriological Laboratory many problems are being studied respecting the function of micro-organisms in the soil, to which its fertility is largely due, and especially as regards the influence of nitrogen-fixing bacteria in the root nodules of leguminous plants. The principle of inoculation for the growth of clover crops is comparatively old now; but more recently it has been discovered that different crops require different kinds of bacteria. Not all clover crops benefit from inoculation, because such crops may already be well supplied with the particular organism used. The growth of lucerne—a crop introduced into England about 1650—has been mainly confined to the south-eastern quarter of England; but by the use of inoculated seed in soils where the proper organism is not naturally present its area of cultivation is being extended.

At Rothamsted the laboratory work is directed towards ascertaining the life-history of soil organisms and of those in the root nodules of leguminous plants. It has been found that the effect of phosphates is to increase the motility of soil organisms. These accelerate the migration of organisms through the soil, and so a more readily accessible supply of food is available for the growing plant.

Study is also directed towards ascertaining the number of different soil flora, and the methods of counting such flora have been improved. Thus, whilst formerly it was possible to count from 40 to 50 million different living organisms in a gramme of soil—a gramme being the equivalent of a saltspoonful—it is now possible to count as many as 3,000 millions of such organisms in a single gramme. This is effected on statistical principles by taking the number in a small given space and multiplying that number by the total space. As it has been proved that the distribution of soil organisms is a random one, the total count must be at least approximately correct.

Working in conjunction with the Fermentation Department of the Station, the Bacteriological Laboratory is studying the problem of the purification of the effluent from sugar beet factories, and also the synthetic production of fertilisers from waste vegetable products, including straw. After three years' experiments, a product was obtained similar in effect to farmyard manure. Where arable farmers buy store cattle for feeding to obtain manure at a cost of 10*s*. per ton or more, the synthetic manure, without animals, can be made for 7*s*. or 7*s*. 6*d*. per ton. The experiments which led to this discovery were expensive, but were carried through with the generous assistance of the Hon. R. Guinness, now Lord Iveagh. The product called "Adco" is on the market.[1] It is estimated that, in addition to farmers, about 20,000 gardeners in England and Wales are using it with satisfactory results.

Since the death of Lawes and Gilbert 30 years ago agricultural science has made immense progress, and every fresh discovery opens out new vistas and presents new problems. Whilst the field experiments of Lawes and Gilbert are rightly regarded as classical, it has been found necessary to institute fresh series on what are termed " replicated " plots, wherein by the application of modern statistical principles the experimental errors due to variability of soil or other factors are eliminated or reduced to negligible proportions. So, too, statistical science plays an important rôle in connection with the attempts now being made to correlate meteorological phenomena with agricultural data and crop results. Microbiology, fungology, bacteriology and mycology represent modern developments, each with its special lines of study and problems of absorbing interest and with possibilities of great importance for application to practical agriculture.

Publications and Library.—The results of the experiments as conducted by Lawes and Gilbert were, as a rule, communicated to the world by reports and papers in the journals of the learned societies, notably those of the Royal Society, the Royal Agricultural Society and the Chemical Society, and soon after its establishment in 1889 the Board of Agriculture arranged for the collection and binding in three quarto and seven octavo volumes of all the available papers issued from Rothamsted, and for their presentation to various national institutions throughout the world. At present the researches at Rothamsted are so complex and employ so many workers in different branches of science that the Rothamsted publications are correspondingly numerous and varied. They comprise technical papers relating to agriculture and its problems, papers of a general character, papers relating to crops and fertilisers and many relating to microbiology. They are being published in appropriate scientific organs. In addition, there are the publications of the Rothamsted Station itself, consisting of books and pamphlets for farmers, for students, for agricultural experts, for use in farm institutes and schools, and for the general reader.

In connection with recent developments, the Station has gradually built up a library of about 21,000 volumes, including some very valuable ancient works, amongst which is a copy of the rare 1432 edition of Fitzherbert's " Boke of Husbandrie," the first printed work on English agriculture.

[1] Sold by the Adco Co., Ltd., of Harpenden, Herts. The Company is financed by Lord Iveagh, and profits are devoted to further scientific research.

THE BIOLOGIST on the FARM.—No. XXXVII.

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Poison Oak.—In many beautiful parts of California among natural vegetation by the sides of woods and in the woods themselves there is a sinister abundance of Poison Oak or Poison Ivy, *Rhus diversiloba,* which is very troublesome to many constitutionally sensitive people. About one person in eighteen is said to be markedly susceptible. The poisonous plant belongs to the same genus as the common wayside sumac, which has a vicious variety usually restricted to the margins of swamps. The Californian species of poison oak, whose technical name is noted above, also occurs in Oregon and Washington, and there are two other closely related species in the eastern States. There are two habits of growth, (*a*) as stiffly erect shrubs springing from winding underground stems, and (*b*) as clambering plants on trees and walls, to which the stem clings by äerial roots like those of the English ivy.

The poison is in the sap of resin-canals which penetrate through and through the plant except in the old wood. There seems to be no poisoning unless the surface is broken. If the poison is not itself a resin, as some say, it is intimately mixed with a resin. "It is a clear amber-red, sticky, non-volatile liquid which floats on water." When liberated on the tree, it darkens and hardens into a black shiny varnish, reminding one that the sap of a related species forms one of the Chinese lacquers. Those unfortunate people who are very sensitive to the poison often declare that it reaches them from a distance, but experiments point to the conclusion that there must be direct contact with the plant, or with something which has touched the plant. Botanists say that the air-borne pollen is harmless, but this is vigorously denied by sufferers. Many people are not affected at all, and much seems to depend on the penetrability of the skin. Animals are not usually susceptible; cattle, horses and goats eat the poison ivy without ill effects.

The poison causes great irritation of the skin, then swelling and blistering. The effects last for a week or so. Very useful in early stages is iron chloride in the proportion of 5 per cent. to a half and half mixture of alcohol and water. Later on, the blisters must be treated like burns. As to the plants, the U.S. Department of Agriculture recommends spraying with kerosene or sodium arsenite solution, or treating the cut stems with sulphuric acid.

One cannot but ask what use it is to the plant to have this peculiar poisonous substance in its sap, like the formic acid in nettle-hairs; but, so far as we know, the question is unanswered as regards the poison ivy. It may be that the poison is a mere by-product of the ordinary chemical routine or metabolism, and without much significance.

Tenacity of Life.—In these pages we have repeatedly referred to the quality of grit that many living creatures show. While some are delicate—like flickering flames easily blown out—others have surprising firmness of foothold. We saw an eloquent instance the other day in the Yosemite Valley, near a place where the mountains rise sheer for 2,000-3,000 feet on either side, and the gorge is only about half a mile across. At a height of 1,100 feet above the level of the valley (which is 4,000 feet above sea-level) there was growing on a ledge of the vertical rampart of granite a single pine tree. To the unaided eye it looked like a small shrub, but it was 82 feet in height, 2 feet in basal diameter, and about 6 feet in girth—an isolated pine-tree perched on sheer wall of rock. What a conquest of life over difficulties!

Save the Redwoods.—Compared with Britain, it seems to us that America moves quickly when it moves. Thus as strangers in this strange land, we hail with cordiality the many efforts that are now being made to remedy earlier destructiveness. There are many reservation areas and sanctuaries, and the legislature seems to respond readily and rapidly to popular demands for the conservation of birds and beasts, flowers and trees. In the National Park at Yosemite we expressed a wish to have the merest twig of a big tree, *Sequoia gigantea*, to take home to Britain, just to make sure for ourselves that the tree was the same as the beautiful imports which we call Wellingtonias, as is indeed the case. The driver of the sight-seeing car, which had stopped opposite a planted Sequoia in the low grounds of the valley, gave us to understand, with characteristic American nonchalance, that we might take a twig if we pleased, but at the price of a fine of 25 dollars. This is the proper spirit, expressing a sense of the irreplaceable preciousness of noble living creatures. The only macroscopic animal that one is allowed to kill in the National Park is the rattlesnake. Similarly, in other parts of California, there are " Save the Redwood " societies, which seek to check the careless destruction of the other species of giant tree, *Sequoia sempervirens*, which grows on the coastal slopes. It has served to build many towns, and there is still an abundant supply of its valuable timber; but there is need for realising its preciousness, for these Sequoias are the oldest living creatures in the world and relics of an ancient race, once of much larger range.

The general principle, as applicable in Britain as elsewhere, may be stated as follows. Except in rare cases, where living creatures prejudically affect wholesome human interests or endanger what may be called the higher values, every effort should be made to preserve noble living creatures which are threatened with extermination, especially at man's hands. The reasons for this are manifold: that a living creature, an heirloom of the ages, can never be replaced if it is lost; that most plants and animals are things of beauty which should be kept as joys for ever; that many organisms play an important part, as yet imperfectly known, in preserving the Balance of Nature; and that man must think of himself as the trustee of the whole Kingdom of Life, which includes many plants and animals whose secrets are but imperfectly read. As to creatures that threaten man's wholesome interests, which do not include egret plumes, and man's higher values, such as health and serenity, a menacing increase in their numbers is usually due to man's interference with the Balance of Nature. Thus the persecution of birds of prey and beasts of prey is sure to be followed by an increase of troublesome pests such as rats and mice, and if the destruction of the destroyers is necessary, as in the case of some poisonous snakes, like the Rattler, man must discover some way of accentuating some other form of check. And as to parasites in or on his own body, which must, of course, be destroyed, their prevalence is largely due to careless eating and drinking, or to lazy habits of life. We are far from saying that the conservation of fine forms of life is an easy task, but what man can often do is to lean his weight on the side of the finer forms of life, as opposed to the cruder. It is deplorably bad business that Britain should lose reindeer and gain rats, or lose ospreys and gain cockroaches. But part of the difficulty of man's trusteeship is involved in his irrepressible and invaluable impulse to play an experimental part in Organic Evolution, e.g. in introducing newcomers into an old country, whether rabbits into Australia or European sparrows into the United States. What can we say save that every deliberate introduction should be carefully considered by a biological committee of the Foreign Office. Well may one say: Who is sufficient for these things? But that is not to hinder us from intelligently leaning our weight on the right side.

Primitive Exploitation.—In early days, before history began, it was natural enough that man should pit himself without compromise against his enemies among the beasts, and should seek to make the most of any opportunity he had for utilising the rest of creation. Ideas like the Balance of Nature and the Web of Life were not as yet above the horizon, and it is probable that primitive man took a long time to learn that it is unwise to kill the goose that lays the golden eggs. Many men have not learned this lesson even in 1930 A.D., though it is interesting to notice that fur-farms (for fox, skunk, ermine, and the like) are now being successfully and profitably established in such territories as Alaska, which are still teeming with wild mammals. Our present point is that we must not be too superior and unsympathetic in our attitude to men working for their living near the margin of subsistence. We may try to prevent their extermination of animals that are threatened with extinction, but we must find them another livelihood, and we must not think of them as ruthless destroyers.

An instance of the survival of primitive exploitation came recently under our notice on the Californian coast, where there are several kinds of seals and sea-lions that need all the protection they can get, such as those which are readily seen from the shore at the Golden Gate leaning out of the Bay of San Francisco into the Pacific. These attractive seals and sea-lions require protection and they are getting it; yet not many years ago it was a very natural thing for an unsophisticated hunter to row out to an island and come back with a seal or two. The animal meant such a lot to him, and the idea of regulating the hunting was still far distant. From a leaflet of the beautiful Santa Barbara Museum of Natural History (February 1930) we cite a first-hand narrative of such experiences on the Californian coast about fifty years ago (1875-1879).

"In those days," says Mr. E. F. Rogers, "my brother and I owned a fifty-ton schooner, and were engaged in killing seals (Californian sea-lions) for their oil. We used to go in June to Flea Island off San Miguel, where there was a large seal rookery. The seals were so plentiful that if they had stayed quiet enough, a man could have walked over the whole island on their backs. We used to take a big kettle, set it up on the island and try out the blubber in it, feeding the fire with strips of fat. In one season we used to get fifty to a hundred barrels of oil. This we sold to paint dealers in San Francisco for about 50 cents a gallon. The skins we sold to a tannery in Oakland for 5 to 7 cents a pound. The leather was used for belting. The genital organs of the bull seals we sold to the Chinese. As one Chinaman said, 'Mandarin no catchum child. He eatee these, he catchum child quick.' From each bull we also got from six to eight of the stiff whisker hairs. The Chinamen set these in silver or gold and use them for toothpicks." The story is in one aspect lamentable, for the fine creatures are on the downgrade as the result of greedy persecution, but our point is that the exploitation without remorse was natural fifty years ago in a way that can never be possible again. In any case we cannot but admire the thoroughness with which all parts of the sea-lion were utilised—even to the whisker-hairs!

The same Mr. Rogers got the last of the sea otters off the Californian coast about 1875, when the skins were worth from 250 to 500 dollars. This unique mammal is now almost extinct, and when it vanishes, the world will be the poorer. The Director of the Museum adds: "We shall probably never again see a sea-otter's sleek brown head above the kelp. They are gone like the passenger pigeon and the buffalo. Th sea-lions still roar in the caves of the Channel Islands off the Californian coast. The fishermen grudge them the fish which they eat, but we hope that the increasing feeling for preserving wild life will ensure our grandchildren the sight of some wild creatures larger and more interesting than a ground squirrel."

This story may seem a little irrelevant, but the Biologist on the Farm is wandering just now, and, after all, the idea of conserving lives worth saving, and of making the most and the best of all, is as applicable to a Scottish farm as to a Pacific island. The principle is the same and the interest too!

Papaya Growing.—Part of the charm of California is the abundance of sunshine, and this means that green plants have a generous supply of radiant energy which they change into the potential energy of sugar and starch, proteins and oils, and other valuable foods. If there is water enough—sometimes a big " if " —plants can do wonders in the way of growing and fruiting. Thus it often becomes of great value to the farmer when he can produce some favourite fruit or vegetable at a time when other States are not doing so. Few things pay so well as fruits out of season! As to growth, if we go to the Big Trees, which fill our mind day after day, we must remember that all these colossal masses of timber represent the tree's utilisation of captured sunshine, just like our coal measures. One of the largest of the Redwood giants contains potentially 426,000 square feet of inch-thick timber, a fact more picturable, perhaps, when we say that this amount would serve to build forty five-roomed cottages. Another way of putting it is that on August 26th, 1919, seventy-two sailors got inside the base of a hollow big tree!

A visit to California is very encouraging to a fresh eye because of the rapidity with which man can make a desert blossom like the rose. At the Golden Gate Park at San Francisco, a stretch of sand-dunes and little else has been transformed in a few years into an earthly paradise of gardens and parks, playgrounds and golf links. The magician in this case was a Scots city gardener, but there are many with similar persuasiveness; and the only condition of the magic is water. Fancifully, we cannot help feeling in this country that Nature is friendly even when this is not what her first appearance suggests. We have seen in California many different kinds of farms, from orange-groves to bulb nurseries, from walnut-orchards to acres of Calla lilies, from miles of artichokes and brussels sprouts to vineyards creeping up the mountains; but the strangest culture that we have come across as yet is that of Papaya. This plant, of South American origin, has become abundant and popular in South Africa, and now it is being introduced by an energetic cultivator, Mr. John Harvey, into California. Its virtue is in the digestive ferments which are so abundantly present in the fruit that its use at breakfast makes the dyspeptic eupeptic for the rest of the day. The ferments are present in some other parts of the plant, for the leaves are sometimes wrapped round chickens to make them tender before cooking. Thus Papaya is being used to make digestive tabloids and also as a digestive fruit at meals; and the enterprising grower's hope is that it will be a great success in California.

The Papaya is also called the Cantaloupe Tree, but it really is a herbaceous plant growing to the height of a giant sunflower. There are several species. The fruits are large, and there may be 200 on one " tree." As a breakfast fruit it is likely to go far because of its peptic ferment. It is also used as a component of fruit salad, or along with lettuce, or in preserved form. On the same farm there is a cultivation of the Australian edible

Passion-Flower, which is said to be of great merit. It is grown like a grape-vine or trained on pergolas and trellises. The tough-skinned fruits are "excellent long distance shippers," and "taste like the Elixir of Life mixed with ambrosia and sparkling "—a notable eulogium in this dry country! But one wishes success to everyone who grows something new.

Plants Watering Themselves.—In many ways Southern California is an earthly paradise, but there is often a cry for water. The very high sunshine record dries up the soil; the luxuriant quickly-growing vegetation means an incalculable imprisoning of water in living matter and in organic compounds. There is a tendency towards desert, and the permanent desert is not far distant. No doubt the background of mountains must mean a considerable precipitation of the water-vapour borne in by clouds from the Pacific, and it is one of the many surprises in a sun-bathed—indeed sun-baked—town like Los Angeles to lift one's eyes (we are writing towards the end of February) and see through the glare the snow-capped hills not many miles away. Much depends, of course, on the streams from these hills, but the supply of water is not equal to the demands made by the irrigators, and progressive efforts are being made to tap new sources. It seems likely that some ten years hence there will be a utilisation of the large volume of water in the Colorado River, which is responsible for the Grand Cañon.

It is interesting to notice the success of plants of the cactus habit, which have reduced their transpiration surface and increased their water-storing tissue. But another feature has impressed us in the coastal region, which is subject to coastal fogs, i.e. to a saturation of the atmosphere with water-vapour borne in from the sea. We had thought of this humidity as keeping the exposed parts of the plants comfortably moist, but we had not realised vividly enough that the water-vapour, condensed on the surface of the leaves of trees with rich foliage, sinks as droplets to the ground and may thus eventually reach the roots and be most beneficially absorbed. Thus some plants water themselves effectively and flourish greatly—the Redwood trees being the finest instance of all.

CARROT GROWING IN GARDENS AND ALLOTMENTS,

With Special Reference to the Control of Carrot Fly.

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Probably no other vegetable has been so much the hope and despair of the gardener as the carrot, and the patience, perseverance and renewed attempts devoted to its cultivation in gardens and on allotments are remarkable. This state of affairs is due to determination to overcome the difficulties, to the achievement represented by well-grown, clean specimens, their general utility, and to the fact that the carrot is an "all the year round" vegetable.

There are no difficulties involved in the actual growing of the carrots; they are easily cultivated so long as reasonable attention is given to their peculiar requirements. The whole trouble is due to attack by the Carrot Fly, which is the cause of the cankered, undeveloped roots so well-known to gardeners all over the country. The persistence of the pest and consequent disaster to the crop have been the means of bringing all the ingenuity of the gardener to bear upon the subject, with the result that all sorts of contrivances and devices—some of which are guarded as close secrets—are in vogue annually.

Cultivation.—*Soils.*—The most suitable for carrot growing are sandy soils and sandy moss or peat; others include light and medium loams and alluvial deposits, the least favourable being clay, thin and gravelly soils and loams of boulder clay origin, and old vegetable garden moulds. Many of the last-named soils, owing to generations of wrong methods of tillage and to the use of dung alone in excess quantities, are little more than a rank, sour mass of organic matter.

Rotation and Tillage.—Carrots are not exacting in their demand for manure, under average garden conditions, and no difficulty should be experienced in placing the crop in its proper place in a simple scheme of rotation in the vegetable garden or allotment. Dung for carrots should have been applied to a previous crop, and arrangements should be made for them to follow cabbage, cauliflower, leeks or celery.

As it is of some importance that the soil for carrots be deeply and thoroughly cutivated, careful consideration should be given to the character and requirements of different soils. With this in view, it will be found that favourable growing conditions will be secured by cultivating heavy soils during the autumn. The necessary digging of soils of a medium character, such as loams, might be carried out during winter, whereas February or March would be a suitable time for cultivating light sandy soils. The double-digging process should be adopted in all cases, and as the work proceeds the surface should be ridged so as to expose it to the beneficial effect of weather conditions till the time for seeding arrives.

Manuring.—Where the rotation recommended cannot be adopted, such as in the case of a new garden or allotment, or where vegetables are not grown, as they should be, in sufficient variety, a dressing of well-made farmyard manure at the rate of three good barrow loads per square rod, or about 20 tons per acre, should be dug in during the autumn. Where necessary, such as in old garden soils, a dressing of ground lime should be applied at the rate of 9 lb. per square rod, or 12 cwt. per acre, sown broadcast some three or four weeks previous to seeding.

Artificials should be applied—perhaps a day or two previous to seed sowing—as follows :—

For old garden soils and heavy loams where a good scheme of rotation is being practised :—

1 part superphosphate (18 % P_2O_5),
1 ,, steamed bone flour,
1 ,, sulphate of potash (48 % K_2O),
½ ,, sulphate of ammonia.

For light and thin soils and for new gardens and allotments :—

1 part superphosphate (18 % P_2O_5),
1 ,, steamed bone flour,
2 parts potash salts (30 % K_2O),
1 part sulphate of ammonia.

After being thoroughly mixed, the artificials should be applied broadcast at the rate of 1½ oz. per sq. yard, 3 lb. per sq. rod, or 4 cwt. per acre. (A second application at the same rate should be sown carefully between the rows about ten days after singling.) The manure, together with any available soot and wood ashes, having been applied when the soil is sufficiently dry, the ground should be gone over very lightly with a graip or digging fork, when all clods will be broken down and ridges, if any, will be reduced and levelled out. This greatly improves the texture, a fine tilth is obtained, and the artificials are thoroughly incorporated with the soil.

Carrots do well under firm soil conditions, and at this stage of the operations the plot, under average soil conditions, should be tramped lightly but evenly from end to end and then from side to side so as to cross the previous tracks at right angles.

The plot should then be carefully raked from end to end and crosswise if need be; stones and refuse can be removed, and an even surface and the necessary fine tilth for seeding will be secured. In all cases the greatest care should be taken in this preliminary work, as the coarse, unshapely carrot roots so frequently seen are the direct result of negligence in the manuring and preparation of the soil. (See Fig. I.)

The demand for young carrots during winter and spring has led to their limited cultivation in frames on the French garden system. Further early supplies may be obtained by sowing for succession on sunny, sheltered borders from the end of February onwards. The main sowing, however, will not be made till about the end of April or early in May, according to earliness or lateness of district. Drills, or rows, should be 10 to 15 inches apart, the greater spacing being adopted for late supplies and for varieties of the Intermediate and St. Valery types. In all cases seed should be sown in shallow drills running north and south, on carefully levelled ground, except on heavy clay soils, where better results will be obtained by sowing in ridged drills 18 inches apart.

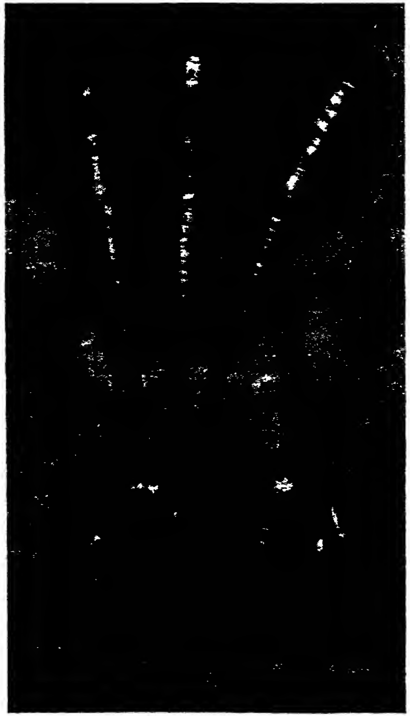


Fig. I.

Above—Shapely roots as grown in good soil

Below—Coarse roots as grown in unsuitable and badly prepared soil.

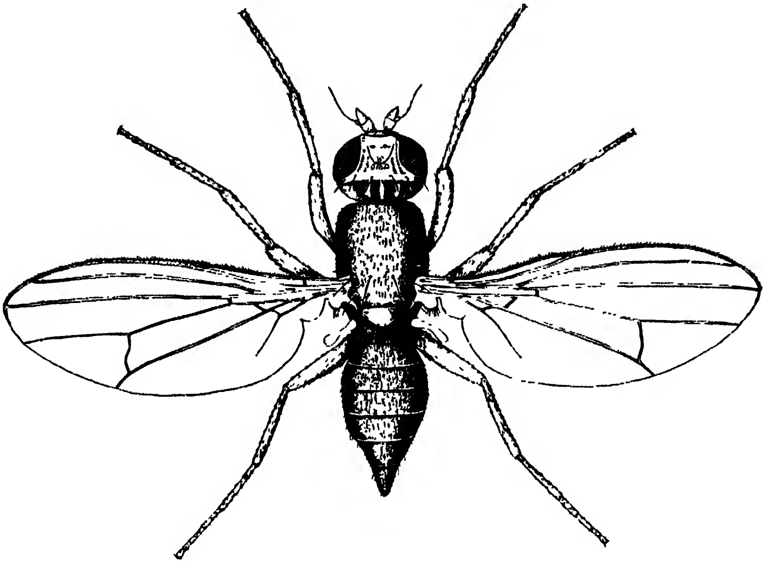
Fig. III.

Above—Clean roots from naphthalene plot.

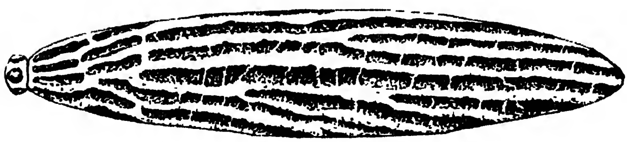
Below—Cankered carrots from control (untreated) plot.

[Fig. II.

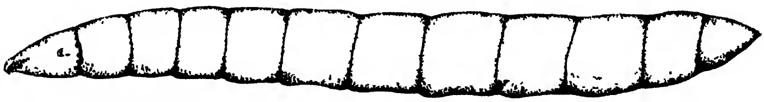
Fig. II.



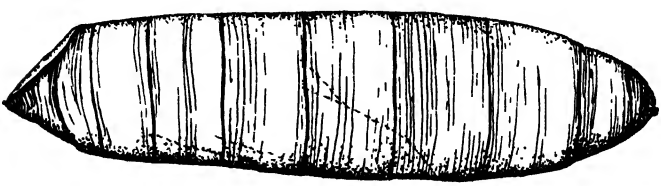
(*a*) Female Carrot Fly. [*Psila* rosæ (Fabr.)]
(Natural size 1/5 inch long and 1/2 inch across wings.)



(*b*) Egg of Carrot Fly. (Natural size 1/50 inch long.)



(*c*) Mature larva of Carrot Fly. (Natural size 1/3 inch long.)



(*d*) Puparium of Carrot Fly. (Natural size 1/5 inch long)

[Figure II (*a*)–(*d*) drawn by G. D. Morison.

Varieties.—Carrots are available in sufficient variety to meet all requirements. French Forcing is a good sort for frame work, to be followed by early out-door sowings of Nantes and Early Horn, and later, for succession, by Market Favourite, Stump-rooted, Intermediate sorts and Long Red Surrey. St. Valery will be found to be the most suitable sort for late supplies. Early Horn is larger, sometimes coarse, and has much more core than Nantes, which is the best early carrot for general purposes.

Seeding.—Seed sowing must be looked upon as an operation of first rate importance in carrot growing, and all reasonable care should be exercised, as it is in reality the first step in our defence against the Carrot Fly.

It may be assumed that there are between 23 and 24 thousand seeds to the oz., and as the germination rate is, as a rule, fairly high, every effort should be made to sow evenly and thinly at the smallest possible rate consistent with ordinary methods. Even a beginner should aim at sowing at the minimum rate of 1 oz. of seed to anything between 300 and 500 feet of drill, the special object being to sow sufficiently thinly and evenly to reduce singling to the lowest possible minimum. Even then a certain amount of thinning will be necessary, and this should be carried out at an early stage. Should showery weather set in when the seedlings are about 1 to 2 inches in height, advantage should be taken of these favourable conditions, and the carrots should be thinned out to, as nearly as possible, 3 to 4 inches apart in the row, care being taken to remove all thinnings from the ground as the work proceeds.

It is commonly recommended to thin out the seedlings to 6 inches apart, and where this is done—assuming the rows to be 12 inches apart—the average weight per root must be 6 oz. in order to obtain a crop equal to 14 tons per acre. A 6 oz. carrot is often somewhat coarse, and for that reason undesirable. The most useful size of carrot will be found to weigh about 3 to 4 oz., and for that reason care should be taken not to over-thin.

It is interesting to note that where carrots are singled to 3 inches, with 12 inches between the rows, this would give approximately 140,000 plants, and assuming the average weight of the roots to be 3 oz., the crop would be equal to 15 tons per acre.

An exhibitor adopting a spacing of 12 × 15 inches when singling would require carrots averaging 1 lb. to obtain a crop that would compare with that obtained under field conditions. In singling carrots, therefore, one would be better advised to leave too little rather than too much space, as it follows that, the greater the spacing, the more difficult it becomes to produce a satisfactory crop of good quality per acre.

The Carrot Fly. (See Fig. II.)—The havoc wrought by the Carrot Fly is well-known all over the British Isles where the growing of carrots is attempted within the shelter of the garden or allotment. The pest itself, however, and its mode of attack would appear to be imperfectly understood, as, in many cases, a good deal of time and material is devoted to the special preparation of the soil as a means of dealing with the pest during winter and early spring. A little careful study of the habits and life history of the "fly" would show that any previous treatment of the soil must be quite useless.

The insect (Fig. II (*a*)) is shiny black in colour, and in size much smaller than the house fly. It appears on the wing during May or June, sooner or later according to locality, weather conditions and earliness or lateness of season. It deposits its eggs in the soil near the young carrot plants (Fig. II (*b*)), preferably in small cracks or openings in the soil, and sometimes on the leaves of the seedlings. The maggots or larvæ (Fig. II (*c*)) are yellowish in colour, legless, and may be about one-fourth of an inch in length when full grown. The tiny newly-hatched grub in the first instance works its way downwards in the soil along the outside of the carrot root, which it is as yet unable to damage. Having penetrated to the full extent of the root, the grub now commences to feed upon the tender tip, and, as it gains in size and strength, works back towards the surface, eating, tunnelling and destroying the outer layer of tissue. The larvæ when fully fed pupate in the soil, where those of the last generation pass the winter in the shape of small brown puparia (Fig. II (*d*)).

There would appear to be at least two generations of flies in one season, and although June and July is the critical period, we have observed in our trials that occasionally we get a slight attack in August and September, and long after the time when it was considered that further applications of the preventive treatment would be necessary. It is recognised, however, that this does not afford proof of later broods; the occurrence may be explained by delayed developments from the second or even a first generation.

The utter futility of previous treatment of the soil with chemicals as a remedial or preventive measure will thus be apparent; the real danger is from above and not from the soil. It must also be clearly stated that, once the fly has been allowed to deposit its eggs amongst the carrot plants, nothing can be done to save the crop. To accomplish the destruction of the pest as it attacks the crop, treatment would require to be of such a lethal kind that the plants would also be destroyed. Remedies are therefore ruled out as unsuitable and unpractical, and control must depend solely upon preventive treatment.

Symptoms of Attack.—The leaves of affected plants wilt, turn yellow and develop a reddish fringe, giving a clear and characteristic appearance so distinct as compared with the foliage of normal plants that a glance is sufficient to indicate whether the crop is affected or free from attack. In a slight attack, growth is arrested and the roots may be so badly "cankered" as to be almost useless, whereas in a severe attack the whole crop may be completely destroyed. (Fig. III.)

The sense of smell in the Carrot Fly and similar insects is very highly developed, and it is quite unlikely that the fly would be able to locate the carrot crop or distinguish between the carrot and other crops in the garden by its limited sense of vision. Practical experience furnishes ample evidence of the fact that the fly is attracted to the crop solely by its sense of smell. In proof of this it will be sufficient to mention the common experience whereby undisturbed carrots invariably escape the attentions of the pest. There is also the case where the seedlings remain free from attack up to the time for singling, when, in the absence of treatment, the pest is attracted and the remaining seedlings are often destroyed within the next few days.

Perhaps the most interesting case of all, in this connection, is the somewhat ancient method of growing onions and carrots in the same drill, a method frequently resorted to in gardens where, apparently, it was impossible to get roots free from "canker" when the carrots were grown as a separate crop. Their immunity when grown side by side with onions in the same drill has, in the past, been the subject of much wonder, discussion and speculation as to the cause. The obvious explanation is that the pungent odour of the onions, masking the natural smell of the carrots, provided an effective barrier and the pest was unable to locate the carrots.

Treatment.—Of the numerous ways and means devised to circumvent the attentions of the "fly" may be mentioned, as examples, amongst others—early and late sowing, transplanting, the sowing of mixed onion and carrot seed in the same drill, large holes filled with a special light compost on the surface of which two or three seeds are sown; of materials used in different forms as preventive or remedial measures may be mentioned—paraffin, naphthalene, tar oil, creosote, crude carbolic acid, sheep dips, soot, lime, salt, proprietary articles, lawn mowings and others.

Of the methods widely employed, most are unpractical in operation and, at best, enable one to grow carrots only on a very limited scale. Most of the materials mentioned require careful dilution; others must be mixed with sand, soil or other material to enable one to apply them with safety. Those which are not mere nostrums are considered to be too troublesome in preparation and application, and in the use of these, although the grower begins with the best intentions, the regularity of the applications become interrupted during the busy season and the crop readily becomes a prey to the Carrot Fly.

Some seven or eight years ago our experiments dealing with this matter, at Craibstone, near Aberdeen, were narrowed down to the use of paraffin, crude carbolic acid and naphthalene. Finally, the superiority of naphthalene became so firmly established that for the last six years no other material has been employed on the plots at our demonstration centres.

Our method is now being widely practised in the area of the North of Scotland College of Agriculture, and to some extent outside the College area. Many growers, in all classes, have expressed themselves as delighted with the results, and not a single instance of results proving less than we claim for the treatment has come to our knowledge. Our long experience with the treatment, together with results obtained by others who have adopted it, gives us confidence in our claim that the naphthalene treatment has been the means of removing all previous difficulties in the growing of carrots in gardens and on allotments.

Not the least important part of our method is the simplicity of the treatment, the procedure being as follows. When the carrot seedlings are well above ground, which may be towards the end of May or beginning of June, crude or flake naphthalene should be sown broadcast over the carrot bed, or plot, at the rate of 1 oz. to 2 sq. yards, or, say, 1 lb. to 40 sq. yards, further applications being given at the same rate at 7-day intervals till the end of June, when three further applications might be given at 10-day intervals. The whole treatment would involve 6 to 8 applications at a total cost of 2*s*. to 2*s*. 6*d*. for a plot of carrots not exceeding 40 sq. yards in extent.

To protect all the carrots that would be grown in the average garden or allotment by the use of crude or flake naphthalene the total cost should not exceed 1*s*. to 1*s*. 4*d*. It should be possible for anyone to purchase either of these forms of naphthalene from seedsmen, horticultural chemists or sundries-men at a cost not exceeding 4*d*. per lb. Ground crude naphthalene is a grey or dark coloured powder, and although a little sand may be added as an aid to distribution, it requires no dilution or preparation of any kind. It is easily purchased, easily applied, and there is no danger of the carrots becoming tainted with the material so long as the instructions are carefully followed.

Although both kinds of naphthalene can be used with equally reliable results, we prefer the purified or flake naphthalene, which is a pure white flaky material, hence the applications can be seen as they are given to the carrot plot, whereas the crude material, being dark in colour, is invisible when applied. The flake is lighter and more economical in use, and if purchased in not less than 7 lb. lots the cost should not exceed 4*d*. per lb., and will probably be less.

Finally, we claim for our method of naphthalene treatment that it is a thoroughly practical, simple, esonomical and most effective means of growing clean carrots, free from "canker," in the garden or on the allotment.

I have to acknowledge the assistance of Mr. Guy D. Morrison, B.Sc., Ph.D., first, for his useful suggestions, and secondly, for his valuable drawings of Fig. II illustrating the various stages in the life-history of the Carrot Fly.

INSECT PESTS.—No. VIII.

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

Moths—*continued.*

Swift Moths (*Hepialidæ*).

Of the nine European Swifts five are British species. The moths are moderate in size with all the four wings somewhat elongated and narrow and almost the same size. The mouth-parts of the adult are rudimentary so that no food is taken; the life of the moth is therefore short.

The caterpillars, which have the typical sixteen legs, look very like one another, but there are certain features which help to make one sure that the caterpillar is that of a Swift, viz. the caterpillars live underground at and inside roots and stems; they are white in colour with brownish-yellow heads; there is a brown horny shield on the upper surface of the joint behind the head; they are extremely active wrigglers when one handles or disturbs them; and if one examine, with a hand-lens, the sole of the abdominal feet, a circle of hooks will be seen running right round the foot; the lens will also reveal little dots scattered over the skin each carrying a hair.

The pupæ are also characteristic; the body is elongated, and on the upper and lower surfaces are horny spines or ridges by means of which the pupæ can come to the surface for the escape of the moths.

For description we take two species common from south to north—the Ghost Swift Moth and the Garden Swift Moth.

The Ghost Moth (*Hepialus humuli*).—The common name is due to the colour of the male, whose four wings are silvery white. The fore wings of the female are yellow-orange with wavy brownish markings; the hind wings of the female are greyish (this is sometimes the case with the male). In both sexes the under side of the wings is brown. The males are conspicuous in the twilight as they sway and hover to and fro, and the attracted female drops to the ground with a male and pairing follows. There is a variety in Shetland—with its very light summer nights—where male and female have almost the same colour of wings.

The moths are found in flight in June and July. In Mid-lothian I have found eggs being laid in the third week of June. Further north times can be later. Thus pupæ which came from Cromarty at the end of July yielded their moths in the third week of August.

The fertilised females drop their eggs as they fly over low plants. The caterpillar, on hatching, passes to the roots of such plants as grasses, and a number of garden vegetable and other plants, including such weeds as dock and dandelion. The caterpillar passes the winter as caterpillar; full-fed in the next late spring or early or late summer, the caterpillar pupates in the soil under cover of a delicate cocoon from which, when ready, the pupa wriggles free so as to reach the surface.

The moth has a wing expanse of $1\frac{1}{2}$ to $2\frac{3}{4}$ inches; the full grown caterpillar measures an inch and a half.

The Small Garden Swift Moth (*Hepialus lupalinus*).—This is a smaller species measuring up to $1\frac{1}{2}$ inch in spread of wings. It is not so common in Scotland as the last. Both sexes are more or less alike. The front wings are yellowish or reddish-brown with a pronounced pale line and spots; in the female the pale markings are much less clear; the hind wings are grey-brown. As with the last species, there is considerable variation in colour and pattern.

The life-history resembles that of *H. humuli*. The caterpillar has a great range of food plants, the underground parts of garden vegetable and flower plants, and also strawberries and raspberries.

The caterpillars are troublesome to fight. Where the plants allow, the working of the soil with the disturbing and turning up of the caterpillars is useful. Bulbous plants that are suffering should be lifted and replanted. As an insecticide powdered naphthalene has some value, 1 oz. to the square yard, worked into the soil.

The Family of Clear Wings (*Sesiidæ*).

The moths of this Family have clear glassy wings with conspicuous dark veins, and so differ from moths and butterflies in general whose wings are covered with scales. Further, while most moths fly at dusk or at night the Clear Wings fly actively in the sunshine. Their bodies are banded and coloured like wasps, for which they are often mistaken.

As an example of this Family we take the Currant Clear Wing Moth (*Aegeria tipuliformis* or *Trochilium tipuliforme*), an enemy of currants, black currants suffering most. The moth has the wings characteristic of the Family; on each side of the thorax is a yellow stripe, and there are four yellow rings on the otherwise dark body; the abdomen ends in a fan-like tuft of hairs.

The moths are found flying in June and July. The female lays her eggs on currant shoots. The caterpillar on hatching eats into the branch and reaches the pith, which is then tunnelled. The caterpillar is yellow-white with a brown horny head; the body has warts bearing hairs; the legs number sixteen. The caterpillar spends the winter in the bored shoot and pupates in the tunnel after preparing an escape hole for the future moth. Pupation takes place in April or May, and when the moth is ready the pupa, aided by a series of spines, wriggles partly out of the prepared hole and the moth issues from the ruptured pupal-skin. The spoiling of the shoot reduces feeding area, with consequent loss of fruit.

In concluding this review of moths of importance in Britain to the farmer, market-gardener and fruit-grower, we shall select the remaining examples from the great section of Micro-Lepidoptera, the moths chosen being small, scarcely reaching an inch in spread of wings, and easily passed over by the general observer unless when their numbers are much above the average.

The Codling Moth (*Cydia pomonella*).—This is a moth which has been carried all over the world in commerce and is now found wherever apples are grown. How the insect is spread will be understood when one knows that the caterpillar spends its life inside the apple, not leaving the apple until it—the caterpillar—has completed its growth, and then only to seek a shelter place, make a cocoon, and pupate. Now, full grown caterpillars may leave infested fruit while in transit and form cocoons in the crevices and corners of crates and packing cases from which in a new country the moths may escape into the open

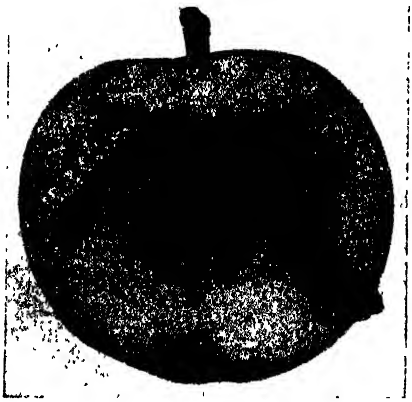


Fig. 1.
Nature of damage done by Caterpillar of the Codling Moth.

air; or caterpillars may issue from fruit carried to another district or country and stored for some time.

In warmer countries the Codling Moth is a much more serious enemy than with us, for abroad there may be two and even three generations in the year; the usual thing in Britain is one generation in a calendar year.

Besides the apple, the pear, the quince, and some other Rosaceous fruits are host plants for the caterpillar; outside of the order Rosaceæ, walnuts, e.g. in England, may be spoiled by the Codling; the caterpillar must in this case be careful to escape from the kernel before the shell has hardened. The Codling Moth is one-third inch in length and has an expanse of wing of less than three-quarter inch. The front wings are grey, with wavy brown lines; a special feature is a large brown patch at the outer edge of each front wing; the hind wings are grey-brown and lustrous. The moths rest during the daytime on trunk or twig, with the wings held somewhat roof-like over the body, and so resting, easily escape notice. The moths may be found at the end of May or June.

The female lays her eggs singly on the very young apple and sometimes on twig and leaf. The eggs are flat and scalelike. On hatching the caterpillar enters at the calyx end or eye of the apple—as a rule—and eats to the centre, where it nourishes itself on core and pips.

There are other two kinds of caterpillar or larva which live in the apple fruit and are sometimes confused with the Codling caterpillar. The three kinds of caterpillar are distinguished thus :—

Codling Moth Caterpillar.	*Apple Sawfly Caterpillar.*	*Apple Fruit Miner Caterpillar.*
Has 16 legs.	Has 20 legs.	Has 16 legs.
Pinkish white or cream white in colour.	Whitish yellow, with a dark plate on the last joint.	Flesh red (when grown), and with a brown plate on the first and last joints.
One-quarter to three-quarter inch in length when full grown.	Half-inch in length when full grown.	One-quarter to one-third inch when full grown.
Generally enters the apple at the eye or calyx end and makes a gallery right to the core, where it feeds for a time.	Enters at the side of the apple and eats out an irregular cavity in the flesh.	Enters at the side of the apple and makes for the centre, not directly but by a winding mine; diameter of mine small.
One larva to an apple.	One larva to an apple. (A large apple may hold more than one larva.)	Several or many larvæ (double figures) to an apple.

When the Codling Moth caterpillar is full-fed it tunnels to the side of the apple, and leaving the apple crawls to some shelter place. Sometimes an apple falls with the caterpillar inside, in which case also the caterpillar eats to the outside and seeks for shelter. A common retreat is a crack or crevice in the bark of the stem, or it may be litter or leaves under or near the tree. The caterpillar now spins round itself a cocoon of silk—the cocoon may embrace in it little pieces of bark or litter—and in this condition passes the winter. In the genial conditions of South England some caterpillars may pupate at once, and a second generation of moths go on to egg-laying. The usual happening in Britain, however, is one generation in the year. The summer caterpillars lie in their cocoons of silk until late spring of the next year, when they turn to pupæ, whose moths appear at the end of May and in June.

Control Measures.—An excellent control measure is to provide places where the caterpillars will make their cocoons. For example one might fix two bands of old sacking, one on the trunk a little way above the surface of the soil, the other tied round just before the trunk branches. The caterpillars from infested apples that have fallen will on leaving these apples most likely start to climb the trunk, and they will nestle in and spin their cocoons in the folds of the lower band of sacking. The caterpillars that leave apples before these fall or are picked will, as they crawl down, come to and make use of the upper band of sacking for their cocoons. At the end of the season the bands of sacking can be removed each with its haul of cocoons.

In certain conditions spraying with an arsenate of lead spray is practised. Such spraying must be done within a week of the fall of the blossom, before the calyx begins to contract and close the eye. With the tiny fruits upright in position, the intention is so to spray that the eye will receive a dose of arsenic, and this will poison the young caterpillar as it starts to eat into the apple at the eye.

The mention of arsenical sprays against the Codling Moth caterpillar recalls the suspicion that the eating of apples from a crop so sprayed may be attended with risk. Now and again one reads in the newspapers of cases of poisoning ascribed to, and sometimes proved as due to, the eating of apples that had been so sprayed. This danger was some years ago the occasion of a circular by the Ministry of Health. Indeed there was such an arsenic scare that owing to the slump in apple buying the loss

FIG. 2.
Argyresthia conjugella. (Magnified.)

on the season was estimated as something like £250,000. In a climate like our own with a one year cycle of the Codling Moth and a single spraying, and with the average summer rainfall, there is no risk. But there is a risk of the collection of arsenic, following arsenical spraying, on apples from countries where there are at least two generations of the moth in the year, that is more sprayings than one—at least an earlier and a later one—especially if such a country has a very low rainfall. Apple growers and exporters in such countries are very much alive to the importance of this question. There is constant experiment with various methods of wiping and removal of possible arsenical residue, and continual improvement in the plant and machines used in this work.

Abroad there have been interesting experiments in the endeavour to reduce the number of Codling Moths by trapping them. The Codling Moth, unlike many moths, is not attracted to bright light. The lure then was not a light-trap, but traps or containers made of glass or enamel or aluminum and holding a bait of fermenting apple juice. The experimental work is not complete but has so far proved very encouraging; great numbers of Codling Moths, attracted by the baits, flew into the juice and were drowned. A high percentage of these trapped moths were females who had not yet completed their egg-laying.

The Apple Fruit Moth or Miner (*Argyresthia conjugella*).—In the summer of 1925 there was both in England and Scotland an interesting and, for Britain, quite unusual attack on apple fruits by the caterpillars of this little moth. The typical and ordinary food is the fruit of the rowan. I gave an account of this moth and its caterpillar in *The Scottish Journal of Agriculture*, vol. ix, No. 1, January 1926, and the interested reader may be referred to this article.

Space does not allow description of certain Tortrix Moths of apple whose small but lively caterpillars have the habit of spinning together leaves and blossom, nor of the Ermine Moths, whose caterpillars are occasionally found in immense numbers on apple, plum and other Rosaceous trees.

The Raspberry Moth (*Lampronia rubiella*).—This can be a very troublesome enemy to raspberry in plantations, allotments and gardens. The damage is done by the caterpillars, which feed under cover at the base of the bud and in the pith of the cane or shoot. Attacked buds or shoots wither, leaves and flowers fail, with consequent loss in fruit.

The moth when carefully looked at—it measures only about one-quarter inch long and scarcely a half inch in spread of wings—will be admired; it is light brown in colour, the front wings showing a series of yellow dots and spots most prominent on the inner edge; the paler hind wings are fringed.

The caterpillar is pink at first, the colour deepening to red as it grows older; the head is shining black; a cleft plate is present on the joint behind the head; the legs number sixteen; the full-grown caterpillar is just over one quarter inch long. The pupa, found at the base of the spoiled bud or in the pith of the shoot, is reddish-yellow; it thins out distinctly at the hind end and bears a spine on the upper surface of the last joint.

The life-history—worked out by Westwood and Chapman—is interesting, as the caterpillar feeds in two different regions of the plant, in the first summer in the fruit-receptacle and in the following late spring and early summer in bud and shoot; a hibernating period, away from both feeding places, intervenes. The moths can be found flying about the canes—in daylight as well as later—in June or the end of May according to the season and the part of the country. The females lay their eggs in the raspberry flowers. The caterpillar on hatching enters the plug-like receptacle of the rasp, which it leaves later without the fruit suffering any harm. The caterpillar leaves about the time the fruit is ripening and passes to the soil at the base of the plant or under litter in the immediate neighbourhood, or takes advantage of a crack in a cane or the rough raspberry bark, and in one or other of such places spins a cocoon—one tenth inch in size—under cover of which the winter is passed. In the early April of the next year the caterpillars leave their winter quarters and crawl up the canes to the buds, into which they bore. The caterpillars feed for a month to six weeks at the bases of the buds and in the shoots. It is this feeding which results in death of bud and withering of shoot.

The full-grown caterpillar pupates in a hollowed out cavity where it has been feeding. By a month the moth is ready; the pupa by active movement presses itself partly out. Males and females meet, pairing takes place, and a new life-cycle starts.

Treatment is based on the details of the life-history. When the moths have been in numbers sufficient to attract attention, the grower should take for granted that there will be hibernating caterpillars; these must be disturbed and destroyed and buried by deep forking round and between the stools or stocks. Old canes and cracked stakes should be removed and destroyed..

Limewash applied at the end of March to the stakes and canes and round about the stocks is a protection against the late March and early April caterpillars, which leaving their winter-cocoons will not be able to ascend the canes to the buds.

The Ministry of Agriculture Leaflet [1] recommends spraying the young shoots at the beginning of April with lead arsenate, and gives as formula lead arsenate paste 1 lb., water 15 gallons. The purpose of this spray is to leave a coating of arsenate of lead on the outside of the buds and young shoots, so that any caterpillars that had reached these after hibernating would be poisoned when attempting to enter bud or shoot.

The cutting off and destruction of infested withering shoots between April and June would account for caterpillars and pupæ.

The Diamond Back Moth (*Plutella maculipennis*).—The Diamond Back Moth is present every year in the fields, but only at intervals is the insect numerous enough to be a pest. Pest years come at varying intervals, e.g. 1883, 1888, 1891, 1914, 1923 and 1926. The 1923 and 1926 attacks were more local, being confined to the Lincolnshire and the Kent coasts. When a plague year comes, the eastern seaboard counties of England and Scotland suffer most. The favouring conditions for the Diamond Back Moth are warm dry weather in summer; the parasites of the caterpillar in too low numbers, and perhaps the addition to our own species of migrating Diamond Back Moths that have come over the North Sea.

The last bad plague year in Scotland was 1914, when from Orkney all down the eastern counties there was interference with farm operations and loss; in addition Perth, Lanark, Roxburgh, Dumfries, Wigtown, Ayr all suffered.

The caterpillars are enemies of cruciferous plants—weed plants and crop plants, but are specially harmful on swedes, turnips, cabbage, kale and their allies.

In 1914 turnips and swedes had had on the whole an excellent

[1] Collected Leaflets on Insect Pests of Fruit Trees, p. 89.

start in the various parts of Scotland, but severe drought came and checked the plants. The caterpillars of the Diamond Back, favoured by the warm dry weather, appeared in immense numbers on the plants and prospects were gloomy indeed. In some cases entire fields were lost; the fields were ploughed up and another crop taken. In some places when things were at their worst heavy rains came and not only destroyed great numbers of the caterpillars, but also so helped the plants that the farmers got off with a 20 per cent. to 25 per cent. loss. This sensitiveness to weather conditions has great importance in relation to the Diamond Back Moth. Both the moths and the caterpillars are wiped out by heavy rains, and more than once a seeming calamity has been stayed by the onset of some days' heavy rain.

The moth is a small one measuring one-third inch in length and two-thirds inch in spread of wings; the prevailing colour of the body is grey brown; the wings, when the moth is resting, cover the body, and their hind end is somewhat tilted up as a little tuft; each front wing has three white marks, and these marks or lines meet when the insect is resting and form somewhat diamond-shaped figures, hence the common name for the moth; the hind wings are narrow and silver-grey. The moth flies at night, and when disturbed in the daytime by one brushing against the plant on which the moths are resting, the moths jerk forward lazily with their antennæ projecting in front.

The caterpillar measures a half inch in length when full grown; it tapers rather in front and to the hind end; the colour varies with the age and stage of the caterpillar. The young caterpillars are grey, with dark heads, but later the general colour of the body is green, the head being grey; the joint next the head has black dots on it (use a lens), and the two next joints have a pale spot on each side of the middle line; the legs are 16 in number. The caterpillars do not like being interfered with; on being touched they wriggle actively and drop down from the leaf on a spun thread, sometimes to reach the soil, sometimes to use the thread to climb up and back to the leaf.

Life-history.—The moths fly from the end of June; they are not long-lived, but as a complete cycle from egg to egg can be completed in seven weeks (a little less in favouring environment, more in not so favouring conditions) there is time for at least two generations, and moths may therefore be found right on till the autumn.

The fertilised females lay their eggs on the under surface (sometimes the upper) of the leaves of crucifers; the eggs are laid singly or in small groups and near a vein. The caterpillars gnaw the leaves from the underside—in cauliflower and cabbage they enter the heads—leaving only the upper skin; as the caterpillars increase in numbers the leaves show a number of holes and later only the main rib or ribs are left. When full grown the caterpillar spins a cocoon of inter-crossing silken threads; the cocoon is somewhat flimsy, elongate-oval in shape, and open at the two ends. Under cover of the cocoon lies the pupa, which may be seen through the silken threads. The cocoons are attached to the undersides of the leaves. The cocoons of the second and later brood remain attached, over the winter, to the stalks and stems of crucifer plants.

Control.—As a rule measures are taken too late. One should, especially in warm dry periods in June and July, when the turnips and swedes are flagging, look on the under sides of the leaves for early notice of the enemy. Caterpillars can be dislodged from the plants by dragging branches across the under sides of the leaves; silken threads are broken and some of the dislodged larvæ are killed and others buried by a following scuffler.

Dressing the under sides of leaves with a mixture of soot and lime—one part lime to three of soot—at the rate of two to six bushels an acre has been practised, but the experimental records are contradictory.

A measure practised in America—the Diamond Back Moth is cosmopolitan—is the dusting of affected leaves with a mixture of one ounce tobacco dust and four ounces of lime; this is dusted on the plants when the leaves are wet with dew.

It has already been pointed out how heavy rains check this insect. There are also ichneumonid parisitic enemies of the caterpillar, and these parasites in average seasons play a great part in keeping the Diamond Back in control.

In plague years or in plague localities where it was too late in the season to replace a spoiled crop by resowing it, favourable results were obtained by replacing the swedes with rape or white turnips or yellow hybrid turnip.

The Pea Moth (*Cydia nigricaus*).—The caterpillars of this moth injure peas before these are harvested. The moth, which is found as far north as Perthshire, is a small one with a half inch wing-spread; front wings dark brown with white streaks, hind wings brown; both fore and hind wings have fringes. The caterpillar is greenish or yellowish-white with the head and a horny plate behind the head dark; dark hair-carrying dots are seen over the skin; legs 16 in number.

The moths are in flight from June to August. The females lay their eggs on the young peapods or on the sepals [1] of the flower. The caterpillars on hatching make their way to the peas, which are gnawed and spoiled. The caterpillar completes its growth in the pod, which it then leaves and passes to the soil, where it surrounds itself by a cocoon. Thus protected, the caterpillar lies till the next late spring or early summer when pupation takes place.

If the caterpillars have been troublesome the land should receive a thorough hoeing or discing after being cleared of peas; this exposes and kills caterpillars. Deep ploughing, before winter, following attack, will so bury cocoons that moths from unharmed cocoons will not be able to reach the surface.

[1] W. H. Brittain in Proceedings of the Entomological Society of Nova Scotia, 191[illegible]

THE following is a summary of a report received from the North of Scotland College of Agriculture on an interesting experiment carried out at Craibstone Experiment Station during the winter months of 1928-29 for the purpose of comparing the outdoor and indoor systems of management of cattle.

Wintering of Cattle.

During the past quarter of a century our ideas regarding the housing of live stock have undergone considerable modification. At one time it was thought that the keeping of stock in byres, &c., at comparatively high temperatures would necessarily mean a saving in food, because the heat required to keep the body at its relatively high normal temperature is obtained from the consumption of food, and it was assumed that if the animals were kept warm, less food would be required. It was customary, therefore, to house live stock in buildings at comparatively high temperatures, even although this meant restricted ventilation.

Recent research work and actual practical experiments have, however, shown that these ideas were erroneous, and that there is always being generated in the body a large amount of waste heat sufficient to counteract comparatively low external temperatures, and that, therefore, there is really no saving of food but rather the opposite, as stock are found to do better with free ventilation at low temperatures rather than at high temperatures with restricted ventilation.

Some few years ago a series of experiments on the housing of dairy stock was carried out under the auspices of the Highland and Agricultural Society under the direction of Mr. John Speir of Newton and Professor Hendrick of Aberdeen. The general results showed that dairy stock kept at comparatively low temperatures, around 45°- 50° F., did better than those kept at temperatures of 60° or upwards. A full account of these experiments will be found in the Highland and Agricultural Society's " Transactions " for the years 1909-1911.

More recently, several farmers in this part of the country have found that, even under our inclement climatic conditions, cattle can be successfully wintered outside, and in order to find out how far this is economically sound, the experiment outlined below was carried out at Craibstone during the season 1928-29.

For the purpose of this experiment 20 Irish bullocks were used. These were bought in the month of October, and on November 5th were divided into two lots of 10 each, the lots being as nearly as possible of equal condition and weight. The gross weights of the two lots were :—

	cwt.	*qr.*	*lb.*
Lot A	67	1	22
Lot B	67	1	21

Up to the date of weighing, all were grazed in the same field. At this date the cattle in lot A were housed under ordinary conditions in the byre, and those in lot B were put on a field in third year's grass, on which at the commencement of the experiment there was a fair amount of foggage. The field is naturally dry, and at no time during the winter was there any considerable poaching on the surface. It was interesting to note, also, that the stock did not make use of a shelter shed which had been erected, but were found lying out in practically all weathers.

Both lots got only turnips and straw during the winter months. Straw, fed at the rate of 15 lb. per head per day, was practically all consumed, except in the case of the outside lot, which ate little straw during the last week or two in April after the grass had begun to grow.

Turnips were fed according to appetite. At the commencement, the inside lot consumed approximately 6¾ cwt. per day per lot, and the outside lot 8¾ cwt. Yellow turnips were used until about the middle of February, when they were gradually replaced by swedes. The winter season extended from the 5th November to the 29th April, and during this time the total amounts of turnips consumed were :—

Lot A (inside)	66 tons.
Lot B (outside)	92 ,,

The cattle were weighed every five weeks during this period, both lots making steady progress except for a short period during the latter part of December and the early part of January, when the outside lot lost weight considerably, and even the inside lot made only a comparatively small increase. From the 5th November to the 29th April the gross increases were as follows :—

	cwt.	*qr.*	*lb.*
Lot A	11	3	10
Lot B	15	3	26

During this period the outside lot made a live weight increase of 4 cwt. 16 lb., just under a half cwt. per head, over the inside lot.

On the 29th April the turnips and straw were discontinued and all the cattle were put on a field of third year's grass. They were weighed again a week after, and it was found that during this time the lot that had been inside lost weight to a very considerable extent; the lot that had been outside during the winter, on the other hand, lost very little. The losses during this week were :—

	cwt.	*qr.*	*lb.*
Lot A	4	3	8
Lot B	0	2	1

The large loss incurred by the inside lot would not represent actual loss of live weight, but rather loss of stomach contents owing to the scouring effect of the fresh pasture, and when this effect had passed off, lot A regained a considerable part of this loss.

It was at first intended to carry on this experiment until early autumn, but as some of the cattle were getting into market-able condition in the beginning of June, the last weighing was made on 11th June. During the period from 29th April to the 11th June the gross increases were :—

	cwt.	*qr.*	*lb.*
Lot A	7	–	24
Lot B	10	–	6

During the whole of the experimental period from the 5th November 1928 to the 11th June 1929 the gross increases made were :—

	cwt.	*qr.*	*lb.*
Lot A	19	–	6
Lot B	26	–	4

This shows a balance of 6 cwt. 3 qr. 26 lb., practically 7 cwt., in favour of the outside lot.

As the average price per live weight cwt. eventually realised for all the cattle was 51*s*. 8*d*., and as the outside lot consumed 26 tons of turnips more than the inside lot, taking the turnips at 10*s*. per ton, we have the following balance :—

7 cwt. live weight at 51*s*. 8*d*. per cwt. ...	£18	1	8
26 tons of turnips at 10*s*. per ton	13	0	0
Balance in favour of outside lot ...	£5	1	8

We must remember, however, that no value has been put upon the winter pasture consumed by the outside lot, and at ordinary valuation this would more than counterbalance the difference above, which works out at practically 5*d*. per head per week for the 25 weeks from the 5th November 1928 to the 29th April 1929.

Another important point to notice is that the outside lot used very little litter, and, therefore, made very little farmyard manure; on the other hand, they entailed much less labour.

As the cattle were bought at different times and different markets, and again were not all marketed at the same time nor in the same market, the prices realised have no direct bearing on the results of the experiment itself, because any difference between the amounts realised for the different lots might be due more to fluctuations in the market prices than to the different systems of management and feeding.

One or two figures obtained, however, are of importance. Eight cattle, four from each lot, were marketed on the 5th July. From the live weight, the dead weight and the percentage carcase of these, it was noted that the outside lot killed about 2 per cent. better than those fed inside during the winter time.

Also, the cattle were marketed just as they were considered ready, and it was found that, on the whole, the outside lot were ready sooner than the inside lot. Of the last four marketed, one only belonged to the outside lot and three to the inside lot.

The experiment is being repeated again this season with the difference that during the winter time half of each lot are getting concentrates in addition to the turnips and straw. An effort will be made, also, to counteract as far as possible the scouring which was experienced last year when the inside lot are put out to pasture at the commencement of spring. This will probably be effected by feeding Bombay cake. Certain other alterations are being adopted in order to avoid faults which became apparent during the course of last season's experiment.

THE following article has been contributed by Mr. D. W. Steuart, B.Sc.

Swedish Stock Feeding Reports.

No. 284. Professor Hansson has verified Fjord's figures for skim milk and whey to replace barley in pig feeding. Thus 12 lb. whey or 6 lb. skim milk is equivalent to 1 lb. of average barley, provided that the dairy bye-products do not exceed 35 per cent. of the food value of the ration. The high biological value of the proteins and other beneficial effects of these foods will have their maximum effect when they are fed in moderate quantities and to the younger pigs. Butter milk should be limited to 6-9 lb. per head per day, in which case it is equivalent to separated milk, if water has not been added. Pasteurised skim milk has a very slightly higher food value than unpasteurised. Sweet skim milk has a higher food value than sour. Much sour milk spoils the quality of the bacon. Whey a couple of days old is not measurably inferior to fresh whey. Condensed whey has a value relative to whey in proportion to the dry matter. Whole milk has its best use just after weaning and 3 lb. is equivalent to 1 lb. of barley. If skim milk is fed up to 22 lb. per head, it will have a lower food value than if the proportion is halved. So also with whey, using 40 lb. per head is less efficient than 20-30 lb. daily. As already stated, these dairy bye-products should be restricted to 35 per cent. of the food value of the ration.

No. 285. Here Professor Hansson discusses the use of substitutes for dairy bye-products in pig feeding. Suitable foods for this purpose are fish meal, herring meal, blood meal or flesh meal. Protein-rich vegetable feeds can partly replace these, viz. peas, groundnut cake, soya, coconut or palmnut cake or young green fodder. Kitchen waste may be quite useful, and it requires 3 to 4½ lb. of this to equal 1 lb. of barley. Herring meal containing less than 3 per cent. salt is excellent for pigs up to 110 lb. live weight, and in quantity not exceeding 5-7 oz. per head per day. Of this 0·65 lb. is a fodder unit. Of blood meal 8-9 oz. can be fed, and 0·65 lb. is equal to 1 lb. of barley. Of pea meal 1 lb. constitutes a fodder unit, but it cannot entirely replace the animal foods.

No. 302. Swedish fish meal mixed with other foods can be fed to cows in quantities of 2-3½ lb. Of this 1 lb. is a fodder unit. It tends to raise the fat percentage of the milk. For pigs it may constitute 10-12 per cent. of the ration in the absence of dairy bye-products.

No. 309, by H. Edin, deals with digestibility experiments using cromium oxide as a control substance. Here we find that the digestibility of green fodder depends on the time of cutting. With lucerne the digestibility coefficient was 67 per cent. on June 27th, gradually decreasing to 57 per cent. on July 10th. With timothy, also fed as green fodder, the digestibility of the organic matter was 71·4 per cent on June 12th, decreasing steadily to 53·8 per cent. when cut on July 20th.

No. 312. Shell is appreciated by hens as shell-building material and is used by them at the rate of about ⅛th oz. per head per day. Limestone grit is not a suitable substitute for either shell or grit. If limestone grit is offered them in place of shell it is taken only unwillingly, and when subsequently the hens are offered shell they use abnormally large quantities of it.

No. 314. Here Professor Hansson deals with the development of lambs during their first year. The ewes were Shropshire and Oxford Downs and Cheviots. The weights of the ewes and details of the feeding and management are given throughout. Per ewe 1·53 lambs were born and 1·3 weaned. The birth-weight of the lambs averaged 9·2 lb.; Oxfords 10·4, Shropshire 8·9, Cheviots 8·8. The singles averaged 10·6 lb., twins 8·6, triplets 7·5, and one lot of four each 4·2 lb. The death-rate among the lambs in their first year was 16·3 per cent., being 9·1 per cent. for singles, 17·4 per cent for twin lambs, 26·7 per cent. for triplets, and 100 per cent. in the case of the four. The average growth rate was 0·36 lb. per head per day, and on the 10th October the lambs weighed 68-99 lb. Taking the growth of singles at 100, the growth of twins was 91·4 and triplets 83·4. The ewe lambs grew 15 per cent. slower than their brothers. The daily growth decreased in each of the first seven months of life thus, 0·45, 0·44, 0·43, 0·41, 0·26, 0·24 and 0·23 lb. per head. The weight of lamb produced per ewe depends on the number of lambs, the growth-rate is lower and the death-rate is higher for twins and triplets than for singles. If we put the production of lamb per ewe at 100 for singles, we get 165 for doubles and 210 in the case of triplets. The quantity and quality of the food also affects the growth-rate of lambs, and at one centre Oxford lambs on excellent pasture put on 0·78 lb. per head per day during the first two months of life. The ewes were clipped twice a year.

No. 322. Till 1922 the Swedish pig feeding experiments were conducted with ordinary farm pigs. In 1923 elaborate breeding control experiments were commenced with selected strains of pure bred pigs. These have been found to have a greater capacity for food, and show a quicker rate of growth and more economical utilisation of food. Improvement in this direction was desired. There are 24 strains under review, of which 15 are Yorkshires. Already the results show that fattening pigs have attained the correct bacon size seven days earlier. Class I bacon pigs have a long body and thin back fat (3·65 cm. against 4·6 cm. in Class

III). Pigs should not weigh over 210 lb. at slaughter, otherwise there is an increase in thickness of the back fat. Class I pigs lose 2 per cent. more at killing (than Class III), and so have to fetch a higher price at the bacon factory. Gilts tend to have a greater body length and thinner back fat than hogs. Long-bodied pigs tend to have a higher growth-rate and are less inclined to produce back fat. Greater depth of sides tends to a favourable classification. Pigs showing a high rate of growth tend to obtain a good classification provided they are not fed too long. In this connection the pigs under consideration averaged 198 lb. at 180 days old, while 21 per cent of them reached this weight at less than 170 days (average 164), and 22 per cent. took over 190 days. In favourable cases then the pigs have reached say 200 lbs in 5½ months. Well-bred pigs, if they are properly fed, should reach full bacon size for a consumption of 3½ fodder units (lb. of barley equivalent) per 1 lb. of live weight increase.

No. 327. The food requirements of hens, and particularly the protein content of the ration, is dealt with here by Professor Hansson. The experimental hens were White Leghorns weighing 3½-4½ lb. Such hens, when 50-70 per cent. of them are laying, require from 3·5 to 4·2 oz. of barley equivalent per head per day, or 22-26 fodder units per 100 hens daily, depending on the size of the hens, on the number laying daily, and to some extent on the time of the year. The amount of protein required in the ration depends partly on its biological value, i.e. on a certain proportion being of animal origin. In this case the minimum permissible is 0·11-0·115 lb. digestible protein per fodder unit, while the optimum is about 0·12-0·13. Rations containing only 0·08-0·09 lb. per unit and consisting entirely of grains and their bye-products are inadequate. Rations containing over 0·13 protein per unit are not so satisfactory, while over 0·145 lb. per unit has an unfavourable effect. The protein can be partly made up with soya meal or something similar, but 5-10 per cent. of the dry mash should consist of fish meal, flesh meal or dried blood. The mineral requirements of the hens must also be satisfied. In the absence of meat meal or fish meal the ration may suitably contain 1-2 per cent. of bone flour. Then about ½ per cent of salt may be included in the mash. For shell building shell is satisfactory and about one-sixth to one-third oz. per head per day should be given. To improve the vitamin content of the ration codliver oil to the extent of 1 per cent of the dry mash was used, but mixed with a little meal and put down fresh daily. Roots also were supplied to the hens. The American method of feeding was adopted in these tests; dry mash supplied in automatic feeders to which the hens had constant access, and about 1½ oz. of mixed grain scattered under the litter. Exclusion of male birds (saving 5-6 per cent of the food) to get infertile eggs caused no decrease in egg laying: such a flock gave the best results. Yellow yolks result from feeding soya meal, yellow maize or lucerne meal, while green fodder and young grass gave yolks with an orange tinge. The use of 15 per cent. lucerne meal in the dry mash gave no better colour than 10 per cent. Fish meal in moderate quantities does not affect the flavour of the eggs. The lighting of the hen houses morning and evening to give the hens a 12-14 hour working day, along with adequate feeding, makes the Jan.-Feb. egg yields like those of April and May. Lighting in one case increased the proportion of hens laying from 23 per cent. to 40 per cent. In these experiments from January to May it required 3-3½ fodder units to produce 1 lb. of eggs.

Behaviour of Wild Animals in relation to Agricultural Experiments.

THE following observations have been contributed by Mr. John I. Craig, B.Sc., Assistant Superintendent of Experiments at the Craibstone Experiment Station of the North of Scotland College of Agriculture.

While engaged in carrying out field experiments one occasionally finds that wild animals interfere to some extent with the various plots, and often in such a manner that distinct preferences become apparent. In some cases the preference can be explained, while in others the explanation remains a mystery, although one may speculate as to the possible cause. Nevertheless, some incidents which have occurred at the Craibstone Experimental Station, together with possible explanations, may throw some interesting sidelights on varieties of agricultural crops.

The first incident to be recorded occurred in the spring of 1926, when a trial of eight varieties of oats was laid out in triplicate. The varieties included were Abundance, Cropwell, Crown, Fortuna, King, Record, Silver and White Odal, while Victory was used as a control, a plot of it separating each of the other varieties. The variety White Odal occupied three widely scattered positions, and it was therefore most interesting to note that a hare, in crossing over the area, ate only of the White Odal from each of the three positions while the crop was in the young stages. In no case did it touch any of the other varieties in spite of the fact that it returned quite regularly to the same three points. It is difficult to advance any explanation for this, since White Odal did not markedly differ from the other varieties except in the colour of the straw when ripe. The straw of White Odal shows a very distinct red coloration, and this pigment factor may be bound up in the question. On the other hand it may just be a matter of the habits of the hare. This animal, as is well known, is very regular in its feeding habits, and once it has eaten a certain thing in a certain place it comes back repeatedly. It also seems to have some natural faculty which enables it to recognise the same variety even if grown in a different place. This has been repeatedly observed in connection with trials of swedes. For some reason hares fix on one variety of swede in a trial and stick to it throughout, but

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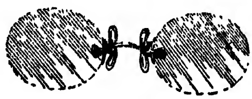

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curiously enough it is not always the same variety in different years. Best of All, Picton, Stirling Castle and Superlative have all been noted as varieties favoured by hares in different years, and whether it is a matter of softness, thickness of skin or sugar content is hard to say.

Another striking example of preference was observed during the spring of 1929 in connection with a trial of different samples of red clover which was laid down in the previous year. Commercial samples of red clover were sown in rows and arranged alphabetically according to their country, or in the case of English, their county, of origin. The foreign samples were thus scattered here and there among the home-grown ones which formed the majority, and it was not at all unusual to find a foreign sample completely surrounded by English ones. It was, therefore, all the more remarkable that hares sought out and ate several of the weaker foreign samples and left untouched the stronger growing home ones. The samples which were eaten came from Lombardy, Switzerland, Transylvania and the Tyrolese Alps. They were widely separated, yet all were equally eaten down, while neighbouring rows were left intact. The only explanation offered is that of relative vigour, but the real reason may be more subtle when one considers the next illustration.

In the same year a bed was similarly sown with samples of wild white clover, or should we say samples of clover described as wild white. These samples had all been submitted to the picric acid test for hydrocyanic acid as used by Dr. Pethybridge. Varying reactions had been obtained, and, in sowing the bed, a selection was made so that samples giving a weak or no reaction were sown between others giving strong reactions. This was done to facilitate comparison. In May and June of 1929 it was noticed that certain rows were being eaten and others left severely alone. The vigour of the rows could not then be taken into account, for all were uniformly small and growth had just commenced. A closer examination was made taking into account the source of the seed and its response to the chemical test. It was then noted that all the samples eaten had given weak reactions or none at all and, as the vegetative characters afterwards showed, were samples in which ordinary white clover predominated. The question then arises, can hares discriminate between wild white and the undesirable article we often get under that name, or is it again a case of hares sticking to a thing they have tried and found palatable?

Another rather remarkable feature became noticeable this autumn in the distribution of moles over an area recently laid out in a manurial experiment. A piece of uniform land about 1¾ acres in extent was divided into three sections, each of which received different applications of artificial manures. The area was then in a root break and 13 drills each of yellow turnips and potatoes were grown in each section. The area was thus divided into six strips, three of yellow turnips alternating with three of potatoes. In the autumn the crop was removed, the turnips being topped and the tops ploughed down shortly afterwards. In 1929 oats and grass seeds were sown over the whole area and the crop harvested in due course. Following on that, a survey was made of the " take " of grass seeds in consequence of the previous treatment. It was then found that the three strips on which turnips had been grown were covered with mole heaps, while the potato strips showed only on two occasions tracks of a mole crossing over from one turnip break to the next. The dividing line between each strip was clearly marked, and it was perfectly evident that the distribution was not fortuitous. The explanation may be that the ploughing down of the turnip tops had an influence on the earthworm population, or it may be that the different rooting habits of the two crops had an effect. Then again, the oat crop was heavier after the turnips and the " take " of grass seeds correspondingly lighter. Manurial residues may also have some effect, for certainly manurial applications have an effect on earthworm distribution.

During 1928 and 1929 a piece of lawn 2 yards wide and 50 yards long was divided into plots to which dressings of sulphate of ammonia, superphosphate and muriate of potash were applied in mixtures and alone. Taking worm casts as evidence of the worm population, it was obvious from this experiment that worms avoid plots receiving sulphate of ammonia and show up in great numbers where that manure has been omitted from the dressing. In all probability worms are susceptible to slight differences in soil acidity and avoid if possible strongly acid conditions. The point is of interest to greenkeepers and others with lawns under their care.

The last instance of peculiar animal behaviour to be related tends to show that rats are not so indiscriminating in their feeding as would be expected. Indeed it seems to show that rats have a pretty taste in potatoes. During the winter 1926-27 boxes of potatoes were stored in a rather thin wooden shed. In order to keep out frost, straw was packed against the walls and the boxes placed along the protected wall. Light wooden frames filled with straw were placed in front and on top of the boxes so that the potatoes had a complete straw covering. During a frosty spell of weather rats got amongst the potatoes, and although this was known, nothing could be done, for any steps towards eradication would have meant exposing the tubers to frost. When milder weather came, the shed was cleared out and the damage estimated. A box of Edzell Blue which had been previously laid aside for use in an experiment was found to be almost empty, while adjacent boxes were scarcely touched. A search was then made for a few surplus boxes of the same kind, and, although these were some distance away, they too had suffered badly with the neighbouring boxes again in good order. Witchhill and Di Vernon were next found to be badly destroyed, the latter variety being so badly cut up that half-eaten pieces had to be picked out and kept for planting. Arran Victory, Arran

Chief, Abundance and Kerr's Pink were other preferred varieties, but the most outstanding feature was with Majestic. Thirty boxes of this variety had been stored together in the midde of a row. Rats had been running freely over them as could be seen from excreta, potatoes had been eaten from the boxes on both sides, yet Majestic remained untouched. To detail the degree to which all the varieties were eaten would occupy some time. The facts can best be summarised by stating that all the evidence went to show that rats prefer dry, mealy potatoes to those of a wet and waxy texure. It would perhaps be difficult to turn this natural faculty of the rat to practical account, but as an unbiased judge he might some day be useful.

Composition of Swedes.

In this Journal (Vol. IX (1926), 160; X (1927), 429; XII (1929), 310) an account was given of the work carried out since 1923 by the Committee appointed by the Department of Agriculture for Scotland to investigate the chemical composition of swedes. Since then further trials have been carried out with the same varieties at Boghall and East Craigs and Dr. Lauder has recently published the results for the past season (1929); these are in close agreement with those obtained in previous years.

		Average Percentage of Dry Matter. 1926–27–28.	1929.
Group I.	Kinaldie	12·52	12·62
„ *II.*	Bangholm ... ... Stirling Castle ... ... Aberdeenshire Prize ...	11·85	11·93
„ *III.*	Best of All ... ... Magnum Bonum ... Caledonian ... .. X'L All ... ... Bronze Tankard ...	11·41	11·46
„ *IV.*	Picton	10·70	10·77

The figures for 1926-27-28 are the average from three centres (Boghall and East Craigs (Edinburgh) and Craibstone (Aberdeen)); for 1929 they are the average for Boghall and East Craigs only.

The earlier work has shown that swedes grown at Boghall contain a higher percentage of dry matter than those grown from the same seed at East Craigs; a similar difference has been found for the 1929 crop, although the differences are less striking than in former years.

Yield of Dry Matter per Acre.—The figures for the yield of dry matter per acre are, as already expained, somewhat less reliable than those giving the percentage of dry matter in the roots; the average yield of dry matter per acre at Boghall was 3·11 and at East Craigs 3·08 tons; Kinaldie, with the highest percentage of dry matter, gave at Boghall 3·01 and at East Craigs 2·97; Picton, with the lowest percentage of dry matter, gave at Boghall 2·93 and at East Craigs 3·08 tons dry matter per acre; the yield was substantially the same; Bangholm had 3·33, Best of All 3·38, and Caledonian 3·36 tons dry matter per acre at Boghall; the figures for East Craigs were Bangholm 2·90, Best of All 3·18, and Caledonian 3·23. When it is remembered that the experimental error in these determinations is probably considerable, we cannot say more at present than that the different varieties tested give similar yields of dry matter per acre.

In co-operation with the Plant Breeding Society at East Craigs experiments are being carried out in the selection of individual roots having a high percentage of dry matter to use for growing seed; this investigation inevitably takes time, but should yield interesting results when sufficient data have been obtained.

Craibstone.

Notes from Agricultural Colleges.

Experiments with Oats, 1929.—Recently, several new varieties of oats, chiefly from Denmark and Sweden, have been put on the market. Several of these were compared (in triplicate) on clean land with Record and Victory, as representing the older varieties of the same general type, and a new variety from the Scottish Plant Breeding Station. The seed was well graded and sown at the rate of 2½ million seeds per acre on 17th March. The following table shows the order of ripeness and the average weight of grain and straw obtained.

	Order of Ripeness.	Per acre. Grain. cwt.	Straw. cwt.
Echo	5	33·5	46·3
Record	3	28·0	43·3
Silver	2	34·0	50·5
Sovereign	6	32·5	43·6
Star	1	41·5	45·8
Victory	4	34·5	47·3
S.S.P.B. Aa 612 ...	7	34·2	40·1

Echo is a Swedish variety with a bright yellow-coloured grain of medium size. It stood well, but it was somewhat late in ripening.

Record went down somewhat under the heavy rain at the beginning of August, but did not suffer so much in this respect with subsequent rains. Its yield was comparatively poor.

Silver is a Danish variety with a characteristically narrow leaf and a dark green colour. It was slightly laid at the beginning of August and went down more before the end of the month. It ripened somewhat earlier than Victory and the yield was similar.

Sovereign is also a Danish variety and is distinguished by a very broad leaf blade. It was slightly laid at the beginning of August, but gradually became worse, and was worst in this respect when cut. It was late in ripening and the crop was comparatively poor.

Star is a Swedish variety said to be a cross between Victory and Crown. When it brairded, it was distinctly darker in the leaf than Victory. Except for one small spot in one of the plots, it was standing. It was somewhat shorter in the straw than Victory, ripened about a week earlier, and gave a consistently heavier yield of grain in all three plots.

Victory went down slightly at the beginning of August and rather more later on. The yield was less than it usually has been in former trials, and as it was in another trial this year recorded later.

S.S.P.B. Aa 612 brairded somewhat thinly and remained thin during the season, which may have made it later in ripening than it otherwise would. It was later than any of the other varieties. It was short in the straw and stood up well, and had a distinct and characteristically spreading ear. The amount of grain produced was much greater than the appearance indicated.

Several trials dealing with the standing power were made. As in several former trials, the advantage of early sowing was again well demonstrated in the case of Victory. Plots were sown at weekly intervals commencing on 8th March and going on to the first week of May. All the crops in the plots sown in March were standing, that sown in the first week of April was slightly laid and the lodging grew worse every week, the last sown plot being flat from side to side.

The reduction in yield on the medium sown plots was not so great as in most seasons, as sufficient rainfall in May and June prevented them suffering from drought to the same extent as they do in most seasons when there is usually a spell of dry weather in these months.

The advantage of using graded seed was again well demonstrated, as is seen in the following table.

	Per acre. Grain. cwt.	Straw. cwt.
Plot 1. 300 lb. Ungraded seed	28·5	51·2
Plot 2. 224 ,, Same amount taken and 76 lb. small sifted out	29·7	50·6

In the first plot, which was slightly thicker, many of the stalks were weakly and the crop was slightly laid, whereas in the second the stalks were much more uniform, the ears were larger and the crop was standing. In addition to producing a rather heavier yield of grain there was a considerable saving of seed.

A trial of varieties that were considered likely to stand was made in a field after lea in which there was a good close sole of wild white clover. All the plots, except part of a duplicate plot of Star which was unmanured, were manured with ¾ cwt. sulphate of ammonia and 2 cwt. superphosphate per acre. The crop came away much quicker on the manured part, and in June was about 12 in. high compared with 6 in. on the unmanured part. It kept this lead and was ripe about seven to ten days earlier. In addition, the crop on the unmanured part was worse laid than on the manured part. Unfortunately, the parts could not be weighed as a gale mixed the sheaves.

The early sowing and the manuring have the effect of making the crop stand better because it is further advanced and nearer maturity when the large amount of nitrogen from the wild white clover is made available.

The season was extremely suitable for a standing-power trial as both rain and wind were prevalent, and there was thus every opportunity for the crop to lodge. During July there was a dry spell and the early varieties—Yielder and Superb—were beginning to suffer from drought when rain came at the end of the month. There was a goodly fall of about 2 in., which was sufficient to bring about a partial recovery in these varieties. It has been observed in previous trials that Yielder requires plenty of moisture; in dry seasons it suffers more than most varieties and is obviously not suited to dry conditions.

The rain at this time had the following effect on the varieties tried :—

Standing.—Banner Tartary, Superb, Yielder and Marvellous.

Slightly laid.—Upright.

Some laid.—Mansholt, Star and Victory.

Worst laid.—Record and Beseler's Prolific.

More heavy rain about the middle of the month caused the varieties that went down to go down further, while a wet windy week-end about the 25th broke Superb badly. High wind at the beginning of September broke Superb down still further, and affected also Marvellous and Banner Tartary to some extent. Upright and Mansholt were only slightly broken down, while Star and Victory were hardly touched and Yielder remained standing; later, however, Yielder and Marvellous were both badly broken down by wind.

Superb, Marvellous, Yielder and Banner Tartary (in that order) therefore appear to suffer most from high wind just when they are almost ripe. Of course, in practice it is likely that the first three of these varieties would have been cut before the wind broke them down. On the other hand, Yielder, Marvellous and Banner Tartary (in that order) stood up well against rain, while Mansholt and Upright went partially down before both rain and wind.

The result with Star and Victory is interesting. In this trial Star was worse laid with rain than Victory, but in the other trial on clean land Star stood better than Victory.

The weights obtained were as follows :—

	Order of Ripening.	Per acre. Grain. cwt.	Per acre. Straw. cwt.
Banner Tartary	9	33·7	51·5
Beseler's Prolific ...	8	26·8	45·2
Mansholt	6	29·6	49·1
Marvellous	3	30·4	43·1
Record	7	30·7	49·4
Star	4	34·5	48·2
Superb	2	30·4	42·7
Upright	5	30·7	52·1
Victory	10	40·8	58·5
Yielder	1	28·3	43·9

Victory, which was latest in ripening, gave much the heaviest yield, while Star was next best, quite opposite to the result of the other trial. The possible explanation of this is that in the first trial, where Star was best, there was no apparent suffering from lack of moisture, but in the other trial, as already mentioned, the earliest varieties—Yielder and Superb—showed signs of suffering. It is therefore likely that the varieties next in earliness—Marvellous and Star—were also beginning to suffer, with a consequent effect on the final yield. Victory, on the other hand, was at this time quite fresh and green and was apparently not suffering in the least.

The yield of Yielder suffered from two causes, viz. the dry conditions in July and the high wind.

Imperial Bureaux of Animal Nutrition and Animal Genetics.

At the Imperial Agricultural Research Conference held in London in 1927 the proposal was made that certain Bureaux should be set up—on the model of the existing Bureaux of Entomology and Mycology—to act as clearing houses for the interchange of information of value to research workers in agricultural science throughout the various parts of the Empire. The purpose was to promote co-operation among workers in the investigation of problems of common interest.

The functions of a Bureau were stated to be—

(1) Collecting, collating and abstracting information concerning research in its particular line carried out in any part of the Empire, and the recording of results of such work as published in scientific literature or otherwise.

(2) Distributing such information in reply to queries from Empire research workers or more generally by circulated memoranda.

(3) Supplying information regarding centres of post-graduate study, facilitating exchange of workers, and arranging for conferences of workers interested in the same problems.

Following upon the recommendation of the Imperial Research Council, the proposal was considered by the Home and Empire Governments, and eventually it was agreed to establish an Executive Council charged with the administration of a common fund out of which the Bureaux would be maintained. The Executive Council consists of one representative of each of the contributing parts of the Empire, thirteen in all. The first Chairman of the Council is Sir Robert Greig, and the Secretary is Sir David Chadwick.

Eight Bureaux have been established as under :—

(1) *Soil Science.*—Rothamsted, Herts.

(2) *Animal Nutrition.*—Rowett Research Institute, Aberdeen.

(3) *Animal Health.*—Veterinary Research Laboratory, Weybridge.

(4) *Animal Genetics.*—Animal Breeding Research Department, Edinburgh University.

(5) *Agricultural Parasitology.*—Institute of Agricultural Parasitology, St. Albans.

(6) *Plant Genetics* (for crops other than herbage plants).—Plant Breeding Institute, Cambridge University.

(7) *Plant Genetics* (for herbage plants).—Plant Breeding Institute, Aberystwyth.

(8) *Fruit Production.*—Fruit Research Station, East Malling, Kent.

In each of these cases the Head of the Research Institute acts *ex-officio* as Director of the Imperial Bureau attached thereto.

It is necessary to point out that these Bureaux are still in the experimental stage. The policy of the Executive Council is to allow them to develop slowly in response to the demands for help made upon them, rather than to force the development in accordance with any preconceived plan. It will take several years for them to establish that close connection with workers and administrators throughout the Empire which is the first essential for success. Moreover, as they become richer in accumulated information they will become of increasing value to the research workers of the Empire.

It is of special interest to note that the establishment of a Council with executive power, entrusted with the administration of funds drawn from all the Governments of the Empire, and responsible to the various Governments only through their accredited representatives, is without precedent in the history of the Empire. The Council of the Bureaux is really the first executive Imperial body.

It is also interesting to consider the possible effects of the action of the Bureaux in bringing together research workers and administrators from different Empire States for the consideration of problems which may affect the Empire as a whole. The incidental influence of the Bureaux in helping thus to consolidate the Empire may turn out to be no less important than their efforts in applying science to its economic development.

Imperial Bureau on Animal Nutrition.—The Imperial Bureau on Animal Nutrition was set up in April 1929 at the Rowett Research Institute. There was already in existence at the Institute the Reid Library, which on a limited and local scale was already working along the lines proposed for Bureaux. With the consent of the Committee controlling the Reid Library the Bureau was housed there, and the Library with existing abstracts and other materials and facilities put at the disposal of the Bureau.

Four workers, two of whom are temporary, have been appointed to form a staff, and in the course of the past year the work has proceeded along the following lines :—

1. Communication has been established with the senior research workers and administrators, both at home and overseas, interested in animal husbandry, and statements from each of them, outlining the research work in progress in their country or area, have been received. The information contained in these statements is at present being arranged in a form which will show (*a*) the chief investigations in progress in each part of the Empire, (*b*) the main problems common to several different parts of the Empire.

2. When this register is complete, information bearing on these problems in which the largest number of workers are interested will be collected. The collection of information on these different problems is not necessarily to be done by the staff of the Bureau in all cases. An authority on each subject may become responsible for the collection and collation of the information required. In many cases these will be men working at institutions in the Dominions or Colonies. Pending the completion of this survey information is being collected on the influence of diet on susceptibility to disease, which is known to be a subject of interest to many research workers in nutrition.

3. A survey of the present position of animal husbandry within the Empire is being made. This survey will give for each Dominion, Colony and Protectorate such information as the number of each class of animals, the total production of milk, wool, carcases, eggs, &c., the exports and imports, the chief factors which favour or limit development of the industry, and the main research activities. The

Bureaux on Genetics and on Animal Health are co-operating in the survey.

In addition to these main lines of work the Bureau is endeavouring to make itself useful by finding and supplying information asked for, and by placing such information and facilities for study as the Bureau already possesses at the service of men from overseas visiting this country either on leave or for short courses of special study.

Imperial Bureau of Animal Genetics.—It is just a year since the Imperial Bureau of Animal Genetics was created and attached to the Animal Breeding Research Department of Edinburgh University; and in that time it has had to define its scope and problems, prepare an information service, and make contact with research workers in all parts of the Empire. It may now be said to be well on its way, with nearly one hundred regular research correspondents in different parts of the Empire ranging from Australia to Zanzibar, and over a hundred more in Great Britain and Ireland and in foreign countries. Of foreign workers, its main correspondents are American biologists and agriculturists, German biologists, and the animal husbandmen of the French colonies. Close contact with Russia is difficult, but some progress has been made towards garnering the fruits of recent biological research and of practical breeding in that country, and it is hoped there is more to come. In fact, the main complaint of the Bureau is that agricultural research workers, as distinct from pure geneticists and physiologists, in Britain have been the slowest to make use of it. A considerable number of translations have been made of work important to animal breeders, mainly from articles in German, Russian, and Czecho-slovakian periodicals. An index has been maintained of current research in practically all countries. Considerable progress has been made towards building up as complete a bibliography as possible on all the subjects with which the Bureau deals—though this, of course, must be the work of years, and to a large extent can be done only in response to specific enquiries. Three subjects now completely covered are the genetics of the horse and the pig, and the weights and growth rates of the horse. The first number of the Bureau's quarterly Bulletin was issued in December, and the next number is now in the press. It is a record of current research and problems—largely suggested by its correspondence—with a running commentary on their relation to other and partly forgotten studies.

National Mark Beef.

CONSIDERABLE progress has been made with the scheme which was inaugurated by the Department of Agriculture for Scotland during the last week of October 1929 for the grading and marking of Scottish-killed beef under the National Mark. As was explained in the previous issue of the JOURNAL, the scheme is an experimental one, and provides for the grading and marking at Aberdeen and a number of centres in Aberdeenshire and Banffshire of Scottish beef destined for Smithfield from that area. These counties were selected for the purpose of the experiment because they form a compact unit, and because nearly all the Scottish beef sent to Smithfield is consigned from there.

Since the commencement of the scheme there has been a steady increase in the number of consigners of National Mark beef to Smithfield, and on the 8th March 1930 the number of applications which had been approved by the Department for the services of the official graders amounted to 97.

The number of sides of beef graded and marked rose from 537 during the week ended 2nd November 1929 to 1,958 during the week ended 21st December 1929. Following the Christmas period there was a seasonal fall in the number of sides presented for grading and marking, but by the beginning of February the number of sides of beef graded and marked weekly had again reached the level attained before Christmas. The rate of increase has been maintained, and during the week ended 8th March 1930 the total was 2,469. This represents a very large percentage of the total quantity of Scottish-killed beef consigned to Smithfield during that week.

In order to meet the unsatisfied demand in London for Scottish beef marked under the Scottish National Mark, an additional grader has been appointed to operate at centres in the north-eastern district of Aberdeenshire, where hitherto it has not been possible to provide an adequate service for the grading and marking of beef.

The weekly average number of sides of beef marked with the Scottish National Mark has been as follows :—

	Select.	*Prime.*	*Total Sides marked (quarters and pieces omitted).*
5 weeks ended 30th Nov. 1929 ...	579	166	745
4 weeks ended 28th Dec. 1929 ...	1,355	163	1,518
4 weeks ended 25th Jan. 1930 ...	1,340	157	1,497
4 weeks ended 22nd Feb. 1930	1,777	172	1,949
5 weeks ended 29th March 1930	2,081	266	2,347

Agricultural Conditions.

BOISTEROUS weather with frequent rains prevailed during December in practically all districts, and cultivation was much retarded; there was, however, little or no frost. During January the weather was generally mild and open in the north-eastern and most of the northern counties, with occasional high winds and some rain; there were some short spells of frost, but practically no snow. In this part of the country good progress was made generally with ploughing and with the carting of manure. In the eastern and south-eastern districts conditions were also generally favourable, but elsewhere excessively wet weather was experienced and arrears of ploughing accumulated. February was generally dry and frosty, with practically no rain and comparatively little snow except in parts of Perth and Angus, where there were heavy falls. Cultivation was more or less seriously retarded by frost in a number of districts, but the carting of manure and other operations were well forward by the end of the month. In some areas the frost proved beneficial in drying up land which had previously been too sodden for working.

The winter sowing of wheat was completed in most districts early in December, and by the end of the year a strong and regular braird was showing on many fields. The open weather of January favoured the crop, and in most cases the reports were satisfactory. In south-west Perth, however, some plants rotted out on wet stiff land, and in Dumbarton the braird was somewhat patchy on heavy soils; in the latter district some fields that had been intended for wheat were left unsown on account of the continuous wet weather. Growth was checked by frost during February, and in a number of districts the young plants were more or less discoloured, especially on later sown fields, but the set-back is not regarded as serious.

The reports on potato stocks furnished at the end of January indicated that the crop had not then been taken from the pits in a number of districts, but that in practically all cases where the tubers had been lifted they were in good condition. In some instances sprouting was found to be more prevalent than usual, and in north Ayr part of the crop was found to be badly diseased, but speaking generally the crop was reported to be of excellent quality.

In most districts sheep stocks have thriven well throughout the winter and are in healthy condition, apart from some cases of foot-rot in the north-eastern and eastern districts; in a few areas ewes lost condition owing to the excessive rainfall during January, and in Shetland and Harris liver fluke is said to be prevalent. Sheep on turnips on heavy land have had a trying time throughout the winter in several districts. Lambing began in January among early flocks in Berwick, with satisfactory results. In Angus hill ewes had a trying time during February owing to snowstorms, and hand-feeding was required on many farms; in Caithness, also, hand-feeding began early in the month. Lambing prospects are generally reported to be satisfactory, North Argyll, North Ayr and Wigtown being the only districts in which the prospects are stated to be more or less below the normal. In the districts where lambing has already begun, the fall of lambs has been satisfactory; none of the reports refers to any abnormal death-rate, but in Berwick there have been some cases of joint-ill.

The reports on roots at the end of February indicate that turnips have kept well, and in practically every district are in excellent condition. Supplies are generally ample for requirements and the feeding of oats and potatoes to live stock on a number of farms has tended to conserve stocks of turnips. In North-West Lanark and North Ayr, however, supplies of turnips are running somewhat low; in these districts, and in a few isolated areas elsewhere, a small amount of sugar-beet pulp has been used as a supplement to the rations, but, speaking generally, little beet pulp has been fed to live stock in Scotland.

In December there was a certain scarcity of regular labour from time to time in some of the eastern districts, but since then the supply has generally been ample for requirements; from Central Perth and Berwick it is reported that numbers of ploughmen are out of employment.

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, Department of Agriculture, York Buildings, Edinburgh.

CROPS AND SEEDS.

Breeding Improved Varieties of Forage Crops. *Lawrence E. Kirk, Jour. Amer. Soc. Agron., Vol.* 19, *No.* 3.—Forage crops offer many opportunities for improvement. Nearly all the hay and pasture crops are normally cross-pollinated, and are known to consist of a multiplicity of forms among which may be found both desirable and undesirable combinations of characters. Selection within self-fertilised lines is now being used intensively by plant breeders as a means of obtaining uniformly strong strains of many normally cross-pollinated crops.

In experiments with sugar beet, Nelson found that certain strains showed no loss of vigour after five generations of selfing. Fertility was plainly inherited, and strains which possessed this character had larger and better developed seed.

Work by Hayes and Barker and by Hayes and Clark indicated that timothy does not show nearly as much reduction in vigour as maize or red clover.

Freergaard found that on selfing turnips (*Brassica campestris*) all the selfed lines were less vigorous than the original varieties. On the other hand, rutabagas (*Brassica napus*) gave only two out of thirty-five selfed lines which showed any approximate decrease in yield as a result of selfing.

M'Rostie has obtained selfed lines of timothy which out-yielded the better open fertilised strains under test.

It is concluded that controlled pollination with selection of the more desirable selfed lines is the most promising mode of attack for the improvement of normally cross-fertilised crops after adapted varieties have been obtained.

The Principles of Compounding Mixtures of Grass and Clover Seeds. *By Professor A. Volkart, Scientific Agriculture, Vol. IX, No.* 8.—In order to understand the principles underlying the successful establishment and management of mixtures of different kinds of grasses and clovers it is essential to understand the reasons why some species disappear more quickly than others. The most obvious reason is unsuitability of soil and climate. This is not the only reason, however, since quite often certain kinds are able to establish a splendid stand if sown in pure culture, but fail in mixtures under identical soil and climatic conditions. Low species are easily suppressed by high-growing plants if the mixture is not used as pasture and kept short by grazing. A well-known example is white clover.

Perennial ryegrass is an excellent pasture grass in heavy, wet soil, but only where the winter is mild. In mixtures which are cut for hay it is not able to develop to any great extent because it is a low grass overgrown by the high grasses.

Besides the low grasses another category of forage plants which are very often suppressed is the late species. Alsike clover is an example. Clovers and grasses which owe their quick development to speedy formation of roots do not easily agree with other species. One of the grasses presenting difficulties in this respect under Swiss conditions is Italian ryegrass, which develops so strongly, especially on good soil and after mild winters, that even red clover gets damaged.

Experiments have shown that it is not a desirable practice to use too many species in a mixture. The inclination to make this mistake often arises from the assumption that even though three or four additional kinds would not improve the mixtures greatly they would at least do no harm; but the contrary is true.

For grazing, species should be chosen which develop well in pastures, for instance perennial ryegrass (if the winter is not too severe and the snow does not last too long). White clover should be sown only if it does not develop without sowing. If the mixture is not pastured but is mainly cut for hay, no purpose can be served by growing low-growing species such as white clover, perennial ryegrass, or crested dogstail. A peculiarity which should not be neglected in compounding a mixture is the *sociability*. Grasses like Italian ryegrass, which develop too much at the cost of other plants, disappear, often very soon, and they are better left out. The author indicates that here he is in a certain opposition to Stapledon.

The author concludes that the selection of species for a mixture depends upon the following points:—(1) suitability for hay making or grazing; (2) duration; (3) adaptation to climate or soil; (4) mode of tillering; (5) time of sprouting (early or late); (6) sociability; (7) precautions against damage through unfavourable weather.

Chemical Weed-Killers. *S. H. Vigor, Department of Agriculture, Regina, Sask. Scientific Agriculture, Vol. 9, No. 9.*—This paper gives an account of the effects of various treatments with chemicals made by the staff of the Field Crops Branch of the Saskatchewan Department of Agriculture. Herbicides for controlling or eradicating weeds are being used on an extensive scale in some countries. The spraying of large fields of grain such as are found in the wheat-growing sections of the United States has been resorted to in order to destroy the weeds in the growing crops. The following were amongst the weed killers used:—sulphate of iron, Stoldt weed killer (composition unknown), sodium arsenite, sulphuric acid, sodium chlorate, copper nitrate, oil such as kerosine fuel oil and lubricating oil.

Extensive tillage methods were found to be still the most economical means of control in cases of infestation with perennial weeds, but it is thought that if a cheap effective herbicide could be obtained which would eliminate perennial weeds a tremendous saving in time and labour would be effected.

The experiments were sufficiently satisfactory to warrant continuation.

It is emphasised that in districts generally infested with weeds, tillage and cropping practices are still the chief means of control. Chemicals are yet too costly for use on large fields.

Chlorate for Weed Control. *By C. R. Megee, Michigan State College. American Potato Journal, August and November* 1929.—Chlorates are proving effective for the control of couch grass, bind weeds and other troublesome weeds. Cultivation usually is not effective, since it tends to spread the underground parts and infest the entire field. One pound of sodium chlorate dissolved in a gallon of water is sufficient to spray a square rod, and most weeds will require three applications at intervals of thirty days. The application should be repeated until the weeds fail to produce top growth. Sodium chlorate is not poisonous in small doses, but live stock should be removed from the field when areas of a considerable size are to be treated. It is not advisable to attempt to grow crops during the season of treatment, but tests have shown that crop production may be resumed the next season. This crop should be sown to allow inter-cultivation.

A number of plots was laid out in a field infested with couch grass, and a standard dressing of one pound of chemical (sodium chlorate, magnesium chlorate or a proprietary mixture) to one gallon of water was applied to 1/100th of an acre on August 11th, September 1st and October 1st. Part of the area was cropped with a cereal and inter-cultivated in the following season. The results indicated that one dressing (August 1st) was not sufficient to kill couch when the land was left bare in the following year, but where one dressing was applied and the land cultivated the couch was very much thinned out. Two treatments were far more effective, and where this was followed by an inter-cultivated crop no trace of couch was found.

Different strengths of chlorate solution were used, and two dressings of half strength were found to be much more effective than one of the full strength.

Experiments to test the Yield and Other Properties of Various Species and Strains of Herbage Plants under Different Methods of Management. *R. G. Stapledon and Wm. Davies, Welsh Plant Breeding Station Bulletin, Series H, No.* 10.—The bulletin reports on a series of trials on 22 species and strains of grasses and clovers and on two mixtures. The seed was sown broad-cast, and the yield, leafiness and other properties of the plants were investigated under three main systems, viz. incremental cutting with a lawn mower, grazing by sheep, and taking hay and aftermath. No manures were applied in the seeding year.

The most rapid growth is made by Italian ryegrass, commercial tall oatgrass, broad red clover and commercial perennial ryegrass. The pasture yields fall progressively from year to year. All the indigenous strains out-yield the non-indigenous in the later harvest years. Over 70 per cent. of the pasture from grasses is produced in May and June. The clovers have a shorter growing season than the grasses, but they produce a higher proportion of their total yield during July and August than do the grasses. In the first harvest year, when the non-indigenous are at full vigour, they show to better advantage than the indigenous during the period March–April, but this is reversed during September–November.

The crop taken as hay and aftermath has shown an even greater progressive falling off from year to year than when it is taken as pasture. The proportion of total yield of hay and aftermath contributed by the aftermath varies for different species and strains. It is very high in indigenous cocksfoot and indigenous meadow foxtail, but relatively low in the less leafy perennial ryegrass and very low in crested dogstail. The aftermath contribution is, how-ever, generally high, and tends to increase relatively to hay from year to year. The average yield of hay and aftermath for the four harvest years has on the average been over double that of the aggregate of the sum of the pasture cuts. In leaf yield hay and aftermath hold an advantage of about 25 per cent., and in the case of ryegrasses and crested dogstail the leaf yield has been actually higher from pasture than from hay and aftermath aggregated. The species and strains which give the heaviest hay yield are those which show the highest proportion of stem shoots to leaf shoots.

SOILS.

Action of Nitrogenous Fertilisers on Acid Soils. *D. Meyer and P. Obst, Zeit. Pflanz. Düng.*, 1930, 9 *B., p.* 18.—Here are described a number of pot experiments with cereals on acid soils. Using oats and barley, nitrate of soda and nitrate of lime produced similar results. Nitrate of ammonia was less effective than the nitrates of soda and lime on these crops, but the difference in the case of oats was less marked than in the case of barley. Ammonium sulphate produced negative results with barley but positive effects with oats. Urea and ammonium nitrate were about equally effective on oats and barley. Calcium cyanamide was in most cases equal to and in some cases better than nitrates of soda and lime. The beneficial effects of cyanamide and urea may be due to the neutralisation of the soil acidity by the ammonia produced from them. Oats utilised the greatest proportion of the added nitrogen in these experiments. The fertilisers most utilised were the nitrates of soda and lime, followed in descending order by cyanamide, nitrate of ammonia, and sulphate of ammonia.

Neutralising Values and Rates of Reaction with Acid Soils of Different Grades and Kinds of Liming Materials. *W. H. Pierre, Soil Science,* 1930, *XXIX*, 137.—This paper describes the results of experiments devised for study of the reaction, after various periods of time, of ground lime-stone, crushed oyster shell, and basic slag of different degrees of fineness with soils in greenhouse pots, especially as influenced by the hydrogen-ion concentra-tion of the soil.

The following is a summary of the results. The finer the liming materials the quicker will the soil acids be neutralised. Ground limestone coarser than 20 mesh is very slowly reactive. Limestone passing a 20 but not a 60 mesh sieve was nearly three times as active. Crushed oyster shells gave much the same values as the crushed limestone. With medium acid soils it was found that after two years only about 80 per cent. of the potential neutralising capacity of ordinary basic slag was effective. Low grade slag was much less effective than the ordinary.

ANIMAL BREEDING.

Cattle.

Normal Day to Day Variability of Yield of Milk and Fat of Individual Cows. *By Stephen Bartlett.* 1929. *Jour. Agric. Sci., Vol. XIX, pp.* 438-451.—Three cows were used for part of this work. The record of the weight of milk and butter fat content were made throughout a lactation period. In addition to these data, there were the monthly records of individual animals sampled at each milking on three consecutive days each month; the records covered five years, and the greatest care was taken to prevent variation owing to change in the personnel of the milkers, particular care being taken that the cows should be treated quietly. It was found that the variability in the yield of milk and fat of cows was affected by many factors, especially the stage of lactation and the season of the year. Variability is high during the first month of lactation and usually highest in the month of May. It has a general tendency to be higher during the summer than the winter months. When cows are milked twice daily at unequal intervals the yield of milk obtained in 24 hours is slightly less variable if a morning milk yield is added to the subsequent evening yield, than if an evening yield is added to the subsequent morning yield.

If, however, the variation were due to varying quantities of milk retained in the udders of cows at milking time, the author suggests that incomplete milking may be a possible cause of day to day variability. This does not necessarily imply that the milking has been faulty, but is probably due to the cow being somewhat nervous as a result of discomfort, ill-health or other causes.

Variations in fat yield may be due to varying rates of secretion of fat as well as to incomplete milking. The fat yield was found to vary approximately twice as much as milk, and the reason for this may be found largely in the fact that the last milk drawn from the cow is considerably richer in fat than the total milk drawn at a complete milking; therefore if a proportion of milk is retained in the udder at any milking, the proportion of fat retained is correspondingly greater.

The author also suggests that there is a greater tendency for the rate of secretion of fat to vary more from day to day than the rate of secretion of milk.

Blood Tests in Cattle. *Von J. Merkens, Ztschr. f. Tierzuchtung u. Zuchtungsbiologie. Bd. XVI, Heft. 3. Dez.,* 1929, *pp.* 361-400.—In an interesting paper on crosses between east Zebu type of cattle and European breeds, the author refers to blood tests of cattle which are of considerable interest.

The relationship between the buffalo and other races of cattle was found to be by no means close, and to be considerably less than the relationships between other races. The Dutch Friesian was found to be closer to the *Bos sondaicus* than to the Zebu. Some evidence has been found in support of the theory that some of the European breeds of cattle are of mixed origin. Some further facts are stated concerning the fertility of the cows between the various races of cattle, but the chief significance in this paper lies in the fact that different blood compositions have, for the first time, been found to exist in cattle, a fact which has been known for some time in man and has been more recently discovered in sheep. These blood groupings, which are hereditary, are intimately connected with resistance to disease, &c.

What determines Horn Growth in Cattle and Goats? *By W. F. Dove* (1927), *Wisconsin Sta. Bull.* 396, 64-67.—It has been found possible by the transplantation of tissues to produce on cattle or goats almost any type of horns, comparable to the solid horn of the deer, the sheathless horn of the giraffe, the casting and sheath renewal of the prong-horned antelope, and the rhinoceros type of horn, since the type of horn depends largely upon the character of the underlying bone structure to which it is attached.

Sheep.

Growth of Horns in Sheep: The Effect of Castration on the Development of Horns in Rambouillet Ram Lambs. *By J. E. Nordby, Jour. Heredity,* 1928, *Vol.* 19, *pp.* 119-122.—In a study of the effect of castration on the growth of horns in Rambouillet rams at the Idaho Experiment Station, monthly measurements of the length, diameter and spread of the horns in two normal rams and two rams castrated at three months of age showed that castration reduced the growth of the horns about one-third in the succeeding 4-week period and about one-tenth in the 12-week period following castration. It was further found that the increase in the length and diameter of the horns occurs entirely at their base during growth.

Horses.

The Gait of the Horse. *By J. Buchmann* (1929), *Thesis, University of Breslau.*—The author reviews the literature regarding the gait of the horse, and amongst other things he states that the inheritance of gait comes from both sides, but where the parents were practically accurate in their gait they transmitted their gait to a greater proportion of their progeny than those animals which were not so accurate. The difference between the trotting and the pacing gait is probably not inherited in a simple manner, the matter being complicated by the training which the horse might receive. It seems possible, however, that the gait of the hackney behaves as a simple dominant over the ordinary gait. The author also states that certain defects of the hoof are hereditary.

Pigs.

Birthweight of Pigs. *By A. H. Kuhlman and L. S. Cole, Wisconsin Sta. Bul.* 405 (1929), *pp.* 51-53, 54, 63, 64.—Up to a birth-weight of 2·8 lb. the percentage of pigs raised increases, but heavier birth-weights have no advantage. Only 75 per cent. of the pigs farrowed survived the first four days, and 37 per cent. were lost during a 56-day suckling period. The average birth-weight of 972 pigs farrowed by yearling sows was 2·35 lb. and of 1,344 pigs farrowed by aged sows 2·55 lb. At the end of the suckling period 207 pigs from yearling sows averaged 23·02 lb. and 227 pigs from aged sows averaged 27·1 lb.; the difference in weight at 98 days of age was 9·38 lb. in favour of the pigs from aged sows. The results of this study indicate that pigs of a low birth-weight are apt to be an economic loss, and that, in general, aged sows produce larger and more uniform litters and take better care of their pigs than yearling sows.

ANIMAL NUTRITION.

The Influence of Artificial Drying on the Digestibility of Pasture Herbage. *H. E. Woodman, J. W. Bee and G. Griffith, J. Agric. Sci.*, 1930, *20*, 53.—In view of the high nutritive value of young pasture, attempts are now being made to conserve such herbage by artificial drying for feeding during winter. It was necessary, however, to demonstrate that young pasture could be artifically dried without affecting its nutritive value. From experiments carried out it has been shown that grass does not suffer any depression in respect of digestibility when it is dried (*a*) at the temperature of steam, or (*b*) by direct heat in a kiln.

The Value of Whole Sugar Beet in the Nutrition of Swine. *H. E. Woodman, A. N. Duckham and M. H. French, J. Agric. Sci.*, 1929, *19*, 669.—Although neither customary nor desirable to use whole sugar beet for feeding purposes, circumstances might arise when the farmer would be desirous of feeding the whole or part of his crop. In further digestive trials with pigs the authors conclude that whole sugar beet, suitably grated, may be used to replace barley meal up to 25 per cent. of the total ration in the production of bacon pigs. Substitution should be effected at the rate of 3½ lb. sugar beet to 1 lb. of barley meal.

The Value of Dried Sugar Beet Pulp and Molasses: Sugar Beet Pulp in the Nutrition of Swine. *H. E. Woodman, A. N. Duckham and M. H. French, J. Agric. Sci.*, 1929, *19*, 657.—In experiments with pigs it has been found that these two foodstuffs are digestible almost to the same extent as in the case of ruminants. Sugar beet pulp, however, although a good source of carbohydrate for ruminants is not entirely suitable for pigs. When included in the pig's ration up to the equivalent of one-sixth of the total food it causes the mixed ration to be very bulky after the usual soaking in water. This leads to difficulties in securing satisfactory consumption of the food, as pigs are unable to consume as big a ration as is possible when sugar beet pulp is omitted. It depresses the rate of live weight increase. Its bulk prevents its being suitable except in small quantities when it is desired to make pigs into bacon as quickly as possible. It can, however, be used in moderate quantities for breeding pigs or for pigs not being fed to their maximum with a view to early maturity.

STATISTICS.

PRICES of AGRICULTURAL PRODUCE, FEEDING STUFFS and FERTILISERS in December 1929, and January and February 1930.

LIVE STOCK : Monthly Averages of Prices at certain representative Scottish Markets.

(Compiled from Returns received from the Department's Market Reporters.)

Description.	December. 1st Quality	December. 2nd Quality	December. 3rd Quality	January. 1st Quality	January. 2nd Quality	January. 3rd Quality	February. 1st Quality	February. 2nd Quality	February. 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 8	55 0	44 6	62 11	55 5	43 10	62 10	55 4	43 8
Cross-bred (Shorthorn)	58 8	51 5	40 6	58 7	51 5	40 8	58 10	51 9	41 3
Galloway	57 0	51 11	48 0	58 7	54 2	..	57 6	53 3	...
Ayrshire	55 9	44 3	33 9	54 10	44 5	34 5	56 0	43 6	34 6
Blue Grey	66 6	63 0	...	...	...	...	...	...	...
Highland	...	...	...	56 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	14¾	9½	...	15¼	9	...	16	9	...
†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	14	12½	9	14¼	12¾	9¾	14½	13	10½
Half-bred	13¾	12½	8½	14	12½	9½	14½	13	10½
Blackface	14	12½	8¾	14¼	12¼	9½	14¼	12½	10¼
Greyface	14	13	9¼	14½	13	10	14¼	13¼	10¾
Down Cross	13¾	12½	8½	14	12½	9¼	14	12½	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 .. .	13 7	13 1	...	14 5	13 8	...	14 11	14 1	...
Porkers	14 6	13 9	..	15 3	14 4	...	15 10	14 10	..

* Live weight. † Estimated dressed carcase weight.

Live Stock : Monthly Averages of Prices at certain representative Scottish Markets—(*continued*).

Description.	December. 1st Quality	December. 2nd Quality	December. 3rd Quality	January. 1st Quality	January. 2nd Quality	January. 3rd Quality	February. 1st Quality	February. 2nd Quality	February. 3rd Quality
STORE STOCK :—									
Cattle—	Per head. £ s.	Per head. £ s.	Per head. £ s.	Per head. £ s.	Per head. £ s.	Per head. £ s.	Per head. £ s.	Per head. £ s.	Per head. £ s.
Aberdeen-Angus :									
Yearlings	16 5	11 15	11 10	16 14	12 6	11 10	17 16	12 15	9 15
Two-year-olds ...	22 18	18 10	14 10	23 16	18 9	...	24 2	18 16	....
Cross-bred (Shorthorn) :									
Yearlings	14 16	11 9	10 8	15 12	11 4	...	16 12	12 13	10 4
Two-year-olds ...	21 13	17 7	14 5	22 10	17 7	...	22 16	17 10	...
Galloway :									
Yearlings	13 0	...	...	14 0	...	...	13 12	...	...
Two-year-olds ...	...	...	...	...	23 0	...	...	16 10	...
Ayrshire ;									
Yearlings	...	...	...	...	...	...	14 0	9 0	...
Two-year-olds ...	...	...	...	...	...	...	20 0	18 0	...
Blue Grey :									
Yearlings	...	...	...	...	...	...	...	...	...
Two-year-olds ...	...	...	...	...	...	...	...	...	...
Highland :									
Yearlings	...	...	..	...	...	...	...	...	...
Two-year-olds ...	...	...	..	...	...	...	...	...	...
Three-year-olds ...	...	...	...	...	...	...	...	...	...
Dairy Cows—									
Ayrshire :									
In Milk	31 18	23 8	12 0	29 18	22 7	12 0	28 5	20 15	12 5
Calvers	30 7	22 17	15 10	29 2	22 4	15 6	28 18	20 18	15 10
Shorthorn Cross :									
In Milk	32 0	25 16	...	32 17	25 6	22 0	32 11	24 9	...
Calvers	31 12	23 16	20 5	30 10	22 11	18 7	29 11	21 12	18 2
Sheep—	*s. d.*	*s. d.*	*s. d.*	*s. d.*	*s. d.*	*s. d.*	*s. d*	*s. d.*	*s. d.*
Cheviot Hoggs ...	...	...	...	45 9	28 0	...	51 6	43 9	...
Half-bred Hoggs ...	49 1	40 0	...	59 6	46 0	...	64 8	46 2	...
Blackface Hoggs ...	31 9	25 0	19 8	33 10	25 9	19 11	31 2	25 6	...
Greyface Hoggs ...	49 3	41 8	34 0	50 6	40 5	32 2	53 7	42 11	38 0
Down Cross Hoggs	48 6	...	...	55 3	...	...	...	...	...
Pigs—									
(6 to 10 weeks old)	46 2	31 9	...	53 5	35 2	...	59 4	40 0	...

DEAD MEAT: Monthly Average Prices at Dundee, Edinburgh, and Glasgow.

(Compiled from Returns received from the Department's Market Reporters.)

Description.	Quality.	December.			January.			February.		
		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	9¼	9¼	10½	10	9½	10½	10	9	10½
	2	8⅝	...	9⅝	9	...	10	9	...	10
Bull	1	7⅞	7¼	6⅝	8	7⅝	7	8	7½	7
	2	6⅞	...	6	7	...	6	7	...	6
Cow	1	6½	6⅝	6	6½	6¾	6⅜	6½	6⅝	6½
	2	5⅞	...	5⅛	6	...	5⅞	6	...	6
Irish—										
Bullock or Heifer ...	1	...	...	8⅞	...	...	9½	...	...	9½
	2	...	...	8¼	...	...	8¾	...	...	9
Bull	1	...	...	...	...	...	...	...	...	...
	2	...	...	...	...	...	...	...	...	...
Argentine Frozen—										
Hind Quarters ...	1	7	7¾	...	7	7¾	...	7	7½	...
	2	6⅝	6½	...	6⅞	6⅝	...	6½	6½	...
Fore ,, ...	1	5⅝	5½	...	5½	5½	...	5¾	5¾	...
	2	5¼	5¼	...	5¼	5¼	...	5½	5½	...
Argentine Chilled—										
Hind Quarters ...	1	8⅝	8¼	8	8⅛	7¾	8	7⅝	7½	7¾
	2	8¼	7⅜	7⅝	7¾	7¼	7½	7⅝	6⅞	7¼
Fore ,, ...	1	5⅞	5¾	5⅝	5¾	5⅝	5⅝	6	5¾	5⅞
	2	5⅝	5¼	5⅜	...	5⅛	5⅜	5¾	5⅛	5⅝
Australian Frozen—										
Hind Quarters ...	1	...	...	6¾	...	...	6¾	...	...	6¾
	2	...	...	...	...	...	...	...	...	...
Crops	1	...	...	5¾	...	...	5¾	...	...	5⅝
	2	...	...	...	...	...	...	...	...	...
New Zealand Frozen—										
Hind Quarters ...	1	...	...	6¾	...	...	6¾	...	...	6¾
	2	...	...	...	...	...	...	...	...	...
Fore ,, ...	1	...	...	5	...	...	5	...	...	5
	2	...	...	...	...	...	...	...	...	...
MUTTON :—										
Hoggs, Blackface ...	under 60 lb.	13	11⅝	11½	13	11¾	11½	13	11⅝	12⅜
	60 lb. & over	12	...	11	12	...	11	12	...	11½
,, Cross	under 60 lb.	13	11⅝	11½	13	11¾	11½	13	11⅝	12⅜
	60 lb. & over	12	...	11	12	...	11	12	...	11½
Ewes, Cheviot	1	...	7¾	7⅞	...	8⅛	8½	...	9	9⅞
	2	...	...	7	...	...	8	...	...	9⅜
,, Blackface ...	1	8¼	7¾	7⅞	9	8⅛	8½	9	9	10
	2	7¾	...	7	8½	...	8	8⅛	...	9⅜
,, Cross	1	7	7¾	7⅞	7	8⅛	8½	7	9	10
	2	6	...	7	6	...	8	6	...	9⅜
Argentine Frozen ...	1	...	...	6	...	...	6	...	...	6
	2	...	...	...	...	...	5⅛	...	...	...
Australian ,, ...	1	...	6⅝	5⅞	...	6¾	5½	...	7⅝	5½
	2	...	5¾	5	...	6	5	...	6⅛	5
New Zealand ,, ...	1	...	...	5⅜	...	...	5⅛	...	...	5½
	2	...	...	5	...	...	5	...	...	5
LAMB :—										
Home-fed	1	...	...	12⅞	...	...	13	...	..	13
	2	...	...	11⅛	...	...	12⅛	...	...	12⅛
New Zealand Frozen ...	1	...	9⅝	8⅛	...	10⅝	8½	...	11⅝	8⅛
	2	...	8¼	...	...	9	...	...	...	...
Australian ,, ...	1	...	...	8	...	...	8	...	...	8
	2	...	...	...	...	...	...	...	...	...
Argentine ,, ...	1	...	...	7⅛	...	...	7½	...	...	7⅛
	2	...	...	...	...	...	...	...	...	...

Eggs: Monthly Average Wholesale Prices at Aberdeen and Glasgow.   **Provisions: Monthly Average Wholesale Prices at Glasgow.**

(Compiled from Returns received from the Department's Market Reporters.)

Market.	Description.	Quality.	December. s. d.	January. s. d.	February. s. d.
Aberdeen.	Country ... ... per doz.	1	2 6	2 1	1 11
		2	2 5	2 0	1 9
	Duck ... ... ,,	1	2 8	2 3	2 0
		2	2 7	2 1	1 10
Glasgow.	Country .. ... per doz.	1	2 9	2 4	2 3
		2	2 5	2 2	2 0
	Irish ... ... per 120.	1	27 9	20 11	17 9
		2	26 2	19 4	15 8
	,, (Cold stored) ... ,,	1	15 9	...	...
		2	...	...	...
	,, Duck ... ... ,,	1	20 0	19 8	17 8
	Argentine ... ... ,,	1	16 1	...	...
	Australian ... ... ,,	1	19 2	18 6	...
		2	18 3	18 0	...
	Belgian ... ... ,,	1	21 0	16 11	13 6
		2	...	...	...
	,, (Pickled) ... ,,	1	17 5	14 5	10 5
	Canadian ... ... ,,	1	17 4	...	...
		2	...	...	...
	Chinese (Black) ... ,,	1	13 3	12 2	9 1
	,, (Violet) ... ,,	1	14 0	13 3	...
	Danish ... ... ,,	1	23 8	...	...
		2	...	...	...
	,, (Pickled) ... ,,	1	...	...	...
	Dutch ... ... ,,	1	19 0	15 9	13 11
		2	...	15 0	...
	,, Duck ... ,,	1	14 5	13 6	13 3
	Egyptian ... ... ,,	1	11 5	9 0	7 6
		2	...	7 2	7 0
	Polish (Blue) ... ,,	1	13 5	12 7	9 4
		2	11 10	10 1	7 3
	,, (Red) ... ,,	1	11 6	...	...
	Russian ... ... ,,	1	15 3	...	...
		2	12 6	...	...
	Swedish ... ... ,,	1	18 11	12 5	14 9
		2	...	...	...

Description.	Quality.	December. s. d.	January. s. d.	February. s. d.
Butter:				
Irish Creamery ... ... per cwt.	1	174 0	...	...
,, ,, (Unsalted) ,,	1	178 0	...	...
Australian ... ... ,,	1	171 3	160 5	157 0
Danish ... ... ,,	1	183 6	177 5	178 6
,, (Unsalted) ... ,,	1	187 6	182 0	182 9
New Zealand ... ... ,,	1	173 6	166 0	159 0
,, (Unsalted) ... ,,	1	178 6	184 0	173 0
Siberian ... ... ,,	1	171 3	166 0	...
Swedish ... ... ,,	1	175 3	166 2	161 6
Cheese:				
Cheddar ... ... ,,	1	111 0	111 0	111 0
	2	104 0	104 0	105 0
Cheddar Loaf ... ... ,,	1	120 0	116 5	115 0
Dunlop ... ... ,,	1	102 6	105 7	110 0
	2	96 0	102 0	105 6
Canadian... ... ... ,,	1	102 0	103 0	104 0
New Zealand (Coloured) ,,	1	99 0	94 10	95 9
,, (White) ,,	1	99 0	94 10	95 0
Hams:				
Irish (Smoked) ... ... ,,	1	177 0	183 0	192 0
	2	160 0	167 7	177 0
American, Long Cut (Green) ,,	1	106 0	104 7	106 6
American, Short Cut ... ,,	1	101 0	106 2	110 0
Bacon:				
Ayrshire (Rolled) ... ,,	1	148 6	163 7	172 0
Irish (Green) ... .. ,,	1	130 0	140 5	150 6
,, (Dried or Smoked) ,,	1	134 0	146 0	156 0
,, (Long Clear) ... ,,	1	138 6	152 5	158 0
Wiltshire (Green) ... ,,	1	134 0	148 5	159 0
,, (Dried or Smoked) ,,	1	140 0	155 7	167 0
Danish, Sides ... ... ,,	1	115 6	117 2	119 0
Dutch, Green (Wiltshire Style) ,,	1	111 0	114 0	113 6
American Long Clear, Middles (Green) ,,	1	107 0	100 0	105 0
American (Short Clear Backs) ,,	1	103 0	102 5	103 9

FRUIT AND VEGETABLES: Monthly Average Wholesale Prices at Glasgow.

(Compiled from Returns received from the Department's Market Reporter.)

Description.	Quality.	December.	January.	February.
FRUIT:—				
Apples—		s. d.	s. d.	s. d.
British—				
Bramley Seedling per box (70 lb.).	1	9 0	9 6	*10 0
Other Cooking per barrel (10 stone).	1	18 0	17 0	17 0
Other Dessert ,, ,,	1	20 0	18 0	17 0
Imported—				
Californian per case (40 lb.).	1	13 0	12 6	12 6
Canadian ... ,, ,,	1	10 6	11 0	12 0
Oregon ... ,, ,,	1	18 0	16 0	18 0
Pears—				
Californian ... per case (40 lb.).	1	18 0	17 0	15 0
South African per tray (28 pears).	1	7 0	6 3	6 0
VEGETABLES:—				
Beet ... ... per cwt.	1	5 0	4 7	4 2
Brussels Sprouts ... ... ,,	1	21 6	20 0	24 6
Cabbage, Coleworts ... per doz.	1	1 3	1 2	1 0
,, Red ... ... ,,	1	2 9	3 0	2 11
,, Savoy ... ... ,,	1	2 0	1 10	1 9
Carrots ... ... per cwt.	1	5 0	5 0	4 9
Cauliflowers—				
Broccoli, *Cornish* ... per doz.	1	5 8	4 11	5 2
Other British ... ,,	1	...	...	4 0
French ... ... ,,	1	6 0	4 11	5 3
Celery ... . per bunch.	1	2 3	2 0	2 2
Cucumbers ... ... per doz.	1	6 0	10 6	24 0
Greens ... ... per doz. bunches.	1	9 0	7 6	6 0
Leeks ... ... ,,	1	2 6	2 6	2 5
Lettuce, Cos ... ... per doz.	1	2 6	2 2	2 9
Onions, *Dutch* ... ... per cwt.	1	5 0	4 8	4 2
,, *Valencia* .. per case.†	1	9 3	9 8	8 11
,, *Spring* ... ... per bunch.	1	0 8	0 6	0 5
Parsley ... ... per cwt.	1	15 0	14 5	15 6
Parsnips ... ... ,,	1	10 0	8 5	8 0
Radishes ... ... per doz. bunches.	1	1 9	1 11	2 0
Rhubarb ... ... per cwt.	1	‡64 0	‡43 7	‡40 6
Spinach ... ... ,,	1	32 0	32 0	36 0
Tomatoes, *Scottish* ... per lb.	1	0 8	...	...
,, *English* ... ,,	1	0 4½	...	...
,, *Channel Islands* ,,	1	0 4¼	0 5½	0 5½
Turnips ... ... per cwt.	1	2 0	2 0	1 11
Vegetable Marrow ... per dozen.	1	5 0	...	...

* Per case (40 lb.). † 9 stone (approx.). ‡ Forced.

Potatoes : Monthly Average Wholesale Prices at Aberdeen, Dundee, Edinburgh, and Glasgow.

(Compiled from Returns received from the Department'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. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.
December.							
Aberdeen, per ton	1	...	...	...	...	...	2 9 0
Dundee ,,	1	...	...	...	...	...	2 10 0
Edinburgh ,,	1	2 10 0	2 10 0	...	...	...	...
Glasgow ,,	1	...	2 14 0	...	...	5 11 0	3 0 0
January.							
Aberdeen ,,	1	...	...	...	...	...	2 6 0
Dundee ,,	1	...	...	...	...	...	2 4 0
Edinburgh ,,	1	...	2 10 0	3 10 0	3 10 0	...	...
Glasgow ,,	1	...	2 6 3	5 5 0	...	5 0 0	2 13 6
February.							
Aberdeen ,,	1	..	...	...	...	...	1 19 0
Dundee ,,	1	...	..	...	...	5 0 0	2 0 0
Edinburgh ,,	1	...	2 0 0	4 0 0	2 11 3	...	...
Glasgow ,,	1	...	1 15 0	4 11 3	...	3 12 6	2 0 0

Roots, Hay, Straw, and Moss Litter : Monthly Average Prices at Aberdeen, Dundee, Edinburgh, and Glasgow.

(Compiled from Returns received from the Department'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.										
* Aberdeen, per ton	1	...	...	...	80 0	...	...	...	33 9	...
‖ Dundee ... ,,	1	...	...	17 6	110 0a 100 0b	...	77 6	70 0	77 6	52 6§
¶ Edinburgh ,,	1	...	...	...	117 6a 115 0b	...	60 0	...	60 0	...
‖ Glasgow ,,	1	...	...	...	97 6	100 0	60 0	...	62 6	33 9§§
January.										
* Aberdeen ,,	1	...	...	..	80 0	...	...	...	32 6	...
‖ Dundee ... ,,	1	...	...	16 7	109 0a 100 0b	...	76 0	70 0	76 0	53 0§
¶ Edinburgh ,,	1	...	...	...	116 0a 112 6b	...	60 0	...	60 0	...
‖ Glasgow ,,	1	...	...	...	96 6	100 0	60 0	...	62 6	34 0§§
February.										
* Aberdeen ,,	1	...	...	...	80 0	...	...	...	31 3	...
‖ Dundee ... ,,	1	...	...	13 6	108 9a 95 0b	...	62 6	...	62 6	52 9§
¶ Edinburgh ,,	1	...	...	...	108 2a 103 9b	...	54 5	...	54 5	...
‖ Glasgow ,,	1	...	...	...	95 0	100 0	57 6	...	61 3	35 0§§

* Loose, ex farm. ‖ Straw delivered baled. *a* Delivered baled.
b Delivered loose. § Foreign, ex quay. ¶ Straw delivered bunched.
§§ Home (in 1½ cwt. bales).

FEEDING STUFFS : Monthly Average Prices at Glasgow and Leith.

(Compiled from Returns received from the Department'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 18 2	12 10 0	12 13 0	12 2 0	11 16 11	11 10 0
Foreign	12 7 6	...	12 3 6	11 16 3	11 8 9	10 15 0
Decorticated Cotton Cake	11 6 3	...	10 14 0	...	10 5 8	...
Undecorticated do.—						
Bombay (Home-manufactured)...	7 5 0	6 12 6	7 0 0	6 6 0	..	5 17 6
Egyptian (do.)	7 9 5	7 0 0	7 3 0	7 0 0	6 13 2	6 5 0
Palmnut Kernel Cake	10 18 9	...	10 12 0	...	9 15 0	...
Soya Bean Cake ...	...	...	...	10 16 3	...	9 17 6
Coconut Cake ...	11 7 6	...	11 7 0	...	10 13 9	...
Groundnut Cake, Undecorticated—						
(36-37 per cent. Oil and Albuminoids)	8 18 9	...	8 9 3	7 15 0	7 13 2	7 0 0
(39-40 per cent. do.)	9 4 5	...	8 16 3	8 0 0	8 2 6	7 5 0
Maize Germ Cake—						
Home	10 12 6	...	9 12 0	10 5 0	9 0 0	...
Foreign	10 7 6	...	9 18 0	...	9 5 0	...
Maize Germ Cake Meal	8 16 3	..	8 7 6	...	7 13 9	...
Rice Meal	7 7 6	...	6 17 0	6 17 6	6 9 5	5 15 0
Bean Meal	10 12 6	11 5 0	10 12 6	10 17 6	10 9 5	10 15 0
Barley Meal ...	10 0 0	9 0 0	9 17 0	9 0 0	9 3 2	8 7 6
Fish Meal	19 5 0	18 7 6	19 6 0	18 10 0	19 8 2	18 10 0
Maize Meal—						
Home-Manufactured	9 10 8	8 16 11	9 0 6	8 8 0	8 7 6	7 15 0
South African—						
(Yellow) ...	8 8 5	8 10 0	7 19 3	8 0 0	7 3 2	...
(White) ...	8 12 2	...	8 5 0	7 15 0	7 8 2	...
Locust Bean Meal (Fine)	10 0 0	9 2 6	9 18 6	8 17 6	9 13 2	8 10 0
Maize Gluten Feed (Paisley) ...	9 0 0	...	8 12 0	...	8 0 0	...
Maize—Plate ...	8 9 5	7 18 2	8 1 3	7 12 0	7 7 10	6 19 6
Do. African, Flat	8 19 5	...	8 9 0	...	8 3 2	...
Do. American ...	9 9 5	...	9 6 6	...	9 1 3	...
Oats—Home ...	7 3 9	7 1 11	6 16 6	6 12 6	6 3 5	5 17 6
Do. Plate ...	7 16 7	8 0 0	7 5 6	...	6 9 5	...
Do. Canadian No. 2	7 12 6	8 0 0	7 5 0	...	6 16 3	...
Barley Feeding (Home)	9 0 0	8 7 6	9 7 0	8 1 3	8 16 11	7 9 0
Do. Bran ...	9 5 0	...	9 5 0	8 5 0	9 0 0	...
Wheat—						
Home	10 9 1	10 2 6	10 19 9	10 1 0	9 19 5	9 3 9
Poultry	10 1 11	9 19 2	10 3 0	9 16 0	9 13 9	9 3 2
Imported... ...	9 12 10	...	10 3 0	...	9 11 7	...
Middlings (Fine Thirds or Parings)	7 18 2	7 5 0	7 9 3	6 15 0	6 18 2	5 18 9
Sharps (Common Thirds) ...	7 0 11	6 16 3	7 0 0	6 7 0	6 7 10	5 10 8
Bran (Medium) ...	7 2 10	6 19 5	6 19 3	6 5 6	6 6 3	5 10 0
,, (Broad) ...	7 5 8	7 14 5	7 2 3	7 0 6	6 10 0	6 5 0
Malt Culms... ...	7 6 3	...	6 17 0	6 0 0	5 18 2	5 0 0
Distillery Mixed Grains—Dried	...	9 0 0	...	8 1 11	...	7 9 5
Brewers' Grains— Dried	8 6 11	7 15 8	7 9 9	7 3 9	6 15 4	4 16 3
Distillery Malt Grains —Dried ...	8 6 11	...	7 17 0	...	6 11 11	...
Crushed Linseed ...	26 10 0	...	26 6 0	...	26 0 0	...
Locust Beans, Kibbled and Stoned	9 0 0	8 2 6	8 17 6	8 0 0	8 10 8	7 18 9
Beans—China ...	9 11 7	...	9 15 6	...	9 6 7	...
Do. Sicilian ...	9 13 5	...	9 17 0	...	9 12 2	...
Do. Scots ...	...	...	10 3 0	...	9 13 5	...
Pease, Chilian ...	...	...	14 15 0	...	14 2 6	...
Do. China ...	...	10 0 0	...	...	...	...
Do. Calcutta (White)	...	8 10 0	...	...	...	...
Feeding Treacle ...	7 0 0	7 5 0	7 0 0	7 5 0	7 0 0	7 0 0
Linseed Oil, per gall.	0 6 0	...	0 6 0	...	0 6 0	...

Fertilisers : Monthly Average Prices at Glasgow and Leith.

(Compiled from Returns received from the Department's Market Reporters.)

Description.	Guaranteed Analysis.	December. Glasgow.	December. Leith.	January. Glasgow.	January. Leith.	February. Glasgow.	February. 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	9 17 0	9 15 6	9 19 5	9 19 5	10 2 0	10 2 0
Sulphate of Ammonia (Neutral and Granular) § ...	N. 20·6	9 17 0	9 15 6	9 19 5	9 19 5	10 2 0	10 2 0
Nitrochalk § ...	N. 15½	...	...	9 19 0	...	...	9 19 0
Superphosphate ...	P.A. 13·7	2 15 0	2 15 0	2 15 0	2 15 0	2 15 0	2 16 11
,, ...	,, 16·0	3 1 3	3 1 3	3 1 3	3 1 3	3 1 3	3 1 3
,, ...	,, 17·4	3 6 3	...	3 6 3	...	3 6 3	...
,, ...	,, 18·3	...	3 7 6	...	3 7 6	...	3 7 6
Ground Mineral Phosphate ...	P.A. 26	a2 6 6	b2 5 0	a2 6 6	b2 5 0	a2 6 6	b2 6 2
,, ,, ,, ...	,, 26	c2 9 0	c2 7 6	c2 9 0	c2 7 6	...	c2 8 8
,, ,, ,, ...	,, 34	...	b3 7 6	...	b3 7 6	...	b3 8 8
,, ,, ,, ...	,, 34	...	c3 10 0	...	c3 10 0	...	c3 11 2
Kainit (in bags) ...	Pot. 14	3 6 9	3 2 6	*3 7 4	3 2 6	*3 7 6	3 2 6
Calcium Cyanamide	N. 20·6	§8 19 6	§8 18 0	‖9 1 6	§8 19 6	‖9 4 0	...
Potash Salts ...	Pot. 20	3 16 6	3 10 0	*3 17 4	3 10 0	*3 17 6	3 11 11
,, ,, ...	Pot. 30	5 3 6	4 17 6	*5 4 8	4 17 6	*5 5 0	4 19 5
Muriate of Potash... (on basis of 80 per cent. purity)	Pot. 50	9 9 3	8 15 0	*9 11 10	8 15 0	*9 12 6	9 0 8
Sulphate of Potash (on basis of 90 per cent. purity)	Pot. 48·6	11 10 9	10 17 6	*11 14 2	10 17 6	*11 15 0	11 3 2
Steamed Bone Flour	P.A. 27½/30 N. 82	5 5 0	5 11 3	5 13 0	5 12 6	5 15 0	5 12 6
Bone Meal (Home)	P.A. 28 N. 3¼	8 0 0	...	7 16 0	...	7 15 0	...
,, ,, (Indian)	P.A. 19¼ N. 4	9 5 0	†8 15 0	9 5 0	†8 15 0	9 5 0	†8 15 0
Basic Slag ...	P.A. 14	2 7 6	...	‡2 13 6	...	‡2 10 0	...
,, ,, (Belgian)	,, 18	...	3 2 6	...	3 2 6	...	3 4 6

Abbreviations :—N. = nitrogen ; P.A. = Phosphoric Acid ; Pot. = Potash.

§ Carriage paid in 6-ton lots.
‖ Carriage paid in 4-ton lots.
* Less 5s. 6d. per ton if taken ex quay.
† P.A. 22·9 ; N. 3¾.

a = 75 per cent. fineness through prescribed mesh sieve.
b = 80 per cent. fineness through standard 100-mesh sieve.
c = 85 ,, ,, ,,
‡ 80 per cent, Citric soluble, 80 per cent. fineness.

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WEATHER IN THE EMPIRE.[1]

Sir NAPIER SHAW, LL.D., Sc.D., F.R.S.

SURELY the year 1929 will be a red letter year for meteorology and possibly also for agriculture, for it was the year in which, judging by appearances, meteorologists and agriculturists found that there was real practical advantage to be gained by putting their heads together, or at any rate the information contained in them.

In the days of sailing ships it was understood that you could not tell a seaman anything about the weather; he could tell you a good deal, and was willing to supply you with information or even with observations if you wished them; because a seaman is always a handyman willing to oblige. You could make meteorology out of them, whatever that might mean, if you liked; but you could not give him anything in return; whatever was worth knowing he knew already.

And now of course that steam or oil has displaced sails, a ship may have a morbid kind of interest in fogs or hurricanes, but what does it care for rain or snow, for temperature, wind or humidity, the things that so-called meteorologists prattle about?

And so with farmers, and particularly shepherds. What meteorologist would be so bold as to tell a farmer when he should sow his corn or cut his hay. What good to him to know that Anderson away in the east had 30 inches of rainfall in the year on his farm, and Jones in the west 60 inches. It hardly requires an expert to explain that fourteen days without rainfall means an absolute drought, and a month with less than the third of an inch of rainfall all told a partial drought. Such information might be useful for anybody who is interested in figures, but is not exactly helpful to the man on the land.

Normals and accidents.—Reasons for this detachment are obvious. Everybody is interested in the weather. Talk to a seaman about the weather and he will remember strange happenings of storm or calm the like of which neither you nor he has ever seen before or since; and so the farmer will tell you

[1] Conference of Empire Meteorologists, 1929. Agricultural Section: Report, Papers and Discussions.

of the year when drought nearly ruined him, or of another when the persistent rain came only just short of completing the ruin.

What we somehow came to realise at the meeting of meteorologists and agriculturists in 1929, without anybody saying so, was that after all, in any part of the Empire, it is the average year that carries the average crop that really matters, that it is the normal years upon which we live, and the excesses and defects are stimulants that are remembered more acutely but have not the same meaning for the supply of food and clothing; not by any means the same normal for every district still less for every country; for each its own normal is sufficient.

This dawn of consciousness of a fact that everybody is aware of when you mention it, shines out with undeniable brightness when you have in the same room people from different parts of an Empire like ours. Then we realise that normals are things to be thankful for, because upon them one can build systems of cultivation. When a system has become established by years or centuries of experience it is hard to remember that there was a time when it had to be made. In an old country crops have already been adjusted to the climate and farmers know what seasons to expect and allow for, but in a new country everything has to be learned.

The peculiarity of the British climate is that on the whole it is something like the normal year that we want—a bumper year is very good for some things, very seldom for all; and then after the bumper year comes what? Who knows?

We may perhaps find an answer to that question if we have a compendious record of the weather for a long series of years, which a farmer may keep for himself in a diary or a central office can include in its records. It will certainly be different for every different county and indeed for every different farm. But conditions are sufficiently alike over such districts as Scotland East, Scotland North and Scotland West to make it worth while to associate the records of rainfall, temperature, wind and weather from a number of stations to describe the average conditions for the district, with due note of exceptional figures at the individual stations.

There are notable differences between the districts of the British Isles. All have their summer together, their autumn, their winter and their spring, and the recorded figures justify us in expecting some rainfall every month, and something between 20 inches and 100 inches in the course of the year. But there is a curious difference between the eastern fringe and the western fringe. Looking at the world as a whole we find that roughly speaking rainfall, which is essential for everything, is a summer experience over the great continents and a winter experience over the oceanic islands, and presumably over the oceans themselves if we could get the figures. Our islands lie on the margin between the greatest of the continents on the east and the best known of the oceans on the west. On the oceanic west the rainfall is most abundant in the winter; the east has its summer rains like the continent, but makes a compromise between summer and winter by getting its most abundant rain in October. The Caledonian Canal seems to have been drawn on the map to mark the dividing line between the two systems.

If there are differences between the comparatively small districts of the British Isles, how much greater are the differences between the countries which were represented at the Conference. Those countries were as diverse as they well could be. First, India with its continental summer-rains, known to all the world as the monsoon, and its winter drought; Australia with the prodigious rainfall of its north-east corner, the persistent drought of its western district and its arid central region; Canada and Newfoundland with a whole range of climates from British Columbia, where the inhabitants pride themselves on the growth of British ivy, the fertile prairies of the middle west with the right amount of rainfall to grow wheat, the eastern provinces with a rainfall almost uniformly distributed throughout the year, the ice-bound soil of weary tundras of the uninhabited north and the dreary cold of Labrador, which exhibits nature's pitiless compensation for the astonishing geniality of the British climate. There were representatives too of New Zealand, our own antipodes, which therefore ought to give and does approximately give a replica of our climate; South Africa with its summer continental rainfall and its peculiar south coast; Eastern and equatorial Africa with abundant water-supply; the West Indies in the equatorial current and in the track of the most destructive hurricanes of the world; Hong Kong, which shares the like dangers but calls them typhoons; the Malay States, the homes of abounding thunderstorms; Gambia in West Africa and the Gold Coast with its regular seasons, which so far as I can make out holds the key to the supply of water to the far distant Sudan and the eternal Nile.

So for anyone who has to think about weather a meeting of that kind is remarkably inspiring.

Who shall describe in the compendious pages of a magazine what was in the minds of that assembly when they were asked to consider what to one or other of them was meant by the word weather?

Turning over the pages of *Notes and Queries* the other day I found a summary of the year's weather culled from books of weather-lore something like this:—

January—White.	**May—Flowers.**	**September—Tree fruits and harvest.**
February—Fill dyke.	**June—Leafage.**	**October—Chill.**
March—Winds.	**July—Ripening.**	**November—Dreary.**
April—Showers.	**August—Gathering.**	**December—Frost.**

To how many or how few of the members of the Conference would such a summary represent the facts and what would the various representatives put instead?

The French revolutionaries abolished the calendar as we know it and substituted instead a series of twelve periods based on weather and agriculture, which is like but not the same as the series of *Notes and Queries;* beginning with December 21 the periods are those of snow, rain, wind, buds, flowers, grass-crop, grain-crop, heat, tree-fruits, vintage, fogs, sleet.

Truly if agriculture requires the assistance of a weather-office to make the most of its opportunities for the British Isles or Republican France, what sort of a weather-office ought there to be for the Empire in order to find the best system of agriculture for each part of the whole and to trace the progress of the growing crops?

A week or longer.—One is naturally impelled towards finding the relation between weather and crops. We ask ourselves, for example, whether the curious relationship between the wheat crop of eastern England and the rainfall of the previous autumn has any and if so what parallels. For more than a century meteorologists have been putting together in an organised form the facts about the weather, waiting for the agriculturists to put together the corresponding facts about crops in order that the two may be compared.

And now with the guidance of a committee of the Ministry of Agriculture in England and the Department of Agriculture for Scotland we have begun to combine the information, and the first thing that happens is that we realise that meteorologists have from the beginning been addicted to the month. They might feel insulted if we concluded therefrom that they still thought the weather to be controlled by the moon; but even the best of their forbears, like Sir William Herschel and Luke Howard, used to pay special attention to the moon. I wonder if it would be fair to twit them with the idea that they have followed the bad example of Augustus Caesar in ignoring the differences between the month and the moon, for what have been called months for twenty centuries are very poor representations of the moon. And meanwhile for the farmer the month is only a sort of milestone of the calendar. His market-day is weekly or fortnightly, and so are a good many other things, other things are seasonal, hardly anything is monthly; even monthly wages which in India used to be and perhaps are still paid on sight of the new moon are going out of fashion.

It is therefore not surprising that fifty years ago when the authorities of the Meteorological Office in London were considering with the originators of the Experimental Station at Rothamsted, Sir John Lawes and Sir Henry Gilbert, the best way of setting out the records of weather for comparison with the agricultural facts of Rothamsted and elsewhere, they decided that a weekly report was the best, and initiated one that with various developments was issued week by week on Wednesdays from 1879 until the year 1928. Special observations were collected weekly from about ten stations in each of the twelve districts of the British Isles, Scotland North, East and West, Ireland North and South, England North-East and North-West (with North

Wales), Midland Counties, England East, South-West (with South Wales), South-East and the Channel Islands. So little was known of the weather of Scotland North at that time that nothing was said about it for the first few years and the district was known as O. The districts on the east side were called the principal wheat-producing districts and those on the west the principal grazing districts. The elements recorded were temperature, rainfall and subsequently sunshine. Temperature was recorded in a special manner as accumulated warmth above 42°F., which was thought to be specially appropriate in reference to plant-growth. In later years small daily charts of wind and weather were added, so that a week's report of ten pages was a complete weather-guide for the whole country. We are now supplied with ten large pages of information about the weather of every single day of the year; but if we want a general idea of the weather week by week we must make it ourselves or wait till the year is over.

The advantage of a weekly record is that after a sufficient number of years one can put up an indication of the week's weather for a district in three words, one for rainfall, a second for warmth and a third for sunshine; that can be abbreviated to three letters according as the rainfall has been very light, light, moderate, heavy or very heavy; the warmth very unusual, unusual, moderate, deficient or very deficient for the time of year; and the sunshine very abundant, abundant, moderate, scanty or very scanty. Information for every week of twenty years can thus be put on a page of the size of this.

Perhaps that is not of much direct importance for the ordinary farmer of the British Isles, but when we enlarge our outlook to the British Empire, and, from the point of view of marketing, want to have before us the state of the weather and consequent prospect of the crops of raisins, currants, rice, cotton, tobacco, sugar beet, apples, cacao, bananas, palm oil, wheat, oats or grass, what better plan can be suggested than a weekly note of the weather with a corresponding note of the progress of the crops in each of the districts concerned?

A weekly note would be effective for any district of the Empire; a monthly report reduced to few words might obliterate such salient features as frost or flood which in a week could not be overlooked.

A seven day week, with four weeks and a little over to a moon, fifty-two weeks and one day over to the year, has taken a strong hold upon humanity. One may wonder why. Various other periods have been proposed for statistical purposes when people have wished to be independent of social habits and customs, the ten-day decade, the five-day pentade have been tried, and a distinguished meteorologist has proposed a six-day period with 61 to the year, one day short three years out of four. But the week is found appropriate for many social purposes, for country newspapers, for holidays and half-holidays, for the week's wash and for many other.

According to the story of its establishment, if the process of creation had had to be limited to five days instead of six before the day of rest, we should have missed either the dividing of light from darkness, or alternatively the existence of man himself.

Fifty-two, made up of four thirteens, comes up again in every pack of playing-cards with a joker as a reminder of the extra day to make up the year's pack. I sometimes wonder whether the four suits are seasons and the thirteen cards in each are the weeks, let us say the labour of spades for the autumn of the farmer's year (September, October, November), the pugnacity of clubs for winter (December, January, February), the joy of hearts for spring (March, April, May), and the wealth of diamonds for summer (June, July, August).

This for our climate, for Mediterranean countries it might be different. In the Mediterranean the summer half-year is generally rainless, the corn harvest is gathered by May, the harvest of tree fruits, grapes, olives and dates is finished by October, and in the hot interval between the corn harvest and the vintage, so far as one can judge by a cursory glance at history, the practice was for the men to go fighting. So we may have to consider hearts to indicate the spring season, February to April; the pugnacity of clubs, May to July; the wealth of diamonds, August to October; and the labour of spades, November to January.

There is talk about changing our calendar, and by the way when they changed it before in Scotland at the beginning of the 17th century what a pity they did not begin the year with what is now the 8th November, so that the other seasons might begin with 8th February, 8th May and 8th August! There are obvious reminiscences of that kind of calendar in Scotland marred by the loss of eight days in 1600.

Now that there are agricultural research stations in many districts and in various dominions and colonies, it should be possible to get a weekly note about the weather and the crops that would keep us informed about the way things are going. The Conference made it clear that associated with the weather we should want notes about insect pests, about diseases of plants, about the abundance or scarcity of mice and other vermin, all of which in their turn seem to take advantage of, or are punished by, the peculiarities in the weather.

That is not all—we have still a good deal to learn about growth. For the more precise student our information about the weather presents the crude general view that an outsider might take. If we want to know how crops grow we must find out about the warmth and moisture in the air and in the soil which the plants are actually using. That wants a new technique, a week is far too long; we must devise instruments which record their own readings and are close up to the growing plants or to their roots.

Those have still to be devised and are matters for the more ambitious research stations rather than for the agriculturist. We ought to be content if the Conference gives to those who are interested as much information as can be got in the ordinary way week by week from the various parts of the Empire from which we obtain material for food, or clothing or tobacco.

Weather Forecasting.—For many people the word meteorology implies nothing more than forecasts of weather for a day or a week or a season; but that is not the aspect of the subject which was in evidence at the Conference; we were concerned, as I have said, more with the average procedure of getting crops out of the land than with the incidents of weather that go to make up the year.

Since broadcasting came into fashion and forecasts of weather have been broadcast to millions of listeners the interest in forecasting may be said to have come into its own. It is hardly necessary to say anything about it on this occasion. Though it uses observations like those of any other branch, it is a special department of meteorology that has its own expositors. What one notices about it, as a listener, is that it has its own language in which the words depression and secondary, anticyclone and Iceland are very prominent. That is explained by the fact that the forecaster always talks with a map in front of him, and a listener who wants to keep up with him must imagine a map in front of himself—a map with the British Isles in the centre, Iceland across the Atlantic to the north-west, the Bay of Biscay and France to the south, Belgium, Holland and Germany to the south-east and east, Sweden, Norway and Denmark to the north-east. On his imaginary map the listener must have imaginary lines which exhibit the distribution, generally described or hinted at by the forecaster, of the records of the barometer at sea-level, calculated if necessary for that level from the original readings. He should have also temperature and weather, but the information in the forecaster's report is rather scanty.

On that map a depression is an area of low pressure round which air is circulating against the hands of a clock, with a drift inwards towards the centre; and an anticyclone is on the contrary an area of high pressure round which air is circulating with clock hands and with a drift away from its central region. Anticyclonic regions, limited by a closed pressure line from which air is drifting, are generally fine, warm in summer, cold in winter; and regions of depression, bounded by a closed pressure-line across which air is drifting inwards, generally have some rain associated with them, and change from warm to cold as the wind changes from south-east or south-west to north-west or north. A secondary is a local convergence of air carried along in the air-current of a large depression, and the region south of Iceland is the normal centre of a vast depression natural, especially in the winter months, to the North Atlantic between Canada and Ireland.

The forecaster has in mind the passage of these things across the map and the weather-changes which they typify. Without a map to guide them listeners can only make guesses of the way the game is played. Worked by the map, which changes from day to day, forecasts, as we know them, are for to-morrow's weather at the most. One of the efforts that arose out of the Conference was to get a broadcast in the afternoon that would enable farmers to make their plans for to-morrow with a knowledge of what the day's weather was likely to be. What meteorologists would like to give, if they could, is an anticipation of the weather of the coming week or coming season. That is quite another story; it cannot be done by daily maps. No forecaster would like to draw next Monday's map a week ahead.

A question of that kind has to be approached by the study of the weather of the world and its ways. There are not wanting in the world people who are willing to undertake the prediction. Announcements appear in the public press from time to time. According to English law, those who make them are liable to prosecution with palmists and crystal-gazers and fortune-tellers as rogues and vagabonds. And that is perhaps why, fifty years ago, the Meteorological Council laid down the rule that no forecast should be issued without the information upon which it was based and a candid statement of the reasons for it. The map and the daily report are the conventional compliance with that salutary rule.

For forecasts beyond the range of the map there is no method which has received the general approval of scientific practice. Solar observatories have been established to trace the immediate influence of sun-spots or other changes in the sun. Weather may run in periods, the cold spells of Alexander Buchan, the leader of a band of distinguished meteorologists who formed the Scottish Meteorological Society, have had quite a vogue this year, but year in and year out they are not at all good time-keepers. Or it may be numerically dependent upon what happened months ago in some other part of the world. The how and why are part of the meteorological problem as yet unsolved.

India is the only country where an official intimation about the weather of the coming season is given in advance, and that information is not broadcast; if it were, the exposition of the method and the reasoning would be a liberal education in itself. We are not ready for it yet.

A Conference of Empire meteorologists would find a discussion of weather-forecasting very embarrassing. Each country has its own weather system as it has its own crops. We have not yet attained a system of forecasting for the world that can be modified for the various regions, that is the true aim of the science of meteorology; but meanwhile each system would need separate discussion; each forecaster knows his own bitterness—a stranger intermeddleth not with his joy.

But none of us are strangers to the beneficence of weather. This is not by any means the first time that attention has been concentrated on the relation between weather and crops.

Here is a brief sketch of the subject twenty-five centuries old which surely no one can read unmoved by its reality :

Thou shalt shew us wonderful things in thy righteousness, O God of our salvation: thou that art the hope of all the ends of the earth, and of them that remain in the broad sea. . . . .

They also that dwell in the uttermost parts of the earth shall be afraid at thy tokens: thou that makest the outgoings of the morning and evening to praise thee.

Thou visitest the earth, and blessest it: thou makest it very plenteous.

The river of God is full of water: thou preparest their corn, for so thou providest for the earth.

Thou waterest her furrows, thou sendest rain into the little valleys thereof: thou makest it soft with the drops of rain, and blessest the increase of it.

Thou crownest the year with thy goodness: and thy clouds drop fatness.

They shall drop upon the dwellings of the wilderness: and the little hills shall rejoice on every side.

The folds shall be full of sheep: the valleys also shall stand so thick with corn, that they shall laugh and sing.

Times have changed and the world is vastly different from what it was when that poem was written; but we still with advantage may turn our thoughts in the same direction and realise the contribution which the constituent parts of the Empire have made or can make to the great problem of the world supply of food and clothing.

THE SCOTTISH POTATO MARKET.

D. W. INNES.

THE Department do not accept responsibility for opinions contained in articles contributed to this Journal. In my view this dissociation should be noted specially by the reader in connection with this contribution, since it differs to some degree in standpoint from the general.

1928 Crop—Prices.—Prices for main crop were poor throughout the season October to May, but in the Edinburgh and Glasgow areas there was no complete collapse in values. Average wholesale prices per ton for ware potatoes (other than Golden Wonder and Red Soils) were as follows :—

1928.	October	£5, 0*s*.
	November	£4, 6*s*.
	December	£4, 5*s*.
1929.	January	£4, 5*s*.
	February	£4, 5*s*.
	March	£4, 10*s*.

In out-station areas prices throughout were much lower.

The following quotations are given by a representative Kincardineshire grower for average sales up to 31st December 1928.

Arran Chief, seed, certified 99·5 per cent.	£4, 15*s*. per ton.
Do. ware	£2, 10*s*. ,,
Kerr's Pink, ware	£2, 15*s*. ,,
British Queen, ware	£3, 0*s*. ,,

There was little or no enquiry for certified seed of Kerr's Pink and British Queen.

Seed to produce this crop had been expensive, averaging for ordinary varieties about £6 per ton, but even with this addition to cropping cost the grower who cleared his stocks before 31st December escaped heavy loss.

Growers who held for better prices, and these were in the majority, faced a complete collapse. Towards the end of the season (March 1929) pits of previously dressed ware were sold at 5*s*. per ton for pig feeding. Many pits were left to rot. Exact figures of the extent of the loss are in the nature of things unobtainable.

1928 Crop—Market Control.—The disparity between these conditions and those obtaining in the Edinburgh area would appear to indicate that merchants with contracted supplies and merchant growers were able to maintain some degree of market control for their own stocks for at least a part of the season.

1929 Crop Prices.—The price failure of Second Earlies and main crop (except for Golden Wonder, which has a scarcity value) has been complete throughout the season. Ordinary ware has been quoted at 15*s*. to 17*s*. 6*d*. per ton in the south-western area from January 1930 onwards. Retail stores in Glasgow have sold as low as 30*s*. per ton in cwt. lots, and at 4*d*. per stone. In the north-eastern districts, Aberdeen to Montrose, retailers have been selling at 1*s*. 3*d*. per cwt. during the period November to March.

Market Capacity.—Merchants to whom I have referred accept without much qualification the following figures of normal market requirements in Scotland :—

400,000 tons Scottish ware consumption.
170,000 tons seed for home planting.
50,000 tons ware to England and abroad.

Figures of seed sales to England and abroad are disputed. One recognised authority quotes as an average 280,000 tons. This gives a total normal market capacity of 900,000 tons, but it should be noted that the demand for Scottish seed drops with the price failure of ware in the English market.

Sales of seed from both the 1928 and 1929 crop were greatly below average; from the north-east sales were chiefly under previously contracted or merchant growers' stocks.

Cropping Capacity.—The average area under crop during the past 30 years was 144,000 acres. For the years of exceptional surplus, 1923, 1928 and 1929, areas were respectively 136,976, 144,026 and 144,770 acres.

The decennial average of crop has been 870,000 tons. The crops of 1928 and 1929 were estimated at 1,032,000 and 1,150,000 respectively. Obviously control of supply by reduction of acreage is not advisable.

Consumption of Table Potatoes.—There is no evidence of any decline in local consumption. There is much evidence (quoted later) of increased foreign demand.

There is no obvious profiteering by wholesalers or retailers. A very low price, say 1*s*. 3*d*. per cwt., does not appear to increase offtake. Retailers state that potatoes sell as readily at 1*s*. per stone (£8 per ton) as at 2*d*. per stone, and since a daily ration of ½ lb. would cost the consumer, at the higher figure, only 3*d*. per week, this statement may be accepted.

Scottish Earlies.—The Epicure crop in the south-west reached a total of over 100,000 tons from about 8,000 acres, and of this, according to report, some 30,000 tons were held in warehouses at or near the period when the main crop was arriving on the market.

Continental earlies encroach on the market for Scottish earlies to an increasing extent annually, and over production of Epicures affects the main crop market.

Foreign Competition.—In years of local surplus imports directly aggravate that surplus.

Scottish prices have nevertheless *not* been greatly influenced by the price of foreign potatoes imported in 1929 and 1930.

This opinion will not be accepted by many merchants and growers. It is admitted that very little, if any, main crop foreign ware reaches Scotland, but it is argued that the demand for Scots ware in England is affected by foreign imports to that country. This subject has an important bearing on the possibility of control of surplus.

Import parity may be tested at any centre. For example, there was a demand in France for a short period in the spring of 1929, which was only met by foreign import to French Channel ports at about £5, 5*s*. per ton and £6 at Marseilles.

A close comparison of import statistics with local prices appears to confirm that a similar import parity, in the region of £5, 10*s*. per ton, ruled for the English market for the period 1925 to 1929.

Foreign Markets.—The diet of the peoples in very large and populous areas, in Asia Minor, Egypt and the East generally, has been slowly but steadily changing. An approach is being made towards a diet of wheat products and potatoes. One outstanding example of this movement may be quoted. Export of wheat from the Punjab at one period, about 20 years ago, equalled that of Canada. That crop is now very largely absorbed by Indian demand—from dwellers in the larger towns and from the cotton-growing areas.

This change in the East from a diet of rice, gram and pulses to products of the agriculture of the West has not hitherto attracted attention. It may well be pregnant with great possibilities.

India.—Imports to India of foreign grown potatoes have reached a value of £500,000 annually. Bombay took £86,000 last year from Italy alone. Prices wholesale in October 1929 were £12 per ton, declining gradually, as local hill station supplies became available, to £7, 10*s*. in March 1930. Import duty is 15 per cent. ad valorem; freight from Glasgow to Bombay, 40*s*. per ton. Italian earlies packed in baskets arrive from June to September. Main crop is shipped in bags, and carrying lines report frequent damage in transit. Packing in ventilated 100 lb. boxes is safe but expensive. A Glasgow firm quotes 2*s*. 1*d*. each, equal to £2, 7*s*. per ton. Empty fruit barrels cost about £1 per ton, but are possibly limited in supply. It should be possible to ship potatoes safely in bags surrounded with a light and cheap wooden frame. Shipments of green vegetables are made in tropical areas in this form of packing. The aim is to provide against too close contact in steamers' holds.

The Export Potato Committee of the Scottish Agricultural Organisation Society, Ltd., sent small experimental consignments to Bombay, Madras and Calcutta. These, although reaching their destination far too late in the season (March), arrived in excellent condition, and their quality has been approved.

Large white-fleshed potatoes are popular.

Eastern parts of India import potatoes to the value of about £300,000 annually, supplies coming chiefly to Calcutta from the Upper Shan States, *via* Rangoon. Rangoon quoted £9 per ton in January 1930.

Ceylon.—Colombo imported 13,845 tons last year, of which 50 per cent. were Italian and 5 per cent. French. The import season for main crop is from October to February; duty 40 cents per cwt., equal to 7*s*. 6*d*. per ton; freight 50*s*. Potatoes arriving in March carried excellently and sold at £10 per ton in harbour, the consignees paying duty and landing dues.

Singapore, Penang, Bangkok.—Supplies are obtained from Java, Australia, U.S.A., Upper Shan States, &c. Imports are at present comparatively small in volume, Singapore, for example, taking 950 tons annually. From what is known of American and Australian costs there should be a market here for suitably packed ware. Prices vary greatly according to season and quality. Bangkok imported American supplies at £20 per ton. Singapore quoted in January 1930 at £9, 6*s*. per ton.

Argentine.—The Export Potato Committee (S.A.O.S.) are indebted to the Bank of London and South America, Ltd., for a very full report on this market from which the following information is taken.

Buenos Aires Central Market clears 1,300,000 kilos daily from March to September. 40,000 tons were imported at this port alone from October to December 1929, of which 12,000 tons came from Britain.

Prices opened as high as £22 per ton, and fell gradually to £8 per ton on arrival of the early summer crop from the Northern Provinces in December. Their main crop reaches market in March.

In Monte Video there is a permanent annual demand, "*British production being much favoured.*" In Uruguay the supply grown locally is always insufficient to meet the demand. Only in the past three years have potatoes for consumption been imported to any extent at Buenos Aires. The market in imported seed is, however, permanent and considerable. This was at one time a French monopoly, but latterly, owing to insufficient results from the "early rose" French variety, part of this trade has passed to Holland. British seed is alleged to suffer by reason of "lack of coincidence" of the seasons.

This obstacle, I may add, should not be insuperable. An eminent Forfarshire grower has been very successful in the export of seed to South Africa, where divergence of seasons is at least as great.

Buenos Aires repeats the certificate given by Monte Video :—"*British potatoes for food consumption enjoy a reputation for excellent quality.*"

Egypt.—Imports at Alexandria amount to 26,000 tons annually. Import duty is 8½ per cent. ad valorem; the season for our main crop is from October to January; prices range from £10 to £7; freight 25*s*. to 30*s*.

The Ottoman Bank, Alexandria, supplied the following quotations, dated 6th December 1929 :—English, £10; French, £7, 5*s*.; Italian, £5, 10*s*. Sources of supply in 1928 were :—Italy, 13,000; France, 3,500; United Kingdom, 3,600; Cyprus, 2,500 tons.

Asia Minor.—Total figures of imports are not obtainable. It is, however, an important outlet for the Italian crop, and there are large, but irregular, French imports. A yellow-fleshed potato is popular, of the type "Pertuis."

The Export Potato Committee sold 5 tons to Haifa (Palestine) at £7 per ton. Exports to Asia Minor and Egypt carry well in bags.

South Africa.—German shipments of ware to the Cape are reported at £12 per ton. The following quotations, dated 6th December 1929, were obtained :—East London, £16 to £10; Durban, £12 to £8; Cape Town, £10, 10*s*. to £8, 10*s*. The season for our main crop would appear to be a short one—October to November.

West Indies.—Kingston, Jamaica, reports prices in March 1930 at £11 per ton. Imports came almost entirely from New Brunswick. A few British shipments received have been of bad keeping quality. This would be due to bad packing, or unseasonable date of shipment. As Kerr's Pink arrived in Madras in sound condition in March, they should carry across the Atlantic under any decent conditions.

General.—The facts quoted in the foregoing paragraph seem to indicate that there is an opportunity of establishing a considerable and increasing export trade in British potatoes. There is ample evidence from widely different parts that the quality of British potatoes is justly appreciated in foreign countries. Reference has been made above to the favourable reports from Buenos Aires, Monte Video and Alexandria. It is also significant that Italy permits import from only two countries, of which Britain is one, and that Austria prohibits the entry of any except British potatoes. Further, the Indian Department of Agriculture reports that "Scottish potatoes introduced in the Simla Hills have given a return of Rs.84 (say £6) per acre more than local varieties."

While it is not claimed that in years of average home prices the private trader could profitably undertake export in large quantity, mainly because of the impossibility of his keeping in constant touch with buyers at the various centres, a central organisation, representative of all interests, could be formed which would be in a position to obtain reliable and up-to-date information as to foreign markets and could develop and maintain an export trade of permanent national importance.

A simple outline of the policy which might be followed by such a body is given in the final paragraph of this article.

Farina Production.—Comment here is merely supplementary to the full technical details given in the article [1] published in the January issue of this Journal.

Holland furnishes a very striking example of co-operative farming enterprise in this form of outlet for potatoes. The first private factory was started in 1840, the first co-operative factory in 1898. The latter have now double the output of the private factories.

The production of 36 factories in operation in 1927-8 from 540,000 tons of potatoes was 106,000 tons of potato flour. The production of dextrine was 18,000 tons, and of glucose 25,000 tons. (These round figures are taken from a report by H.M. Legation, The Hague.)

Members of co-operative factories are under contract to deliver given quantities of potatoes at a fixed price. At the end of the season profits are shared according to the quantities delivered. The first of these factories cost about £5,000 to establish; later factories cost about £30,000.

I have up to the present failed to obtain exact figures of Dutch production costs and profits. The following estimate of present working costs in this country has been supplied by an eminent engineering firm :—

[1] Surplus Potatoes: Industrial Uses, General Policy and Marketing, *Scottish Journal of Agriculture*, vol. xiii, No. 1, p. 37.

6 tons raw potatoes at 25*s*. per ton	£7 10 0
25,000 gallons water	0 10 0
Heat and power	0 5 0
Management, wages, interest, maintenance and depreciation	1 15 0
	£10 0 0

There is a large home market for the various forms of potato extracts estimated at the equivalent of 400,000 to 500,000 tons of potatoes annually. Current prices for farina are £11 to £13.

Industrial Alcohol.—The chief burden of a glutted market at present falls on growers in northern and north-eastern counties. In these counties many whiskey distilleries are at present standing idle. The matter has been sympathetically considered by distillery owners, and the following digest of opinion on the possibilities of this production may be quoted :—

(1) Distillers would need regular guaranteed supplies of raw potatoes.

(2) Prices of alcohol were hardening, but at present no better price for a guaranteed supply of raw potatoes, smalls, &c. than 12*s*. 6*d*. per ton could be suggested.

The German and Austrian production was fostered by payment of part of the duty on potable spirits to producers of power spirit in the form of a bonus which reached 1*s*. 7½*d*. per gallon for a fixed annual quantity, and 9*d*. per gallon on surplus. It should be noted that 1*s*. per gallon of bonus affects production costs to the extent of £1 per ton on the price of potatoes.

In this connection I again refer the reader for technical detail to Dr. M'Intosh's valuable summary on page 37 of the January issue of this Journal.

Summary.—Price failure has been due to the absence of all effort to control surplus, and that surplus occasioned mainly by increased tonnage per acre.

In table quality our potato is supreme, in cropping capacity our seed the most free from virus diseases. When a better potato is possible, the Scots farmer will grow it.

The farmer has, in the past two years, done his part of the job too well; the merchant has demonstrated, for the 1929 crop, the failure of *individual* enterprise.

From the point of view of national policy the situation demands organised control of surplus. Failing this, we shall have a recurrence of glut and scarcity, in wicked sequence, detrimental to the consumers' interests, ruinous to the general body of growers, and all tending towards rural depopulation and aggravated urban unemployment.

If growers and merchants lack a sense of community of interest and fail to create the necessary organisations, the State could, and should, do what is necessary.

Policy.—A sketch of an exceedingly simple form of Control is here outlined.

(1) Existing marketing arrangements, for seed and ware sold in the ordinary course by wholesalers and retailers, should not be disturbed.

(2) All merchants, merchant growers and farmers should combine in contract to contribute a fixed levy per £ per ton on all potatoes sold in the ordinary course.

(3) The levy should be collected, and operations governed, by a central body representative of all interests, including the consumers.

(4) The Control policy should be to co-ordinate supply to demand by withdrawal of surplus in the direction found most economical. Export, for example, should be arranged by purchase of supplies at current market rates, at, or near, suitable ports of shipment, adjusting the loss, if any, to the debit of Control funds.

All combinations of growers tend to increase production. The Control would, in time, be able to guarantee supplies at a suitable price to farina mills and distilleries.

(5) Preliminary assistance by Government loan to the extent of £250,000 would be necessary to start and stabilize the funds raised by levy, but the Control should, in a very short period, be self-supporting. No army of officials would be necessary. Administration charges should be low.

STRAWBERRY DISEASE IN LANARKSHIRE.

N. L. Alcock, D. V. Howells and C. E. Foister.

PART I.—FIELD INVESTIGATIONS.

D. V. Howells.

Strawberries were first grown commercially in the neighhood of Crossford about 1872. At that time one small field was planted. During the next decade a number of growers in the Clyde Valley made a beginning with this crop, but it was not until 1890 that the strawberry became the most important fruit crop in the area. At the height of its prosperity more than 1,500 acres were devoted to the crop. The strawberry-growing area embraced the holm land along the Valley and the surrounding hill land, and extended from Carluke on the east to Kirkmuirhill on the west, while it reached Lanark on the south and Hamilton on the north.

The crop was grown successfully at altitudes of from 150 to 1,000 feet above sea level, and on soils varying from sandy soils to heavy clays. So great is the soil variation in the Valley that on the same holding it was quite a common thing to find the crop thriving on soils of very different physical characters. The industry has always been famous for a high level of cultivation, for the great amount of spade work associated with the crop, and for the heavy applications of manure. In no part of the British Isles is there a higher level of cultivation or are heavier applications of manure given. According to report the crops were very heavy in the earlier years, the most popular varieties being the " Countess " and " Eltons Pine." During the past thirty years many new varieties have been introduced, some of which have been grown for a few years and then been discarded as unsatisfactory, while others have had a more enduring popularity. Within recent years the crops have not been nearly so heavy as formerly. Even in the absence of disease there has been a general decrease in the yield per acre. This is a characteristic of the strawberry crop throughout the world and is not peculiar to Lanarkshire. Locally, at least, this is not attributable to any lowering in the standard of cultivation or to a diminution in the quantities of manure applied. Little change has taken place in this matter, though with the advent of the motor car the manure obtainable is not of such good quality as formerly.

Method of Cultivation.—The crop is grown on what is called the " bed system." This is not peculiar to Lanarkshire, but is also practised in Cornwall and in Canada. This system has the advantage of preventing winter heaving and consequent killing of plants on heavy soils, and of affording cover and shelter in exposed situations. The single row system has not proved a success under local conditions.

After a rotation lasting from two to five years, the land is cultivated with spade or plough and manured at the rate of from 40 to 60 tons of farmyard or stable manure per acre. Most growers do not keep cattle and have to rely on town manure. The manure is ploughed in in the spring and the land well tilled previous to planting. Since it is not usually possible to obtain a good stand of plants from autumn planting, spring planting is the rule. As the runners are not produced before late autumn, late summer planting as practised in some parts of England is not practicable.

The rows are set 14 inches apart, three rows forming a bed, with 28 inches between the beds. The spaces between the beds are called the " strawberry roads," and these are dug each winter. Wider cross roads are provided to facilitate cultivation and picking operations. The dibber is used in planting. During the first summer the young plants are usually prevented from flowering and kept persistently hoed and weeded until growth ceases in the autumn. Towards autumn they throw out runners which are allowed to root themselves. In the spring these runners are lifted, the beds are weeded and stirred and artificial manure is applied. After the crop is picked, weeding of the beds is continued until growth ceases. Some growers allow young plants to become " matted " in the bed, while others keep the three lines distinct. The "roads" are then dug or otherwise cultivated and left over the winter. Early in spring, dressings of artificial manures are given. There is no standard artificial dressing, but the most usual is a compound manure having the following percentage composition:—4 per cent. nitrogen; 5·5 per cent. soluble phosphoric acid; 5·5 per cent. insoluble phosphoric acid; 10 per cent. potash. The manurial treatment varies greatly on different holdings. The beds are allowed to remain as long as they will produce a satisfactory crop. Formerly it was quite a common thing to find beds seven or eight years old in a good condition, and previous to the incidence of disease some plantations endured to a much greater age. Of late years four years' duration has been considered satisfactory.

Varieties.—The most popular varieties are:—(1) Ruskin; (2) Lord Overtoun (Dumbarton Castle); (3) Scarlet Queen; (4) Bedford; (5) Seedling 17 (New). Many other varieties are grown.

Economics of the Crop.—The strawberry is a very expensive crop to plant and maintain. It takes from £75 to £90 to plant and maintain an acre until the first picking. About half of this amount represents wages. In subsequent years labour charges vary from £20 to £30 per acre. In 1925 the wage bill on a strawberry farm of 28 acres, half under strawberries and half under rotation crops, was over £1,000.

The yield (on disease-free farms) averages about 1½ tons per acre, and the price realised varies from £40 to £56 per ton.

Occurrence of the Disease.—In 1920 the so-called Lanarkshire Strawberry Disease made its first noticeable appearance and it has spread rapidly ever since. The first large outbreak was at Braidwood on a moderately light soil of good depth. This field was under strawberries for the second time. The disease appeared first in a one year old plantation which was apparently quite normal in the early spring, but towards the end of May the crop had a sickly appearance and whole areas died out. Previous to the appearance of the disease the runners, which were very plentiful on the maiden plants, had been sold to a number of different growers, and the disease was thus disseminated over a wide area. Practically every holding on which plants from this source were set has since remained contaminated. Not only have stocks obtained from the original source or from those growers who had purchased therefrom exhibited disease symptoms, but other strains have become infected. It has been observed that plants obtained from disease-free areas when planted on holdings which have been infected, even though the actual fields have not been previously under strawberries, succumb in their new situation. (Plants obtained from the same source set outwith the district have flourished.) From careful observation it is evident that—

1. On holdings where the disease is prevalent new land has become infected probably by implements, by workers and by other contactual points.

2. Plants obtained from infected holdings when planted on fresh land or even on farms where strawberries have never been grown may develop the disease.

3. The disease is prevalent in many parts of Scotland both on fruit farms and in private gardens. It is possible to link up the majority of these infections with other similar outbreaks. In almost every case infection by plants is traceable.

In 1925 details of three very serious outbreaks occurring on farms situated at great distances apart were obtained. The only point in common was the stock of plants.

In 1921 apparently healthy plants were despatched from holding A to holding B.

In 1923 apparently healthy plants were despatched from holding B to holding C.

Disease was not noticeable on holding A or B until the summer of 1923, but by 1925 the total stock of the particular variety on A, B and C had to be discarded, and since then it has become unprofitable to grow strawberries on B and C. The affected plantations included those of all ages from one to five years. From A to B the distance is over 90 miles, B is separated from C by at least 200 miles, and a like distance separates C from A. These diseased beds were situated on very different soils. On A the disease occurred on both light and heavy soils; on B the disease occurred on a sandy peat (the land had been used for early potatoes); on C the soil was of a gravelly nature.

From this it may be deduced that the disease can be carried in plants and that the virulence of the disease is not lessened by soil changes. Young beds are more susceptible than older plantations.

Field Symptoms.—The symptoms of the disease in the field vary very considerably and differ somewhat according to season and variety. Usually diseased plants occur first of all in the lowest part of the field and the disease spreads from this " centre of infection "; but a centre of infection may occur at the top of a slope and the disease spread downhill. The spread is usually quicker uphill than down, and is often checked by cross roads or by isolation. As previously mentioned, the three-row bed is by some growers allowed to form a matted bed, while others keep the individual rows apart. In the former case the disease sweeps right along the bed, while in the latter it travels most quickly along the row, the lateral spread being much less pronounced. The net result is usually the same.

Plants that have apparently wintered quite satisfactorily start into growth in the spring and the runners may appear quite healthy. Towards the middle of May patches appear on which the plants instead of developing more foliage actually shrink in size and any new leaves formed have a stunted appearance. Later the plants may collapse entirely owing to the cutting off of the water supply. Varieties which naturally produce abundant foliage collapse more quickly than others, and the affected areas present a scorched appearance. Examination of the root shows a badly developed system with comparatively few rootlets and much diseased tissue. Many of the roots have a red core, which has become the growers' field test for disease.

After the middle of June there is a partial revival of growth on the diseased areas, and many beds have been allowed to stand as the disease appeared to be checked. If a prolonged wet period be experienced in late July or August, autumn spread is usually severe and winter killing is very noticeable. The maximum activity of the disease as seen in the field is in May, June and September to October. The root destruction is similar on all soils except that on the lighter soils greater destruction is observable and the collapse is more marked.

In young plantations the disease is much worse after potatoes than after any other crop, and is least virulent after a cereal crop.

Economic bearing of the Disease.—The area under strawberries has diminished from 1,500 to less than 500 acres, with a corresponding reduction in the amount of labour employed. The loss to the growers has been very serious, many having experienced actual losses of from £500 to £2,000. In many cases fields have been cultivated, manured and planted without any crop being gathered, and irrespective of any loss of crop there has been a serious loss of capital. Much of the land is highly rented and so situated that only spade cultivation is possible. On such land only a crop of high acre value is economically sound and many of the smaller holdings have become unprofitable.

Experimental Work.—Various experiments for the prevention and the control of the disease have been carried out both in field plots and by the use of pot cultures under greenhouse conditions. Both tests were conducted on similar lines.

In the absence of knowledge as to the specific cause of the disease these experiments included (1) tests of spray materials; (2) partial soil sterilisation methods; (3) manurial treatment coupled with soil sterilisation and spray methods; (4) cultivation methods, drainage and manurial treatment; (5) isolation and treatment of infected areas; (6) varietal tests for susceptibility or immunity.

In each series an adequate number of control plots was set up. The experiments were carried out both on infected and on non-infected land, one plot being outwith the affected district.

The results briefly were :—

1. No spray material gave permanent benefit, though lime sulphur appeared to exercise a temporary control.

2. All methods of soil sterilisation gave a measure of control, but soil infection persisted too long for the results to be permanent.

3. Among the soil sterilisers the most effective was

cresylic acid. Very little benefit was observed where formaldehyde was used.

4. No method of cultivation nor any manurial treatment gave any marked result, though owing to the improved physical condition applications of lime on heavy soils gave a greatly improved root development. On light soils lime was either without effect or positively detrimental to the crop. Neither additional drainage nor deeper cultivation effected any permanent improvement. So far as manuring is concerned, it appears that the disease is much worse when very heavy applications of stable manure are given.

5. Isolation of infected areas acted as a temporary check.

The following varieties have been tried, among others :—Ruskin, Overtoun, Scarlet Queen, Royal Sovereign, Laxton, Le Febre, Kooi Laxtonian, Filbasket, Alphonso, Bedford, Frith, Sterlingworth, Duke and Tardive de Leopold, but none show any marked resistance. Under pot cultivation diseased runners can be coaxed to grow and fruit, but they do not produce the foliage or fruit of healthy plants. An isolated garden plot was infected by the introduction of diseased plants and methods of soil sterilisation were afterwards tried. The land became infected but the results of sterilised treatment were disappointing. In the same garden, disease-free plants set out at the same time are now in their fifth year and growing and fruiting satisfactorily.

PART II.—PHYTOPHTHORA DISEASE.

N. L. Alcock and C. E. Foister.

Symptoms in the Field.—The first sign of this trouble is usually a more or less circular patch in the strawberry plantation. The plants on this patch are unthrifty and small, and the outer leaves die off; they do not fall off but remain, brown and stiff, attached to the plant. The area becomes brown early in the autumn and the plants may die off altogether, leaving a bare spot; the patch increases and becomes large and irregular, often following the line of the rows. After a time the whole crop may go down, or here and there a sturdier plant may survive while those around are dead. These patches can be well seen in May and June.

The plants on these infected areas often pick up a little in June, but go down again with an increase both in the size of the patch and the severity of the infection in each plant in the autumn; the slight recovery in the spring and early summer is well known.

Symptoms in the Plants.—Above ground the symptoms are a withering and drying up of the tops and a general dwarfing of the plants. There is no evidence of any parasitic attack on the aerial parts of the plant. On the leaves and stem of strawberry plants there are several well known diseases such as mildew, leaf spot of various origins, red plant, &c., and the diseases caused by eelworm, but the over-ground parts of the strawberry in the disease under discussion show none of the symptoms of diseases already known. It is the roots of the plants that are attacked, consequently the water supply and much of their food is cut off.

Roots.—The root system of a healthy strawberry plant shows a rich development of fibrous rootlets and a firm system of larger roots. The system of roots, when attacked by this disease, shows a great lack of fibrous rootlets. A pale, greyish almost transparent appearance of the tips is usually the earliest sign of the trouble. Long dark roots with no side roots are also an indication of the disease, and, in the early stages, such roots have an india-rubber like texture. When the disease is a little further advanced, the points and often half the root will be black and shrivelled. Often when wet conditions prevail the attacked portion of the roots will rot off, and the central cylinder will remain like a coarse hair proceeding from the stump left. The fact that the attacked portion can be pulled off with finger and thumb, leaving the central core, has led to the common name, "Red Core." This core is usually reddened, probably merely an oxidase effect, but usually connected with a quantity of spores lying along the vascular bundle (Fig. 24). The striking features of the diseased plants are the lack of roots, both large and small, the absence of rootlets and the general darkening or blackening. On examining the roots internally the cause of the disease becomes apparent. Some years ago, when examining strawberry roots to discover the origin of this disease, we were struck with the constant occurrence of circular or oval structures suggesting some kind of resting spore. This suggested a line of investigation which has since been followed up. During the autumn, winter and spring of 1928-29 we received plants once a week from the diseased area. Some 250 plants, both healthy and diseased, were examined, along with some additional healthy plants from other parts of the country. This test was repeated during 1929 and 1930 from October to June, about 650 plants being received and examined each week. Of these about 250 were healthy. In every instance when this disease was found the resting spores were present; in no instance were they discovered in a healthy plant. In the first examination, October-May 1928-29, these spores were found in 105 diseased plants; in the second examination, October-June 1929-30, in about 400 plants.

The Fungus associated with the Disease.—The first signs of the fungus that we saw were the large oospores. These bodies are round objects with a firm wall lying in a persistent case, which is often coloured a yellow brown. The oospores can be seen with a strong lens, and are very large and distinct under a microscope. In size they average 33 μ, lying in an oogonium that averages 44 μ in diameter. (Fig. 18.)

They are often present in quantity in the diseased roots, especially lying along the centre. The roots containing them rot off into the soil, where the resting spores must complete their life history. Further investigations along this line are needed, as we do not know how they germinate. If the weather is very moist the sporangial stage of the fungus may very occasionally be seen when the plant is first examined under magnification. There may be one or two large sporangia, looking like lemon shaped balloons held by a string, emerging from the sides of the root. If not present at first they can be induced to come out verv easily by leaving the tip a few hours in water. If some form of nourishment—a little potassium nitrate, a boiled dead fly, or a little bog water—be added, the sporangia come out more freely. (Fig. 20.)

These large sporangia are very variable in size, some reaching 70 μ in length, but many about 50 μ. They contain zoospores, and the emergence of these little swimming spores can be seen very readily when the sporangia are watched under the microscope. Another point in the formation of the sporangia that helps to determine the fungus is the fact that when the sporangium has discharged the zoospores and is empty another sporangium will grow up from the base of the first, within the walls of the old sporangium. (Fig. 22.) This may occur more than once. If the infected tip is laid on a thin plate of agar, the oospores (or resting spores) can sometimes be observed forming along the centre of the tip. This has been observed on several occasions, and slides have been made of the oospores at various stages. It soon became apparent that the oospores were formed in two ways (Figs. 8 and 13), and that both amphigynous and paragynous fertilisation took place in about equal proportions. A third form of spore occurs, a *Chlamydospore*. (Fig. 23.) The mycelium is the usual big non-septate mycelium that mycologists connect with the phytophthoras.

Cultures.—Attempts to get the fungus into culture have so far failed, but are being continued. More than 1,700 attempts have been made and 30 varieties of media tried. On one or two occasions a few oospores have been found, but only in an impure culture. The sporangial stage has been reproduced, however, in abundance on fresh strawberry fruits by inserting pieces of diseased tissue into the fruit.

The following rather crude experiment has been carried out (with controls) several times over, however, quite successfully. To a pan of sand, sterilised in the autoclave, small portions of diseased roots (which microscopical examination had shown to contain the oospores) were added, and young, clean strawberry runners, which, on careful examination, appeared perfectly healthy, were planted in this mixture and allowed to grow under glass for six weeks. Examination at the end of this period showed that the tips of the roots of the runners, especially of the new ones that had arisen since planting, were discoloured and decayed for distances of from about one-eighth to over one quarter of an inch from their growing points. Some of the lateral roots were also decaying. In the central cylinder of the diseased parts of the roots the phytophthora was found again, both in the form of rather coarse non-septate mycelium and of oogonia (containing oospheres or oospores) with amphigynous and paragynous antheridia. Similar runners planted in similarly sterilised soil, but without the addition of chopped diseased roots, showed no decay of the roots.

In carrying out the experiment this spring the roots were cut off the runners almost completely, so that those examined had grown since planting, and sterilised soil was used instead of sterilised sand. Very good, young, fresh material of the disease can be obtained in this way. It appears from the experiments and from the repeated observations of this fungus on the plants that this phytophthora is the cause of the disease that has appeared along the Clyde Valley and that has been called the Lanarkshire disease.

Some confirmatory evidence has also been obtained. Cases of this disease have occurred where the oospores have been found on plants taken from the diseased area and planted elsewhere. Other quite free plants, especially a Belgian variety, planted in diseased soil have acquired the disease.

Control.—It appears to be clear that the infection comes from the soil. Any form of soil disinfection on a large scale would prove both difficult and costly. One of the writers has done a great deal of preliminary work in investigating soil disinfectants, and work on this line is continuing.

Little is known of the origin of this phytophthora or of the life of the disease in the soil. Dr. Ashby of the Imperial Bureau of Mycology considers that the fungus closely resembles the well-known *Phytophthora cinnamomi*, which is believed to be the causal agent of the disease known as *Inchiostro* (Ink Disease) from which chestnuts in Italy suffer.

It certainly seems significant that the beginning of the disease in the Clyde Valley coincided with a change in the type of manure used. Owing to the scarcity of horse manure, town manure, which contains refuse of all kinds and is often obtained from the docks, has been used to supplement the usual artificial manures, and there is a possibility that the fungus may have been introduced in this way.

These various aspects of the problem are now in course of being investigated, and field tests have also been instituted with a view to discovering immune or resistant varieties. Now that there is reason to believe that the causal organism has been discovered, it is hoped that further investigation on these lines will add materially to our knowledge of the disease and may lead to an effective method of controlling it.

To Professor Wright Smith and Dr. Malcolm Wilson we are indebted for much help and encouragement.

Thanks are due to the growers of the Clyde Valley, without whose help this work could not have been carried through.

PLATE I.

FIG. 1.—Patches of disease in a strawberry field.

PLATE II

FIG. 1.—Diseased strawberry plant left. Healthy strawberry plant right.

FIG. 2.—Diseased roots enlarged one and a half diameters.

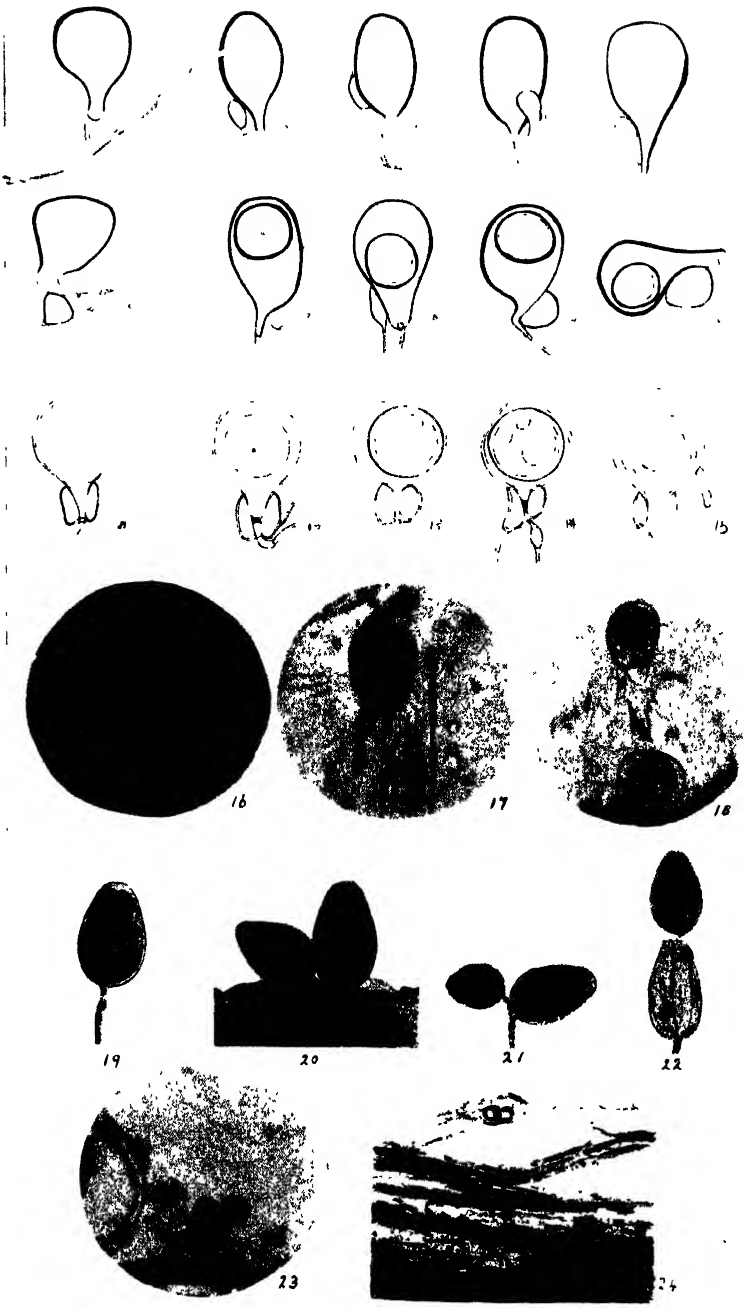

PLATE III.

FIGS. 1 to 6. Strawberry phytophthora oogonia with paragynous antheridia.
FIGS. 7 to 10.—Same as Figs. 1 to 6, but showing oospores.
FIGS. 11 to 14.—Oogonia of same fungus with amphigynous antheridia, showing successive stages in development.
FIG. 15.—Oogonium showing both para- and amphigynous antheridia.
FIGS. 16 and 17.—Oogonium showing amphigynous antheridium.
FIG. 18.—Oogonium showing paragynous antheridium.
FIG. 19.—Sporangium.
FIG. 20.—Sporangia on root.
FIG. 21.—Sporangia.
FIG. 22.—Sporangium proliferating.
FIG. 23.—Chlamydospores.
FIG. 24.—Oospores lying along central cylinder.

Especially we should like to thank Mr. Robert Reid for a steady and careful supply of plants and much observation in the field.

Special help has been forthcoming from the Ministry of Agriculture's Plant Pathological Laboratory at Harpenden throughout the work, and in instituting the field experiments for the coming year.

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AGRICULTURAL SURVEYS.

DURING the winter of 1925-26 and again in the spring of 1927 agricultural surveys of certain selected parishes in Kincardineshire, Berwickshire, Dumfriesshire and Wigtownshire were carried out by the Department. Summaries of the reports on these surveys appeared in the issues of the JOURNAL for July 1926 and January and April 1928. In view of the value of the surveys it was decided that a further series should be carried out during the past winter, and the following areas were selected for this purpose, viz. :—

3 parishes in Aberdeenshire;
2 parishes in Sutherlandshire;
1 parish in Perthshire;
1 parish in Argyllshire;
2 parishes in Ayrshire.

The reporters were furnished with much valuable information, some of which was, however, of a confidential nature and cannot consequently be disclosed. Summaries of the available information have been prepared and will be published in successive issues of the JOURNAL. The present article deals with the survey of the parishes in Aberdeenshire.

SURVEY OF THREE PARISHES IN ABERDEENSHIRE.

This survey was made in October and November 1929, and it should be kept in mind that the report refers to conditions existing at that time. The method employed in carrying out the survey was briefly as follows: Every holding of over thirty acres under crops or permanent grass was visited. Information regarding the general methods of management, the kind and quantity of stock kept, the yields of grain per acre, and the systems adopted in laying down and manuring the different crops, &c., was readily given by farmers, and was corroborated and supplemented by the reporters' own observations. As the three parishes are characteristic of three distinct types of district in the north-east of Scotland, a summary of the main features of the agriculture of each parish is given, with general comments on the three parishes.

Parish A.

This is a high lying parish in which sheep and arable farming are closely associated. Of the 11,300 acres of agricultural land, 1,500 consist of arable land lying between 800 and 1,300 feet above sea level, 350 of permanent grass land, the remainder being classified as "mountain and heath land used for grazing." According to the Annual Agricultural Returns there were 36 holdings over one acre in extent (exclusive of rough grazing land) in this parish as shown in the following table :—

Size:	1–30 *acres.*	30–50 *acres.*	50–75 *acres.*	75–100 *acres.*	*Over* 100 *acres.*	*Total.*
No. of Holdings ...	11	8	10	4	3	36

Of the 11 holdings under 30 acres three had recently been added to farms, while, with the exception of one, the others were occupied by retired people or by people having other means of livelihood. In the great majority of cases all the holdings above 30 acres had a portion of rough grazing attached.

Soil.—The arable land in this parish is a kindly, free-working loam, and for the most part is naturally drained, not more than 2 per cent. to 3 per cent. being in need of drainage. According to the "Soiltex" test the bulk of the land is shown to be fairly to strongly acid, but as the crops grown are relatively tolerant to acid conditions these do not appear to suffer much from lime starvation. Practically no liming has been done within recent years, but the remains of no fewer than 16 lime kilns in the district indicate that liming at one time had been extensively carried out. Manures are applied chiefly to the turnip crop, a dressing of 4 to 5 cwt. of a compound turnip manure being usual.

Crops.—The general rotation followed is the easy six-course, viz. three years' rotation grasses, followed by oats, roots, and a clean land cereal crop with which the grass seed is sown.

Grain.—Practically the only cereal crop grown is oats, the popular variety being Potato. Newer varieties are in use, but generally speaking they have not been favoured by farmers. Considering the elevation of the parish fairly good crops are grown, but difficulty in regard to ripening is constantly being experienced. In 1929 the grain on even the highest farms matured well and was successfully harvested. In the two previous seasons seed corn and even meal had to be purchased. The average yield of grain even in a good year is well under 5 quarters per acre.

Roots.—Generally speaking fairly good crops of healthy turnips are grown. Swedes are grown only to a small extent, while the principal varieties of yellows are the Aberdeenshire Green Top and Golden Yellow. Only a few acres of potatoes are grown.

Grass.—The grass seed mixtures are now fairly well up-to-date, but it is only within the past year or two that wild white clover has been extensively used. This is well instanced by the appearance of some of the older rotation and of all the permanent grasses. The latter, partly because they occupy the poorest and highest lying land, and partly because they were sown down with unsuitable mixtures, are not merely very poor, but appear to be gradually deteriorating. On most farms the quantity of rye-grass included in the seed mixture is still too high to allow of the proper development of such natural grasses as cocksfoot. The rough grazings are dry and for the most part heathery and cannot be considered as valuable. The heather appears, however, to be fairly well burned.

Stock.—*Cattle.*—The cattle in this parish are for the most part exceptionally well-bred animals of the Aberdeen Angus type. About half of the number actually sold from the parish are reared within the parish. Of those bought in, about half are bought as young calves and half as weaned calves. Difficulty is constantly being experienced in getting a supply of suitable young calves.

The methods of rearing vary. About one-half of the calves are brought up on the pail, the ration of whole milk being supplemented by calf meals, gruels, &c. The other half are suckled. During the first winter a little concentrated food is usually given. Until recently, cake was almost invariably used, but now, owing to the relative cheapness of oats, mixtures of oats and bran are being used. On the smaller farms the cattle are usually sold as stores at the age of eighteen months, but on the larger farms the cattle are mainly fed off, the farmers vying with each other as to who will top the market quotation per cwt. live weight at some of the more important auction sales within the county. For feeding animals of medium size the usual ration consists of 80 to 90 lb. turnips given at three feeds, oat straw as required, say about 12 lb., and 3 to 5 lb. concentrates, now mainly oats. All the cattle are sold off between the ages of two to two and a half years. It may be remarked that the reporters noticed that although the greatest care was taken in the selection of the bulls used, less discrimination was employed in the selection of the females employed for breeding. Farmers seem to be tempted by high prices to sell their best young heifers, instead of keeping them for herd purposes. It is open to question, too, whether or not an infusion of Shorthorn blood could usefully be employed in order to increase the substance of the cows used for breeding.

Sheep.—Blackfaced ewes only are kept in this parish, these being mated with Blackfaced rams on the larger grazings. On the smaller holdings Border Leicester rams are used, the flock being kept up either by buying in cast ewes for one season only or purchasing gimmers. On some farms, especially those where rough grazing is not available, lambs are purchased at the autumn sales and are wintered.

Pigs, Poultry, Bees.—Few pigs are kept in this parish. The number of poultry kept per holding over 30 acres averaged 77, and as a rule were only moderately well managed. Until recently there were some 40 to 50 hives of bees in the parish, mostly owned by the non-agricultural community, but within the last year a large number had succumbed to Isle of Wight disease.

Labour.—On the majority of holdings in this parish the work is mainly carried out by the farmer and his family. Hired labour is obtained by engaging married men for a year or single men for the half year, these latter being accommodated in the farm kitchen, their sleeping quarters being either in the farmhouse itself or in some building adjoining or forming part of the steading. There are very few cottar houses for married men in this parish.

Business Methods and Financial Results.—Few of the farmers in this parish are connected with the co-operative movement. Cattle and sheep are sold to dealers or consigned to auction marts. Eggs are collected at the farms by grocers' vans.

After making an allowance for the farmer's own labour it was estimated that only 55 per cent. of the farms over 30 acres in extent were yielding any return whatsoever for the capital invested.

General.—Owing partly to the relatively heavy costs involved in arable cultivation and partly to the relatively small returns from crops, especially those grown at the higher elevations, the trend of affairs has undoubtedly been to put more land down to grass. Reviewing the history of the parish it would appear that from the seventies until the close of the war the acreage returned as arable land was fairly constant. Since the close of the war there has been a sharp decline in the amount of arable land. This decline in some measure is reflected by a rapid decrease in the school population, the reporters being informed that the number of children attending the main school had dropped from 85 to 30 within the past thirty years. Within the same period the number of tradesmen (blacksmiths, miller, &c.) employed in the parish has declined from seven to two.

PARISH B.

This parish is typical of many in the north-east, lying at an elevation of about 600 feet. The breeding and feeding of cattle are the predominant features of the agriculture of the parish, but sheep and poultry are important and oats are sold. The total agricultural area is 4,100 acres, of which 2,850 acres are arable, 400 acres permanent grass land, and 850 acres "mountain and heath land used for grazing." There were 47 holdings in the parish as follows :—

Size:	1–30 *acres.*	30–50 *acres.*	50–75 *acres.*	75–100 *acres.*	*Over* 100 *acres.*	*Total.*
No. of Holdings ...	15	4	10	6	12	47

Of the holdings under 30 acres, three were occupied by retired people, seven by persons having other means of livelihood, four were attached to farms, and only one provided a living for the tenant. Of the 32 holdings above 30 acres, ten were led farms.

Soil.—The soil in this parish is generally free, open in texture, and according to the " Soiltex " test varies from strongly to medium acid. During recent years a fair amount of liming has been done, but in quantities seldom exceeding 10 cwt. per acre. It was observed that liming had definitely effected improvements in the pastures, but little or no improvement was noticeable on other crops.

Manures are applied on a much more liberal scale than in Parish A. It is customary to apply most of the artificials to the turnip crop, a typical dressing being ½ cwt. sulphate of ammonia, 2 cwt. superphosphates, 2 cwt. ground mineral phosphate, and 1 cwt. muriate of potash. Experiments conducted by the North of Scotland College of Agriculture had demonstrated the importance of both phosphate and potash for turnips and clovers. Usually the clean land crop gets from 2½ to 3½ cwt. of a special grain and clover mixture, but in some cases as much as 6 cwt. of manure, principally slow acting phosphates and potash, are applied.

Crops.—Most of the holdings are being worked on the easy six-course rotation, but on some of the larger and more successfully conducted farms the rotation has been lengthened so as to permit of the land lying down longer to grass.

Grain.—Apart from a few acres under barley the only grain crop grown is oats, principally of the Potato type. For 1929 the estimated yield was 42¼ bushels on farms under 100 acres and 46 bushels on farms above 100 acres.

Roots.—Yellow turnips of the Aberdeenshire Green Top variety are mainly grown. Generally speaking the crops appear to be free from finger-and-toe. On several farms the turnip seed for home use is grown on the farm from specially selected roots, the same strain frequently having been in use for the past 20 to 30 years, and as a result of this rigorous selection is showing continuous improvement. Potatoes are grown almost exclusively for home use.

Grass.—In general, the rotation grasses are fairly good, every farmer sowing wild white clover. In several instances farmers were found to be sowing too much ryegrass in their mixtures. The permanent pastures, mainly above 800 feet above sea level, are very poor.

Stock.—*Cattle.*—Like the cattle in Parish A, those in this parish are mostly well bred blacks, half of which require to be bought in. The rearing of young calves is extensively developed, but difficulties in regard to a supply of suitable animals necessitate the purchase of young calves from markets as far away as Inverness and Dingwall. Various systems of rearing are adopted. On one of the smaller farms as many as five calves were being reared for every cow kept, whole milk being given for a very limited time, and thereafter calf foods being used with very good results. Feeding is carried out on most of the holdings in the parish. All the fat cattle and most of the stores are stall fed during the winter. Store animals usually get little or no concentrated food during the winter period until after January. Feeding is mainly done in the spring months, all the forward two-year-olds being fattened then, while the backward animals are finished off in the back end of the year. Recently, partly as a result of improved pastures, there has been a tendency to buy in six-quarter-old cattle for long keep. These are kept on a store ration during the winter and fed off the grass. From an economical point of view this system has much to commend it, as the expense of concentrated food is reduced to a minimum. Oats have almost entirely replaced cake as the concentrated form of ration. Of the seven bulls in the parish six are pure bred Aberdeen Angus, the remaining one being a pedigreed Shorthorn.

Sheep.—Sheep are kept on the majority of holdings, but as many of the holdings do not possess rough grazing, and as the customary rotation scarcely permits of sheep as well as the normal stock of cattle being summer grazed on the available grass, many farmers keep cross hoggs for feeding during the winter. Where ewes are kept, the Blackface is the common breed, Border Leicester tups being used for crossing.

Pigs and Poultry.—Comparatively little attention is given to pigs in the parish. A great improvement in the poultry industry has, however, recently taken place. Over 50 per cent. of the farms have colony houses, while many are equipped with incubators and brooders. Flocks range up to 200 laying birds and over. On some farms very creditable results have been achieved by such means as careful attention to strain, early hatching, suitable feeding (the mash being scientifically compounded), correct housing, and the use of artificial light in the winter. On many farms the income from poultry is second only to the returns obtained from cattle. Increasing interest is being shown by most farmers in their poultry, and information regarding better methods of management is eagerly sought after. Nevertheless in spite of this gratifying improvement it was evident to the reporters that faulty methods of management as reflected by non-winter laying and the prevalence of liver disease were evident in too many instances.

Labour.—Labour conditions in this parish are similar to those of Parish A. The class of labour employed is good, but there is a lack of houses.

Business Methods and Financial Results.—Unlike the farmers in Parish A, most of the farmers in this parish are members of an agricultural co-operative society. Nevertheless for various reasons, such as love of individual bargaining, lack of means, &c., loyalty to the society is not sufficiently pronounced to permit of purchases of manures, seeds, &c. being made exclusively through that channel. Cattle and sheep are usually sold by auction, grain by private deals, and eggs are collected by grocers' vans.

On the holdings between 30 to 100 acres it was estimated that the average farmer received no return for his capital. On holdings over 100 acres the average return was estimated at over 5 per cent., this figure being due largely, however, to the very good results obtained by a few farmers who had laid down a large proportion of their land to grass, or who were giving a great deal of attention to poultry.

General.—As in Parish A, there is a growing tendency in this parish to put more and more land down to grass. Poultry, sheep and cattle are all increasing in numbers. Few farmers, however, seem to be able to analyse their accounts with a view to eliminating unprofitable operations or adjusting their system of management to meet changing economic conditions. One of the striking features, that the reporters observed in this parish, was the marked influence for good that one progressive farmer has on others. Thus, the now generally recognised importance of potash in part of this parish might be traced back to the results obtained from one single manurial test done over twenty years ago under the auspices of the College of Agriculture. Ever since then potash manuring had been persisted in by the experimenter, and gradually the neighbours have adopted similar manurial mixtures.

PARISH C.

Unlike Parishes A and B, the land in this parish is almost entirely arable. Of a total of 4,100 acres of agricultural land, 3,900 acres are under rotation crops and 200 under permanent pastures, mainly policy parks. This parish is typically a fertile low ground parish with an elevation of about 300 feet. The rearing and feeding of commercial cattle is the chief industry, but oat growing, the breeding of horses, of pure bred cattle, of commercial and pure bred sheep and of pigs, together with dairying and poultry keeping, are important branches of activity. The following table shows the numbers of holdings of various sizes :—

Size:	1–30 *acres.*	30–50 *acres.*	50–75 *acres.*	75–100 *acres.*	100–300 *acres.*	*Total.*
No. of Holdings ...	16	4	6	9	15	50

Of the holdings under 30 acres only two are apparently providing a living for the occupiers, the remainder being occupied by persons having other means of livelihood.

Soil.—The soil is a rich, dry, fertile loam mainly overlying rock, with a medium acid reaction. Little lime has been applied of recent years, but only from 1 to 2 per cent. of the land actually seems to be suffering from lime starvation or from defective drainage.

Manures are more extensively employed than on either of the other two parishes. Not only is the turnip crop fairly heavily dressed with compounded turnip manures, but the " yaval " and clean land corn crops also receive considerable dressings. Potash is extensively used in this parish and has undoubtedly been a factor in improving the clovers.

Crops.—42 per cent of the farms are on the easy six-course rotation; on other 42 per cent. this rotation has been extended by taking a second or " yaval " crop after the lea oats, making it a hard seven-course rotation; the remaining 16 per cent. of the farms have more than three years' grass.

Grain.—Owing to the custom of taking a " yaval " crop on many farms in this parish the acreage of land under grain is fully one-third of the total. Very little barley is grown. Of oats the chief varieties are Victory, Potato and Gordon. Many varieties are grown, however, a confession in point of fact that there is, at present, no outstanding variety of oat suitable for fertile conditions in the North of Scotland. What is required is a heavy-yielding, early-maturing oat with a straw which, though stiff, is not brittle. On farms under 100 acres the average yield in 1929 was estimated at 56½ bushels per acre, on farms over 100 acres at 58¼ bushels.

Roots.—Very good crops of both swedes and turnips are grown in this parish and the amount of finger-and-toe is practically negligible. Only a small acreage of potatoes is grown, mainly for home consumption.

Grass.—Most of the temporary pastures are very good, the seed mixtures being based mainly on those recommended by the North of Scotland College of Agriculture. In a few cases, however, too much ryegrass is being sown.

Stock.—*Horses.*—Unlike Parishes A and B, horse breeding is of importance in this parish. The quality of the animals bred is excellent, and although horse breeding is at present under a cloud most farmers persist in rearing and breaking in young horses.

Cattle.—Strangely enough in this, the most fertile of the three parishes, the number of calves bred within the parish approximates more to the actual numbers required than in either of the other two. Only pure bred Aberdeen Angus and Shorthorn bulls are kept. The quality of the cattle kept is very good. Most farmers aim at being self-supporting in the matter of cattle, and in order to be in this position young calves are brought in, chiefly black polls from local dairy herds or from such markets as Dingwall and Inverness. Oats are rapidly displacing cake as a concentrated food for fattening purposes.

It is interesting to note that on several farms in this parish the younger store cattle, instead of being tied up all winter, are allowed to run loose in half open courts or in sheds having access to outside fields. In one or two instances no overhead shelter is provided beyond that of a wood. It is claimed that store cattle treated thus thrive better than those tied up in stalls, and when the grazing season starts do not incur any backset as do those coming straight out from the byres. The total gain is estimated at roughly one cwt. live weight. Ordinarily, store cattle on a ration of straw and turnips increase very little in weight during the winter period, and may even lose half a cwt. live weight (belly weight) when first put out to grass. Cattle going outside, if given their ration of turnips and straw, make headway almost throughout the whole winter season.

Sheep.—About 70 per cent. of the farmers keep sheep, mainly half bred, though there are several small Border Leicester flocks. The lambs are usually sold fat during summer. The health of the sheep is very good.

Pigs and Poultry.—On several holdings as many as four breeding sows are kept, the bulk of their produce being sold as weaned pigs. The principal breed is the Large White.

The average number of fowls kept per farm is about 130, the principal breed being the White Wyandotte. Several farms are well equipped with incubators, brooders and foster mothers. The importance of winter laying as a factor in profitable egg production is well recognised by some of the farmers, who now aim at keeping mainly pullets during the winter.

Labour.—The labour supply is sufficient and of good quality. There was, however, a tendency amongst farmers to economise in their labour bills by employing younger and cheaper men.

Business Methods and Financial Results.—Most of the farmers in this parish are members of an agricultural co-operative society supplying manures, feeding stuffs and seeds.

In estimating the probable returns some difficulty was experienced owing to the fact that the business of some of the farms in the parish was linked up with other activities. Excluding certain farms it was estimated that one-fourth of the farmers were receiving no return whatsoever for their capital, but in no case could these farms be described as being ably managed. In view of the price of oats the "yaval" crop was undoubtedly a losing proposition. Even in this fertile parish corn growing and the winter fattening of cattle would appear to be non-paying propositions, and such profits as are made appear to be derived from sheep, pigs, poultry and the summer grazing of cattle.

General.—In this parish it was evident that the process of laying down land to pasture had already begun. Some farmers are trying to economise by employing less skilled and lower paid men or by attempting to work the usual amount of land with a reduced staff, using double furrow ploughs, but it was plainly evident on some of the farms that the cultivation was suffering rather grievously. Gratifying increases in the numbers of cattle and sheep were noted. This is the direct outcome of the introduction of wild white clover, but probably the most gratifying change in recent years is the keen attitude now adopted by most farmers towards the poultry industry.

GENERAL REMARKS ON THE THREE PARISHES.

As stated above, the three parishes surveyed present considerable differences in type, but it is convenient to deal generally with certain aspects of the enquiry. During the survey an attempt was made to classify the holdings into three categories designated Class " A," Class " B " and Class " C.". In Class " A " the reporters placed those farms which were well managed, in Class " B " those which were moderately well managed, and in Class " C " those that were badly managed. The following table shows the percentage of farms falling into the different classes :—

Size of Holding.	Class.		
	"A."	"B."	"C."
	per cent.	per cent.	per cent.
30–100 acres	69	28	3
Over 100 acres	90	7	3
All holdings	76	21	3

In all three parishes it will thus be seen that in the main both small and large farmers, but especially the larger farmers, are able managers of both land and stock. The crops grown are thoroughly well suited to the climate and soil, while the rotation and whole system of management is so balanced that the farms are as nearly as possible self-supporting in the matter of stock, summer and winter food, &c.

Turning to the financial side of affairs, which from the individual farmer's point of view must, in most cases, determine the direction and scope of his activities, the reporters bring out results which are of particular interest at the present time. Balance-sheets were made out for each holding as accurately as could be done from the available information in order to ascertain what main factors, in the districts surveyed, determined whether the particular holding was a success financially or not. The principal factors elicited by this method are briefly :—

(1) *Skill in Management.*—Undoubtedly all round skill in management, as distinct from the particular system of management followed, plays an all important part in determining whether the holding will or will not pay. Of course the skilful farmer is most capable of readily adapting his system of management to meet changing conditions, and consequently skill in management was generally found to be closely associated with other factors.

(2) *Labour.*—The reporters bring out striking differences

as between one farm and another in regard to labour, and the comparative prosperity of certain farms could partly be attributed to the economic use of labour. This does not, of course, necessarily mean the employment of less labour or the payment of lower wages.

(3) *Rotation.*—The farms, generally the larger ones, which were being worked on a wide rotation (i.e. with more than half the arable land under grass) showed, other things being equal, better financial results than those worked on a less extensive system.

(4) *Oat growing.*—Under present circumstances oat growing, in itself, appears to be generally speaking a non-paying proposition in the districts surveyed.

(5) *Sheep* were found to be a profitable branch. The comparison between farms on which sheep were kept and those on which there were no sheep is not so striking as might be expected, but this appeared to be due partly to the fact that a number of the farms included in the " sheep group " were rather poor.

(6) *Poultry.*—The calculations of the reporters indicate that the influence of poultry can scarcely be overestimated. A point which may be mentioned is that at the present time poultry keeping provides a satisfactory outlet for grain.

(7) *Pigs.*—The reporters had comparatively few figures in regard to pigs, but they express the opinion that at the time of the enquiry pig keeping was a profitable concern, though in view of the nature of the pig market the results from one year might bear little comparison with those from another year. One obstacle to the development of this branch is that in most cases the existing farm holdings are not well adapted for this type of stock.

As already indicated in discussing the trend of affairs in each individual parish, gradual, but striking, developments are now taking place. The number of poultry on many farms has at least doubled within the past few years. In Parishes B and C the numbers of sheep have also doubled within the past sixteen years, while the cattle have increased by 12 per cent., an equivalent increase in the stocking, reckoning five sheep as equal to one cattle beast, of 21 per cent. Within the same period the second and third years' rotation pastures have probably doubled in value as judged by their capacity to produce beef or mutton. The farm buildings throughout the parishes are generally well built and substantial, and though capable, at the time of building, of accommodating all the stock, in many cases do not now provide sufficient accommodation for the animals kept on the farm. This, incidentally, has led to the system of keeping the younger animals outside all winter, getting merely overhead or night shelter. In the matter of oat growing, record yields are constantly being obtained on individual farms in the fertile areas, but in the high lying districts less gratifying results are achieved. The reverse side of the picture includes many features in which stagnation is evident. Probably at no time within the past forty years has the condition of many of the permanent pastures been worse than it is now. In the words of the reporters, "the tale of the systematic neglect of these pastures is one of the blackest pages of the history of Scottish agriculture." Even in the realm of temporary pastures considerable improvements might still be effected. It is not inconceivable that the hay crop might be increased by 50 per cent. A comparison of the results achieved in cattle breeding on one farm as compared with another, reveals the fact that a general toning up in the matter of quality is very much required. So, too, in the matter of grain yields one finds striking differences even on two neighbouring farms.

In regard to the oat crop the reporters observe that on the more fertile farms difficulty in harvesting the crop is constantly being experienced. Even the stiffer strawed kinds do not solve the problem, as they are apt to break over in the straw, and this accentuates the difficulties of harvesting. Moreover, the numerous varieties at present in use make it difficult for grain merchants to secure a sufficient quantity of any one variety to enable them to compete against sellers of foreign oats in southern markets. Many problems centre round this crop. Farmers would in many cases lengthen their grass rotation, were it not for the fear of the subsequent oat crop going down. Again, the recent slump in the price of oats has been a matter of the gravest concern to the farmers in two of the parishes surveyed. Unless oats can be sold at a profit or utilised in some other profitable manner, say by feeding to stock, the whole system upon which the agriculture of the north-east has been founded will require to be drastically modified.

As things are, farmers are playing for safety. Labour and other expenses are being cut down; more and more land is being sown down to grass; rural employment is diminishing; small farms are being added to large farms; and the number of small holdings is decreasing.

THE BIOLOGIST on the FARM.—No. XXXVIII.

Prof. Sir ARTHUR THOMSON, M.A., LL.D.,

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A Puzzle.—Under a loose divot on a bare field a colleague found five pieces of a plump fresh earthworm, still bleeding at their edges. What animal had hidden them there? It does not seem at all like the work of any bird, and there were no traces of moles in the field. Could it be the work of a carnivorous beetle or of a centipede, whose meal had been interrupted? Or might it mark an episode in the life of the carnivorous slug Testacella, which we have seen struggling with an earthworm larger than itself. But Testacella usually swallows its victim whole, from the tail end foremost, whereas we have here to do with some carnivorous creature that first cuts the worm into pieces under half an inch in length. The answer to the puzzle may be very simple, but we do not know it.

Scent Glands in Butterflies.—Many people have noticed that certain Lepidoptera, such as the White Butterfly, have a fragrance which steals off into the air. The fragrance is due to superficial scent-glands, with which specialised scales are sometimes associated. These may end in a microscopic brush of filaments, well suited for the diffusion of the perfume. Thus the transformed scale may have a disc surrounding or covering the scent-making cells, then a flexible stalk, and then a terminal tuft of hairs—a fine instance of the intricacy of detailed structure that is so characteristic of the world of life. The scent is sometimes repulsive, and may be present in both sexes. Or it may be restricted to the male, and be of use in attracting the female. In a case recently studied by Eltringham the male has two separate and independent scent-organs, which may function simultaneously, liberating two chemically different kinds of odour. There is often an extraordinary subtlety in life,—even in these white butterflies that are flitting about the hedges just now.

Dry Seeds.—The farmer empties the dry seeds—of tares and beans, let us say—into the sowing machine, and may think no more about it, beyond of course making sure that the seed is good and that the outside conditions of season and soil are as favourable as he can secure. But the biologist stammers over difficulties. These dry seeds rattling in a bag, each a young life, what state are they in? If living matter is a colloidal fluid, how does it keep alive in its dry dormancy? How do the seeds remain alive for years in the seedsmen's store, and what happens when the "life" goes out and the seeds are like genuine "mummy wheat," no longer germinable. For "mummy wheat" that germinates has never lain long in a mummy. It is easy to say "latent life," but it is not without difficulty that we think of protoplasm becoming brittle and recovering itself.

The seed is an embryo plant in a resting phase. To begin with, it is often nourished by stores of reserve food in its immediate vicinity or within itself, as in the cotyledons of peas and beans. It is also nourished by its intimate partnership with the parent plant, from whose seed-box (badly called ovary) it receives food, just as an unborn mammal does from its mother's womb. For seeds illustrate viviparity. But in a short time this symbiosis with the parent comes to an end; the seed is ripe, and ready to be scattered. But here arises the further problem that many ripe seeds will not sprout, but persist in lying low for a variable period—it may be a couple of years or more. What is the meaning of this dormant or "after-ripening" period, as it is often called? Or, to put it in another way, what is the significance of the delayed germination?

One must go back to the fundamental idea of a life-curve, divided into arcs—e.g. embryonic development, sprouting or germination, growing into a seedling, advancing to a young plant, leafing, shooting, flowering, fruiting, seeding, waning, withering, dying. Some of these arcs on life's trajectory can be lengthened out, as when the Century Plant remains for a human generation without flowering, while other arcs may be telescoped down, as when a mangrove seed sprouts from the fruit on the tree and a fair-sized young plant drops off into the water and is borne away, floating erect. All through the living world we find this lengthening out of one chapter and shortening down of another *in adaptation to particular conditions of life*. The safely cradled nestling may have a prolonged infancy, but the mound-bird, hatched out in a warm heap of fermenting vegetation, may be able to fly on the day of its emergence. A mayfly sometimes has four years of larval preparation in the stream and one evening of winged aerial life. So we get hold of the idea that certain arcs on the curve of life may be lengthened out and others shortened down, and that the punctuation may be slowly adjusted in adaptation to the circumstances or conditions of life.

Some seeds, like those of willows, crucifers, and grasses, are able to germinate whenever they are sown; but many, like hawthorn, require a winter's rest; and some, like conifers, require several years. It may be that the seed-envelopes are too strong to be quickly ruptured; it may be that they keep out the awakening water or oxygen; it may be that the embryo is not so much resting as going slow, and that its life would be endangered if it were liberated too soon. All these factors may be in some cases eliminated, e.g. by artificially removing the seed-coats, yet without inducing germination in favourable conditions. Such experiments point to the conclusion that in some cases the delay in sprouting is due to the slowness of some necessary biochemical change within the cells of the seed. This is the case in the aquatic Euryale ferox, recently studied by Okada. He has shown that some changes in the chemical composition of the embryo take place in the course of the after-ripening (normally lasting for 18-20 months), and the appearance of reducing sugar is one of the most important of these. Forcing can be induced by supplying the seeds with sugar or by altering the external conditions (e.g. by cold storage) so that the producing of sugar is hastened. In any case it seems that it is reducing sugar that awakens the sleeping life.

The Heath's Partner.—It was about 1879 that the great botanist De Bary showed that the primitive plants called lichens, familiar encrustations on rocks and walls and trees, are really double plants, consisting of a network of fungus with algoid cells in its meshes. The fungus and the alga live together in mutually beneficial partnership, the fungus absorbing soil-water or rain-water, and the alga building up carbon-compounds by photosynthesis. This is what is called symbiosis, and De Bary's interpretation of lichens was soon confirmed and extended. Thus several botanists, such as Bornet, were able to build up lichens by bringing together two appropriate partners, an alga and a fungus. In many other connections the occurrence of symbiosis was discovered, thus, as every farmer knows, the root-tubercles of clovers and vetches and other Leguminosæ contain partner bacteria which are somehow able to capture the free nitrogen in the soil-atmosphere or soil-water, and to assist in adding to the plant's capital of nitrogenous compounds. The ploughing-in of Leguminous plants to improve poor soil is now a more or less intelligible, as well as familiar, device. Similarly, it was found that the vigour of many trees, such as most conifers, is dependent on the presence of a mycorhiza fungus in intimate partnership with the roots. Instances multiplied, and it is possible that enthusiasm, naturally engendered by follownig a very promising clue, led to some exaggeration. Thus there has been some recent criticism of certain instances of alleged obligatory symbiosis; and one of these instances is the common heath or ling, *Calluna vulgaris*.

In 1915 Miss Rayner was led by observations and experiments to the conclusion that the common heath or ling is a dual plant, with a partner-fungus that penetrates it through and through. The fungus, which Miss Rayner found in root and shoot, leaf and flower, and even in the envelope of the seed, was described as *Phoma radicis callunæ;* and that is of interest because it has been reported that some species of Phoma are able to effect fixation of free nitrogen, which would be an invaluable advantage to the heather growing in the poor or unready soil of mountain and moorland, where so few plants can flourish. Miss Rayner was also led by her experiments to the conclusion that the seed of the heath cannot germinate normally unless the fungus is present and brings about infection. In the absence of the fungus no roots are produced, and the development of the seedling's stem is restricted and abnormal.

But some recent re-investigations by Professor Lewis Knudson of Cornell University are rather upsetting, for he finds that the seeds of Calluna may germinate without the assistance of any fungus. In a nutrient solution without any fungus germination took place readily and normally, and there was a strong root-development. Yet Miss Rayner could not make a mistake in saying that in her experiments the seeds did not develop normally in the absence of the fungus. Professor Knudson's suggestion is that the seeds in question were badly injured by the mercuric bichloride which Miss Rayner used in sterilising them, so as to ensure the absence of the fungus. We must, of course, hear Miss Rayner's reply; but the value of active scepticism is evident.

Fungi of Orchid Roots.—It is not a far cry from the farm to the heather, but it may seem that the growth of tropical orchids is a somewhat remote subject. Yet none of the linkages of life are very distant from one another, and what concerns the orchid grower to-day may touch the farmer or the forester to-morrow. For a long time it has been known that it is difficult or even impossible to grow a new generation of imported orchids from seed; and this fact became intelligible in 1909 when an ingenious botanist, Bernard, suggested that the germination could not occur without the assistance of a fungus, which was abundant in the tropical forést, but absent from the European greenhouse. When the fungus is forthcoming, the germination succeeds. It should also be recalled that orchid seeds are usually minute and without nutritive reserves. They are poorly developed when liberated from the parent plant; they germinate very slowly; and in some cases there is no chlorophyll in the developing embryo for the first four weeks or more. No seeds ever needed help more than orchid seeds, and even in their native haunts there seems to be great infantile mortality. Professor Knudson notes that in Guatemala he once sowed 200,000 seeds of an Oncidium orchid on a croton plant on which the parent was growing, and after six months he could find only two tiny seedlings. " So careful of the type she seems; so careless of the single life."

Not long ago at Cornell University we had the pleasure of seeing several vigorous orchids that had developed without any help from fungi; and some of them were flowering bravely. Professor Knudson gave us a test-tube with dozens of vigorously sprouting seedlings which were flourishing in a sterilised sugary solution. It seemed as if Bernard's attractive theory had been fatally punctured. But this is probably too extreme a recoil.

Knudson's general conclusion is that the orchid embryos are in their early stages unable to synthetise food for themselves, and are purely saprophytic, that is to say, dependent on decaying organic substances found in the substratum on which they are sprouting. Extraneous micro-organisms, perhaps including the common root-fungus, are the agents in transforming insoluble organic matter into soluble form. The presence of the fungus in the orchid seedling is not of course denied, but it is regarded as a case of mild parasitism, not of partnership. The fungi may be pathological, but kept in check; or they may be ancillary to the transformation of decaying organic substances into soluble and more utilisable form. In any case, the alleged symbiosis is not obligatory, and the orchid is self-supporting after its critical youthful period of saprophytism has been successfully passed. One would have liked to have heard Bernard's reply to Knudson, but the French botanist is no longer with us, and it devolves on others to defend or modify his thesis. Here we have a second good instance of the way in which science progresses by the adaptation of old conclusions to meet new facts. No one doubts the association or linkage between orchid and fungus; the question at present is whether it indicates symbiosis or not, and if the former, whether the symbiosis is obligatory.

A Plea for Birds of Prey.—In the spring number of *Bird Notes and News*, the quarterly organ of the Royal Society for the Protection of Birds, Major Anthony Buxton makes a shrewd appeal for Birds of Prey. He has something to say to those who confuse humane sentiment with sentimentalism, i.e. with emotion based on ignorance, superstition or misunderstanding. Friends of sport should realise that the sport sinks to a lower level if the birds have become stupid or weakly through over-preservation or for lack of sifting by their natural enemies. "Would not the fatted pheasant be a better bird if he were less enclosed in cotton-wool and had to keep his wits against a natural foe." Secondly, killing birds of prey to increase the number of game-birds has consequences far beyond the end aimed at. Giving a free hand and free cartridges to kill what is labelled and libelled vermin "has resulted in the destruction of far more than the proved enemies of game." Thirdly, even from the narrow utilitarian point of view there is much to be said for the birds of prey. The Honey Buzzard used to be familiar in England, but persecution has made it a rarity. The eggs are said to be worth £5 a clutch, and a pair of dead birds may fetch £40. At Geneva Major Buxton made the Honey Buzzard's intimate acquaintance. Its menu consisted of "wasps, hornets, frogs, and the fruit of lords-and-ladies, but, above all, wasps, and wasps at the rate of 1,000 grubs at least a day." Of course there is something to be said for wasps in their turn, but we are talking about birds just now. Fourthly, there is the highest appeal of all, that these birds that are disappearing before Man—the crown of creation—are irreplaceable masterpieces of which we should be the jealous trustees.

Reproductive Hormones.—This title is sometimes applied to hormones which influence the reproductive function but do not originate in the reproductive organs, as might be illustrated by hormones produced in the pituitary body which may have an effect on fertility. Or the title is applied to hormones which are produced in the reproductive system, and may incite structural or functional changes either in that system or elsewhere in the body. Thus a hormone produced by the essential male organs or testes may bring about a re-habilitation of testicular activity when it has degenerated or waned; whereas a similar hormone may restore the normal size and appearance of a castrated cock's comb which has atrophied. Similarly, a testicular hormone may invigorate the epididymis in which sperms are stored, or it may induce the growth of antlers on the stag's forehead—which is very far away from the reproductive system.

In the female mammal the ovary produces a hormone called œstrin which incites the phenomena of "heat," and another called kythin or progestin which induces important changes in the wall of the uterus, leading on to the development of the placenta. But the placenta itself may produce a hormone which stimulates the ovary to make more kythin. A valuable and luminous summary of our rapidly growing knowledge of hormones concerned with reproduction is given in the April number of *The Eugenics Review* by Dr. B. P. Wiesner, a leader in this new line of investigation. We are simply concerned here with distinguishing the two senses in which the term "reproductive hormones" may be used.

Whirligig Beetles.—In a quiet pool on a stream by the side of the farm we sometimes see little companies of whirligig beetles, which spend most of their life darting about on the surface of the water. They are very interesting little creatures, and we wish we knew more about them. One of the commonest kinds is called Gyrinus, and we have often watched them spinning round one another with great rapidity and apparent ease. They swim on the surface by means of their two hind pairs of legs, which are fashioned into neat paddles. They catch small aquatic animals, living on or near the surface, and one cannot but admire the lightness of their movements. They sometimes dive, but that seems to be usually a reaction to surface disturbance. They have two pairs of eyes, which are very sensitive to light; and recent investigation has shown that their dashes in one direction or another are orientated in reference to different degrees of illumination. They make for brightly illumined patches, and this may be part of the reason for the numbers that are sometimes seen together. They draw to the light, like moths to the candle, in a very automatic fashion. In experimental conditions they dive to the bottom if the only source of light is from below. For the same reason, probably, a swarm breaks up in darkness, for there is then no centre to which they react with unanimity. They swim about anyhow when there is practically no light. The larvæ are strange creatures, very unlike beetles, with a row of tiny mobile gill-tufts on each side of the posterior body. We must find out more about whirligig beetles.

AGRICULTURAL CO-OPERATION IN SCOTLAND.

In October 1929 the Secretary of State for Scotland appointed a Committee "to enquire into the present position of agricultural co-operation in Scotland, to consider what steps are practicable and desirable with a view to the development and extension of co-operation, and to report." The members of this Committee were :—Major Mark Sprot of Riddell, D.L.,[1] John M. Biggar, F.L.A.A.,[2] Joseph F. Duncan,[3] Robert Kemp,[4] James Lennox,[5] and George G. Mercer.[6] Their Report, which was submitted to

[1] President of the Scottish Agricultural Organisation Society.
[2] Accountant in Glasgow.
[3] Secretary of the Scottish Farm Servants' Union.
[4] Manager of the North-Eastern Agricultural Co-operative Society.
[5] Past President of the National Farmers' Union of Scotland.
[6] Past President of the Scottish Chamber of Agriculture.

the Secretary of State on 3rd April and has been published by His Majesty's Stationery Office, gives a lucid statement of the results of their enquiry, and of their views and recommendations in regard to the future development of agricultural co-operation.

In the first Section of the Report interesting particulars are given in concise form of the organisation and the financial arrangements of the Scottish Agricultural Organisation Society, which, as an educational and propagandist body for the encouragement and promotion of agricultural co-operation, receives annual grants from the State, and of the trading operations of the existing agricultural co-operative societies. The Committee describe as somewhat disappointing the results of the efforts made to foster co-operation in the Western Highlands and Islands, and, in referring to the position of the societies in Orkney, they observe that, although co-operation has done much to develop the trade in the export of eggs, the societies are showing little enterprise in adopting up-to-date methods of handling their eggs, and are finding that, with the development of motor transport, the competition of private traders is much keener. In commenting on the operations of the Supply Societies—i.e., societies undertaking the supply of seeds, fertilisers and other requisites to members, the Committee give some striking figures showing the remarkable success and development of the North-Eastern Agricultural Co-operative Society at Aberdeen. An adequate description is also given of the circumstances in which the recently formed large-scale co-operative marketing agencies came into being, their objects, and the results of their operations up to the time of preparation of the Report. The societies referred to are the Scottish Milk Agency, the Scottish Wool Growers, the Scottish Borders Farmers (Co-operative Slaughterhouse and Meat-selling Agency), and egg-collecting and marketing societies.

In the description of the position of the Scottish Milk Agency in the west and south-west of Scotland, attention is directed to the advantages which are held by a minority of the milk producers who are not members of the Agency in being in a position to sell their milk on a balanced liquid-milk market to the detriment and at the expense of the members of the Agency. The Committee's view of the attitude of the four important retail consumers' co-operative societies in Glasgow who have withheld recognition of the Agency is expressed thus :—" The four consumers' co-operative societies have informed us that they regard the Agency's scheme as establishing an alliance between the producers and distributors which is a menace to the consumers. Although it is admitted that these societies have always dealt fairly with their farmer suppliers, it seems regrettable that, in distinct contrast to the attitude adopted towards the Agency by the Scottish Co-operative Wholesale Society, they are unwilling to recognise and appreciate the right of a farmers' organisation to apply the principle of co-operation to its trading, particularly as we understand that a considerable number of farmers who are supplying these societies are in sympathy with the objects of the

Agency and would prefer to be members of it. The societies have refused to accept the Agency's invitation to discuss the position with a view to arriving at some understanding. It is unfortunate that an important section of the co-operative movement in a large industrial centre should be permitted to flout the principles of that movement."

In the second section of the Report the Committee discuss the future development of agricultural co-operation. They are wholeheartedly in favour of the extension of co-operation for reasons which may be summarised as follows :—(i) the existing agricultural co-operative organisations have justified themselves, and have proved that the principle of co-operation is a sound and practical method of improving the farmers' position ; (ii) the rapid development in the formation of amalgamations and combinations on the supply side, and the growth, on the marketing side, of combinations of producers and exporters in other countries is placing the individual farmer conducting his buying and selling independently at a very serious disadvantage ; (iii) the need for orderly marketing as a means of mitigating the depression in the agricultural industry.

In regard to future organisation, the Committee state :—"We are convinced that Supply Societies, if they are to be successful and are to offer substantial aid to agriculture, must be organised on lines similar to the North Eastern Society. They should be based on seaports giving facilities for direct import, and should be on such a scale as would enable them to provide their own plant for manufacture or preparation of manures, feeding stuffs, &c. Probably five such Supply Societies would meet the needs of agriculture in Scotland." The Committee also express their conviction that the principle of organised marketing is applicable to all the main farm products. It is explained that the proper function of an agricultural marketing organisation is to organise the supply, to bulk it and grade it, and to place it on the market in such a way as to prevent gluts and shortages ; and that, in fulfilling that function, the operations of the organisation will not be injurious to the interests of the consumers and, while helping to eliminate speculative dealers, will not create any unnecessary risks to legitimate merchants. The Committee emphasise the importance of the establishment of closer relationship between the producers' and consumers' co-operative organisations.

The most important recommendation in the Report is that relating to the provision of financial assistance by the State for the organisation of agricultural co-operative enterprises. Such assistance is urged as necessary in the existing depressed condition of the agricultural industry. The Committee suggest that the State should be prepared to guarantee to recognised banks loans and overdrafts to approved agricultural co-operative societies to the extent of £1,000,000, and that an Agricultural Finance Committee should be set up by the Department of Agriculture for Scotland to deal with applications from societies for advances under the State guarantee. It is further suggested that, for the purpose of facilitating the administration of finance and establishing co-ordination of the relations and activities of the Supply Societies and Marketing Agencies, a Scottish Agricultural Co-operative Federation should be formed of which these Societies and Agencies would be members, and through which applications for loans and overdrafts would be made to the Agricultural Finance Committee.

In order that the provision of State assistance may be regarded as a temporary aid, it is contemplated that the co-operative organisations will be required to adopt a satisfactory system of strengthening their financial position by a gradual accumulation of a substantial amount of share capital to the credit of members by annual increments from payments due for sales of produce and from bonuses earned. In making this suggestion, the Committee recommend the increase from £200 to £500 of the present statutory maximum limit of a member's shareholding. It is also contemplated that each society will arrange to build up trading reserves.

Other amendments in the law to facilitate the development of co-operation are proposed. As a Marketing Agency in conducting its operations will require to be in a position to make interim advances to members who are holding produce until a suitable market is available, the Committee recommend that, as security for such advances, an Agency should be empowered to take a charge over merchandise in its members' possession when the members are under contract to sell their produce through the Agency. It is also recommended that any doubt that may exist whether membership contracts for the sale of produce through a Marketing Agency can be legally enforced should be removed.

A further important recommendation is that a system of compulsory grading should be introduced for application to different products as may be found advisable.

As was to be expected, the desirability of protecting Marketing Agencies against the actions of recalcitrant minorities of the producers is referred to in the Report. It is a question which has recently been much discussed within the agricultural industry owing to the manner in which the Scottish Milk Agency has been embarrassed and hampered in its operations by the minority of producers who have not become members. The Committee consider that protection could be afforded by giving a Marketing Agency through which 75 per cent. of the production of a commodity is being sold the right to apply to a tribunal for an order requiring the minority to market their production of the commodity through the Agency. The tribunal would require to be satisfied that the application was reasonable, and could make conditions providing adequate safeguards for the consumers' and other interests.

While advocating the organised marketing of home produce as the first necessity, the Committee express the view that any organisation for the promotion of orderly marketing and the stabilisation of prices will be crippled in its efforts unless protected from the operations of speculators, and that it is necessary for the health of the agricultural industry to prevent fluctuations of prices by uncontrolled imports.

Special reference is made to the position of agricultural co-operation in the crofting areas in the Western Highlands and Islands. After fully reviewing the results obtained by the efforts made to promote and foster small agricultural co-operative societies in these areas, and making an analysis of the trading operations of the existing societies, the Committee reach the conclusion that under existing conditions there is little prospect of the successful development of agricultural co-operation in these crofting districts, and suggest that there might be greater scope and possibilities in the encouragement of co-operation along the lines of the consumers' co-operative movement.

As responsible duties in encouraging and promoting the organisation of additional large-scale societies and their co-ordination within the proposed Federation will devolve upon the Scottish Agricultural Organisation Society, the Committee, in addition to making other minor proposals for the improvement of the internal organisation of the Society, recommend that the annual grants to it from the Development Fund should be increased and stabilised for a period of years so that continuity of policy and economy in administration may be assured.

The Report is one which should be read with interest by farmers and by all who are concerned in the prosperity of Scottish agriculture. Copies may be obtained, price 9*d*. net., from H.M. Stationery Office, 120 George Street, Edinburgh, or through any bookseller.

LEAF STRIPE or YELLOW LEAF OF OATS.

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This disease was first brought to our notice several years ago by a well-known firm of seedsmen who grow an extensive acreage of seed oats in various parts of Scotland and England. It was their experience that oats grown in the Monkton district of Ayrshire gave rise to a very fine sample when threshed and dressed, and that the germination as returned by the various Seed Testing Stations was invariably very high. In spite of this, however, they found that such oats gave a very thin braird when sown, not only in Scotland but in England, and many complaints were forthcoming as to the quality of the seed.

This experience served to bring home to the firm the fact that there was no reliable correlation between germination of the seed as determined in the laboratory at the Seed Testing Station and its establishment in the field.

There is no doubt that attack by specific pests is one of the main causes of poor establishment of oats in the field. The thinning out of plants due to the action of leather jackets or wireworm is well known and easy to detect, but the diagnosis of a fungus disease is much more difficult, especially when the plant is attacked in the early stages of growth, as occurs when the disease is seed borne, i.e. when the infection is carried in or on the seed. Even here, however, careful examination will reveal such troubles. For instance, in the Monkton district of Ayrshire the presence of a very destructive fungus disease was diagnosed by us on seedling oat plants, and this we found to be responsible for the comparatively poor establishment from seed grown in this district.

Extending our observations we found that this disease—commonly called Leaf Stripe or Yellow Leaf of Oats and caused by *Helminthosporium avenæ sativæ* (Br. and Cav.)—was general throughout Scotland, but that oats growing in the south-west showed a very much higher percentage of infected plants than oats grown elsewhere. From a survey of oat fields in the counties in the south-west, we found that on an average 25 per cent. of the established plants were affected with this disease, the percentage of diseased plants varying from 10 to 41.

Leaf Stripe is by far the most destructive disease affecting oats in Scotland and causes a greater loss than all the other diseases put together. It is mainly responsible for the many poor brairds of oats commonly encountered and for the heavy rate of seeding—up to 8 bushels or, in exceptional cases, 10 bushels per acre—that is necessary in order to get a good cover of the ground. In the past many poor stands of oats which have been attributed to the destruction of the seedlings by leather jackets, wireworms or eelworms have been in reality due to *Helminthosporium avenæ*. Further, the practice adopted by farmers in the south-west of Scotland of introducing new seed every second or third year from the east or north-east can be traced to the prevalence of Leaf Stripe. In those districts from which the change of seed is derived infection with Leaf Stripe is much lower than in the west of Scotland.

Symptoms.—The disease is noted at two stages in the life cycle of the oat plant.

1. In the seedling almost as soon as the seed begins to germinate—the primary phase of the disease.

2. In the established plant at or about the flowering stage—the secondary phase of the disease.

1. Many plants which are affected fail to appear above ground. The shoot, instead of growing vertically upwards, wanders about in the soil for a short time and finally succumbs. Such behaviour may be due to the shoot lacking the virility to push its way up through the soil or to its inability to react to the stimulus of

gravity. Others reach the surface, but succumb before the first seedling leaf has emerged from the coleoptile.

A number of affected plants do succeed in establishing themselves in the soil; on these the first symptom observed is the appearance of small whitish rounded dots on the first leaf of the plant almost as soon as it emerges from the germinating seed. This bleached circular area very soon becomes more conspicuous, and takes the form of a reddish brown spot with a pale brown or yellowish white centre (Plate I, fig. 1). There may be only one such spot, but more often there are several on the leaf. From the affected spot the discoloration proceeds upwards towards the apex and downwards towards the base of the leaf, so that ultimately a distinct brownish or yellow stripe is noted running the whole length of the blade. The location of the spot or stripe is not definite. Sometimes it occurs close to the margin, at other times almost at the centre of the leaf.

About a week after such plants have brairded similar spots can be noted on the second seedling leaf, which as before give rise to the characteristic stripe as in the first seedling leaf (Plate I, fig. 2). The third seedling leaf becomes attacked almost as soon as it appears (Plate I, fig. 3).

In the meantime the first seedling leaf has succumbed to the disease. Its whole area becomes brown or reddish in colour, then it dries and shrivels up (Plate I, figs. 2 and 3). Ultimately the second and third seedling leaves meet the same fate. On the

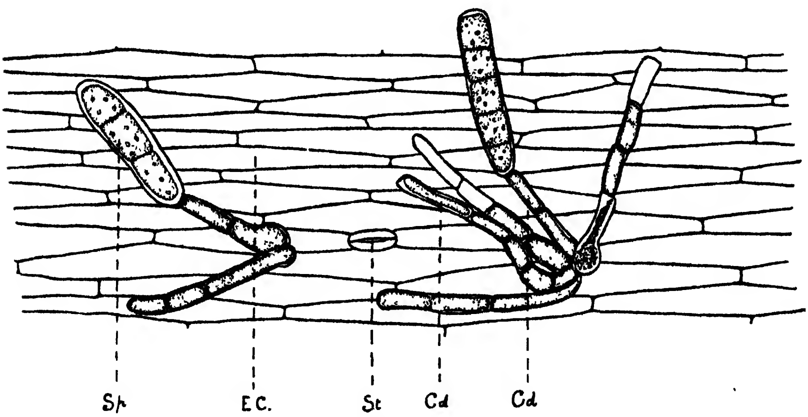

FIG. 1.

Upper surface of a dead leaf on which spores are being produced. (× 180)

Sp.—Spore or conidium.
E.C.—Epidermal cell of leaf.
St.—Stoma of leaf.
Cd.—Conidiophore or hypha on which the spore is borne.

death of these leaves the fungus proceeds to give rise to spores in great abundance (Fig. 1). These are very loosely attached to the fungal hyphæ and are readily dispersed by wind or insect agency.

Under good soil and climatic conditions the plant has usually sufficient strength to carry it over this fairly extended period of

infection and the disease dies down. Under poorer conditions affected plants may die without producing a fourth leaf, especially if a period of slow growth due to cold weather intervenes.

The tillers produced by plants which have survived primary infection are generally stunted and few in number. Such plants, since they have lost three out of the six or seven leaves which normally are found on an oat plant, can be picked out in the field throughout the whole season. (Plate II.)

2. The second period during which the disease becomes obvious is at the flowering stage of the plant. Brown or reddish spots appear on the uppermost leaves of affected plants. These enlarge and spread upwards and downwards on the leaf surface in the form of long narrow stripes. The tip of the leaf becomes brown and withers and ultimately the whole leaf dies. Later, spores are produced on the surface of the leaf (Fig. 1). These are readily carried by the wind to the open flowers of neighbouring plants, both healthy and diseased. Here they germinate and produce a mycelium which invades the surface layers of the grain (Fig. 2), and such grain carries over the infection to the succeeding crop if it is used for seed.

The premature death of the uppermost leaves of an infected plant, which has probably also suffered from the disease in the early stages of growth, seriously interferes with the normal development and maturation of the spikelets. Generally on an infected plant a considerable number of spikelets, especially at the base of the ear, fail to produce grain and are barren. Such barren spikelets, which are white in appearance, have been described in the past as being "blind" or "blasted." (Plate III.)

It should be noted that other troubles due either to insect or fungoid agency may produce a similar blindness in the spikelets of the ear, and consequently this symptom is not of real value in the diagnosis of the disease.

Relative Susceptibility of Various Varieties.—From observations on the susceptibility of different oat varieties to Leaf Stripe, we can conclude that the old straw-producing varieties (Potato, Sandy, Tam Finlay, &c.) are much less susceptible to Leaf Stripe than the newer grain varieties (Victory, Star, Ascot, Marvellous). No variety, however, seems to be immune. Of the grain-producing varieties Marvellous, Victory, Ascot, Record and Supreme appear to be highly susceptible.

Effect of Time of Sowing on the Incidence of Leaf Stripe.—From experiments carried out by us to determine the effect of time of sowing on the incidence of Leaf Stripe we noted that oats sown early in spring showed a very high percentage of plants affected with primary leaf stripe compared with those of later sowing from the same stock of seed. The percentage gradually decreased from over 40 in March sowings to less than 5 for seed sown late in May. It seems, therefore, that the soil temperature at time of sowing has a very pronounced influence on the infection of the seedling from the mother seed. If the

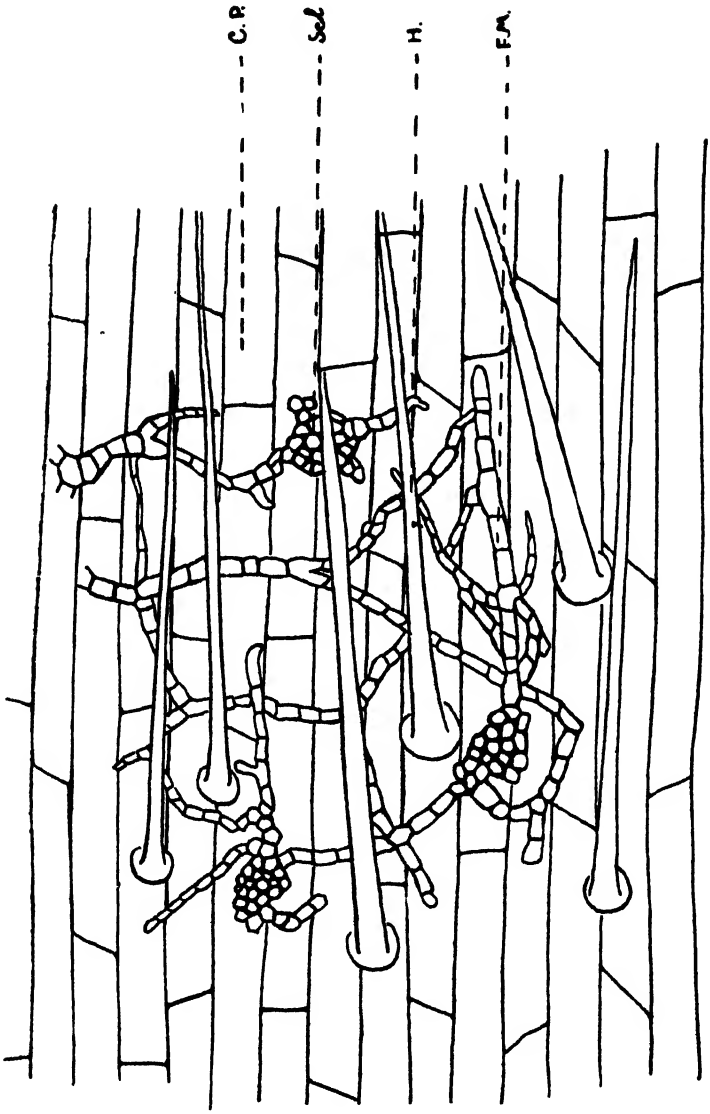

Fig. 2.

Resting mycelium and sclerotia on the surface layers of the kernel of an oat grain. (× 360)

C.P.—Cell of the pericarp.
H.—Hair on surface of kernel.
Scl.—Sclerotium.
F.M.—Fungal mycelium.

soil temperature is low at the time of sowing the shoot readily becomes infected from the grain; but if on the contrary the temperature is high the shoot rapidly emerges from the seed and escapes infection.

The results from seed treatment of early sown oats are therefore much more obvious than with later sowing.

Effect of Locality on the Severity of the Disease.—As already stated, oats grown in the south-west of Scotland and particularly in the Monkton district of Ayrshire are very susceptible to this disease, while oats grown in the east and north-east are relatively free. In some cases, however, where seed from the east and north-east was badly contaminated, it almost invariably was found that such seed was grown from oats which had come from the south-west in the previous year. The district or locality, therefore, has a marked effect on the incidence of Leaf Stripe, and possibly on the virulence of the disease.

Characters of the Fungus.—The fungus, which grows well on all standard media, can be readily obtained in pure culture from diseased oat leaves.

The mycelium or vegetative part of the fungus is smooth, almost hyaline, and divided by numerous septa (Fig. 3). On

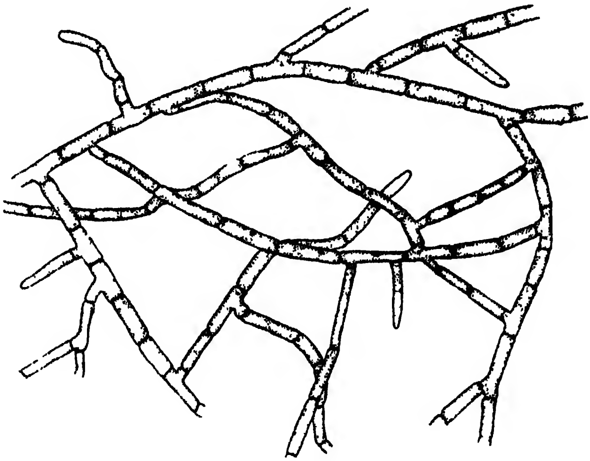

FIG. 3.

Mycelium of *Helminthosporium avenæ sativæ*. (× 180)

artificial media the fungus shows a tendency to form solid aerial tufts, and the media in which it is growing generally assumes an ink black colour. Sclerotia (small clumped masses of mycelia) are quite commonly found on the surface of the media.

In an infected plant the mycelium can be detected especially in the intercellular spaces of the mesophyll. Later when the leaf begins to die, conidiophores (special branches of the mycelium) push their way out through the leaf surface to give rise to a type of spore specially adapted for wind dispersal called a "conidium."

The conidia are pale straw to light brown in colour and are divided by septa into 2 to 8 cells (Fig. 4). They can be found

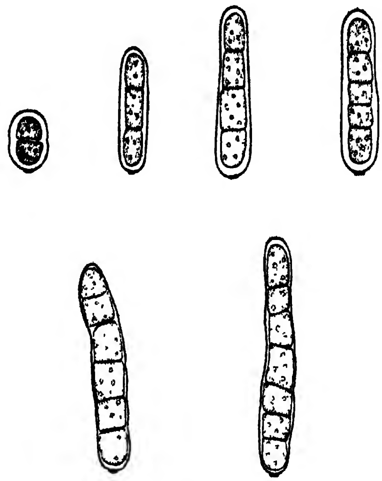

FIG. 4.
Spores on *Helminthosporium avenæ sativæ*. (× 180)

on the dead leaves of affected plants, and after settling on a leaf of an oat plant they begin to germinate in presence of water (Fig. 5). The germ tubes, which generally arise from the

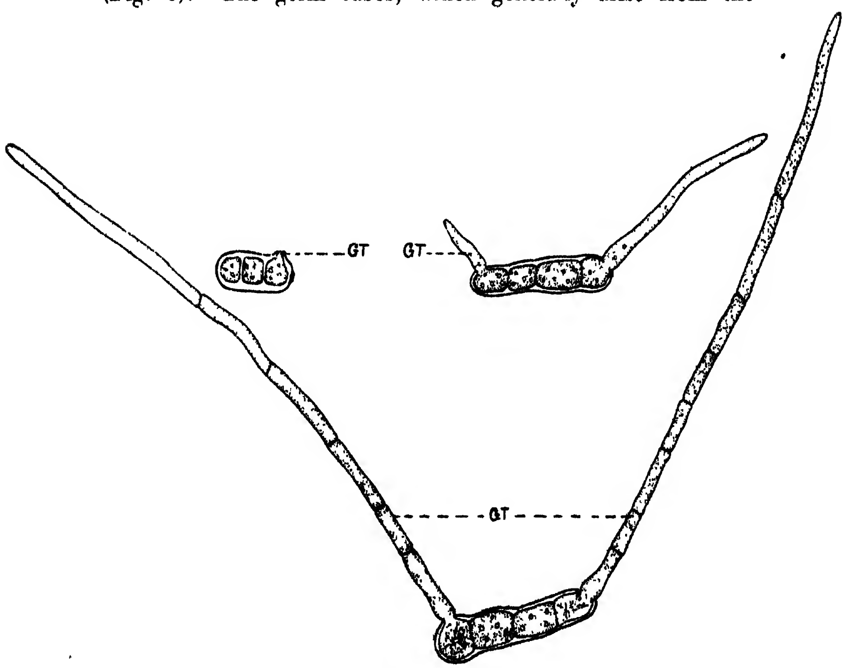

FIG. 5.
Successive stages of the germination of spores in water. (× 180)
G.T.—Germ tube.

terminal cells, penetrate the epidermis of the leaf and serve to bring about infection on the uppermost leaves. The conidia produced on the upper leaves at and subsequent to the time of flowering serve to infect the developing grain in the spikelet.

Control of the Disease.—Fortunately, perhaps, the disease is transmitted by the seed, and experiments with a view to controlling the disease have been carried out by us for several years. At first these experiments were conducted on a small scale under carefully controlled conditions. For this work a wire cage was used and small plots were laid down with the object of finding out mainly what was the most suitable seed-disinfectant to use. The seeds were sown in rows 8 inches apart with a space of 4 inches between each seed and covered with ½ inch of soil. A very fine surface tilth was secured so that conditions for germination were almost ideal.

The same two varieties of oats—Victory and Record—were used in all the trials, and care was always taken to select only Ayrshire grown seed.

After the oats brairded the percentage of plants that had established themselves and also the number of plants that showed symptoms of the disease were noted.

The results of our trials in the year 1927 are set out in Table I.

TABLE I.

	Victory.			Record.		
	Establishment.	Disease.	Germination. (Lab.)	Establishment.	Disease.	Germination.
	per cent.	per cent.	per cent.	per cent.	per cent.	per cent.
Untreated ...	56	19	93	54	21	94
Formalin ¼% ...	80	14	90	84	10	89
,, ½% ...	78	11	84	85	11	84
Germisan ½% ...	93	1	93	93	1	95
,, 1% ...	92	0	93	93	0	93
Uspulun ¼% ...	93	0	92	93	0	93
,, ½% ...	94	0	93	94	0	92

In the above table in addition to giving the percentage establishment and the percentage of diseased plants on the various plots, we give for the sake of comparison the germination of the various samples as determined by the Seed Testing Station for Scotland.

It is evident from the above table that the disease can be effectively controlled by the use of certain seed disinfectants, and of those recorded above, two—Germisan and Uspulun—stand out as being eminently suitable. Both are organic mercury compounds which have been put on the market quite recently, but even in the short period which has elapsed since their introduction reports of tests carried out in other countries indicate that they are superior to the old seed disinfectants. They do not lower the germination of the sample, and the establishment of the treated seed in the field may be as high as the germination returned from the Seed Testing Station. Further, they act as stimulants during germination and the treated always brairds quicker than the untreated diseased seed. There is no evidence, however, to show that seed treatment will hasten the germination of disease-free seed.

Treatment with either Uspulun or Germisan necessitates the soaking of the grain in a weak solution of the disinfectant and then either sowing the grain immediately or spreading it out on a floor to dry. The attendant disadvantages are obvious in ordinary farm practice. In most cases there is neither time nor facilities for treating large quantities of grain just before sowing, and if the treatment should be attempted earlier there is usually not sufficient floor space on which to spread the grain, or else the atmosphere is so humid that drying is impossible.

In the experiments carried out in 1928 the same disinfectants were used as in 1927, but with the addition of a new substance named Tillantin. This is a fine dry powder which is applied by simply mixing it with the seed in an air tight container. The great advantage of this dry or powder treatment, as it is called, is that no drying of the seed is necessary after treatment, and consequently, under the conditions that obtain on most farms, it is by far the most practicable. The seed can be treated at any time previous to sowing. Generally speaking the longer the better, as it follows that the longer the disinfectant is in contact with the surface layers of the seeds the more thoroughly will the seed become disinfected.

The results obtained in 1928 confirmed those of 1927 in the main, and we were agreeably surprised to find that the dry powder treatment with Tillantin, although it did not eliminate the disease, yet gave very satisfactory control.

The experiments were again repeated in 1929 with the results given in Table II. Tillantin was replaced by Tillantin R.

TABLE II.

	Victory.			Record.		
	Establishment.	Disease.	Germination.	Establishment.	Disease.	Germination.
	per cent.	per cent.	per cent.	per cent.	per cent.	per cent
Untreated ...	51	16·0	98	70	12·0	94
Water Soaked (1½ hours at 70° F.)	45	13·0	95	73	10·0	96
Hot Water (15 mins. at 129° F.)	80	12·0	94	87	3·0	94
Formalin ½% ...	89	6·0	89	84	2·0	94
Uspulun ½% ...	95	0·2	95	94	0·1	93
Germisan ½% ...	92	0·2	92	90	0·2	95
Tillantin R (Ceresan)[1] (2 oz. to the bushel) ...	92	0·4	97	93	0·3	97
Iodine Dust (2 oz. to the bushel)	46	7·0	94	73	6·0	94

[1] New name for Tillantin R.

The deductions to be drawn from these experiments are that effective control of this disease can be brought about by using any of the liquid organic mercury compounds like Uspulun and Germisan, and that almost as satisfactory results can be secured by using Ceresan,[1] which being in the form of a powder specially designed for dry treatment makes a strong appeal to the practical farmer.

So impressed were we with the results obtained with seed disinfection in the years 1927, 1928, and 1929 that we determined to carry out extensive field trials in 1930. A considerable quantity of seed was treated with Ceresan by farmers, especially in the south-west of Scotland, and the results obtained have fully borne out those already recorded for the small experimental plots. In every case the farmer carried out the treatment himself and selected his own seed, so that there could be no criticism that undue care had been taken with the treatment or that the seed selected for experiment was not of average quality. Further, the selection of the ground was left entirely in his hands.

The results of experiments carried out on certain farms are tabulated in Table III.

TABLE III.

	Home-grown Seed. Establishment.		Home-grown Seed. Percentage diseased.	
	Untreated.	Treated.	Untreated.	Treated.
	100*	209	24·0	3·0
	100	161	32·0	4·0
	100	143	25·0	9·0
	100	190	27·0	4·0
	100	193	24·0	7·0
	100	213	32·0	4·0
	100	190	28·0	1·0
	100	228	29·0	1·0
Average ...	100	191	28·0	2·0

* For convenience the establishment on *each* untreated section has been put at 100. The figures for the treated section are calculated on this basis.

The farms on which the experiments were being carried out were all visited after the crop had brairded. A sufficient number of counts was made of the plants established on a small fraction of an acre to allow of an estimate being made of the average establishment on the treated and untreated sections of the field. In every case the braird on the treated section was much healthier, more uniform and more vigorous than that on the untreated section. Frequently the difference in the two sections could be seen at a distance of over a mile.

The average increase in establishment of plants due to seed treatment for the eight centres, detailed in Table III, is 91 per cent. In other words, there were practically twice as many

[1] New name for Tillantin R.

plants on the treated section as there were on the untreated; and further, the percentage of plants affected with leaf stripe was 28 on the latter compared with 4 on the former.

At three of the farms where these experiments were conducted, oat seed from the east of Scotland of the same variety as the home-grown seed was sown alongside the treated and untreated plots. The object was to determine if the Lothian grown seed was superior to the treated home oats.

The results are shown in Table IV.

TABLE IV.

	Establishment.			Percentage diseased Plants.		
	Home Seed.		Change Oats.	Home Seed.		Change Oats.
	Untreated.	Treated.	Untreated.	Untreated.	Treated.	Untreated.
	100	213	160	32·0	4·0	10
	100	228	163	29·0	1·0	30
	100	190	135	28·0	1·0	19
Average ...	100	210	153	30 0	2·0	20

On these three farms the treated home oats showed an increased establishment over the untreated home oats of 110 per cent. and over the untreated change oat seed of 57 per cent.; and whereas in the treated home oats there were only 2 per cent. of diseased plants, there were approximately 20 per cent. in the new or change seed oats.

On two farms no home oats were treated, but a portion of the fresh change oats was treated and the remainder untreated. The establishment figures are shown in Table V.

TABLE V.

	Establishment.		Percentage diseased.	
	Untreated.	Treated.	Untreated.	Treated.
	100	140	10·0	Trace
	100	130	8·0	Trace
Average ...	100	135	9·0	...

The increased establishment due to treatment of the change oats was 35 per cent., and the percentage of disease was reduced from 9 per cent. to less than 1 per cent.

In two experiments attempts were made to determine what reduction in the rate of seeding could be practised as a result of seed treatment. In the one case the variety sown was Marvellous, and the rate of seeding of the treated portion was 5 bushels and of the untreated portion 7 bushels per acre.

FIG. 1. FIG. 2. FIG. 3.

PLATE I.

Primary phase of Helminthosporium Disease on Oats.

Fig. 1.—Plant showing infection of the first seedling leaf.

Fig. 2.—Later stage in which the first seedling leaf has begun to shrivel up, and the second leaf has become attacked.

Fig. 3.—Still later stage in which the second seedling leaf has begun to wither, and the third shows symptoms of infection.

Fig. 1. Fig. 2.

PLATE II.

Fig. 1.—Healthy plant grown from treated seed.

Fig. 2.—Plant of same age grown from untreated seed.

In the latter, note the absence of tillers and the diseased basal leaves.

PLATE III.—Ear of Oat plant showing "blasted" spikelets due to Helminthosporium attack.

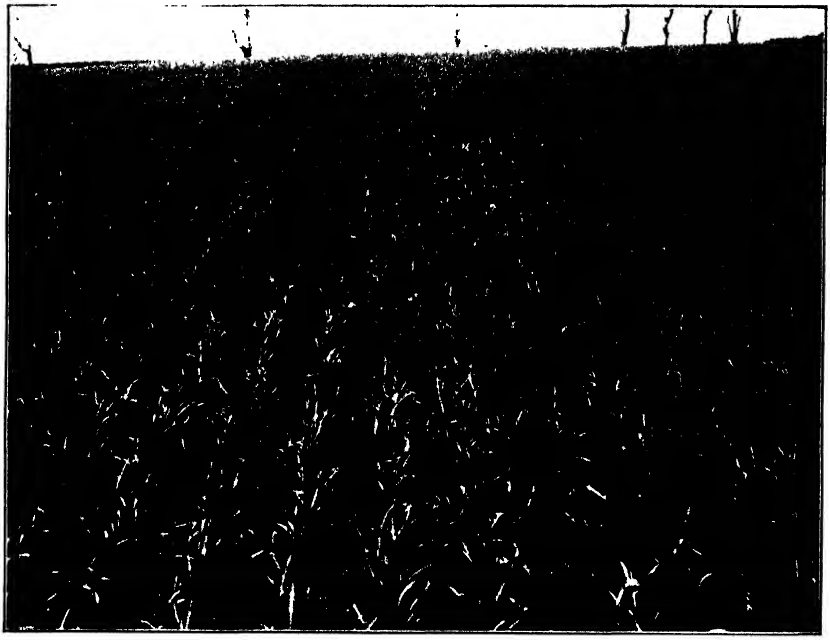

FIG. 1.

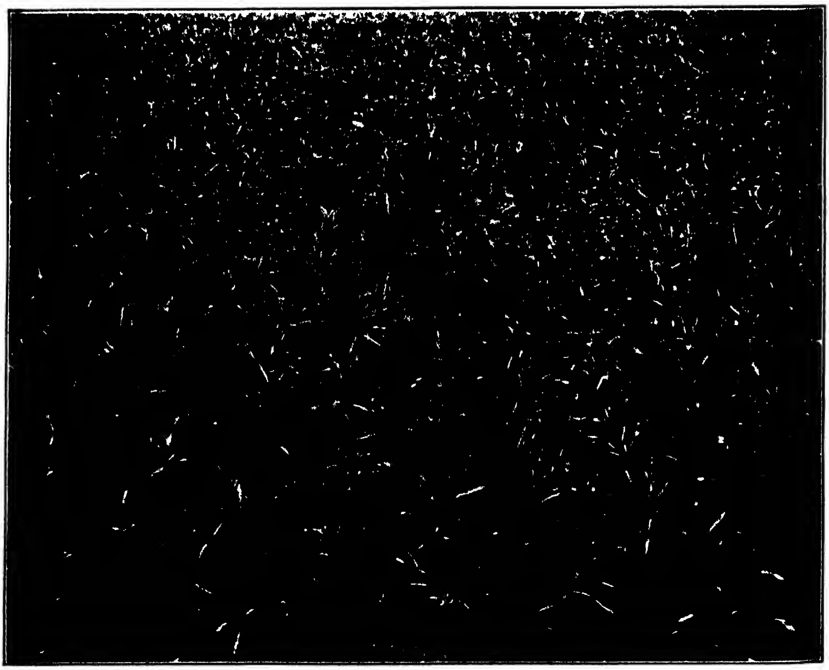

FIG. 2.

PLATE IV.

Fig. 1.—Section of field sown at rate of 4 bushels of Victory Oats per acre—Treated.
Fig. 2.—Section of same field sown at rate of 6 bushels of Victory Oats per acre—Untreated.

The establishment in the treated portion was 49 per cent. better than in the untreated, and there was every indication that the braird on the treated section was too thick. If we assume that the correct rate of seeding to give a proper cover with Marvellous Oats is 7 bushels of untreated seed, it would be possible by using treated seed to reduce the rate of seeding by $1\frac{2}{3}$ bushels to get the same number of plants per acre. That is, a saving of more than 3 bushels of seed per acre could be secured by treating home grown seed.

In the other experiment the variety grown was Victory, and the rate of seeding was 4 bushels of treated home seed as against 6 bushels of untreated home seed. The treated home seed showed a 29 per cent. better establishment (Plate IV, fig. 1) than the untreated (Plate IV, fig. 2). If it is assumed that under the soil and climatic conditions prevailing at this farm the correct rate of seeding of untreated Victory oats to give the best results is 6 bushels per acre, then with treated seed an additional reduction of 1 bushel seed per acre can be made and a similar yield obtained. That is, a reduction of 3 bushels of seed per acre can be effected when home-grown Victory seed is treated.

We do not wish to lay too much stress on the actual reduction in the rate of seeding that can be effected as a result of treatment of home-grown seed. Our results are too few in number to be conclusive, and the reduction will vary according to soil, climatic conditions and time of sowing. There seems to be little doubt, however, that by seed treatment a farmer may reduce his former rate of seeding by 2 bushels or in exceptional cases by 3 bushels per acre and still get the same number of established plants as before.

The same conclusion is borne out by the figures given in Table III. On these eight farms the rate of sowing of the treated and untreated home seed was the same, yet the establishment on the former is almost 100 per cent. better than on the latter. If we assume that the correct rate of seeding of untreated seed is 6 bushels per acre, then it follows that by treatment the rate of sowing can be curtailed by 3 bushels on an average.

In regard to east country seed it becomes apparent from our results that a reduction of from 1 to 2 bushels of seed can be effected as a result of treatment.

In the south-west of Scotland, where a considerable proportion of the oat break is sown with seed from the east or north-east of Scotland, the average reduction in the rate of seeding after treatment would therefore approximate to 2 bushels per acre. If we assume that the average cost of oat seed (home and change) be 4*s*. per bushel, then the saving per acre as a result of treatment is 8*s*.

Against this is to be offset the cost of treatment. It takes 2 ozs. of Ceresan to treat a bushel of seed and the cost of this substance is 1*s*. 4*d*. to 1*s*. 6*d*. per lb., so that the cost is 2*d*. per bushel or 8*d*. per acre, assuming it takes 4 bushels of treated seed to sow an acre. The actual cost of labour involved in the treatment is very low—about ¼*d*. per bushel—and can be neglected in the calculation.

Up to the present we have not been able to get figures for the yields from treated and untreated fields. These will be published in a College Bulletin after the crops under experiment have been saved and threshed. From the results of our small scale plot trials the increased yield might be put at 10 per cent. at the lowest, which even under present conditions represents a monetary value of 7*s*. 6*d*. per acre, so that the nett profit due to treatment would be on an average about 15*s*. per acre, made up by a saving of 7*s*. 6*d*. on seed and 7*s*. 6*d*. due to an increase in yield.

In 1928 there were approximately 34,500 acres grown in Ayrshire, so that in that county alone the nett profit from treatment would be about £26,000; for the area served by this College, where this disease is rife, the nett profit would be 15*s*. per acre on 228,000 acres or £171,000.

In conclusion we desire to thank those farmers and others who have assisted us in carrying out these field experiments.

THE LENGTH OF LIFE OF THE DAIRY COW.

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THE important distinction between the fattening bullock and the fattening sheep on the one hand and the draft horse and the dairy cow on the other is the difference in the relationship of their individual functions to the time element. It is desirable that the bullock and the sheep should be ready for the butcher in the shortest possible time, while the good draft horse remains fit for work over a long period, and the profitable dairy cow maintains her production at a high level for many years.

In view of the attention which has recently been devoted to the duration of life of the dairy cow it may be of interest to review the available data bearing on the problem. At the same time evidence will be produced regarding one factor which has an influence on the length of the productive life of the cow.

That the problem is not a new one is indicated by the fact that an anonymous writer discussed it in 1912 and earlier. After tabulating data from the herd books of the American Holstein-Friesian Association this writer (1) came to the conclusion that the expectation of life for three-year-old cows was six years, and that 28 per cent. of the cows entering dairy herds (evidently at an average age of about 2½ years) would reach the age of ten years. At a later date Gowen and Covell (3) assumed the life of the dairy cow to be ten years, which would give a productive life of seven to eight years.

Great interest has recently been aroused by results secured in West Sussex (8). From these the impression has arisen that the average length of life of the dairy cow after she enters the producing herd is only 2¼ years. The returns secured in this investigation showed that 398 dairy cows died or were drafted out of a total of 1,267 in one year. This means a replacement of 32·2 per cent. per annum. Undoubtedly, however, some of the drafted cows were sold as surplus stock and would go into other herds. Of the 398 cows leaving the herds 74 were sold for reasons not specified, and these would include animals sold as surplus. If all 74 had been sold as surplus, then the annual loss to the herds included would have been only 324 cows, or 25·6 per cent. The fact that all of the animals sold for unclassified reasons would not enter other herds will bring the figure for replacements somewhere between the two percentages given. Then it must be remembered that some of the cows in the herds studied would have had some previous period of productive life in other herds.

When all these facts are taken into consideration it is probable that the average length of the productive life of dairy cows in the West Sussex herds studied was nearer four years than 2¼ years. The productive life of the dairy cow should be regarded as covering the time elapsing, including dry periods, from the beginning of her first lactation until she is put out of the producing herd. The general impression which has been derived from the West Sussex results is unduly pessimistic.

In a study of the problem Roberts (6) determined the losses of dairy cows from all causes except reaction to the tuberculin test. He found that 84·5 per cent. left the herd before their seventh calf. From the ages at which they left the herd it is found that the average life of the cow in the producing herd was on the average 3·5 years if no consideration be given to cows kept beyond the end of the sixth lactation. However, 15·5 per cent. of the cows stayed in the herd after the seventh calf, and if they be allowed only one year after this, that is until the seventh lactation is completed, then the average length of life in the producing herd proves to be 4·1 years.

It is stated by Kay and M'Candlish (4) that the average productive life of the cow is about four years, though no attempt was made to prove this from the data in their paper. This is simply a statement from experience of commercial herds. In a recent study Wyllie (9) found that the average life of the cow in the milking herd was 3·6 years.

The statement is made by Shepherd (7) that the average productive life of the cow is from five to seven years. Then the British Friesian Cattle Society (2) state that the average working life of 300 British Friesian 2,000 gallon cows is about seven years. It must be noted, however, that the first of these statements is not supported by any data, while the latter is based on a selected population. In addition it is not made clear in either of these cases whether it is the whole life of the cow, or only her true productive life, which is being discussed, though it is probably the former.

It is very evident that there is considerable difference of opinion as to the average length of the productive life of the dairy cow. On the whole the evidence available would appear to show that from the beginning of her first to the end of her last lactation the cow will spend about 3½ to four years in the producing herd. This means that from 28·6 per cent. to 25 per cent. of the milking herd must be replaced annually to keep it up to full strength.

Many factors influence the length of the productive life and of the total life of the dairy cow. Feeding, management and disease all play a part, but, though the bearing of these on the life of the cow is often suspected, the necessary evidence from which definite conclusions could be drawn is not always available. The importance of the study of these problems becomes evident if attention be given to the high percentage of replacements needed annually in the dairy herd.

Influence of Age at First Calving.—In a study of the influence of the age at the time of first calving on milk and butterfat production M'Candlish (5) used 4,160 records from 683 Ayrshire cows. This group included only animals with five or more completed lactations, and so can not be used to show the average length of life of the dairy cow. However, the records can be used to study the expectation of life for cows which reach the fifth lactation and the total lifetime production of these animals.

Productive Life and Lifetime Production.

Age at First Calving.	Length of Life.			Lifetime Production.		Relative Lifetime Production.	
	Non-Productive.	Productive.	Total.	Milk.	Fat.	Milk.	Fat.
Months.	Years.	Years.	Years.	Tons.	Cwt.	Per cent.	Per cent.
19–28	2·14	6·52	8·66	20·6	14·9	93	93
29–31	2·51	6·25	8·76	22·3	16·9	100	100
32–34	2·77	6·03	8·80	19·0	14·3	85	85
35–41	3·02	6·02	9·04	18·4	13·8	83	81

In the accompanying table the animals are grouped according to their age at the time of first calving. The average age at the time of first calving and the average productive life for each calving-age class are stated in years, and their sum gives the average length of life of the animals. As the length of the lactations and the intervening dry periods are not definitely known it has been assumed that from the beginning of one lactation to the beginning of the next is one year, and so one lactation with the accompanying dry period is taken as one year of productive life. This is not necessarily strictly accurate, but from other work it was found to be sufficient for comparative purposes in the absence of complete data.

The average lifetime production of milk and butterfat for the groups is given. In addition the lifetime production of each group has been expressed as a percentage of the production of the animals in the 2½-year-old group which calved for the first time at 29 to 31 months of age.

The first point of interest is that the youngest calving-age class has the longest productive life, and from this group to the highest age class the length of the productive life gradually declines. However, when the productive life is added to the non-productive life, that is the life up to the age of first calving, it is found that exactly the opposite occurs. The younger the animal at the time of first calving, the shorter will be its life.

From this it might be concluded that early calving shortens and late calving lengthens the life of the animal. It must be remembered, however, that only animals with five or more lactations are included in this study, and data on those leaving the herd before the start of the fifth lactation would be necessary before this point could be definitely settled.

The next point of interest is the total production of the animals. This gives the production, not for any single lactation or group of lactations, but the total production for the average lifetime. Here it is found that the 29 to 31 month group is in the lead, and, if the yield of this group be taken as 100, then the 19 to 28 month group produces only 93 per cent. as much milk and butterfat, and the 32 to 34 month group only 85 per cent. as much, while the 35 to 41 month group is the least productive with only 83 per cent. as much milk and 81 per cent. as much fat as the 2½-year-old group.

Summary. — It is known that dairy cows do not reach maximum production until they are seven years of age, that is in their fifth lactation. Only a relatively small percentage, however, reach maturity, as their average life in the producing herd would appear not to exceed four years.

When the animals which reach maturity are considered, it is found that those which calved for the first time at an early age have the shortest life but the longest period of usefulness, while those coming into production at higher ages have longer lives but shorter periods in the producing herd. In total lifetime production heifers calving for the first time at about 2½ years of age excel all other groups.

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THE VALUE OF GRAZING FOR FATTENING PIGS.

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THE value of grazing to ruminants such as cattle and sheep, and to other herbivorous animals such as the horse, is obvious. The pig on the other hand is omnivorous, and its stomach is not specialised to deal with only one class of food. There is, as a result, some difference of opinion and doubt concerning the relative importance of grazing in the feeding of pigs. While the wild pig in natural surroundings is not specially constructed to obtain the bulk of its food from grass, the anatomy of its stomach and head indicates that its natural source of food is to be found under the surface of the ground or buried in masses of fallen leaves or in matted tufts of grass. This natural food consists largely of roots and tubers, to which must be added such miscellaneous extras as stolons, rhyzomes, fungi, fallen nuts and fruits, insects and small animals. As even the most nourishing of roots contain a relatively high proportion of water, while many of them also contain considerable proportions of fibre, it is incorrect to imagine that the pig must necessarily receive a ration entirely composed of concentrates. The problem therefore centres round the relative value of grazing to pigs at different times and in different conditions.

Generally speaking it can be said that mature pigs, that is to say breeding pigs and large fattening pigs, require a certain proportion of bulky food in their daily ration, otherwise the small amount of concentrates required to supply the energy requirements would not supply sufficient bulk to satisfy the appetite. In the case of younger animals, say those under 150 lb. live weight, the conditions are different. Up to this weight the amount of concentrated foods, mostly in the form of cereals, required to produce maximum growth provides a satisfactory amount of bulk, though practical experience suggests that some of this can be successfully replaced by more bulky material if any advantage is to be obtained by doing so. In so far as purely fattening pigs are concerned, there are two main advantages which may accrue from the feeding of pasture. In the first place grazing may supply some factor which is necessarily absent from a ration which appears to be otherwise well balanced. Secondly, pasture or green crops may replace either the protein or the carbohydrate portion of the ration should the cost of the latter two make it economical to do so.

Although a considerable number of experiments have been carried out on the value of grazing most of them are indefinite, and while the results show the difference in rapidity of growth and economy of food consumption between pigs fed in sties and those fed outside on pasture, few of the writers analyse these results to show the various factors involved in grazing. Of these the more important may be tabulated as follows:—(1) palatability of food; (2) laxativeness of food; (3) bulk; (4) supply of vitamins; (5) supply of organically combined minerals; (6) access to soil (supply of inorganic materials); (7) exercise of grazing and rooting (i.e. a natural form of exercise); (8) exposure to sunlight; (9) provision of cheap form of protein.

That most of these are of value in the feeding and management of breeding pigs is now generally recognised. It is their value for fattening pigs which requires some further elucidation. As regards palatability, the pig is notoriously a greedy feeder, and it is as a rule only when the ration is badly balanced that the appetite is impaired. Constipation might be expected as a common occurrence in the case of an animal receiving only concentrated foods. Yet a balanced ration such as one composed of 65 parts barley, 25 parts sharps and 10 parts fish meal can give good results with little evidence of this trouble, and while the laxative effect of pasture is always valuable it does not appear to be necessary for successful results. Until pigs are about 150 lb. live weight their requirement for bulk appears to be almost completely satisfied by the concentrated food which they can digest. Above that weight there is a tendency to eat a small amount of the litter unless other bulky food is provided, but it does not appear to be until a weight of about 250 lb. is attained that a pig really requires a fair proportion of bulky food.

In the case of vitamins there is liable to be some confusion of thought. Several experiments have been carried out in which pasture in addition to an artificial and vitamin deficient ration has proved to be protective. Where, however, the ration is normal and well balanced there is evidence that the vitamin requirement of the fattening pig is likely to be satisfied.

Access to soil not only means access to a certain amount of inorganic minerals, but it supplies the grit for which pigs crave, especially when on a forcing ration. A good supply of ashes and soil, however, can easily be fed in pens inside. The value of exposure to sunshine appears to be definite, as is shown by the following American results. Evvard and others compared two pens of pigs both getting maize, meat meal and minerals. One group was fed under cover and the other outside. The latter, exposed to sunshine while feeding, only required 391 lb. of feed for every 100 lb. gain, whereas 425 lb. were required by the group not exposed to sunshine. Similarly Bohstedt and others found that direct sunshine was beneficial to fattening pigs. In three experiments, the pigs, 27 in all, which were fed a deficient grain ration in outdoor brick-paved pens, made on the average a daily gain of 0·63 lb. Their thigh bones had an ash content of 56·8 per cent. and a breaking strength of 427 lb. Where the same grain ration was fed to 19 pigs in two experiments conducted indoors, they made an average gain of only 0·30 lb. per day. Their thigh bones analysed 55 per cent. ash and had a breaking strength of only 249 lb. As in the case of vitamins, one has to appreciate that the marked results obtained with animals on deficient rations are not generally applicable where the ration is normally well-balanced. The difficulty with regard to the value of pasture as a source of cheap protein is that the protein is intimately associated with the more or less indigestible fibre, which thus becomes a limiting factor.

Compared with these advantages, which may be credited to grazing, the disadvantageous factors are few. They may be briefly summarised as :—

1. Loss of energy through exposure to cold.
2. Loss of energy through too much exercise.
3. Necessity of ingesting too much fibrous food.

Passing from these theoretical considerations the following experiments carried out at the Rowett Research Institute may be quoted. In the first case the same balanced ration was fed to two groups of which one was kept all the time in an inside pen with a concrete floor, and the other was kept in a large run on pasture for the first ten weeks and was then brought inside for the remaining two weeks of the experiment. Table I summarises the results.

TABLE I.

	Group I.	Group II.
Average number in group	10	10
Average initial weight	52·3 lb.	52·3 lb.
Average gain per pig per day—		
19/10/25 to 30/12/25	1·04 ,,	1·02 ,,
31/12/25 to 15/1/26	1·53 ,,	2·09 ,,
Food eaten per 1 lb. gain—		
19/10/25 to 30/12/25	3·73 ,, (inside)	3·90 ,, (outside)
31/12/25 to 15/1/26	4·33 ,, (inside)	2·97 ,, (inside)

It will be seen that during the experimental period, which was in the first part of winter, such small difference as was observed was in favour of the pigs kept inside. On the other hand when the outside pigs were taken in they showed a very marked superiority over those that had been inside all the time.

A further experiment was carried out later in order to get fuller information. In this case there were three groups all getting the same standard ration. Of these, two groups were fed inside, one getting the basal ration only, while the second was given as much freshly cut grass daily as it would consume. A third group was kept all the time on the same pasture as supplied the cut grass and was provided with wooden floored huts for sleeping in. The concentrate ration for the first part of the experiment consisted of cubes made up as follows:—Sharps, 30 parts; maize meal, 20 parts; barley meal, 40 parts; meat and bone meal, 8 parts; ground limestone, 1 part; salt, 1 part.

At the end of two months the pigs inside getting no grass, soil nor extra minerals were not making normal gains, and the ration for all three groups was changed to the following :—

Sharps, 20 parts; barley meal, 20 parts; boiled potatoes, 200 parts; separated milk, 100 parts; salt, 1 part.

The change of food resulted in an immediate improvement in group I, which was not, however, reflected in group III on pasture. It has to be noted, however, that the change of food occurred in the middle of September, and at this period there was a considerable increase in the dry matter of the grass as determined at approximately ten day intervals. Observation confirmed that this was due to the ripening of the pasture constituents and to the increased development of fibre in the plants. The pasture at this period had really ceased to be of much significant value for the purpose of feeding to pigs. The results of this experiment are briefly outlined in the following table :—

		Group I.	Group II.	Group III.
		Concentrates only. Inside.	Concentrates + cut grass *ad lib.* Inside.	Concentrates + grazing outside.
Number in group		10	10	10
Average weight at beginning, lb.		76·9	77·9	78·5
15/7/29 to 13/9/29	Average gain per day ...	0·87	1·00	1·24
	Average concentrates (dry matter) per 1 lb. gain ...	4·23	3·94	3·53
	Average grass (dry matter) per 1 lb. gain	...	0·106	(?)
	Average total food (dry matter) per 1 lb. gain ...	4·23	4·05	3·53 +
13/9/29 to 2/11/29	Average gain per day ...	1·36	1·38	1·28
	Average concentrates (dry matter) per 1 lb. gain ...	3·75	3·92	4·05
	Average grass (dry matter) per 1 lb. gain	...	0·15	(?)
	Average total food (dry matter) per 1 lb. gain ...	3·75	4·07	4·05 +

Taking first the earlier period and comparing groups I and II it is seen that the addition of cut grass led to increased daily gains and to a reduced consumption of food per lb. of gain. The difference between groups II and III, however, indicates that factors other than food supply were at work, and exposure to sunlight appears to have been the most prominent of these. In comparison with the results in the second period and with numerous other results, it would appear that the concentrate ration was not, by itself, adequately balanced.

As already mentioned, the grass during the second period was becoming old and fibrous, and this fact probably accounts for the increased dry matter consumed per 1 lb. gain in group II as compared with group I. That grass added to a milk diet does not produce any improvement as measured by the similarity of daily gains is in confirmation of other results. A comparison of groups II and III in the second period, in which the outside pigs showed both a smaller gain and a larger food consumption, indicates that a decrease in sunlight and exposure to cold and damp weather were having an adverse effect.

Taking the results of the two experiments reported in conjunction with other published results it would appear that where a ration for fattening pigs is well balanced, the addition of grazing over the whole fattening period is not of any special value. Many investigators, however, have reported that where pigs were partially fattened on pasture and then finished inside they have shown more rapid gains, and in several cases more economical gains, than pigs not having access to pasture. From another point of view the pig is of a much more active temperament when young and does not so readily accept close confinement till it begins to put on fat in addition to growing. The general application to practice of these conclusions would appear to be that the best management lies in allowing pigs access to pasture when they are young, say for six or eight weeks after weaning, and then finishing them off inside.

No information was obtained from the two experiments reported as to the amount of pasture or green food which can economically be fed to fattening pigs, but some interesting experiments carried out by the Department of Agriculture of the Irish Free State and reported by Sheehy are of interest in this connection. The green food, consisting of rape, cabbages and vetches, was fed to pigs confined to sties and the amounts consumed were accurately measured. Separated milk was fed along with meals to all groups. The results of four experiments at different centres are summarised as follows. The value of a separated milk and meal ration is not enhanced by the addition of green food. Green food, on the other hand, may be economically substituted for part of either the separated milk or meal portion of a pig's diet. The quantity of green food which may be thus utilised is small, being limited by the nature of the pig's digestive organs. If the green food is of good quality, a quantity which is equivalent to an average of 6 lb. per pig per day over the fattening period may be fed economically, this replacing 3·7 lb. (about 3 pints) of separated milk and 0·7 lb. of meals. The replaceable proportions are stated to be approximately :—meals, 1 lb.; separated milk, 6 lb.; green food, 9 to 10 lb.

In the case of grazing, it has to be remembered that the relative amounts of green food consumed by grazing pigs will vary very widely according to the condition of the pasture as affected by seeding, manuring, season and stocking. As compared with green soiling, therefore, it will be impossible to effect any control over the above-mentioned proportions, which confirms the conclusion that it is more efficient to limit grazing to a short period at the beginning of the fattening pig's life.

Summary.—1. Several factors are involved in the grazing of pigs, many of them advantageous, some of them not. In the case of breeding pigs nearly all of the advantages are effective, and the disadvantages do not, as a rule, apply.

2. In the case of fattening pigs a number of experimental

results indicate that when a ration is otherwise properly balanced the addition of green food makes little if any difference. When young pigs are grazed for a few weeks after weaning, however, the advantages of exercise and exposure to fresh air and sunlight lead to an improvement in constitution which is reflected in relatively increased gains when the animals are fattened inside.

3. Where green food must be consumed as being the cheapest available foodstuff, it may be fed, preferably cut and supplied in the sties, at a rate not exceeding an average of about 6 lb. per head daily.

THE INFLUENCE OF ONE CROP ON THE FOLLOWING CROP.

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IN the last century manuring was generally looked upon as being the chief factor under the control of the grower that affected the yield of our farm crops.

Nowadays, however, the suitability of the variety and the origin of the seed and the incidence of different diseases, as well as such factors as the time and manner of seeding, &c., are rightly considered as being at least equal in importance to manuring. Careful consideration of these points will in many cases enable the cost of production to be reduced considerably by increasing the income without in any way increasing the expenditure.

There is another factor, viz., the influence of one crop on the following crop, which, while it has often a considerable effect on the result, is not always sufficiently appreciated. There is a tendency to attribute to artificial manures results which are really due to some other cause.

Interesting examples of this factor have been found in the successive crops in a small scale rotation experiment which was started at Craibstone in 1922, where different root crops and different combinations of manures are being compared. The ordinary six-course rotation of the district is followed, viz. :—

1. *Root Crops*, comprising potatoes, swedes, turnips, and, during the past three years, sugar beet.
2. *Barley*, sown out with the following grass seed mixture—

   13 lb. perennial ryegrass.
   8 ,, cocksfoot.
   4 ,, timothy.
   2 ,, broad - leaved red clover.
   1½ lb. late-flowering red clover.
   1 ,, alsike clover.
   ½ ,, wild white clover.

3. *Hay*.

4 and 5. *Pasture*.

6. *Oats*.

The soil is a medium loam about 10 in. deep, on a gravelly subsoil, and dung at the rate of 12 tons per acre has been applied to all the root crops, and the cultivations for each were the same throughout.

Early potatoes were planted in the middle of May, in drills 24 in. apart, and at the same time swedes and turnips were sown in drills 27 in. apart and sugar beet in drills 18 in. apart. The potatoes were usually lifted in September, while the turnips and sugar beet were not lifted until December. After these crops were lifted, the ground was all dug at the same time, so that the part after the potatoes was therefore bare for a considerably longer time. The shaws of the turnips and sugar beet were dug in on their respective plots. Barley and grass seeds were sown in spring.

No difference was seen in the barley after the different root crops until about the beginning of July. About this time, however, differences were seen and gradually became more pronounced, and at harvest time the parts after potatoes yielded much poorer crops than those after turnips. In some seasons the parts after turnips on some of the plots were laid and were distinctly later in ripening than the parts after the potato crop. The crop after the sugar beet was intermediate. These results have been entirely consistent for all the plots in each year.

The following table gives the average results obtained :—

	Grain. cwt. per acre.	*Straw.* cwt. per acre
After potatoes	15·6	27·7
,, swedes	20·2	42·8
,, turnips	19·9	40·9
,, sugar beet	17·0	34·2

At one time it was thought that these results might be due in part to a considerable proportion of the available nitrogen having been washed out of the land from which the potatoes had been lifted earlier than the other crops, and which had therefore been left bare for a considerable period during which rainfall is usually fairly high. As indicating that this view has the appearance of being correct, it may be stated that the crops after potatoes, even on some of the plots that got nitrogenous manures, appeared to have insufficient nitrogen.

The theory that this result was due to the land being left bare was not borne out, however, by a similar experiment carried out last year with oats. In this experiment, carried out on a field scale, part of the oats was grown after Golden Wonder, a late variety of potatoes which were not lifted until November, and part after yellow turnips which were pulled the following week, so that the ground after the potatoes was bare only a short time longer than that after the turnips.

Victory oats were sown in March, and, as with the barley, the difference between the parts after potatoes and turnips was very marked. The appearance of the crop after turnips was again better than that after potatoes, as the following result shows :—

	With 1 cwt. sulphate of ammonia to oats.		*No nitrogen to oats.*	
	Grain.	*Straw.*	*Grain.*	*Straw.*
	cwt.	cwt.	cwt.	cwt.
Oats after turnips ...	44·1	52·4	38·0	44·7
,, ,, potatoes ...	36·3	45·8	30·7	37·8

1 cwt. sulphate of ammonia was applied to part of the oats, after both potatoes and turnips, and in each case there was a substantial increase of both grain and straw, and it will be seen that the crop after turnips where the nitrogenous manure was not applied was quite as good as the part after potatoes where the cwt. of sulphate of ammonia was applied.

It may be considered that the poorer crop after potatoes was due to the fact that no shaws were left on the land. Had this been the reason, the crop after sugar beet should have been best, as there were fully twice as many shaws from this crop as from the turnips, but in every case there has been less of both grain and straw after the sugar beet than after the turnips.

It has been stated as an argument in favour of growing sugar beet that bigger crops are obtained after it than after any other root crop. In all probability where this has been the case, it has been due to the deeper and more thorough cultivation and heavier manuring given, as it has been shown above that turnips and swedes, grown under equal conditions with sugar beet, have resulted in greater yields in the following crop.

A practical conclusion then is, that a larger quantity of nitrogenous manures is necessary for the grain crop after potatoes than after turnips if the maximum crop is to be obtained.

Soon after the barley crops were cut (and also the oat crop in the case referred to), it was distinctly seen every year and in every case that there was more red clover in the parts after potatoes than in the parts after turnips, and these differences became more distinct as the season advanced. This result was due to the poorer crop of barley after potatoes allowing the red clover to become better established. Many experiments have shown that few plants are so easily adversely affected by the strong growth of other plants or crops as red clover.

Last year part of each plot was cut on 1st June, and the produce after the potato and turnip crops was separated into grass and clover. The following table shows the average results (green weight) :—

	Grass.	*Clover.*	*Total.*
Grass after Barley.	cwt. per acre.	cwt. per acre.	cwt. per acre.
1. After potatoes ...	56	76	132
2. After turnips ...	65	20	85

Here it is distinctly seen that the heavier barley crop after turnips had a considerable adverse influence on the red clover, although the reduction in the weight of the total crop was made good to some extent by the larger quantity of grass present.

Similarly, the influence of different varieties of oats on the red clover in the hay crop has been well observed on several occasions. Generally, the older straw-growing type of oats, like Potato, Scots Berlie and Sandy, which tiller freely, have a much greater adverse effect on the red clover than the grain-producing varieties like Record, Victory, &c., and especially the earlier short-strawed varieties like Yielder and Superb. Where it is considered that there is a danger of the grain crop lodging and spoiling by rotting out the sole, such early and thin-growing varieties, or barley, should be sown. In some cases bere, which is even earlier in ripening, may be used with success for this purpose, especially where land is to be sown out for permanent pasture.

Other precautions that should be taken in this connection, as shown both by experience and experiment, are to have a well graded sample and sow it, not too thickly, as early in the season as soil conditions will permit, and also to cut the crop as early as possible.

The hay crop in its turn also had an influence on the succeeding pasture, and especially on the white clover. It should be mentioned here that, in the case of the hay crop where there is a mixture of different grasses and clovers, the effect on the succeeding pasture is complicated by the closely allied but quite independent circumstance of the influence of one plant on another in the hay crop year in addition to any effect that that crop may have in the succeeding years of the pasture.

Early or quick growing plants, especially those of a spreading habit of growth, generally exert a considerable adverse influence on those of later and slower growth. For example, meadow fescue when sown alone or mixed with other slow starting plants will, on suitable soils, be prominent even in the first year. When, however, even small quantities of ordinary perennial ryegrass are sown along with it, only a few plants are generally present either in the first or succeeding years. Similiarly, perennial ryegrass has a considerable adverse effect on other grasses like cocksfoot and timothy, both in the hay crop and pasture.

The effect of Italian ryegrass in this connection is interesting. While all grasses affect the growth of red clover in the first year, no grass reduces the amount of this clover so much as Italian, and this reduction of clover reduces the weight of hay produced. The smaller amount of red clover, however, keeps the crop opener, and enables the white clover to establish itself more quickly than where there is more red clover.

In the rotation experiment, in all the plots that had much red clover the white clover was much later in being prominent, and was not nearly so thick as where the amount of red clover was small. Thus in the plot without artificial manure, which produced the poorest barley crop and the poorest hay crop with little red clover, the white clover was first in evidence; in addition the white clover, probably by means of the nitrogen taken from the air, helped the grasses so much that the plot produced almost as heavy a crop of green grass during the next two years as did the completely manured plots. The average weights obtained during the past five years are shown in the following table :—

	Per acre.	
	No manure.	*Complete manure.*
	cwt.	cwt.
Hay	37	51
2nd year's pasture (green weight) ...	134	137
3rd ,, ,, ,, ,, ...	162	165

It is quite possible, of course, that the feeding quality of the produce on the no-manure plot was inferior to that from the manured plots.

Although red clover generally contains more moisture than grasses, and is consequently more difficult to dry in wet seasons, the weight of the hay crop depends largely on the amount present; where there is little red clover the total weight of hay is low, even although the amount of grasses may be somewhat larger.

Red clovers influence the other plants in two different and quite independent ways. On the one hand, they help grasses by the nitrogen they are able to take from the air, and on the other, when present in excess they exert an adverse influence on the grasses and tend to reduce the amount of grasses in the hay.

The effect of large amounts of red clover on the amount of grasses present, and also on the succeeding pasture, has been seen in other cases. For example, in the following trials where different nationalities of red clovers were compared, the seed mixture being otherwise the same, the plots with the largest amount of red clover had the smallest amount of grasses.

	Per acre.		
	Grass.	*Clover.*	*Total.*
	cwt.	cwt.	cwt.
English broad-leaved ...	18·3	26·8	45·1
Canadian do. ...	19·8	14·4	34·2
Chilian do. ...	20·9	13·4	34·3
French do. ...	21·1	11·4	32·5
German do. ...	20·0	12·3	32·3
English late-flowering ...	16·2	35·0	52·1

On the other hand, where the red clover was poor the grasses in the first year were less vigorous, although this allowed the white clover to become established more quickly. In fact, in plots where no red clover was sown there was quite a thick covering of white clover even in the first year. This, again, in its turn helped the grasses at first, but ultimately when allowed to get possession had an adverse influence on them.

It thus seems clear from these practical lessons that, while red clover is desirable in the hay crop, too much is detrimental to the future of the pasture. Too thick a seeding, therefore, especially of the late-flowering type, should not be made. In most cases, 2 lb. broad-leaved and 1½ lb. late-flowering appears to be the amount that gives the most satisfactory result in this part of the country, when the conditions are suitable; but the hay crop should be cut early to avoid depressing unduly the grasses and wild white clover. The bad effect of too late cutting has been observed on several occasions, when the white clover was very slow in becoming established and was very patchy even in the third and fourth year; whereas in the same field where the hay had been cut earlier there was a good thick covering in the second year.

In some seasons there is very growthy weather after the hay crop is cut, and there is consequently a good thick aftermath with much red clover. If this again is late in being eaten, as it sometimes is, it has an adverse effect on the white clover in the following seasons.

White clover in a pasture is very sensitive, like a delicately poised balance. When the conditions suit it, that is when the pasture is kept sufficiently eaten down so that the grasses cannot compete against it, it is apt to get the upper hand and depress the grasses. On the other hand, even although there is a good close sole of white clover, if there is a spell of growthy weather and the grasses are allowed to grow too far before the pasture is eaten, or if nitrogenous manures are used in excess, the clover is in great danger of being smothered and rendered useless for the season.

In a case lately where there was a particularly good sole of white clover, the grasses benefited so much by the nitrogen transmitted to them by the clovers that they took the upper hand, so that the clovers were indirectly responsible for crushing themselves out.

Another point in this connection is that wild white clover enables grasses to form more leaves and retard the time of seeding and so prolong the life of the plants. There is no doubt that, since the use of wild white clover has become universal, perennial ryegrass lasts longer in pastures than it did.

In pasture making, much depends on getting a sole of wild white clover early, and for this reason it would be well to keep the field fairly well eaten down until this clover gets established. If the grass gets the upper hand, however, it will prevent the clover getting started. Once there is a good covering of wild white it would be well not to eat the pasture too bare, for two reasons: (1) the amount of feed will be reduced and in a dry spell growth will be very much slower. In fact some pastures are often spoiled by being eaten too bare too late in the season; (2) the white clover will have a detrimental effect on the grasses by tending to choke them out.

In a good pasture, if the maximum amount of food is expected, there should be a good proportion of both grasses and clovers. It will usually be found that complaints of wild white causing scouring are due to the fact that the proportion in the pasture is too large. There should be little or no scouring where there is a suitable proportion of grasses present.

The effect of the composition of the pasture when ploughed up on the succeeding oat crop is so well known that it need only be mentioned. Where there is a good thick sole of wild white clover both grain and straw are greatly increased, except in cases where the crop is so badly lodged that the grain does not get a chance to mature. The following result was obtained from plots seeded with the same grass seed mixture, but one plot had included ½ lb. wild white and the other 1 lb. ordinary white. In the first plot there was a thick covering of white clover, but in the second it was practically absent.

	Per acre.	
	Grain.	*Straw.*
	cwt.	cwt.
After ordinary white clover ...	19·3	28·1
After wild white clover	24·0	37·8

THE LAND DRAINAGE (SCOTLAND) ACT, 1930.

In consequence of the relatively heavy rainfall that prevails over most of Great Britain, the adequate drainage of land is a matter of the first importance for the agricultural industry. Broadly speaking, it has three aspects—field drainage, the drainage of a countryside by streams of more or less importance, and the drainage of a large basin by one of the principal rivers. The first of these has generally received sufficient attention in Scotland, and in recent years it has been assisted by grants made by the Department of Agriculture. The last does not raise so serious a problem in Scotland as in England and Wales. It has not been found necessary to set up drainage authorities, as in the latter country, to deal with large river basins. Such action as may be necessary with regard to the principal Scottish rivers is contemplated in the new Act, as well as the intermediate stage of drainage.

It is this intermediate stage that mainly calls for attention. There are many cases where, through one cause or another, the flow of streams is interrupted, and areas of agricultural land are periodically flooded. The efforts of farmers to drain their land adequately are often frustrated by the existence of obstacles in the streams or rivers that receive the field drainage. Hitherto the remedies provided by law for this condition of things have been inadequate. The difficulty arising from multiplicity of ownership has in recent years been increased through the breaking up of estates and the purchase of separate farms by their occupiers or by others.

The Land Drainage (Scotland) Act of 1847 provided means whereby a person desiring to improve the drainage of his land might obtain authority from the sheriff to overcome objections made by other persons and to carry out the necessary works on other persons' land as well as on his own. This procedure has, however, proved to be so cumbrous and expensive as to render the Act ineffective. It has therefore been repealed by the Land Drainage (Scotland) Act, 1930, which received Royal Assent on 15th April.

The new Act in its first section gives the owner or occupier of agricultural land recourse to the sheriff in the matter of drainage improvement, but only for the purpose of " maintaining the banks or cleaning or scouring the channel of any watercourse." Any one whose land is injured or is in danger of being injured through the neglect of a neighbouring owner or occupier to carry out these operations may serve a notice on him requiring him to do so. Failing a response within two months, the aggrieved person may apply to the sheriff for a warrant authorising him to cause the operations required to be carried out or to join with any other person in doing so. The sheriff, if satisfied (*a*) that there is actual or probable damage; (*b*) that the person on whom the notice has been served is unreasonably refusing or delaying to take the necessary steps; (*c*) that the cost of the operations is not unreasonable, may ordain the person on whom the notice has been served to carry out the necessary operations within a certain time. Failing this action, he may grant a warrant authorising the carrying out of the operations, and it rests with him to fix the proportions in which the cost shall be borne by the parties concerned.

The sheriff may summon a " person of skill and experience in matters of drainage " to act as assessor with him in his inquiry and to report to him on any matter involved in the application. He further may, and on the application of any party shall, direct that the operations shall be carried out under the supervision of a person similarly qualified. The remuneration of these persons is to be fixed according to rules made by the Court of Session. That of the assessor and reporter is to be treated as expenses in the application (unless the sheriff otherwise directs), while that of the supervisor is to enter into the cost of the operations. The sheriff has power to award expenses to or against any party to the application.

If the sheriff is of opinion that the cost of carrying out the necessary operations is such that it would be unreasonable to make an order under this section of the Act, he may direct that the application be referred to the Department of Agriculture for action under Section 3.

Section 2 gives power to the sheriff to enable an owner or occupier of agricultural land to make underground main drains through another person's land when necessary. Provision is made for due compensation for any loss or damage thus caused, and the maintenance and renewal of the drains rests with the owner of the agricultural land.

Section 3 deals with schemes of drainage works, as distinguished from the minor operations contemplated in the preceding sections. The execution of these works rests with the Department of Agriculture, in cases where they are of opinion "that any agricultural land is capable of improvement by drainage works, or that any land in a landward area is being or is in danger of being injured by flooding, and that such injury can be remedied or prevented by the execution of drainage works either on such land or on any other land."

The Department's first step is to prepare a draft scheme specifying the works proposed to be executed, the area to be affected, the estimated cost, the amount recoverable, and the apportionment of that amount among the lands comprised in the area, and the estimated cost of maintenance, which is also to be apportioned. The estimated cost is to include any compensation that may be payable to persons whose interests are adversely affected by the scheme.

The recoverable part of the cost is to be distributed among the lands concerned in such a way that there shall not be apportioned to any land an amount in excess of the estimated value of the benefit expected to accrue to that land, including any probable increase in its value, any depreciation that might be expected to occur if the works were not undertaken, and any other benefit in the way of relief from expenditure on drainage or otherwise.

The preparation of such a draft scheme will clearly involve a considerable amount of work on the part of the Department. Under Section 4 of the Act the Department may authorise any person to enter on any land for the purpose of inspection, measurement, &c. Notice is then to be given to all persons or bodies affected by the scheme, who are to have due opportunity of lodging objections. The Department, after considering any objections made, will settle the scheme and serve copies on all concerned. The owner or occupiers of any land comprised in the scheme may within one month require that the amount of the estimated cost to be apportioned to his land shall be determined by arbitration. Where any person claims compensation, and the Department does not admit his claim or does not agree as to the amount of compensation, this is to be determined, on the application of either party, by arbitration. In either case the arbitration is to be conducted by a single arbiter nominated by a Lord Ordinary of the Court of Session from the panel appointed by the Reference Committee set up by the Acquisition of Lands (Assessment of Compensation) Act, 1919.

When the claims for compensation have been settled, if the Department propose to proceed with the scheme, it will be laid before both Houses of Parliament for the usual period of 28 days. If during that period no address is presented by either House praying that the scheme be annulled, the Department may proceed with it, and their decision to do so must be intimated to the persons and bodies to whom copies of the scheme were previously sent.

If a scheme becomes void either through Parliamentary action or by a decision of the Department, the latter will have to pay the reasonable expenses incurred by any person in connection with the making of the scheme or with a claim for compensation, the amount to be determined, failing agreement, by arbitration in the manner described above. The amount of the cost recoverable by the Department from the several owners of the land comprised in the area affected will be recovered according to the apportionment made in the scheme. If, however, any owner so requires, the amount recoverable from him may be recovered by means of a rate that will discharge the sum payable, with interest at 5 per cent., in a period of not more than thirty years. This rate is to be payable by the owner and occupier of the land concerned in such proportions as they may agree upon, or as failing such agreement the Department may determine, and it is to be levied by the local rating authority on behalf of the Department as if it were a rate leviable by that authority. The cost of maintenance, so far as it does not exceed the estimated cost specified in the scheme, is to be recoverable from the owners of the land, and this also may be levied and recovered by the local rating authority on behalf of the Department.

In case of the division, after the completion of the scheme, of a piece of land between two or more owners or occupiers, the sum payable in respect of it is to be divided among them in proportion to the gross annual value of the separate parts.

Mention has been made above of claims for compensation for damage or injury caused by the execution or maintenance of drainage works under a scheme. It may, however, happen that the damage or injury caused is such that it could not reasonably have been foreseen when the scheme was framed. It is therefore provided that a claim for compensation may be made at any time within two years of the completion of the scheme.

Sections 7 and 8 require special action to be taken in the case of Crown lands, lands belonging to Government Departments, and land below high-water mark, while Section 9 gives, *inter alia*, comprehensive definitions of " drainage works " and " watercourse."

The power of the Department to prepare and settle schemes is, unless continued by Parliament, to cease on the expiry of five years from the passing of the Act, i.e. on 15th April 1935, but the carrying out of settled schemes is not so limited.

While a proportion of the cost of each scheme carried out by the Department is recoverable, a considerable proportion will fall to be borne by the State. For this purpose a sum of £100,000 is made available.

Several important schemes have already been under consideration by the Department, and these will be taken up in succession. The procedure prescribed by the Act, which is designed fully to safeguard the various interests involved, will cause a considerable interval to elapse between the inception of a scheme and its execution. It is hoped, however, that by the co-operation of all concerned this interval will be reduced to a minimum, and that both the larger schemes to be carried out by the Department and the smaller operations to be authorised by the sheriff will bring to Scottish agriculture the benefits expected to accrue from the Act.

Copies of the Act may be obtained from H.M. Stationery Office, 120 George Street, Edinburgh, either directly or through any bookseller, price 3*d.*, or by post 3½*d.*

Farm Wages in Scotland.

THE Department have as usual issued with their Monthly Reports for 1st January and 1st July supplements giving the wages of various classes of workers at Martinmas 1929 and Whitsunday 1930. This article summarises these statements, and gives a comparison with the wages current at Whitsunday 1929; a similar article appeared in the issue of the JOURNAL for July 1929.

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, 1929.	Martinmas, 1929.	Whitsunday, 1930.
Meal, per cwt.	18*s.*	16*s.*	12*s.* 6*d.*
Milk, per gallon	1*s.*	1*s.*	1*s.*
Potatoes, per ton	£2, 10*s.*	£2	£2
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 cows and followers, per cow, per annum	£12	£12	£12

The fall in the estimated value of a hundredweight of oatmeal would mean, for men getting 65 stone per annum, about 10*d.* per week, while that in the value of potatoes would mean, for men getting a ton a year, about 2*d.* per week. The other items show no change throughout the period.

The arithmetical averages of the Department's figures for the wages of married men are as follows :—

Average Weekly Earnings of Married Men.

	SUMMER, 1929.						WINTER, 1929-30.						SUMMER, 1930.					
	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 ...	29	6	7	9	37	3	29	8	7	5	37	1	29	4	7	3	36	8
Cattlemen ...	30	7	8	3	38	10	30	9	7	9	38	6	31	1	7	6	38	7
Shepherds ...	28	5	10	3	38	8	28	9	10	5	39	2	28	10	9	6	38	4

These averages show a slight fall in ploughmen's wages during the past year, the cash wage being lower by 1*d.* and the value of the allowances by 6*d.* Cattlemen's wages show a decrease of 3*d.*, the cash wage having risen by 6*d.*, while the value of the allowances is less by 9*d.* In the wages of shepherds the tendency has also been to increase the cash wage and reduce the allowances, the former showing an increase of 5*d.* and the latter a decrease of 9*d.*, making the total weekly remuneration less than last year by 4*d.*

The following table gives in round figures the weekly earnings of ordinary married ploughmen in summer 1929 and in summer 1930 in 38 out of the total number of 49 counties and parts of counties included in the Department's statement :—

COUNTY OR DISTRICT.	SUMMER, 1929.			SUMMER, 1930.		
	Cash.	Allowances.	Total.	Cash.	Allowances.	Total.
	s.	*s.*	*s.*	*s.*	*s.*	*s.*
Wigtown	24	14	38	24	14	38
Kirkcudbright	34	4½	38½	32	3½	35½
Dumfries	33	4½	37½	34	3	37
Selkirk	30	6	36	34	4	38
Roxburgh	30	6	36	34	4	38
Berwick	34	4	38	34	4	38
Peebles	34	6	40	34	3	37
East Lothian	34	8	42	34	3	37
Midlothian	34	7½	41½	34	3	37
West Lothian	34	7½	41½	34	3	37
Stirling	40	3	43	39½	6	45½
Dumbarton	39	3½	42½	39½	3	42½
Lanark (N.W.) } Lower Clyde Valley	36	3½	39½	36	3½	39½
Renfrew	36	3½	39½	35	3	38
Ayr (N.)	35	4	39	35	8	43
Ayr (S.)	35	4	39	35½	3½	39
Lanark (S.E.)	36	3½	39½	36	3½	39½
Clackmannan	38	½	38½	38	½	38½
Fife (S.W.)	38	½	38½	38	½	38½
Fife (N.E.)	28	10½	38½	28	9½	37½
Kinross	28½	10	38½	28½	9	37½
Perth (S.E.)	29	11	40	29	10	39
Perth (Central)	28	9½	37½	28½	9	37½
Angus (S.W.)	30	9½	39½	28½	8½	37
Angus (N.E.)	27½	9½	37	26	9½	35½
Kincardine	29	10½	39½	27	9½	36½
Aberdeen (E.)	24½	10½	35	24½	9½	34
Aberdeen (N.E.)	24	10½	34½	23½	10½	34
Aberdeen (Central)	23	9½	32½	23	9½	32½
Aberdeen (S.W.)	24½	10	34½	24½	9½	34
Aberdeen (N.W.)	24	10	34	23½	10½	34
Banff (N.E.)	25	10	35	25	6½	31½
Moray	25½	9	34½	25½	9½	35
Nairn	22½	12	34½	22½	10½	33
Inverness (E.)	22½	12	34½	22½	10½	33
Ross and Cromarty (E.)	24	11½	35½	24	10½	34½
Sutherland	18½	12	30½	18½	13½	32
Caithness	16½	14	30½	16½	14	30½
	s. *d.*	*s.* *d.*	*s.* *d.*	*s.* *d.*	*s.* *d.*	*s.* *d.*
Average	29 8	7 10	37 6	29 9	7 0	36 9

The arithmetical average of the cash wages for these 38 counties or parts of counties is higher than last year by 1*d.*, while the value placed on the allowances is lower by 10*d.*

Most of the districts show no change in the cash wage, but an increase of 4*s*. is recorded in Roxburgh and Selkirk, 1*s*. in Dumfries and 6*d*. in South Ayr, Dumbarton and Central Perth, while a decrease of 2*s*. has taken place in Kincardine, 1*s*. 6*d*. in Angus, 1*s*. in Renfrew and 6*d*. in North-East and North-West Aberdeen and Stirling.

The range of the total wages, including cash and allowances, in the various divisions of the country is as follows:—in the southern counties from 35*s*. 6*d*. to 38*s*.; in the south-eastern counties from 37*s*. to 38*s*.; in the Lower Clyde Valley from 38*s*. to 42*s*. 6*d*.; in the rest of the central area from 35*s*. 6*d*. to 45*s*. 6*d*.; and in the north-eastern and northern counties from 30*s*. 6*d*. to 36*s*. 6*d*.

Single Ploughmen.—The average wage of single ploughmen in the south-eastern counties is 34*s*. 5*d*. per week, or 1*s*. 5*d*. more than last year. In the south-western districts wages vary from 27*s*. 6*d*. in Dumfries to 33*s*. in Kirkcudbright, where there is a reducton of 2*s*. per week, while the other districts show advances of from 10*d*. to 1*s*. 11*d*. In the Lower Clyde Valley and North Ayr the cash wage averages 18*s*. 2*d*., as compared with 18*s*. 9*d*. a year ago, with board and lodging valued at 14*s*. The average cash wage in the east-central division is 26*s*. 9*d*., or 1*s*. 4*d*. less than last year, while the allowances, valued at 6*s*. 5*d*., show a decrease of 4*d*. In the north-eastern and northern counties there is little change, but in Kincardine the total weekly remuneration is lower by 3*s*. 2*d*. In Scotland as a whole a single ploughman's wage is unchanged on the year at 32*s*. 9*d*. (cash 22*s*. 7*d*. and allowances 10*s*. 2*d*.).

Women Workers.—Dairy workers receive cash wages ranging from 9*s*. 3*d*. in Orkney to 19*s*. 3*d*. in South Ayr, with board and lodging valued at 14*s*., while in the Lothians and Peebles a cash wage of from 23*s*. to 24*s*. is paid, with no allowances. Other women's rates, including board and lodging or their equivalent, vary between 20*s*. 5*d*. in Caithness and 30*s*. 11*d*. in South-West Aberdeen; where the whole is paid in cash the wages run from 20*s*. to 24*s*. Women paid by the day generally receive from 3*s*. to 4*s*.; in Wigtown, however, the rates are from 2*s*. to 3*s*. 6*d*., while in Stirling from 3*s*. to 5*s*. is paid and in North-East Angus 4*s*. 6*d*.

Boys.—Where board and lodging are provided the estimated total wage ranges from 19*s*. 1*d*. to 27*s*. 6*d*., according to age and experience. In a few districts where the whole is paid in cash the rates are from 15*s*. to 25*s*.

Girls.—In the Lothians and Peebles girls receive 14*s*. per week, with no allowances. Where board and lodging are provided, the estimated total earnings are considerably higher in some cases, rates varying from 20*s*. 11*d*. in Orkney to 27*s*. 10*d*. in South Ayr and Central Argyll.

Casual Workers.—Men get from 4*s*. to 6*s*. and in some cases up to 8*s*. a day; the weekly rate varies from 27*s*. to 40*s*., and the usual rate per hour is 9*d*. Women are usually paid 3*s*. to 4*s*. a day, or 6*d*. per hour.

Grants for Agricultural Drainage.

SINCE the winter of 1921 funds have been provided annually by Government for the direct assistance of agricultural drainage in Scotland, including field, hill and arterial drainage, together with such incidental operations as the removal of trees, hedges, whins, &c. Until 1926 the schemes for these purposes were administered during the winter and spring of each year primarily for the relief of unemployment. They also included during three of these years assistance for farm water supplies and farm roads. The labour had to be obtained through the Employment Exchanges or, if obtained elsewhere, had to be composed to the extent of 75 per cent. of unemployed ex-service men. The maximum rate of grant payable to applicants whose proposals were approved by the Department was (*a*) one half of the actual cost of the work; (*b*) (in the case of tile drainage) a maximum payment of £10 per acre of land improved; or (*c*) the amount paid in wages to the unemployed men engaged—whichever of these amounts was the least. In the winter of 1925-26 the maximum rate of grant was reduced to 30 per cent. of the cost of the work. No grant was paid until work had been certified as having been completed to the satisfaction of the Department.

In 1926 the Government adopted a scheme for the assistance of agricultural drainage as part of their policy for the development of agriculture. Since that year direct assistance has been given to farmers as in the preceding years with the following important modifications:—

(1) Operations qualifying for grant may be carried out during any part of the year instead of during the winter months as in the relief of unemployment schemes.

(2) Save for the condition that the wages of ordinary farm or estate staff are ineligible to rank for grant, no restriction is imposed in regard to the class of labour employed.

(3) The maximum rate of grant is 33⅓ per cent. of the cost of approved work or, in the case of tile drainage, £6 per acre of land improved. The acreage limitation was removed in the scheme authorised for the current year.

The Department also administered in the year 1929 a further scheme for the relief of unemployment, the object of which was to facilitate the transfer of miners from Lanarkshire, which was certified to be a depressed area. The works eligible for grant included, in addition to drainage, the improvement of farm roads and the provision and improvement of farm water supplies. The rate of grant was the same as applied to the schemes which were in operation during the years 1921 to 1924.

Since 1921 the total expenditure in Scotland on State-aided schemes of land drainage has been approximately £400,000, inclusive of the Government contribution, which amounted to £166,600. This has sufficed to improve some 35,000 acres of arable land and 908,000 acres of hill pasture.

The sum available for the scheme authorised for the current year was £29,950, as compared with £12,325 in 1929 and £13,012 in the preceding year. At 29th March, the closing date, the Department had received applications for grants amounting to £40,215. Particulars are given in the following table of the grants offered up to and including 21st June :—

County.	Grants applied for.		Grants approved.					
			Hill.		Arable.		Total.	
	No.	Amount.	No.	Amount.	No.	Amount.	No.	Amount.
		£ s.		£ s		£ s.		£ s.
Aberdeen ...	40	766 0	1	12 0	35	630 10	36	642 10
Angus	42	1,272 10	15	317 5	14	457 0	29	774 5
Argyll	79	1,893 0	} 50	1,070 10	24	572 0	74	1,642 10
Islay	16	355 0						
Ayr	126	5,546 0	48	1,211 10	61	3,216 10	109	4,428 0
Banff	10	447 0	..	...	9	229 0	9	229 0
Berwick ...	22	499 10	6	93 10	11	233 10	17	327 0
Bute	23	432 0	8	161 0	2	48 0	10	209 0
Caithness ...	127	2,295 10	19	362 0	72	1,237 5	91	1,599 5
Clackmannan	5	325 0	1	10 0	3	314 0	4	324 0
Dumbarton ...	18	630 10	7	280 0	3	127 0	10	407 0
Dumfries ...	145	5,160 0	20	444 0	56	2,821 0	76	3,265 0
East Lothian	5	105 0	3	52 0	1	27 0	4	79 0
Fife	9	771 0	...	...	6	147 10	6	147 10
Inverness ...	43	1,132 0	2	54 0	29	753 10	31	807 10
Kinross ...	4	46 10	1	8 10	3	53 0	4	61 10
Kincardine ...	7	106 0	1	18 10	6	85 10	7	104 0
Kirkcudbright	82	3,139 10	26	693 0	17	705 0	43	1,398 0
Lanark ..	59	2,407 10	22	616 0	32	1,515 0	54	2,131 0
Midlothian ...	14	730 10	5	108 0	9	551 10	14	659 10
Moray ...	11	161 10	1	9 10	10	123 0	11	132 10
Nairn	3	163 0	1	68 0	2	82 10	3	150 10
Orkney ...	8	129 0	...	...	7	98 10	7	98 10
Peebles ...	7	231 0	4	64 10	1	80 0	5	144 10
Perth	78	3,106 10	39	1,092 0	21	962 0	60	2,054 0
Renfrew ...	17	487 10	2	55 0	4	110 0	6	165 0
Ross	49	1,537 0	4	182 10	36	914 10	40	1,097 0
Roxburgh ...	39	1,154 0	24	584 0	12	413 0	36	997 0
Selkirk ...	9	157 0	7	163 0	1	12 0	8	175 0
Shetland ...	10	136 0	4	64 0	6	52 10	10	116 10
Stirling ...	41	1,849 10	16	554 0	10	683 10	26	1,237 10
Sutherland ...	31	1,274 10	12	245 0	8	154 10	20	399 10
Wigtown ...	68	1,777 10	23	595 0	23	666 0	46	1,261 0
Totals ...	1,247	40,215 0	372	9,188 5	534	18,075 15	906	27,264 0

Emigration of Scottish Agricultural Workers.

THE emigration of agricultural workers from Scotland during the years 1921 to 1926 has been dealt with in previous articles in this JOURNAL (July 1925, p. 307, and July 1927, p. 340). The publication of the figures for 1929 enables a survey to be made of another series of three years.[1]

The total gross number of emigrants from Scotland in the years 1927 to 1929 was 124,700, as compared with 125,700

[1] *Board of Trade Journal*, March 20th, 1930; see also the issues of March 22nd and April 19th, 1928, March 7th and 21st, 1929, and March 6th, 1930.

in 1924-26 and 169,900 in 1921-23. The number of immigrants was 28,550, so that the net emigration amounted to 96,150. In the years 1924-26 immigrants numbered 29,850, and the net emigration was 95,850. The figures for the second and third periods are very near to one another. All these figures relate only to persons of British nationality.

The following table gives the numbers for each of the nine years :—

TABLE I.

Year.	*Emigrants.*	*Immigrants.*	*Net Emigration.*
1921	41,400	10,600	30,800
1922	39,900	9,000	30,900
1923	88,600	8,500	80,100
1924	39,150	12,250	26,900
1925	37,900	9,600	28,300
1926	48,650	8,000	40,650
1927	43,500	9,400	34,100
1928	38,300	10,100	28,200
1929	42,900	9,050	33,850
Total ...	420,300	86,500	333,800

The net emigration during these nine years exceeded by about 80,000 that between the Censuses of 1901 and 1911, which was previously the largest recorded for any period of ten years. Apart from the exceptionally high figure of 1923 and the high one of 1926, there is a fairly steady average of 30,000 per annum.

Out of the gross total of 124,700 for the years 1927-29, emigrants over 18 years of age numbered 92,100, of whom 47,700 were men and 44,400 were women. The number of men thus exceeded that of women by about 7 per cent. In the years 1924-26 there was a smaller balance on the other side.

The occupations of the men were as follows :—

TABLE II.

Occupation.	*Number.*	*Per cent.* A.	*Per cent.* B.
Agricultural	8,245	17·3	10·5
Commercial, &c.	6,765	14·2	11·1
Professional	1,360	2·8	2·3
Skilled Trades—			
Mining and Quarrying ...	5,145	10·8	11·5
Metal and Engineering ...	7,080	14·8	23·0
Building	1,190	2·5	4·3
Transport and Communications	2,055	4·3	9·7
Other Skilled Trades	6,085	12·8	
Labourers not in Agriculture or Transport	5,425	11·4	27·6
Others	4,350	9·1	
Total ...	47,700	100·0	100·0

The first column gives the actual number, the second the percentage that that number bears to the total, and the third the percentage that the group in question bore to the whole number of "occupied males" at the time of the Census of 1921, so far as the grouping corresponds.[1] A comparison between percentage A and percentage B shows how far emigration among men of any group was above or below the average. Of the groups for which a comparison can be made, the agricultural, commercial and professional contributed more than their quotas, and the miscellaneous groups, for which no exact comparison can be made, exceeded their collective quota, while the four other groups contributed less than their quotas. In the case of agriculture, the exact quota would have been 5,010, and there was what may be called an excess emigration of 3,235. Both actually and proportionally, this gross number of agricultural emigrants was somewhat less than it was in the years 1924-26.

An analysis of the figures relating to England and Wales shows that, as in the earlier periods, emigration was relatively much less than from Scotland, the total gross number of male emigrants over 18 being 112,230, or about two and a half times the Scottish total, whereas the proportionate number would have been eight times the latter. Out of the English total the agricultural group accounted for 25,130 or 22·4 per cent., and it was again both absolutely and relatively the largest of the groups. Its quota would have been only about 10,000. Thus, while emigration as a whole was on a smaller scale in England and Wales than in Scotland, the number of agricultural emigrants from that country, in relation to the total number of emigrants, was considerably greater than that from Scotland.

Of the Scottish agricultural emigrants 5,570 went to Canada, 1,120 to Australia, 290 to New Zealand, 415 to other parts of the Empire, and 850 to foreign countries. Thus about two-thirds went to Canada, as in the years 1921-23, while in the years 1924-26 the proportion was only one-half.

The number of male immigrants over 18 years of age in agricultural occupations was 1,380, so that the net number of agricultural emigrants was 6,865. Of the immigrants, 620 came from Canada, 595 from other parts of the Empire, and 165 from foreign countries. These figures show little variation from those for the years 1924-26.

The next table shows the gross number of agricultural emigrants for each of the nine years in comparison with the total number of emigrants.

[1] The distribution may have altered during the nine years that have passed since the Census was taken.

[TABLE III.

TABLE III.

Year.		Male Emigrants over 18.	In Agricultural Occupations.	Per cent.
1921	... ...	14,860	2,150	14·6
1922	... ...	17,030	2,200	12·9
1923	... ...	46,250	6,200	13·4
1924	... ...	13,530	2,980	22·0
1925	... ...	12,320	2,065	16·8
1926	... ...	17,880	3,255	18·2
1927	... ...	16,450	3,390	20·6
1928	... ...	15,050	2,670	17·7
1929	... ...	16,200	2,185	13·5
	Total ...	169,570	27,095	16·0

The numbers recorded in the last two years show a progressive diminution, and that for 1929 is the smallest since 1925.

In spite of an emigration averaging 3,000 a year, or (apart from the exceptional year 1923) 2,600, the number of regular male workers on Scottish farms has remained almost unchanged. There has, however, been a change in the age distribution, as is shown in the following table :—

TABLE IV.

Year.		Regular Male Workers. Over 21.	Under 21.	Total.
1921	... ...	58,810	23,290	82,100
1929	... ...	60,600	21,470	82,070
Difference	...	+1,790	-1,820	-30

There appears to have been a diminution in the recruiting of lads for agricultural work, averaging about 225 per annum.

Casual workers show considerable variations from year to year, which are of less significance than the variations in the numbers of regular workers, and it is impossible to say whether or not the supply of such workers has been affected by emigration.

The general conclusion is that in the period 1927-29, as in the periods 1921-23 and 1924-26, Scottish agriculture was depleted by emigration above the average of all industries. The actual numbers of agricultural emigrants was a little less in 1927-29 than in 1924-26, and considerably less than in 1921-23. The proportional excess of agricultural emigrants was less in 1927-29 than in 1924-26, but in both periods it was considerably larger than in 1921-23. The years 1924 and 1927, as will be seen from Table III, show the highest proportions of agricultural workers, while 1929 shows one of the lowest.

THE following article has been contributed by Mr. G. E. Fussell :—

The simple language of the parable of the sower describes better than any modern speech the crop prospects of a farmer who sowed his seed broadcast in poorly tilled land.

Corn-Drilling in the Seventeenth Century.

"Behold a sower went forth to sow; and when he sowed, some *seeds* fell by the way side, and the fowls came and devoured them up; some fell upon stony places, where they had not much earth; and forthwith they sprang up, because they had no deepness of earth; and when the sun was up, they were scorched; and because they had no root, they withered away. And some fell among thorns; and the thorns sprang up and choked them; but other fell into good ground, and brought forth fruit, some a hundredfold, some sixty-fold, some thirtyfold."

And in all the centuries of corn growing before the seventeenth there had been no other method proposed for sowing corn than the broadcast, but the era was then just beginning to dawn in which men would attempt the seemingly impossible task of overcoming the difficulties hitherto regarded as natural, inevitable and unchangeable.

It was not until some two centuries later that the practice of drilling corn had been fully discussed, and even then it was by no means the general practice it is to-day; but it was the uncertainty of the results of the ordinary method, combined with an accident, which first gave birth to the idea that the uneven chance given the seed by hand broadcast sowing, however skilful, might be avoided if some other method were adopted.

By the end of the sixteenth century the English literature of farming was some seventy-five years old. Books had been written on special branches as well as general treatises, but it is not till 1600 that we first hear proposals of "setting" corn. An observant farmer noted the consequences of an accident, due to indolence, and decided to experiment in somewhat the same manner as a modern scientist might.

The occasion, we are told, arose in this way. "Happily some sillie wench, having a fewe cornes of wheate, mixed with some other seed, and being carelesse of the worke shee had in hand, might now and then instead of a Raddish or Carret seede, let falle a wheate corne into the ground, which after branding itselfe into manie eares, and yeelding so great encrease, gave just occasion of some farther triall." [1]

The farther trial must, however, have been a very limited experimental plot, because Sir Hugh says, "to my remembrance, the first man that ever attempted the setting of corne, made the first holes with his finger." It is not unreasonable to learn that "this course being afterwards found to be very long and tedious, an instrument was devised, having many teeth or pinnes,

[1] Sir Hugh Platt. *The newe and admirable Arte of Setting of Corne*, 1601, chap. 1.

like a rake, with a staffe fastened in the middest of the backside thereof, which being thrust into the ground, did at one instant make twelve or twenty holes more or lesse, according to the number of teeth or pinnes therein. Afterwards this toole was also disliked as not making sufficient riddance of ground." [1]

The instrument which was to make the work more speedy does not seem a great advance. It was a setting board, 3 ft. long by 10 or 12 ins. wide, punched at regular intervals with holes, through which a dibber could be pushed to make setting holes in the earth. The dibber had a shoulder 3 ins. from its end to prevent it going any further through the board, thus ensuring an even depth of sowing. The line of sowing was kept by a gardener's line. This must have been really a more laborious method than the rake-like tool, because the man had to kneel on the board to use his dibble.

Platt hesitates to recommend the depth and distance apart of the sowing; he has only heard it said that 3 inches deep and 3 inches apart had resulted in a yield of 30 bushels an acre, or about twice the existing average.[2]

Exaggeration in the "vulgarisation" of scientific results is not, however, solely a modern vice, and another writer did not hesitate to promise more certain and adequate results for their trouble to those who would adopt the new system. He supports his statements by an interesting set of imaginary accounts, in which the charges recorded for the normal farming processes are nevertheless probably an accurate reflection of the costs usually incurred in producing wheat at the time. In giving a comparison of the results of the two methods of sowing he says :—

> "The land, according to the use of the common fields, doth lie sommer fallow the first yeare, and beareth corne the other, and so the Farmer payeth two yeares rent before hee hath his crop, which rent cometh to thirtie shillings." [3]

For three acres ploughing and sowing.

Rent	30/-
Ploughing four times, at 2*s.* an acre	24/-
Dunging at 12/14 loads an acre, 6*d.* a load ...	20/-
Seed 2½ bushels wheat or rye an acre, at 4*s.* a bushel	30/-
Weeding, reaping and other charges for 2 years ...	10/-
Total	114/-
Usual increase 2 qrs. an acre, but he allows 2½ at 4*s.* 32*s.* qr. = £12 ...	240/-
Profit, £6, 6*s.* ...	126/-
Per acre	42/-

One acre plow and set.

Rent	10/-
Five plowings	10/-
40 loads dung	20/-
½ bushel seed	2/-
Setting :—	
1 man at 8*d.* a day ; 4 people at 4*d.* for 6 days	12/-
Seeding, &c.	3/4
Total	57/4
Seven or eight qrs. produce at 4*s.* a bushel = £12, 16*s.*	256/-
Balance	£9, 18*s.*
or 5 qrs. at 4*s.* = Balance £5, 2*s.* 8*d.* (to give a lower estimate).	

[1] Ibid., chap. 4. [2] Ibid., chap. 5.
[3] Ed. Maxey. *A New Instruction of Plowing and Setting of Corne*, 1601, D. 3, E. 2 ff.

How far the farmers were convinced of the veracity of this new gospel, or how many tried it, it is now impossible to say, but it is improbable that many were so far beguiled by the alluring prospects held out by Maxey. The matter certainly seems to have been somewhat in abeyance, even in theory, for about thirty years. The next we hear of it is that a patent was taken out by Otwell Worsley in 1637 for a method of setting carrots,[1] and for instruments for mechanical sowing by Ramsey in 1634 and Plattes in 1639.[2]

Fortunately Plattes was articulate, and has given us a more detailed account of his implement than is likely to have been contained in one of the vague patent specifications of that date. Unfortunately he was a little too articulate, and his descriptive matter is too verbose for full quotation, but it was his desire to remedy the costly and inconvenient character of the operation of setting. In his opinion, as is perhaps natural, there was no way to do this " but my two new Inventions or Engines; the first remedieth the great charge and labour of workemen; for by this invention two men, or boys, may set an acre upon a day; whereas before fourtie persons were little enough to do it."

" And the other Engine doth afterwards lay the land in little furrows or ridges, just upon the top of the rowes of corne; so that all other inconveniences are remedied." [3] It is not sufficient to dismiss this machine as one designed " to punch holes in the ground as it went along." [4] It was far more than that, as Plattes' own description shows. It was intended to feed the seed as it went along, and for that purpose had a hopper " ledged about with large ledges to keep the corne from spilling."

It is unlikely that this idea was ever translated into being. Hartlib, mentioning the extravagant rewards offered by such theorists, says that Plattes offered a hundred to one increase. He does not think this possible, and says also, " neither can I recommend M. Gab. Plattes' setting Instrument, for I know there are many difficulties in it, which he himselfe could never wade through." [5]

Another well-known contemporary held the same view. He says: " Mr. Gabriel Plattes' discovery of hidden Treasure is very ingenuous, and could'st thou but fathome his corne-setting Engine, and cleare it to thine own and others apprehensions, it would be of excellent use without question." [6] Blith also mentions a book which does not seem to be any longer extant, " New Inventions for the Improving Lands. Printed for J. S. and sold at the signe of the Ball on Adling Hill, 1646," which described various implements, apparently newly invented, amongst which was a Seed-Barrow. This Blith thinks " might

[1] *Patent Specification*, No. 115.
[2] Ernle, *English Farming Past and Present*, 1912, p. 104.
[3] Gabriel Plattes, *A Discovery of Infinite Treasure*, 1639, p. 50.
[4] Ernle, op. cit., 1912, p. 171.
[5] S. Hartlib, *Legacie*, 1651, p. 8.
[6] Walter Blith, *The English Improver Improved*, 1652. *Address to the Industrious Reader.*

be of some good use, because certainely setting Corne, could it be done with speed and at a certaine depth, and well covered, would be worth discovering, but of this I have as little hope and as low an esteeme as of his other aforesaid Instruments." [1] This seed-barrow only purposed to set one row, and Blith thought hand setting would be quicker.

These criticisms of Plattes' invention were not supported by John Worlidge, whose book was first published some thirty years later (1669), nor by an anonymous author of 1716. The former says he has given Plattes' description of his drill verbatim, "lest any mistake might be imputed to the Relater. To ingenious men it is plain enough, but to others, this and every-thing else besides the plain Dunstable-road is intricate"; [2] the latter quotes Worlidge,[3] but we may perhaps regard Worlidge as a special pleader because he had himself designed a drill. After quoting the normal practice of setting pease, and exclaiming that he himself has set pease "as, beans in a double row at a good distance, with admirable success" (the same method is used at this day about Godalming in Surrey), he goes on to say: "I shall give here a plain and perfect discription of an easy and feasible Instrument that shall disperse your Corn, Grain, or Pulse, of what kind soever, at what distance, and in what proportion you please to design, and that with very great Expedition, and very little extraordinary charge, expense or hazard." [4] The inventor of this implement was certainly modern in his ideas, because he suggested that it was also possible to spread manure with it at the same time.

"By the use of this Instrument," he says, "also may you cover your Grain or Pulse with any rich compost you may prepare for that purpose, either with pigeon-dung, dry or granulated, or any other Saline or Lixivial Substance, made dispersal, which may drop after the corn, and prove an excellent Improvement"; this was to be done either by an extra hopper on the same carriage, or by another drill following immediately behind the seed drill.

But alas for the vanity of human aspirations! Worlidge was able to describe the making of his drill in words and even to give his readers a drawing; when, however, Professor Bradley tried to follow the verbal directions and sketch in building such a machine in 1727, he found it would not work.[5]

While, therefore, the idea of a seed drill seems to have been in the minds of a number of men in the seventeenth century, it was not till the eighteenth that a machine which would do the work was actually built by Jethro Tull, and it seems to have been established that Tull worked out his idea individually, because he was no reader, and therefore owed nothing to those who had toyed with the idea before him.[6]

[1] Ibid. p. 12. [2] *Systema Agriculturæ*, 1697, pp. 47 ff.

[3] *A Complete System of Husbandry and Gardening*, 1716, p. 76 ff.

[4] Op. cit. [5] Ernle, op. cit.

[6] T. H. Marshall, *Jethro Tull and the "New Husbandry" in the Eighteenth Century*. *Econ. Hist. Rev.*, vol. ii, pt. i (1929), p. 1 ff.

Research.

The Hannah Dairy Research Institute.—The First Annual Report of the Hannah Dairy Research Institute, as is fitting, puts upon record the story of its foundation and the reasons which moved the Development Commission to agree to the establishment of a second Institute for Research in Dairying, the first having previously been set up at Reading in accordance with the original scheme of the Commissioners drawn up in 1911. The chief reasons were the importance of the dairying industry in south-west Scotland, the range of varied and complicated problems associated with the production and handling of milk, and the further problems involved in butter and cheese making and the disposal of byeproducts. Most of these problems have a distinctive Scottish aspect, and the Commissioners recognised that it is beyond the resources of a single Institute to undertake research in all the subjects on which the dairymen of the country require scientific assistance.

A Joint Committee of Management was formed in 1927 under the authority of the Secretary of State for Scotland. The Committee contains three representatives of Glasgow University and three of the West of Scotland Agricultural College, along with two nominees of the Secretary of State. Sir Donald Macalister is chairman.

By agreement with the West of Scotland College and with the sanction of the Department of Agriculture for Scotland, the Institute has obtained possession of the farm of Kirkhill, close to the College estate of Auchincruive, and there the Institute and outbuildings are to be erected. This will allow the Institute and the College to collaborate in research, experimental and demonstrational work.

Meantime the work of the staff has been carried on partly in the Physiology Department of Glasgow University, partly in the Royal Technical College, and partly in temporary premises in Ayr.

The report contains reproductions of the plans of the Institute and site, and photographs of the existing buildings.

In spite of the difficulties under which the small staff so far appointed has been working, the report shows a very satisfactory record of research accomplished.

Investigations have been commenced to indicate the relationship of (*a*) quantity and (*b*) quality of food proteins to the maintenance and production requirements of lactating animals.

A study is being made of the genetic construction of the Ayrshire breed of dairy cows, and this is to be extended to the inheritance of productive qualities—milk yield and quality of milk.

With a view to ascertaining the extent and causes of the infection of tuberculosis-free herds, a survey has been made of all the tuberculin-tested herds in Scotland; and data have been collected which indicate the means by which such infection can be obviated. This will be reported upon in due course.

In order to obtain definite information on the possibility and the expense of eradicating tuberculosis from dairy herds on a comprehensive scale, an experimental scheme has been initiated in a restricted area in the south-west of Scotland. The scheme is based on isolation methods, and the work undertaken by the Institute is mainly the free tuberculin-testing of all animals in the area by the double intra-dermal method; supervision of the isolation of reactors and of the rearing of young stock; and the testing of the milk supply of the area for the presence of tubercle bacilli, both before and after eradication. Good progress has already been made.

In connection with the utilisation of milk residues, a comprehensive survey has been made of the existing conditions and of the literature relating to the chemical, bacteriological and engineering aspects of milk drying and condensing; and an experimental investigation is being conducted in the Royal Technical College on the spray process of milk drying.

The report concludes with an appeal to the milk industry in Scotland for financial support, and in view of the importance of the milk trade, both commercially and from the public health point of view, it is to be hoped that this appeal will meet with a generous response.

Reviews.

Report of Empire Marketing Board, May 1929 *to May* 1930. *E.M.B.* 28. H.M. Stationery Office, 1*s*.—The purpose of the Empire Marketing Board is stated to be "to improve the quality and increase the quantity of Empire products marketed in the United Kingdom, and to make Empire buying a national habit."

To achieve these ends many lines of action are being followed, and this report gives a full account of the activities pursued in the year under review. Commercial propaganda and scientific research have both been called into service.

In the former case seven methods of publicity have been employed :—

(*a*) Advertising of Empire products (including home agricultural produce) in general and trade papers.

(*b*) Display of coloured posters on special frames in 450 towns in the United Kingdom; smaller posters with descriptive leaflets being circulated to 20,000 schools.

(*c*) Issue of two million leaflets and recipes.

(*d*) Lectures to audiences totalling 500,000 people.

(*e*) Broadcast talks to housewives.

(*f*) Displays of Empire goods at exhibitions and "shopping weeks," and a special six months' series of Empire produce displays in shop premises in Glasgow.

(*g*) Cinema films.

In the same direction the Board has actively assisted the Ministry of Agriculture and Fisheries and the Department of

Agriculture for Scotland in their schemes for improving the marketing of home produce, notably the use of the National Mark for eggs, beef, wheat flour, malt products, apples and pears, tomatoes and broccoli. Weekly Intelligence Notes are issued regularly concerning (*a*) shipments of fruit and fruit crop prospects; (*b*) supplies of dairy produce, with reports on conditions and on prices, and (*c*) statistics relating to raisins and currants.

Surveys have been made of the world position as regards production and consumption of oranges and of cocoa, and further work of this nature in relation to wool, beef and other commodities is either in progress or in contemplation.

The greater part of the report is taken up with accounts of research work which has been financed by grants from the Board. The provision made for this expenditure in 1929-30 was £482,000, and this was allocated in the United Kingdom, in each of the Dominions, and in numerous Colonies. The subjects dealt with are bewildering in their variety, but in all of them the Board have kept clearly in view their aim to improve the quality and increase the quantity of Empire produce. One excellent feature of the Board's activities on this side is the manner in which they have set themselves to encourage co-operation among investigators interested in similar problems in different parts of the Empire. Several problems are being tackled by teams of workers scattered through the Empire, but kept closely in touch with one another. A notable example of this is the work on pastures shared in by workers in Scotland, England, Wales, Africa, Australia, New Zealand and the Falkland Islands.

Another interesting and useful co-ordination of effort is that concerned with the finding, breeding and distribution of beneficial parasites. The centre of the work is at the Laboratory, Farnham Royal, England, but its ramifications extend to Canada, Australia, South Africa, New Zealand, India, West Indies and the Falkland Islands, and relate to the breeding and distribution of parasites attacking slugs, moths and flies, which themselves are harmful to growing timber trees, or fruit trees, or greenhouse crops, or to sheep.

It is not possible to classify in even a general way the many and various kinds of scientific research which the Empire Marketing Board have so wisely and beneficently assisted, but it can be said confidently that so much genuine effort to advance knowledge and to control natural agencies in the service of mankind is bound to meet with reward.

And certainly the friendly relations promoted among workers throughout the Empire cannot but tend to strengthen the bonds between the mother country and her daughter nations overseas.

A Text Book of Dairy Chemistry, by Edgar R. Ling, M.Sc. (Chapman & Hall, 1930, pp. 200, 6*s*. net.)—The question as to what is the most suitable course in chemistry for dairying students is one which is not easily answered, but it can be said at present that the training provided is far from satisfactory.

Too much time is spent on methods of chemical analysis, especially those methods which are used for the detection of adulteration of dairy produce; this aspect of the subject should be left to the professional analytical chemist.

For those who aspire to become managers of creameries or teachers the time would be much better spent in gaining a knowledge of chemistry and bacteriology.

Mr. Ling's book follows conventional lines; the theoretical part deals with the composition of milk and its by-products, while the analytical methods by which the addition of water to milk can sometimes be inferred are treated in considerable detail. The student who has an adequate training in organic chemistry will find this section rather unnecessary, while to those who know little or no chemistry it will be largely incomprehensible. The second or practical part of the book describes the analytical methods used in the examination of milk and its products.

The information given by Mr. Ling is clearly set out and is thoroughly up to date. The section dealing with the variation in the composition of milk is useful and the directions for the sampling of milk are most helpful.

A satisfactory feature of the book is the references given at the end of each chapter to original papers.

Teinds and Agriculture: An Historical Survey. By Alexander A. Cormack, M.A., D.Litt. Oxford University Press.—Former treatises upon this vexed and complicated subject were written by lawyers for lawyers. The present volume is intended to be of use to landowners, clergymen, and agents dealing with teinds in the course of business. At the same time it contains much curious and recondite information which is not without interest to the general reader.

Teinds, like tithes in England, are defined to be one-tenth part of fruits and profits justly acquired, owed to God in recognition of his supreme dominion over man, and to be paid to the ministers of His church. Their origin is traced to very ancient times and to the practice of primitive tribes of making provision for the due recognition of religion and for the maintenance of its priests. The practice is illustrated by references to Buddhist, Greek and Roman literature. Among the Hebrews the tithe was in use in the time of Abraham. The early Christians made offerings voluntarily towards the maintenance of their teachers and priests and the relief of the poor, and these offerings gradually came to be stabilised at one-tenth of a man's income.

When Christianity came to England the payment of tithes was a recognised part of canonical law, but in practice the payment was not levied on profits of industry on account of the impossibility of assessment, and was confined to the produce of land and certain fishings. In this form the practice was introduced into Scotland in the eleventh century when under Malcolm Canmore and Queen Margaret the Roman Catholic Church was set up under their patronage.

In theory, the purpose of teinds was threefold—to maintain priests, to provide church buildings, and to relieve the poor, all within the area from which the teinds were collected. But inasmuch as the Roman Church spread throughout Scotland largely through its monasteries and bishoprics, the teinds were in great part appropriated to these central organisations and the local clergy were paid comparatively meagre salaries by the teind-holders. For convenience of collection the teinds were frequently leased to laymen, who drew the teind-sheaves on the corn field and remitted an agreed payment in victual to the holder.

At the Reformation the rights to teinds formerly vested in the Roman Church were leased to or appropriated by powerful laymen, and in spite of claims made by John Knox and others it was not until some time after that the obligation was recognised to pay stipends to the Reformed clergy.

An Act of Charles I in 1633 ordered the valuation of teinds and their compulsory sale to the heritors owning the lands from which they were drawn. The valuation was fixed at one-fifth of the rental and the sale enforced at nine years' purchase of the valued teinds. The process of valuation and sale was, however, slow, and continued throughout the seventeenth and eighteenth centuries.

The Act of 1925 was intended to transform the variable burden of teinds into a fixed land charge, the only parties to which will be eventually the landowners and the trustees of the Church of Scotland.

All this and much more of useful information about teinds will be found in Mr. Cormack's treatise, which gives evidence of wide reading and diligent searching among mediæval and later documents.

The Journal of the National Institute of Agricultural Botany. Vol. II, No. 3, 1930.—The present issue of the Journal of the National Institute of Agricultural Botany contains three reports which the Director regards as of particular note. These are upon Trials of Spring Sown Barleys, of Spring Sown Oats, and of Maincrop Potatoes. The reports mark the end of trials conducted over a series of years, and may therefore be regarded as warranting the drawing of definite deductions.

Nine varieties of barley were under trial, and of these Plumage-Archer 1924 and Spratt-Archer are definitely indicated as the two varieties giving the highest average returns per acre to the farmer. On lighter soils Spratt-Archer is more suitable, and on heavier soils Plumage-Archer.

It is pointed out that there is probably no other single factor more clearly indicative of the quality of barley than the nitrogen content of its grain. When this is high the grain is invariably of low malting quality. On this basis Plumage-Archer, Archer-Goldthorpe, and Spratt-Archer are placed in that order of high quality.

The Oat-Trials report refers to the years 1925, 1926, 1927 and 1928. Three varieties were tested throughout, viz. Abundance (as control), Victory and Golden Rain. Other varieties included for two or more seasons were Black Tartarian, Thousand Dollar, A. 88, Black Potato and White Cross—the last three being new varieties. The general conclusion come to is that in any district of the midland, southern and eastern counties of England where the soil and climatic conditions are similar to those of the trial stations farmers are advised to grow Victory or Golden Rain, but if their land is rich and lodging is likely to occur they should try Thousand Dollar. Abundance can be relied on to yield a respectable crop of excellent quality over a wide range of soils.

In regard to Potatoes it is pointed out that all that trials can do is to direct the attention of the practical man to certain varieties which on the average are meritorious, and to certain others which under normal conditions cannot be expected to give a satisfactory return. There can obviously be no "best" variety that will suit all conditions of soil, season and culture.

So far as yield is concerned the varieties tested arrange themselves in the following order :—

Kerr's Pink, Banner, Majestic;
Up to Date, Field Marshal;
Rhoderic Dhu, Arran Consul, Ally;
Tinwald Perfection;
Arran Chief, King Edward;
Bishop, Golden Wonder.

In respect of quality, "Golden Wonder is the best quality potato known."

Descriptions are given of each variety.

Perhaps the most interesting feature of the Journal is a report on the Cereal Crops in Essex, 1927-28. This is said not so much because of the actual returns here published, but because of the method of obtaining these and the intention with which they are collected. The object is to work out the most remunerative varieties of cereals grown in the county, and the returns are made voluntarily to the secretary of the Essex County Farmers' Union, but are examined and arranged by the staff of the National Institute. It is obvious that the value of the returns depends on their character. They must be numerous, representative and accurate; but given these qualities the resultant conclusions should be useful and instructive to all farmers in the county, and the scheme might well be tried in other districts. Thus such points are brought out as that Victor and the Yeomans are the best wheats for Essex, and that early sowing is profitable.

Other reports in the Journal deal with the Lord Derby Gold Medal Potato Trials, 1929; the Potato Synonym Committee's decisions, 1929; the activities of the Official Seed Testing Station for England and Wales, 1929; and the General Meeting of the Institute.

Scheme for the Inspection of Growing Crops of Potatoes.

THE Department's scheme for the inspection of growing crops of potatoes was inaugurated in 1918 for the purpose of ensuring that there would be an adequate supply of pure seed potatoes for areas infected with Wart Disease. Accordingly in the early years the scheme was confined to the inspection and certification of stocks of the varieties that were known to be immune from Wart Disease. In 1922, however, it was decided, in view of representations made by farmers and potato merchants to extend the scheme to include all varieties, immune and non-immune. Certificates are issued in respect of crops that attain to a standard of purity of 99·5 per cent. With regard to crops that do not qualify for such a certificate, reports are issued stating within definite limits the respective standards of purity. These certificates and reports are designed to be of assistance to growers in complying with the requirements of the Seeds Act and Regulations, which prescribe that seed potatoes sold without qualification under the name of a particular variety must be true to that name to the extent of at least 97 per cent. The scheme is also of advantage to growers in view of the provisions of the Wart Disease of Potatoes Order of 1923 of the Ministry of Agriculture and Fisheries whereby the importation of potatoes into England and Wales, under certain circumstances, is prohibited unless they have been inspected by an officer of the Department.

The acreages inspected and certified under the different grades of purity in each of the last six years are shown below :—

I.—*Immune Varieties.*

	Percentage of purity. 99·5 % and above.	Below 99·5 % to 97 %.	Below 97 %.	*Totals.*
	acres.	acres.	acres.	acres.
1924	15,349	2,662	1,262	19,273
1925	20,255	3,310	1,738	25,303
1926	21,098	3,199	1,502	25,799
1927	27,756	3,963	1,494	33,214
1928	29,465	3,364	1,139	33,968
1929	30,319	3,513	715	34,548

II.—*Non-Immune Varieties.*

1924	12,764	6,570	3,139	22,473
1925	15,315	5,153	3,598	24,066
1926	21,057	3,919	2,083	27,059
1927	24,367	3,722	1,599	29,688
1928	18,659	1,888	833	21,380
1929	23,209	1,476	568	25,253

It will be noted that there has been a general increase in the acreages inspected, especially of the immune varieties.

The scheme also provides for the issue of special stock seed reports to owners of potato crops that are found after repeated inspections to be of an exceptionally high standard both as regards purity and freedom from disease. In 1929, 144 such reports were issued in respect of 174 potato crops, consisting of 17 immune varieties and 5 non-immune varieties.

For some time past the Department have had under consideration the extension of the scheme so as to include the inspection of potatoes for health as well as for purity. The various agricultural bodies and others interested have been consulted regarding the proposal, and while it is generally agreed that such an extension is desirable it is felt that further information regarding incidence of diseases should be obtained before the scheme is put into operation. For the purpose of collecting this information the Department are carrying out trial inspections in the different potato growing districts in Scotland this year.

Inspection and Certification of Varieties of Raspberry and Black Currant Plants.

In view of representations by the Scottish Horticultural Advisory Committee and interested growers the Department of Agriculture for Scotland have introduced a scheme for the inspection and certification of raspberry plants grown in Scotland and intended for sale. Stocks will be certified if found to be true to type and apparently vigorous and healthy at the time of the inspection.

During 1930 inspections will be confined to the following varieties of raspberry :—Burnett Holm Seedling, Devon, Lloyd George, Mitchell's Seedling and Pyne's Royal, and will be limited to plants not more than three years old.

The fees payable are on a sliding scale with a minimum of £1, 10*s*. for any number of plants not exceeding 5,000, rising to £3, 15*s*. for 40,000 plants, plus an additional 15*s*. for every 25,000 or part of 25,000 plants in excess of 40,000. Copies of the certificates issued may be obtained by certificate holders at a charge of 3*d*. per copy.

At the close of the inspection season a list will be issued giving the names and addresses of growers whose stocks have been inspected and certified under the scheme.

For the purposes of this scheme and that for the certification of black currants which was initiated last year the Department have established at East Craigs, Corstorphine, a reference collection of the varieties of raspberry and black currant plants grown commercially in Scotland.

Research Fellowships in South Africa.

APPLICATIONS are invited for three Research Fellowships tenable at the Onderstepoort Veterinary Research Laboratory, Pretoria. These Fellowships have been established by the Empire Marketing Board in conjunction with the Government of the Union of South Africa.

Candidates will be required in each case to furnish proof that they are familiar with particular aspects of research, namely :—

(1) *First Fellowship,* methods of tissue culture and work with filterable viruses;

(2) *Second Fellowship,* bacteriological work and the physiology of animals, especially ruminants;

(3) *Third Fellowship,* methods of extracting toxic substances from plants and determining the nature of such substances.

Selection will be made by a Committee consisting of the President of the Royal Society, the High Commissioner for the Union of South Africa in London, the Chairman of the Research Grants Committee of the Empire Marketing Board and the Director of the Imperial Bureau of Animal Health.

The Fellowships will be tenable for a period of three years, with the possibility of renewal for a further period of two years. Remuneration will normally be at a rate not less than £800 and not more than £1,000 per annum, but special consideration may be given to candidates whose qualifications and other circumstances warrant a higher rate.

Each successful candidate will be provided with a free passage for himself and his family from his place of residence to Pretoria. Duties should commence as early as possible.

During the tenure of the Fellowship the holder will be responsible to the Director of the Onderstepoort Laboratory.

Applications should be addressed to the Secretary, Empire Marketing Board, 2 Queen Anne's Gate Buildings, London, S.W.1 (cables "Empmart, London"), and should be received not later than the 1st September 1930.

Applications should be accompanied by six typed copies each of three testimonials and references to any published work.

Agricultural Conditions.

THE weather at the beginning of March was generally open and seasonable, but towards the middle of the month ploughing and sowing were interrupted in several areas by severe frost and heavy falls of snow. Conditions improved during the last week in March, and by the end of the month good progress had been made in most districts in overtaking the arrears of work that had accumulated. Over the greater part of the country the rainfall was unusually light throughout March, except in Skye and Lewis, where rain was frequent. The reports on weather conditions during April showed considerable variation. In Shetland and the north-eastern districts cold wet weather prevailed throughout the greater part of the month, causing work generally to fall into arrear. Cold dry conditions prevailed in the south-west and in most of the western areas; the growth of pastures was checked by the low temperatures, but outdoor work made good progress in these districts. In the eastern and south-eastern districts the weather was, on the whole, more favourable. The weather during May was mainly dry in most areas and was generally favourable for all kinds of farm work and for live stock. During the first fortnight of the month, however, a considerable amount of rain fell in Caithness, some parts of Aberdeen, Harris, Uist and Skye. The progress of the crops was generally satisfactory in many districts, but growth was retarded to some extent by the comparatively small rainfall and low temperatures.

At the end of May wheat was reported to be healthy and vigorous in most districts. In South-East Perth, however, many fields have been badly thinned by wireworm, and in a few areas the crop is patchy and thin in places. According to the estimates furnished by the Department's Crop Reporters, a further diminution in the area under wheat has taken place this year.

Barley is reported to be healthy and vigorous in practically every district. Charlock is unusually prevalent in Berwick, and in many districts the plants are rather backward. The estimates of acreage indicate that the area under barley will be practically the same as that of last year in most areas.

The sowing of oats was generally completed before the beginning of May. Up to the beginning of June the crop had not been attacked by grub to the same extent as last year. On the whole the condition of the crop is fairly good, but in parts of South-East Perth many fields have been practically ruined by wire-worm, while much damage by grub is reported from Berwick, Caithness and Sutherland. Charlock is prevalent in Berwick and in some parts of Dumfries. According to the estimates received the acreage under oats will probably prove to be smaller than in 1929.

At the beginning of June beans were reported to be healthy and vigorous in all districts. Ryegrass and clover seeds are, on the whole, satisfactory, but owing to the low rainfall in May p'ants are somewhat thin in some districts and growth has been below the normal in North-East Aberdeen, North and East Perth, North-East Fife, Harris, Uist and North Ayr. Clover is fairly abundant in some areas, but in South-East Perth and Sutherland it is rather scarcer than usual.

The planting of potatoes was almost completed in many districts before the end of April, and before the end of May the work was finished in practically every district in very favourable conditions as regards both soil and weather. From the estimates furnished by the Department's Reporters, it would appear that the total area under potatoes will prove to be considerably less than last year. The greatest decrease is indicated in South-West Aberdeen, where the area is estimated to be less than in 1929 by 20 per cent., while in Roxburgh, Selkirk and Dumfries the decrease is estimated at from 10 to 15 per cent. In most districts the sowing of swedes and mangolds was practically completed by the end of May. The sowing of yellow turnips was, however, much less advanced, and had not then commenced in Caithness. Owing to the exceptionally dry weather re-sowing was necessary in some districts. The reports received regarding sugar beet indicate a slight increase in acreage as compared with last year, especially in Central Perth and North-East Fife.

Fruit trees have, on the whole, done well so far, and the crop prospects are good in most of the fruit-growing districts.

Pastures are in good condition in most districts, but in some of the higher areas the grass is backward. Grazing cattle made normal progress during May; dairy cows are in good condition, and in practically every district the milk yield is reported to be that of a normal season. Sheep on arable farms have thriven satisfactorily in most districts. Hill sheep have made good progress on the whole, but in Dumbarton the effects of a backward lambing season are still evident.

The fall of lambs has been satisfactory in most districts, and in a few cases the yield has been above the average. In some midland areas and in Central Aberdeen a number of deaths from "wool ball" are reported, and in Kincardine, North and East Perth, Harris and Uist, where ewes have been short of milk, a number of casualties have been recorded. A shortage of twins is reported in Dumbarton and Kirkcudbright. The fall of lambs in North Argyll is estimated to be 20 per cent. below the average.

At the beginning of June the supply of regular labour was reported to be generally sufficient for the needs of the season. In Dumbarton, however, there is a shortage of experienced dairy workers, while in Renfrew the supply of women workers and milkers is not equal to the demand.

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, Department of Agriculture, York Buildings, Edinburgh.

CROPS AND SEEDS.

Experiments to test the Yield and other Properties of various Species and Strains of Herbage Plants under different Methods of Management. *By R. G. Stapledon, M.A., and William Davies, M.Sc., Welsh Plant Breeding Station, Bul. series H, No.* 10.—The trials reported upon included 22 species and strains of grasses and clovers and two mixtures. No manures of any sort were applied after the seeding year.

The indigenous strains outyielded the commercial in all harvest years subsequent to the first. Perennial ryegrass was the only species that showed a slight advantage in favour of commercial. Outstanding results from the present trials have been the high place taken by the indigenous strains of timothy, tall fescue and meadow foxtail. Indigenous tall fescue gave by far the heaviest yield and the greatest amount of leaf for the four years. Timothy, unlike tall fescue, is one of the species most palatable to sheep, and the high leaf yield of the indigenous strain marked it as an exceptionally valuable grass. Indigenous meadow foxtail was noted for its excessive leafiness.

In comparing top grasses with bottom grasses the larger top grasses substantially outyielded the bottom grasses, but the advantage was not markedly in favour of the former species. The value of crested dogstail is apt to be underestimated on account of the excessiveness of its stem production, but under constant cutting it rapidly develops an increasingly leafy habit. In pastures where there is an excess of crested dogstail inflorescences, judicious resort to the mowing machine should be made.

Rough stalk meadow grass and red fescue were seen to develop the greatest number of tillers. Perennial ryegrass came next in the scale of tiller production with an average figure twice as great as that of meadow foxtail. The ryegrasses were closely followed by indigenous timothy and sweet vernal. The average figures showed that the commercial strains of the chief grasses were altogether lower in average tiller production than were the indigenous.

On the aggregate of the "pasture" yields for the four harvest years the indigenous strains surpassed the non-indigenous by 16 per cent. and in leaf yield by as much as 25 per cent. Further evidence was obtained as to the shortness of the active growing season, over 70 per cent. of the "pasture" produce from the grasses being developed in May and June. Even under a system of fairly drastic cutting the tendency of all species and strains was to produce a hay crop in miniature during the hay season. Perennial ryegrass and crested dogstail both suffered from the defect of producing too high a proportion of stem shoots. Generally the species and strains which give the heaviest hay yields are those which also show the highest proportion of stem shoots to leaf shoots.

Studies on Methods for Control of Pollination in Sugar Beets. *By E. M. Down and C. A. Lavis. Jour. Amer. Soc. Agron., Vol. 22, No. 1, January* 1930.—The authors review experiments conducted at the Michigan Experiment Station to control pollination in the production of close-fertilised sugar beet seed. Three methods of controlling pollination were studied, viz. :—

(1) Space isolation of individual mother beets.
(2) Enclosing mother beets within cloth cages.
(3) Covering individual seed stalks with vegetable parchment bags.

The following results were obtained :—Seed was secured from space-isolated mother beets. Seed was also obtained from the plants grown under cloth cages, but it is concluded that 82 per cent. of the viable seed had resulted from cross-fertilisation. No seed was produced on bagged seed stalks, and lack of success might possibly be attributed to the extremely high temperatures which prevailed during the flowering period. Successful production of close-fertilised sugar-beet seed within parchment paper bags has been reported by other workers.

Report on Enquiry in Europe regarding the Feasibility of using Protein Content as a Factor in Grading and Marketing Canadian Wheat. *R. Newton, Ottawa*, 1930.—This report was prepared for the National Research Council.

European milling chemists in general make physical rather than chemical tests on flour quality, and discount the value of the protein test because it indicates quantity rather than quality.

Loaf volume is not accorded by European milling chemists nearly as much importance as is usually attributed to it in America. In the United Kingdom the market demands a loaf of only moderate size, with fine pores and mellow texture. In spite of the fact that most Canadian cereal chemists and some English chemists are convinced of the importance of the protein content of sound wheat within a given class, as an index of baking strength and blending value, most English millers either do not adopt this view or do not feel it practicable to act upon it.

There are two important differences in milling and baking practices in Scotland as compared with England :—

(1) The long fermentation process of baking is still largely used, and this requires strong flour.
(2) The millers mill straight wheats for the most part, leaving the bakers to do the blending.

In Glasgow the "quarter-sponge" method of baking is commonly used with a fermentation period of about 18 hours. In Edinburgh a "half-sponge" method is used, with the flour added in two stages and a fermentation period not longer than 12 hours. The trend even in Scotland is towards shorter fermentation. On the whole, in Scotland, all doubted the value of introducing protein as a factor in marketing Canadian wheat.

In Ireland, millers think that information as to the protein content of the Canadian contract grades of wheat would be valuable to them, provided the quality of the protein can be guaranteed by grade specifications.

In Norway the wheat milling industry is a state monopoly. Officials of the Norwegian State Grain Monopoly were very doubtful if it would be practicable to market wheat by protein content in their country.

With the export market demanding constant quality in the grades, and no sub-division or segregation, it appears that the problem of distributing the sale price of Canada's wheat among the growers in the fairest possible manner, having regard to the real value of their individual lots, is a domestic Canadian problem in the solution of which foreign buyers cannot assist at present. A scientific method of grading should certainly take some account of protein content, and should also give due weight to other factors of value, notably weight per bushel and moisture content.

Sprain or Internal Rust Spot of Potatoes. *By Sydney Burr (Bulletin No.* 160 *issued by the University of Leeds).*—Sprain is very widely distributed here and on the Continent. The first symptoms of the disease are small rusty-brown spots in the flesh of the tuber. These may sometimes be found when the crop is lifted, but more often they appear only after storage for some time, when, however, they develop rapidly and become irregular streaks or blotches within which cavities are frequently formed. The interior of the potato becomes hard and corky and the skin shrivels, and this is usually the first external appearance of the disease.

In a series of variety trials some varieties (Golden Wonder, Bishop and Field Marshal) proved very susceptible to the disease; others (King Edward and Great Scot) were less susceptible, and some (Resistant Snowdrop, Catriona and Majestic) were highly resistant.

Many dressings (e.g. sulphate of ammonia, sulphate of potash, sulphur, superphosphate) were tried but gave no appreciable control of the disease. Green manuring, that is ploughing in a green crop before planting the potatoes, proved highly successful in warding off the disease, and this is confidently recommended as a preventive measure against sprain.

DAIRYING.

Keeping Quality of Butter made from Cream of various Acidities. *William White, C. S. Trimble and H. L. Wilson. Tech. Bull.* 159, *Bureau of Dairy Industry, U.S. Dept. of Agriculture.*—The tendency of modern dairy practice is to churn cream at lower acidities than formerly; nevertheless, there is still a considerable amount of variation in the acidity of ripened cream in different factories. The authors experimented with cream of varying acidities and determined the keeping quality of the resultant butters. They found that ripening cream with a good starter even to low acidities improved the quality of the butter in the period immediately following on its manufacture, but that this improvement was not maintained when the butter was kept under storage conditions. Generally speaking, the keeping quality of butter is correlated to the acidity of the cream and to the temperature of the cold store. Butter made from cream with acidities of 0·15 to 0·31 per cent. kept well in storage at 0°F. for eight months; after twelve months' storage at the same temperature it was found that less deterioration had taken place in butters made from cream with acidities between 0·15 and 0·25 per cent. than in butter made from more highly acid cream (0·28 to 0·31 per cent.). When the storage temperature was 30° to 50°F. instead of 0°F. the deterioration was more rapid, especially in butters made from cream with the greater acidity.

Butter made from cream having an acidity as high as 0·31 per cent. will usually keep well for at least eight months if stored at a temperature of 0°F.; at the same time there is no material advantage in making the cream as acid as 0·31 per cent.

Is all Milk equally suitable as a Medium for the Preparation of Starters? *C. D. Kelly, Sci. Agric.* 10, 328-32.—A number of commercial starter cultures developed a flat yeasty flavour when grown in milk from a certain herd, but produced a typical clean acid starter flavour when grown in the milk from another herd. The quality of the milk is therefore an important factor in starter making, and it may happen that the milk of a certified herd is less suitable for cultures than milk of a lower category, but sterilised by appropriate means.

The Creaming of Raw and Pasteurised Milk. *A. C. Dahlberg and J. C. Marquardt, N.Y. Agric. Expt. Sta. Tech. Bull.* 157.—Experimental work carried out by the authors of this bulletin shows that the volumes of cream layers forming on milk were slightly decreased by pasteurisation at 140°F. for 30 minutes, but the decrease was not significant until a temperature of 145°F. was reached. At 146°F. a 10 per cent. reduction was noted. In order to secure uniform cream layers it was found necessary to standardise all milk prior to pasteurisation. The cream line diminishes if the temperature of the milk rises above 50°F., or if the pasteurisation temperature exceeds 143°F., or if the milk is not promptly cooled to below 40°F.

Further Studies on the Role of Vitamin C in the Nutrition of Calves. *L. M. Thurston, L. S. Palmer and C. H. Eckles. Jour. Dairy Sci.*, 12, 394-404. (1929.)—Calves grow normally to maturity on a ration which produces scurvy in guinea pigs in 20 to 30 days. The livers of the calves contain antiscorbutic vitamin. A heifer, which had been raised from birth to producing age on a scorbutic ration, yielded milk containing the antiscorbutic vitamin. It is concluded that vitamin C is produced in the animal body, but apparently not in the digestive tract.

How long should Holstein Calves receive Milk. *C. H. Crawford and W. E. Krauss. Ohio Sta. Bimo. Bul.* 141, 183-7. (1929.)—When Skim milk or dried skim milk were used in calf feeding it was found that 60 days was too short a period for the skim milk feeding to give good results in growth, while 90 days was too long to be economical.

ANIMAL BREEDING.

Cattle.

The Argentine Meat Trade. *By Dr. Juan E. Richelet. London,* 1929.—This is a volume which contains much miscellaneous information on the world production of beef which must be of interest to cattle breeders in this country. The following are a few of the salient facts.

The population of the United States has increased by thirty million within the last generation, while their cattle have decreased by twenty-five million head. The result must be a world shortage. It must not be forgotten that in the Argentine 65 per cent. of the meat is consumed at home and only 35 per cent. exported. While the stock of cattle in the Argentine, according to the author, has, in the last few years, shown a slight decrease, the actual stock may be calculated at about thirty million head as compared with thirty-seven million head in 1922. Official international statistics show that, as the population of the world increases, the stock of cattle decreases. Mr. Bruce, the Prime Minister of Australia, has stated that within a few years that country will not be able to export any beef as it will all be required for home consumption.

A speech by Sir George Lawson Johnston, the Chairman of Bovril, is quoted fairly fully. His information is that the scarcity and high price of beef in the United States will force Argentine meat into that country, and he quotes President Hoover as stating: "We shall be heavy buyers of Argentine agricultural and cattle products: as regards meat, probably within some three years, and cereals within ten years." Sir George goes on to make the following suggestion:—The countries that produce more cattle than they can consume are, in the Southern Hemisphere, South America, South Africa, Australia. Those that consume more beef than they can produce domestically are countries of the Northern Hemisphere, Europe and America. The seasons are, of course, reversed in the Northern and Southern Hemispheres. It is more economical in this country to fatten cattle on grass in the summer than to feed them on cake, &c., in the winter. Would it not be wise so to arrange matters that in the Northern Hemisphere the plenitude of beef sent in from the home pastures during autumn should be temporarily relieved from foreign competition? On the other hand, when winter has ended, right through spring into summer, when we want to keep our stock on our home pastures ripening, the butchers might have their fill of imported meat, and that time would coincide with the period of the year when the Argentine fat cattle are available, and should be got away before their winter comes.

Emphasis is laid by the author of this book on the use of scrub bulls in this country. He says that many of the bulls used for breeding purposes in some parts of England and Scotland would not be accepted by any cattle breeder in the Argentine, however modest his means.

The greater part of this book deals with the fact that the U.S.A. are excluding Argentine meat not by means of tariffs, but by regulations based on the supposition that the meat from the Argentine may carry foot and mouth infection. Dr. Richelet is at great pains to prove that it is utterly impossible for Argentine beef to carry the infection, and at first appearance makes out a good case. However the other side of the question may be found in the U.S. Department of Agriculture, Miscellaneous Publication No. 68, issued in January 1930, dealing with the 1929 outbreak of foot-and-mouth disease in Southern California.

The steamship "City of Los Angeles" docked at Wilmington, California, on December 9th, 1928. Meats were transferred from its coolers to another steamship, but scraps were placed in cans which went into the garbage, which was collected several times between December 20th and 29th. Part of the garbage was hauled to the Haas ranch where the outbreak of foot-and-mouth disease was diagnosed eleven days later. There can be no doubt that the garbage from the "City of Los Angeles" went to the Haas ranch, the conclusive point being that in the garbage received from Wilmington crockery had been observed with the name of the steamship "City of Los Angeles." After reading the report of the U.S. Department of Agriculture, the case against Argentine meat seems pretty clear.

The author of this book lays great stress on the benefits to British Agriculture derived by the purchase of pedigree cattle. He indicates that if any regulation be adopted preventing free importation of the meat from the Argentine, Argentine buyers of our pedigree stock will become very scarce. In this connection we might draw his attention to the *Journal of the Ministry of Agriculture*, volume 37, page 87, where we find that the total value of cattle exported to the Argentine during the year 1929 amounted to a declared value of only £53,000, which is infinitesimal compared with the colossal quantities of meat which the Argentine exports to us.

While dealing with this subject, attention might be drawn to Sir William Haldane's recent article which appeared in *The Times*, 10th March, and the correspondence between him and Sir Edmund Vestey. Sir William points out that the world beef supplies are shrinking, and that for the next four years home raisers can expect rather a better trade. He draws attention to the not unimportant fact that the organised importers have been the first to secure the rise in market values, and that the unorganised farmers have had to wait.

Studies in Dairy Cattle. *Illinois Sta. Report*, 1928-1929.—Studies and observations by W. W. Yapp on approximately 500 animals produced in the Bowlker herd, which was established by crossing Holsteins and Guernseys, indicated that milk yield percentage of butterfat, protein and ash in the milk, and conformation were hereditary characters controlled by a considerable number of factors, 10 being suggested for milk yield. The percentage of lactose in the milk was similar for the two breeds. The size of the animals was in part hereditary and in part environmental.

There was evidence that the open or protruding shoulder was an inherited character controlled by the operation of one or two factors. Variability in this characteristic was, however, influenced by the type of stanchions used.

Skin colour and colour of the secretions were hereditary, but were difficult to study on account of the high correlation with the amount of green feed consumed. No positive correlation was found between colour of skin pigment and colour of milk fat in dairy cattle. The colour of the skin pigment of the heavy-producing cows was greatly depleted when they did not receive enough green feed. Calves of highly pigmented breeds did not show the same amount of pigmentation as older animals until fed green feed.

Official Testing of Dairy Breeds. *R. B. Becker and P. C. M'Gilliard. Journal of Dairy Science* 12; 337-350.—This paper reviews the work which has been done in different countries as regards testing the dairy breeds of cattle, and the methods employed in different countries are analysed and criticised. It is of general rather than particular interest. The work of the Scottish Milk Records Association is analysed and very favourably commented upon.

Weight of Calves at Birth and Comparison of Birth Weights to Weights of Dam. *Mississippi Agricultural Experiment Station Report*, 1927-28, *page* 21.—These figures are based on 247 Jersey calves of which 118 were bulls, and also upon 77 Ayrshire calves of which 43 were bulls.

The average weight at birth of the Jersey bull calves was 51·41 lb., while the heifers averaged 48·9. The average weight of the Ayrshire bull calves was 70·5 and the heifers 67·61 lb. The gestation period showed no appreciable difference between the sexes; for the Jerseys it averaged 279·51 days, while for the Ayrshires it was 281·5. Other interesting figures concerning the weights of the dams are also given.

Effect of Spaying Cows on Milk Production. *By S. Kostelek Laslo. Budapest*, 1929, 92 *szam* 1935 *O.*—The writer selected ten cows of equal yield He spayed five of them, and these five gave in 235 days a much higher yield. He does not state whether the control cows were in calf or not.

Pigs.

Litter Size. *A. D. Buchanan Smith. Pig Breeders Annual*, 1930-31, 46-52. —The writer comes to the conclusion, from a review of the literature on the subject, that litter size is inherited, as also is the ability to produce litters with regularity. While the boar does not as a rule affect the size of the litter as the sow, to which he is mated, will do, he does affect the size of the litter of his daughters. Unless the breeder constantly maintains the importance of breeding for prolificacy it is likely that the fertility of his herd will decrease.

Records at the Zootechnical Institute, Gottingen. *By J. Schmidt, H. Vogel, C. Zimmermann. Fecundity, Fattening Capacity, &c. Arbeiten der Deutschen Gesellschaft f. Zuchtungskunde, Heft* 47, 146 *p.*—Germany is also joining the ranks of those countries which have Pig Testing Stations. In distinction to the common practice in other countries, the young pigs are not sent to the Testing Station till they are eleven weeks of age, and measurement of food and weight are not commenced till their thirteenth week. The three characters taken in the British and American Testing Stations, fertility, economy and quality, are similarly described at Gottingen. In these tests no appreciable differences were found between pure bred German pigs and an improved native breed. Each breed seemed to show a wide variability in efficiency, and altogether the first results show the extremely useful purpose which pig testing serves.

Pig Testing in Scotland. *A. Calder. Pig Breeders Annual*, 1930-31, 74-85.—Without going into statistical details the writer gives a review of what has been accomplished at the Pig Testing Station in Edinburgh, and how this has affected practice. After describing the method the writer shows that by accurately measuring inherited qualities of groups of pigs, a very good measure is also obtained of feeding and management. Since only half of the litter is tested at the station it can be compared with the remainder on the farm, the difference between the two being directly attributable to feeding and management. If the pigs on the farm are not doing so well as those sent to the station, breeders make inquiries as to how they might improve their methods.

Great differences were found between litter groups as regards economy of live weight gain, the range being between 3·6 and 5 lb. of meal consumed per pound of live weight. Again the age at the time of slaughter was found to vary from 200 to 260 days. The writer also finds marked differences in quality which are due to hereditary characteristics, and concludes by showing how pig testing can improve type, maturity, management and feeding.

Registration of Breeding Pigs in Sweden. *T. Lindahl. Pig Breeders Annual*, 1930-31, 116-120.—During the past ten years the pig production in Sweden has increased by nearly one third. In 1927 the production of pig meat was estimated at 330,000,000 lb., of which 57,000,000 lb. were exported as bacon to the United Kingdom. This has only been achieved by a simultaneous improvement in the quality of the Swedish pig. In the present article are described the methods by which this improvement has taken place. As in Denmark, the basic breeds are the Landrace and the Large White. The Herd Book was established in 1914. Animals are only entered after inspection. Litter testing and recording are in full swing through the pig producing areas of the country. Consequently herd book records are now dependent on type, conformation and performance.

In order to secure an adequate supply of breeding pigs, the Government contributes financially to the establishment of breeding stations, of which there are at present 42. From these breeding stations and from the best families in the private herds, animals are sent to the Government Pig Testing Station. Commercial breeders in the country obtain their breeding stock from these herds and consequently are able to produce a uniform article. By an Act passed in 1928 by the Swedish Parliament no boar can be used for service unless it is licensed. This Act is operative in three out of the 26 counties, but in a short time it will come into force in the majority of the counties.

General.

The Inheritance of Acquired Characters: a Review of two Papers. *Professor F. A. E. Crew, Animal Breeding Research Department, The Eugenics Review, volume 20, pages 55 to 59.*—If characters acquired by the individual were transmitted to succeeding generations, then the work of the practical breeder would be very much simplified. In this article Professor Crew reviews two recent papers which might be interpreted as indicating that, to a limited extent, characters acquired by the individual can be inherited.

In the first paper, Miss King, who is famous for her work with the Wistar rats, which have been bred in captivity for 15 years and might therefore be considered to be thoroughly domesticated, procured 16 males and 20 females of the wild gray Norway rat. Six of the females had litters, the members of which constituted the first of ten generations of captive grays. As the generations advanced there was an increase in the rate and extent of body growth. In both sexes the trend of variability was towards that found in the ordinary stock of Wistar rats. Professor Crew points out that while these results are interesting they do not support the theory that acquired characters are inherited, since there was very little mortality in these captive gray rats. He also points out that out of 20 females only six bred, and suggests that this is due to the fact that these six were better adapted than their fellows to captive conditions. Most of the rats in the first and some in the second generation were savage and many destroyed their young, but this phenomenon grew less marked as the generations advanced.

The other paper reviewed by Professor Crew is by Professor M'Dougall, whose method is to set pure bred rats a puzzle. One of his puzzles consists in learning to escape from a tank of water by the less brightly illuminated of two gangways. Untrained rats at the beginning of the experiment made on the average 165 errors before learning to avoid the bright gangway, while the twenty-third generation of trained rats made on the average only 25 errors. This experiment was carefully designed to test the transmission of acquired characters, and at first appearance one would say that ability to get out of the tank was an inherited characteristic, and that this characteristic was acquired and added to by previous generations. Professor Crew suggests that M'Dougall's results are due to social and not biological inheritance and quotes the following experiment which took place last century. A gentleman was desirous of obtaining a large number of sparrows for purposes of dissection, and constructed a trap which he thought suitable for the purpose. This consisted of a long tunnel bent at the end at a right angle so that the inner end which contained the snare could not be seen from the outside. The birds were induced to enter by a number of baits set along the length of the tunnel. The first year a large number of sparrows were caught, the second year only seven young birds, and the third year none were caught. The investigator noticed that during the second year whenever a young bird approached the opening of the tunnel the older birds began to sound loudly the appropriate danger cry, and in most cases dissuaded the young one from entering. Professor Crew implies that the same facts apply to this experiment of M'Dougall.

Blood Groups in our Domestic Animals. *By S. Schermer. Uber das Vorkommen von Blutgruppen bei unseren Haustieren. Deutsche Tier. Wochen. 36 Jahrg. Nr. 48, 1/12/28, pp.* 797-802.—It has been already shown that in the human being, blood composition is inherited along very definite lines, and that the various blood groupings have a direct bearing on susceptibility or resistance to disease. In this paper the whole subject is reviewed and data are given on sheep, cattle, pigs and horses.

Working with 60 sheep, the author confirms results of previous investigators (Bialosuknia and Kaczkowski). The blood reactions are divided into three groups, and a description of each is given pending a more detailed account.

The reactions in goats' blood were so irregular that they could not be divided into a group scheme, though they showed a close relationship to those of the sheep.

Previous work showed isoreactions in the pig, three groups being found which are analogous to those in the sheep. The reactions in the pig were clearer than in any other animal. The blood of the pig closely resembles that of man.

It is, however, with the horse that the author deals most fully, and finds that there are four main groups which in their behaviour react to each other in the same way as do the four main groups in the human. Furthermore, just as in man the various races show varying proportions of the different blood groups, so also in horses the thoroughbred type have a greater proportion of group 1 and none of group 4, while the heavy type have a smaller proportion of group 1 and a few of group 4. The horse, in contrast to all other animals, apparently shows a more far reaching differentiation as regards the accessory groups.

For the scientist it is a fascinating paper, but for the practical farmer it is of no immediate value.

ANIMAL NUTRITION.

Reproductive Disturbances caused by Feeding Protein-deficient and Calcium-deficient Rations to Breeding Pigs. *H. R. Davidson. J. Agric. Sci.*, 1930, 20, 233.—Previous work suggests that there are two kinds of fœtal atrophy. In one case, reported in rats, the atrophy extends to all members of a litter and produces complete sterility. This has been shown to be connected with a pathological condition of the uterine tissues brought about by the absence of vitamin E. In the second case a partial degree of atrophy has been widely observed, and the present investigation was carried out to determine the effect on this second type of a deficiency in the diet of protein and calcium. The following are some of the main conclusions :—

Partial fœtal atrophy in sows is not due to a deficiency of protein in the ration.

Calcium deficiency is not the major factor in producing this type of fœtal atrophy, though it may be a contributory cause.

The absence of a mineral mixture representing the mineral elements of blood meal produced a very considerable delay in the return of œstrus after weaning. Potassium and iron were the only elements in this mixture not already in good supply in the ration.

A ration deficient in calcium does not produce an immediate effect upon breeding sows, but the effects of the deficiency require one or two generations to become pronounced owing to the capacity to store lime in the body.

Definite evidence was obtained that a calcium-deficient diet leads to a very considerable increase in the number of pigs born dead.

A calcium-deficient ration leads to a very serious reduction and eventual failure of the sow's milk supply. This, combined with a large number of pigs born dead and with fatal accidents which are liable to occur, will eventually lead to the extermination of a group of pigs solely confined to this diet.

Does Cod-Liver Oil of High Acid Content have Toxic Properties? *A. D. Holmes, B. W. Moore and Others. Poultry Science*, 1930, 9, 164.—Cod-liver oil, being rich in vitamins A and D, is known to be a valuable vitamin supplement to a deficient ration. This is particularly so in the case of intensive poultry rearing where birds are often deprived of green food and direct access to sunshine. There would appear to be, however, different grades of cod-liver oil with varying degrees of acidity, and experiments were carried out to test the effect of several of these, having an acidity varying from 1 per cent. to nearly 12 per cent., on growth and mortality in chickens.

The results obtained in the investigation show quite definitely that red cod-liver oils of high acid content may contain substances which are detrimental for young chicks. The red, high acid cod-liver oils used in this investigation caused ruinous mortality. Furthermore, the chicks which were fed the red high acid oils until fourteen weeks of age were at that age undesirable for retaining to grow to maturity. Hence it appears that high acid cod-liver oils may be of questionable value as a supplement to poultry rations.

Studies on the Nutritive Value of Milk: IV. The Supplementary Value of Yeast in Nutritional Anæmia of Albino Rats. *W. E. Krauss. J. Dairy Sci.*, 1930, 13, 246.—In the case of young rats fed exclusively on milk it was found that anæmia developed at an early age. With the addition of yeast the rats thrived and hæmoglobin remained at a high level. This could not be attributed to the vitamin B of the yeast, as milk contains a considerable amount of this vitamin. Moreover the ash of the yeast was equally as effective, which indicates that the factors involved were inorganic. The work of others suggested that copper might be an important factor.

Ten samples of yeast from various sources were assayed for their antianæmic potency. Seven of these showed definite hæmoglobin regenerating power of varying degrees. Some correlation appeared to exist between the copper content of the yeasts and their antianæmic potency. No such correlation was evident with respect to iron. Other substances, for example manganese, believed to be concerned with hæmoglobin regeneration, were not considered.

Some supplementary effect on growth was shown by the addition of yeast to milk. This was attributed to vitamin B.

The Influence of a Low and High Calcium Diet on the Development and Chemical Composition of the Skeleton in Swine. *R. E. Evans. J. Agric. Sci.*, 1930, XX, 117.—Experiments were carried out with pigs to determine whether on a ration consisting chiefly of cereals, low in lime content, the addition of cod-liver oil would safeguard the animals against rickets or whether the addition of lime is also necessary. The experimental animals were confined to concrete floors and were in the second or third generation of calcium deficiency, having been on their respective diets from weaning time.

The animals on the low calcium diets showed obvious signs of malnutrition in spite of the fact that they had a liberal supply of cod-liver oil. Their skeletons showed a very distinct lack of calcification, the percentage of ash being about 12 per cent. lower than the bones of normal animals. A difference of about 360 grams of tricalcic phosphate was found between the same mature bones of the normal and calcium-deficient animals. It was found that the ratio of lime to phosphate is almost the same in the different bones of the same individual as well as in the normal and rachitic bones. The main characteristic of the bones in low-calcium rickets is a low ash content, but the composition of the ash is normal.

INSECTS AND PESTS.

The Potato Eelworm. *By J. Strachan and T. H. Taylor* (*Bulletin No.* 159 *issued by the University of Leeds*).—The potato plant attacked by eelworm loses its healthy appearance and the shoots remain stunted. The foliage turns prematurely yellow and the whole shoot withers and decays. From July onwards, infected plants are found to carry on their roots small spherical bodies which are the " cyst " or egg-containing stage of the eelworm. When potatoes are grown continuously on the same soil, as in small plot allotments, the pest is unchecked, and may develop to such an extent as to render the soil incapable of producing a crop of potatoes. On the other hand, where rotational cropping is practised the eelworm development is retarded and the land does not become infected to the same degree. Ground-keepers growing from an infected crop should be pulled up and destroyed, and all steps should be taken to prevent the spread of cysts by implements, carts, seed from infected areas, &c.

Various soils dressings—sulphur, lime, sulphate of potash, calcium cyanamide, dung and dead grass—have been applied, and only the dung was found to increase the crop. Control measures must depend on the destruction of infected material.

STATISTICS.

PRICES of AGRICULTURAL PRODUCE, FEEDING STUFFS and FERTILISERS in March, April and May 1930.

LIVE STOCK : Monthly Averages of Prices at certain representative Scottish Markets.

(Compiled from Returns received from the Department's Market Reporters.)

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
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 11	55 11	44 2	62 8	55 10	44 2	61 2	54 3	43 0
Cross-bred (Shorthorn)	59 0	52 8	41 8	58 3	52 11	41 8	57 7	51 0	39 6
Galloway	57 9	53 3	...	58 5	58 6	..	57 2	52 9	...
Ayrshire	55 6	43 9	35 6	55 10	44 5	35 0	54 3	43 9	33 6
Blue Grey	...	...	...	...	...	...	58 6	...	...
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	16	9	...	16	9	...	16	9	...
†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	14¾	13¼	11	14	12½	11	14¼	12¾	10¾
Half-bred	14¼	13	11	13¾	12½	10¼	13¾	12½	9¾
Blackface	14½	12½	10½	13¾	11¾	10¼	13¾	12	10¼
Greyface	14½	13¼	11½	13¾	12½	10½	14	12½	10¼
Down Cross	14	12½	10	13¾	12	9½	13¾	12	9¼
†PIGS—	per stone. s.	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	14 11	14 2	...	14 1	13 3	...	13 4	12 4	.
Porkers	15 8	14 11	..	14 9	13 10	...	14 1	13 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 8	12 17	10 0	20 8	15 5	12 6	19 15	14 19	12 3
Two-year-olds ...	24 12	19 4	...	26 11	19 13	15 14	25 3	19 15	16 5
Cross-bred (Shorthorn):									
Yearlings	15 18	12 5	9 15	17 19	14 6	11 12	17 15	14 5	10 15
Two-year-olds ...	22 15	17 13	...	24 4	18 16	15 1	23 5	18 18	15 11
Galloway :									
Yearlings	14 12	...	...	15 1	...	...	16 5	...	...
Two-year-olds ...	19 10	...	...	24 8	19 2	...	25 13	18 15	...
Ayrshire :									
Yearlings	...	...	...	11 15	10 10	...	13 0	12 10	...
Two-year-olds ...	...	...	...	18 0	15 0	...	17 10	...	..
Blue Grey :									
Yearlings	...	...	...	13 0	...	...	...	14 3	...
Two-year-olds ...	...	...	...	...	...	...	...	...	...
Highland :									
Yearlings	...	...	...	...	...	...	...	8 7	7 15
Two-year-olds ...	...	...	...	15 10	...	...	16 0	12 15	10 15
Three-year-olds ...	...	...	...	...	...	...	18 0	16 5	14 0
Dairy Cows—									
Ayrshire :									
In Milk	27 3	20 10	12 0	26 3	18 11	12 0	25 17	17 15	12 0
Calvers	28 4	20 13	14 8	26 18	19 7	14 0	26 17	18 9	14 0
Shorthorn Cross :									
In Milk	31 10	23 12	20 0	30 18	21 19	...	31 14	23 9	20 0
Calvers	29 1	21 1	17 3	28 10	20 3	17 7	29 3	20 18	16 17
Sheep—	s. d.	s. d.	s. d.	s. d.	s. d.	s. d.	s. d.	s. d.	s. d.
Cheviot Hoggs ...	54 8	40 9	36 0	50 9	40 10	...	49 5	40 0	...
Half-bred Hoggs ...	65 2	47 3	...	63 11	47 2	...	61 4	52 0	...
Blackface Hoggs ...	37 7	28 10	...	42 6	32 11	28 7	43 0	34 6	27 1
Greyface Hoggs ...	52 4	43 3	36 8	53 3	44 7	39 2	55 3	45 10	38 9
Down Cross Hoggs	...	...	...	48 0	38 0	...	...	...	...
Pigs—									
(6 to 10 weeks old)	60 9	42 4	...	55 4	38 6	...	55 9	38 6	...

DEAD MEAT: Monthly Average Prices at Dundee, Edinburgh and Glasgow.

(Compiled from Returns received from the Department's Market Reporters.)

Description.	Quality.	March.			April.			May.		
		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	10	9⅝	10½	9⅞	9¼	10⅝	9⅛	9	10¼
	2	9	...	10	9	...	10	8⅛	...	10
Bull	1	8	7⅞	7½	7⅞	7⅝	7⅛	7⅝	7½	7
	2	7	...	6½	7	...	6⅛	6⅞	...	6½
Cow	1	6½	7	6⅞	6½	6¾	6⅝	6¼	5⅞	6½
	2	6	...	6½	6	...	6⅛	5¾	...	6
Irish—										
Bullock or Heifer ...	1	...	...	9⅝	...	...	9½	...	...	9⅝
	2	...	...	9⅛	...	...	9	...	...	8⅞
Bull	1	...	...	...	...	...	...	...	...	...
	2	...	...	...	...	...	...	...	...	...
Argentine Frozen—										
Hind Quarters ...	1	6¾	7½	...	...	7	...	...	7⅛	..
	2	...	6⅝	..	...	6½	...	...	6½	...
Fore ,, ...	1	...	5¾	...	...	4¾	...	...	4⅝	...
	2	...	...	...	...	...	...	...	...	...
Argentine Chilled—										
Hind Quarters ...	1	7¾	7½	7½	7¼	7¼	6¾	7⅛	7⅛	7¼
	2	7⅛	6⅞	7	6½	6⅝	6	6⅞	6⅝	6¾
Fore ,, ...	1	6¼	6	6	4⅝	4⅝	4¼	4⅛	4¼	4⅝
	2	5¾	5⅝	5¾	4½	3⅞	3¾	4⅛	3⅞	3⅞
Australian Frozen—										
Hind Quarters ...	1	...	...	6¾	...	...	6⅝	...	...	6⅛
	2	...	...	...	...	...	...	...	...	...
Crops	1	...	...	5¾	...	...	5½	...	...	4¾
	2	...	...	...	...	...	...	...	...	...
New Zealand Frozen—										
Hind Quarters ...	1	..	...	6¾	...	...	6⅝	...	...	6⅛
	2	..	...	...	...	...	...	...	.	...
Fore ,, ...	1	..	..	5¼	...	...	5¼	...	...	4¼
	2	...	...	...	...	...	...	...	...	...
MUTTON :—										
Hoggs, Blackface ...	under 60 lb.	13	12¼	12	12⅝	11⅝	12⅛	12¼	12⅝	12⅝
	60 lb. & over	12	...	11½	11⅝	...	11⅛	11¼	...	11
,, Cross	under 60 lb.	13	12¼	12	12¾	11⅝	12⅛	12¼	12⅝	12⅝
	60 lb. & over	12	...	11⅛	11¾	...	11⅛	11¼	...	11
Ewes, Cheviot	1	...	9⅝	10¾	...	9⅝	10¼	...	9¼	10
	2	...	...	10	...	...	9⅝	...	...	9⅛
,, Blackface ...	1	9	9⅝	10¾	9½	9⅝	10¼	10⅛	9¼	10
	2	8⅛	...	10	8¾	...	9⅝	9½	...	9⅛
,, Cross	1	7	9⅝	10¾	7¼	9⅝	10¼	8	9¼	10
	2	6	...	10	6¼	...	9⅝	7	...	9⅛
Argentine Frozen ...	1	...	...	7	..	...	5⅛	...	...	4⅝
	2	...	...	...	...	...	...	...	...	...
Australian ,, ...	1	...	7	6⅝	...	6	5⅛	...	5⅝	4
	2	...	6⅛	...	...	5⅝	4	...	3⅞	3¾
New Zealand ,, ...	1	...	...	6⅝	...	...	5⅛	...	...	3⅞
	2	...	...	...	...	...	4	...	...	3⅛
LAMB :—										
Home-fed	1	...	...	...	...	18	20	...	19	19
	2	...	...	...	...	...	...	...	...	...
New Zealand Frozen ...	1	...	9⅞	8⅝	...	8⅞	9¼	...	8⅛	8⅛
	2	...	9	...	...	8¼	...	...	7⅝	8
Australian ,, ...	1	...	...	8¼	...	...	8¼	...	...	7⅝
	2	...	...	...	...	...	...	...	...	...
Argentine ,, ...	1	...	...	7⅝	...	...	8⅛	...	...	7⅝
	2	..	...	...	...	...	...	...	...	...

Eggs: Monthly Average Wholesale Prices at Aberdeen and Glasgow.

(*Compiled from Returns received from the Department's Market Reporters.*)

Market.	Description.	Quality.	March. s. d.	April. s. d.	May. s. d.
Aberdeen.	Country ... ... per doz.	1	1 2	1 2	1 2
		2	1 1	1 1	1 1
	Duck ... ... ,,	1	1 4	1 3	1 3
		2	1 2	1 2	1 2
Glasgow.	Country .. ... per doz.	1	1 4	1 1	1 3
		2	1 2	...	...
	Irish ... ... per 120.	1	11 6	11 8	11 2
		2	11 0	10 8	10 6
	,, Duck ... ... ,,	1	14 2	10 11	10 8
	Belgian ... ... ,,	1	10 5	10 4	10 7
	,, (Pickled) ... ,,	1	8 3	...	...
	Chinese (Black) ... ,,	1	8 0	...	...
	,, (Duck) ... ,,	1	9 4	9 6	...
	Dutch ... ... ,,	1	11 0	...	...
	,, Duck ... ,,	1	11 10	10 10	...
	Polish (Blue) .. ,,	1	8 2	7 8	7 11
		2	6 10	6 9	7 3

Provisions: Monthly Average Wholesale Prices at Glasgow.

Description.	Quality.	March. s. d.	April. s. d.	May. s. d.
Butter:				
Irish Creamery ... ... per cwt.	1	...	126 0	130 9
,, ,, (Unsalted) ,,	1	...	...	...
Australian ... ... ,,	1	143 9	132 10	133 6
Danish ... ... ,,	1	166 0	144 5	135 2
,, (Unsalted) ... ,,	1	170 3	148 5	140 3
New Zealand ... ... ,,	1	147 9	135 5	135 0
,, (Unsalted) ... ,,	1	160 6	148 0	...
Siberian ... ... ,,	1	...	...	...
Swedish ... . ,,	1	151 6	138 5	132 9
Cheese:				
Cheddar ... ... ,,	1	111 0	111 0	112 0
	2	104 9	103 9	...
Cheddar Loaf ... ... ,,	1	113 0	114 0	114 6
Dunlop ... ... ,,	1	111 6	112 0	88 0
	2	107 4	...	...
Canadian... ... ... ,,	1	104 0	...	...
New Zealand (Coloured) ,,	1	91 9	87 0	92 9
,, (White) ,,	1	91 9	85 0	90 3
Hams:				
Irish (Smoked) ... ... ,,	1	192 0	192 0	192 0
	2	175 6	175 0	175 9
American, Long Cut (Green) ,,	1	102 6	102 10	107 3
American, Short Cut ... ,,	1	102 9	102 7	99 0
Bacon:				
Ayrshire (Rolled) ... ,,	1	170 6	160 10	150 6
Irish (Green) ... .. ,,	1	147 6	153 2	142 0
,, (Dried or Smoked) ,,	1	152 6	159 7	149 6
,, (Long Clear) ... ,,	1	159 0	150 0	137 6
Wiltshire (Green) ... ,,	1	160 0	157 2	143 0
,, (Dried or Smoked) ,,	1	163 0	165 2	150 6
Danish. Sides ... ... ,,	1	119 0	119 0	107 0
Dutch, Green (Wiltshire Style) ,,	1	111 9	111 0	98 3
American Long Clear, Middles (Green) ,,	1	102 6	104 0	102 9
American (Short Clear Backs) ,,	1	102 0	102 2	101 6

FRUIT AND VEGETABLES: Monthly Average Wholesale Prices at Glasgow.

(Compiled from Returns received from the Department's Market Reporter.)

Description.	Quality.	MARCH.	APRIL.	MAY.
FRUIT :—		s. d.	s. d.	s. d.
Apples—				
American ... per case (40 lb.).	1	18 11	14 3	...
,, per barrel (10 stone).	1	18 0	26 0	...
Australian .... per case (40 lb.).	1	...	19 5	15 4
Canadian ... ,, ,,	1	10 6	17 0	...
New Zealand ... ,, ,,	1	..	...	17 6
Pears—				
Australian ... per case (40 lb.).	1	...	17 10	...
Californian ... ,, ,,	1	15 0	...	...
South African .. ,, ,,	1	20 0	...	...
Tasmanian .. ,, ,,	1	...	...	13 6
VEGETABLES :—				
Beet .. .. per cwt.	1	4 0	4 0	4 0
Brussels Sprouts... ... ,,	1	29 0	...	...
Cabbage, Coleworts ... per doz.	1	1 0	1 1	1 0
,, Savoy ... ... ,,	1	1 8	2 4	...
,, Red ... ... ,,	1	3 0	3 0	3 0
Carrots ... ... per cwt.	1	4 5	3 11	4 8
Cauliflowers—				
Broccoli, *Cornish* ... per doz.	1	5 6	5 1	4 10
Other British ... ,,	1	...	...	4 0
French ... ... ,,	1	5 5	5 1	4 0
Celery ... ... per bunch.	1	1 9	...	...
Cucumbers ... ... per doz.	1	9 6	6 5	6 2
Greens ... ... per 120 heads.	1	10 6	8 0	6 0
Leeks ... ... per doz. bunches.	1	2 6	2 1	2 3
Lettuce, Cos ... ... per doz.	1	2 9	1 8	1 11
,, Cabbage ... ,,	1	...	1 9	1 8
Onions, *Valencia* per case (9 stone).	1	7 6	7 2	...
,, *Egyptian* per cwt. (bag).	1	...	7 11	9 5
,, *Dutch* ... ,, ,,	1	3 5	3 0	...
,, *Spring* ... ... per bunch.	1	0 4½	0 4½	0 4
Parsley ... ... per cwt.	1	13 0	13 2	11 0
Parsnips ... ... ,,	1	7 9	5 10	5 3
Radishes ... ... per doz. bunches.	1	2 0	2 0	1 11
Rhubarb ... ... per cwt.	1	*44 6	*39 7	4 6
Spinach ... ... ,,	1	40 0	40 0	32 0
Tomatoes, *Scottish* ... per lb.	1	...	...	1 3
,, *Channel Islands* ,,	1	0 4¼	0 4¾	0 11
,, *Canary* ... ,,	1	...	0 6½	0 4¼
,, *Dutch* ... ,,	1	...	1 3	0 8½
Turnips ... ... per cwt.	1	1 9	1 9	1 11

* Forced.

Potatoes: Monthly Average Wholesale Prices at Aberdeen, Dundee, Edinburgh and Glasgow.

(Compiled from Returns received from the Department'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. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.
March.							
Aberdeen, per ton	1	...	...	...	...	4 0 0	1 15 0
Dundee ,,	1	...	...	...	...	4 5 0	1 10 0
Edinburgh ,,	1	...	1 16 8	4 0 0	1 15 0	...	...
Glasgow ,,	1	...	1 7 6	4 8 9	...	3 11 3	1 17 6
April.							
Aberdeen ,,	1	...	...	...	...	3 5 0	1 10 6
Dundee ,,	1	...	..	...	...	...	1 6 0
Edinburgh ,,	1	...	1 11 0	...	...	...	...
Glasgow ,,	1	...	1 5 0	4 10 0	...	3 9 0	1 9 2
May.							
Aberdeen ,,	1	..	...	...	...	...	1 9 5
Dundee ,,	1	...	...	...	...	3 0 0	1 5 0
Edinburgh ,,	1	...	2 0 0	...	...	5 0 0	...
Glasgow ,,	1	...	1 10 0	4 0 0	...	4 13 9	1 15 8

Roots, Hay, Straw and Moss Litter: Monthly Average Prices at Aberdeen, Dundee, Edinburgh and Glasgow.

(Compiled from Returns received from the Department'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.										
* Aberdeen, per ton	1	...	...	..	78 9	...	...	...	30 8	...
‖ Dundee ... ,,	1	...	...	13 0	109 5a 92 6b	...	60 0	...	60 0	52 0§
¶ Edinburgh ,,	1	...	...	...	101 3a 97 6b	...	51 3	...	51 3	...
‖ Glasgow ,,	1	...	...	...	92 6	97 6	55 0	..	60 0	35 0§§
April.										
* Aberdeen ,,	1	...	...	..	75 0	...	...	...	30 0	...
‖ Dundee ... ,,	1	...	...	11 2	108 6a 90 0b	...	68 0	...	68 0	52 0§
¶ Edinburgh ,,	1	...	...	...	94 3a 93 6b	...	48 6	...	48 6	..
‖ Glasgow ,,	1	...	...	...	90 0	95 0	54 6	...	59 0	35 0§§
May.										
* Aberdeen ,,	1	...	...	...	70 0	...	...	...	26 8	...
‖ Dundee ... ,,	1	...	...	9 9	110 0a 90 0b	...	67 6	...	67 6	52 3§
¶ Edinburgh ,,	1	...	...	...	92 6a 92 6b	...	47 6	...	47 6	...
‖ Glasgow ,,	1	...	...	.	86 3	91 3	52 6	...	55 0	35 0§§

* Loose, ex farm. ‖ Straw delivered baled. ¶ Straw delivered bunched.
a Delivered baled. § Foreign, ex quay. §§ Home (in 1½ cwt. bales).
b Delivered loose.

FEEDING STUFFS: Monthly Average Prices at Glasgow and Leith.

(Compiled from Returns received from the Department'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	11 0 0	10 7 6	11 1 6	10 11 0	10 15 4	10 6 3
Foreign	10 10 8	9 9 5	10 4 0	9 18 6	10 0 8	10 2 6
Decorticated Cotton Cake	10 0 8	...	9 15 6	...	9 11 3	...
Undecorticated do.—						
Bombay (Home-manufactured)...	...	5 7 6	...	5 5 6	..	5 0 8
Egyptian (do.)	6 3 2	6 1 3	6 0 3	6 1 0	5 16 3	5 15 0
Palmnut Kernel Cake	9 2 6	...	8 15 0	...	8 12 6	...
Soya Bean Cake ...	...	9 7 6	...	9 8 9	...	9 10 0
Coconut Cake ...	9 12 6	..	9 2 0	...	9 12 6	...
Groundnut Cake, Undecorticated—						
(36-37 per cent. Oil and Albuminoids)	6 19 5	6 17 6	7 0 0	6 18 2	7 0 11	6 15 10
(39-40 per cent. do.)	7 6 3	7 3 9	7 2 0	7 3 2	7 3 9	7 1 8
Maize Germ Cake—						
Home	9 0 0	...	8 13 0	...	8 8 9	...
Foreign	9 0 0	...	8 12 0	..	8 3 2	...
Maize Germ Cake Meal	7 7 6	.	7 8 9	...	7 7 6	...
Rice Meal	5 17 6	5 13 4	5 9 9	5 10 0	5 6 7	...
Bean Meal	10 0 0	10 1 3	10 3 0	9 17 0	10 5 0	10 0 0
Barley Meal ...	8 10 0	8 0 0	8 5 6	9 0 0	7 17 6	8 13 4
Fish Meal	19 17 6	18 11 8	19 6 6	19 0 0	19 2 6	19 0 0
Maize Meal—						
Home-Manufactured	7 18 2	7 5 8	8 12 0	8 7 6	8 11 3	7 16 3
South African—						
(Yellow) ...	7 0 11	...	7 19 0	7 10 0	7 16 3	7 7 6
(White) ...	7 4 1	...	7 15 0	7 10 0	7 10 0	...
Locust Bean Meal (Fine)	9 8 2	8 6 3	9 0 0	7 10 0	8 6 11	6 14 5
Maize Gluten Feed (Paisley) ...	7 10 0	...	7 10 0	..	6 18 9	...
Maize—Plate ...	7 0 8	6 14 0	7 18 9	7 13 0	7 11 3	7 5 0
Do African, Flat	7 16 8	...	7 16 0	...	7 13 9	...
Do. American ...	8 15 0	...	8 12 6	...	8 9 5	...
Oats—Home ...	6 1 7	5 17 6	7 8 0	6 12 0	7 3 9	6 5 0
Do. Plate ...	5 19 5	...	6 5 9	...	5 15 11	...
Do. Canadian No. 2	6 6 8	...	6 5 0	...	...	...
Barley Feeding (Home)	8 15 8	7 7 6	8 2 0	8 1 0	7 17 6	8 0 0
Do. Bran ...	8 11 3	..	8 5 0	...	7 12 6	...
Wheat—						
Home	9 0 8	8 12 6	9 11 3	8 18 0	9 2 2	8 13 9
Poultry	8 13 9	8 13 4	9 7 0	...	8 18 9	...
Imported... ..	9 0 8	...	8 18 0	...	8 12 6	...
Middlings (Fine Thirds or Parings)	6 17 6	5 12 6	6 19 3	6 0 0	7 2 10	5 15 0
Sharps (Common Thirds) ...	6 0 0	5 7 6	5 19 9	5 9 0	5 16 11	5 5 0
Bran (Medium) ...	6 1 11	5 6 3	6 0 3	5 14 0	5 15 4	5 5 0
,, (Broad) ...	6 4 5	6 1 3	6 3 0	6 10 0	5 19 6	5 18 4
Malt Culms... ...	5 7 6	4 16 8	4 17 3	4 2 6	4 13 9	...
Distillery Mixed Grains—Dried	...	6 17 6	...	6 19 0	...	6 17 6
Brewers' Grains—Dried	6 0 0	5 0 0	5 0 0	5 0 0	5 5 0	5 1 11
Distillery Malt Grains—Dried	6 5 8	...	6 5 0	...	6 4 1	...
Crushed Linseed ...	25 17 6	...	25 0 0	...	24 5 0	...
Locust Beans, Kibbled and Stoned	8 5 0	7 11 3	7 15 0	6 17 0	7 1 11	5 19 5
Beans—China ...	8 19 8	...	9 6 6	...	9 7 4	...
Do. Sicilian ...	9 3 9	...	9 9 6	...	9 11 3	...
Do. English ...	9 12 6	...	9 13 0	...	9 13 9	...
Feeding Treacle ...	7 0 0	7 0 0	7 0 0	7 0 0	7 0 0	7 0 0
Linseed Oil, per gall.	0 5 9	...	0 5 0	...	0 4 7	...

Fertilisers : Monthly Average Prices at Glasgow and Leith.

(Compiled from Returns received from the Department's Market Reporters.)

Description.	Guaranteed Analysis.	March. Glasgow.	March. Leith.	April. Glasgow.	April. Leith.	May. Glasgow.	May. 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	10 2 0	10 2 0	10 2 0	10 2 0	10 2 0	10 2 0
Sulphate of Ammonia (Neutral and Granular) § ...	N. 20·6	10 2 0	10 2 0	10 2 0	10 2 0	10 2 0	10 2 0
Nitrate of Lime * .	N. 13	9 12 6	...	9 15 0	...	...	...
Nitrochalk § ...	N. 15½	...	...	9 19 0	...	9 19 0	..
Superphosphate ...	P.A. 13·7	2 15 0	2 17 6	2 15 0	2 17 6	2 15 0	2 17 6
" ...	" 16·0	3 1 3	3 1 3	3 1 3	3 1 9	3 1 6	3 2 6
" ...	" 17·4	3 6 3	...	3 6 3	...	3 6 3	...
Ground Mineral Phosphate ...	P.A. 26	*a* 2 6 6	*c* 2 6 6	*c* 2 6 6	*c* 2 6 6	*a* 2 6 6	*c* 2 6 6
" " " ...	" 26	*b* 2 9 0	*b* 2 9 0	...	*b* 2 9 0	*b* 2 9 0	*b* 2 9 0
" " " ...	" 34	...	*c* 3 9 0	...	*c* 3 9 0	...	*c* 3 9 0
" " " ...	" 34	...	*b* 3 11 6	...	*b* 3 11 6	...	*b* 3 11 6
Kainit (in bags) ...	Pot. 14	†3 7 6	3 12 6	3 7 6	3 8 6	3 7 6	3 2 6
Calcium Cyanamide ‖	N. 20·6	9 6 0	...	9 6 0	..	9 6 0	...
Potash Salts ...	Pot. 20	†3 17 6	3 12 6	3 17 6	3 12 6	3 17 6	3 12 6
" ...	Pot. 30	†5 5 0	5 0 0	5 5 0	5 0 0	5 5 0	5 0 0
Muriate of Potash... (on basis of 80 per cent. purity)	Pot. 50	†9 12 6	9 2 6	9 12 6	9 2 6	8 17 6	9 2 6
Sulphate of Potash (on basis of 90 per cent. purity)	Pot. 48·6	†11 15 0	11 5 0	11 15 0	11 5 0	10 18 9	11 5 0
Steamed Bone Flour	N. 8, P.A. 28	5 15 0	...	5 15 0	5 5 0	5 15 0	5 5 0
Bone Meal (Home)	N. 4, P.A. 28	7 15 0	...	7 15 0	8 10 0	7 15 0	8 10 0
" " (Indian)	N. 4, P.A. 19½	9 5 0	...	9 5 0	8 10 0	9 0 0	8 10 0
Potassic Mineral Phosphate ...	N. 18, Pot. 5	...	...	3 7 6	...	3 7 6	..
" " " ...	N. 18, Pot. 10	...	...	3 15 0	...	3 15 0	...

Abbreviations:—N. = Nitrogen ; P.A. = Phosphoric Acid ; Pot. = Potash.

§ Carriage paid in 6-ton lots.
‖ Carriage paid in 4-ton lots.
* F.O.R. Glasgow.
† Less 5*s.* 6*d.* per ton if taken ex quay.

a = 75 per cent. fineness through prescribed mesh sieve.
b = 85 per cent. fineness through standard 100-mesh sieve.
c = 80 " " "

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FARMING CONDITIONS IN THE UNITED STATES.

Sir WILLIAM HALDANE.

WE have been apt to regard the American view of agricultural as well as industrial problems as based exclusively on direct economic purpose and therefore somewhat different from our own rather broader aims. But in recent years the trend in agricultural policy and opinion, by mutual readjustments, has been towards a view common to both sides of the Atlantic. Thus British and American experiences are now of mutually greater value than in the past, notwithstanding many differences in the respective surrounding conditions.

The "Year Book" of Agriculture in the United States for 1929 recently issued by the Washington Department, a volume of over 1,000 pages, gives a mass of statistical and other information as to agricultural conditions and progress. Much of this is of little interest to readers in this country, but it includes a great deal that is of value to others than the American farmers for whom, as its preface states, it is primarily intended.

The impression given is that, on the whole, farming in America last year was more prosperous than we have been given to suppose from some of the information coming from other sources. Notwithstanding that drought conditions throughout most of the country last year reduced the crop yields below those of any recent year, and that the total acreage grown was apparently no greater than in 1928, it is stated that farm incomes averaged higher than those of any season since 1920-21 except 1925-26, the first year of substantial rise in live stock values from the previous low level.

The total gross income from agricultural production for 1928-29 is estimated at $12,500,000,000, $225,000,000 more than the preceding season, but the return earned on the estimated capital values of agricultural property is reckoned at only about the same as the previous year, 4·7 per cent., it being explained that the farmer's living income last year increased merely a trifle because operating costs, taxes and interests were higher than in the previous years. Income from grains, fruits and vegetables was smaller last year than in 1927-28, but the higher prices for live stock and live stock products was the principal cause of the improvement in the season's agricultural income—in face too of a reduction in the volume of live stock sold. Meat animals and dairy and poultry products together brought in $345,000,000 more than in 1927-28. As regards farm outgoings, it is observed that in the last few years the prices of commodities usually bought by farmers remained stationary in the neighbourhood of 156 per cent. of the pre-war level, while the purchasing power of farm commodities improved.

Notwithstanding the general improvement in farming conditions in the United States it is evident from the Secretary of Agriculture's Report to the President, included in the volume, that the conditions of the farming community vary greatly, and that many farmers are far from prosperous. Much of the economic hardship suffered by the farmers has been caused by too rapid expansion of the area devoted to farming. Public land laws and policies have favoured expansion, and expansion is stated to have been misdirected as well as over-stimulated. " One of the major causes of the post-war depression in agriculture was previous over-expansion under the stimulus of war-time influence and of public and private land policies." It is urged that the " marginal and sub-marginal " lands be got out of cultivation, and production thus curtailed.

Apparently this process is progressing, the poorer farms being abandoned voluntarily or under compulsion. It is stated that in the year to 1st March 1929 forced sales and related defaults were approximately 19 per thousand farms, though a decrease compared with previous years. Erosion and deterioration of land are mentioned as serious menaces, apparently causing much farming loss.

As in this country, the trend of population in the United States is from the country to the towns. A survey showed that at the end of 1928 farm population was the smallest for more than 20 years, though the rate of shrinkage has been falling in the last two or three years as farming prosperity has improved. Economic conditions are apparently the main cause of such movements in population. It is reckoned that nearly 40 per cent. of the country's farm population lives on small farms of poor and difficult land on a standard of living far below what is common on large farms, and that farm families of this low standard group are numerous in nearly all the States.

It was found that in 1925, while the average farm acreage in the United States was 145, 38 per cent. of all the farms were under 50 acres. It is pointed out that though many of these small farms are uneconomic, yet they send their surplus population to the towns and that it is thus of national importance to improve conditions and establish a satisfactory standard of living on the small farm. In the case of small farms in America yields are said to average lower than on the average sized farms, whereas the opposite is found in European countries. The Report recognises that conditions which result in such low earning have their advantage to the occupiers, but that in the interests of the nation it is necessary to raise living standards. Thus the small farm problem is regarded as urgently demanding effective attack as a matter of national policy.

The decline in farm population is attributed also to the rapid progress of the mechanisation of farm processes, enabling increased population to be fed with less farm work. With a new power cultivator one man can cultivate 160 to 200 acres of corn, and it is estimated that there are approximately 853,000 tractors on American farms, and that in ten years there has been a decline of seven million horses. It is claimed that American farm workers using mechanical power now produce from two to five times as much as similar workers in some of the older countries of Europe. Owing to large power units of farm equipment there is of late an accelerated trend towards increase in size of farms, with lower production costs. It is not only the tractor that is effecting the change, but mainly the bigger implements used in the West. Indeed " a contest is on between the tractor and the big team, the outcome of which is not yet determined." In this country with our small units of production area we can watch this contest with but little hope of benefit to our farmers, rather the reverse; though the result may be of practical interest to our Dominions where large scale production is practised.

The Report dwells on the complex problem of raising the economic position of the small farmers and the standards of living of their families, and discusses policy and methods. It frankly accepts the fact that in certain areas small farms should be discouraged, indicating that land tenure system is of little importance in the matter. Of late, tenancy seems to be preferred to ownership. The small farmer is found to be not so ready as the larger farm operator to take advantage of scientific methods, and his opportunities for education may be lacking. " A sound agricultural policy would help to prevent the waste of effort involved in the cultivation of farms where basic physical conditions or general economic conditions, or both, are unfavourable. Such a policy would seek to relieve the farm industry from the depressing effect of misdirected effort and misplaced farms."

The Farm Relief policy under the United States Marketing Act of last year is intended to improve the economic position, its purpose being, as is explained, to strengthen the bargaining power of producers through co-operative selling, stabilising the supply of agricultural products, preventing over-production, broadening markets at home and abroad, minimising speculation, and kindred aims. In recent years co-operative business has increased rapidly, and the aim of the Federal Farm Board is the strengthening and closer integration of existing Associations rather than the creation of new bodies. Nearly 90 per cent. of existing Associations are independent local bodies out of contact with other co-operatives, and consequently more or less in competition. The aim will be to lead them to co-operate on commodity lines rather than merely on a locality basis.

Farm credit is another problem to be attacked. Apparently credit is still very costly in certain areas of the country, and the local banks are regarded as operating on too narrow a basis to satisfy requirements or to maintain their own stability. Improved banking laws are said to be needed in many States.

It is with little reference to the needs of farmers that the new tariff provisions are discussed, with noticeable brevity. American agriculture was formerly more dependent on foreign market conditions than it is to-day. Since 1900 agricultural exports have been diminishing, and last year were only a third part of America's total exports. It is claimed that American agriculture can profit from Protection even as regards crops largely exported. In the case of wheat and maize it is indicated that Tariff Protection can be effective when Argentine or Canadian crops are large and U.S. crops short. In such ways agriculture "can use increased Protection," to the principle of which the nation is committed. It is reckoned that the world's supplies of wheat during the next few years will be maintained.

A noticeable section of the Report dwells on the demand for higher quality products, more general standardisation and the consequent necessity for increased inspection. Improvements in marketing methods are expected to bring more equitable reflection of quality and price differences. As an example, the average price of "choice" and "prime" steers at Chicago in 1928 is stated to have been \$15·82 per 100 lb. (73*s*. per British cwt.) as against about two-thirds of that price for "common" steers. It must be remembered, however, that a large number of American cattle are of low beef quality compared with our own, and that the monopoly American producers hold in their beef markets must tend to weaken effort to raise quality. The average price of beef steers at Chicago for 1929 was \$13·43 (62*s*. per British cwt.), almost the same price as in 1928, and more than double the price of "choice" steers at Buenos Aires for chilled beef.

The section of the American Report on "Helping the Farmer to look ahead" should be of special interest to us. The issue of economic information "in a usable form" was begun six years ago. It combines general economic information with farm management study, and it is stated that the results have been gratifying. "The widespread interest shown in the Reports is indicative of the use made of outlook information by farmers." Budgeting on farm production has been brought into wider use, and thus farmers can decide with increased understanding and confidence. Study of foreign production and consumption of certain products has enabled a forecast to be made of production trends over a period of years. Additional facilities in this work are invited with reference to increased world competition in some agricultural products, to help farmers in planning ahead. A striking illustration of the practical value of such economic study is given as to tobacco production, and it is stated that other illustrations can be cited. Already the Federal Government is expending six million dollars in the year on agricultural economics, and further expenditure on this branch of the Department's work is proposed.

It is to be hoped that this method of practical guidance from which American farmers are gaining such advantage may soon be available for our own farmers to enable them to follow lines of profitable production, and to avoid some of their losses through avoidable over-production.

The work in scientific investigation conducted by the Washington Department in co-operation with State and other institutions covers a vast field of enquiry of great value to their farmers. Their progress in controlling live stock disease is of special interest and importance. They have completely excluded foot and mouth disease, and are apparently making great progress towards getting rid of bovine tuberculosis. In 1928-29 nearly a million cattle a month were tested, the total in round figures being 11,665,000. The degree of infection found was 1·8 per cent. as compared with 3·9 per cent. about eight years ago, these results and other data indicating that tuberculosis among cattle has been reduced more than 50 per cent. since systematic eradication began. The work commenced in individual herds, and was extended first to a county-wide and eventually to a state-wide basis of testing. Last year almost $4,000,000 was paid to live stock owners as Federal indemnities for animals destroyed.

Notwithstanding the fact that the gross value of crop production in the United States was 50 per cent. more than the value of the animal products, the Federal Department spend on animal industry more than three times as much as on plant industry. In this country the position is very different notwithstanding the dominating position of live stock in our farm economics repeatedly pointed out by agricultural economists. The tendency in the United States to help and encourage live stock more than crops may be due to its increasing importance in their farm economy. It is shown statistically that in the last three years the cash income from farm production has been contributed by live stock almost as much as by crops, mainly due to the higher prices which American farmers have received for meat. Contrariwise our farmers have suffered their heaviest losses in the last three years through the fall in meat prices here, since the South American supplies swamped our markets in 1926 and 1927.

Another matter in which we might well take guidance from America is the thorough manner in which the results of agricultural research are brought to the knowledge of the practical farmer. The Report points out that the research done depends largely for its value on the efficiency with which its results are communicated to the public. Last year it distributed free more than 25 million bulletins and other publications in addition to what were sold at prices barely covering printing cost, and it is proposed that further expenditure on publication should be authorised. Even we in this country are generously allowed also to benefit. Other methods of spreading information among the farmers than by directly distributed publications, such as through newspapers and broadcasting, are explained and discussed. It is obvious that without such efforts to bring practical knowledge to those whose minds it is intended to stimulate there must result serious loss of advantage from expenditure of public money in research.

Although American farm problems are in many respects very different from our own there is much that is akin, and much from which we can learn in the enormous efforts the United States are making, largely through economic betterment, to improve the conditions of their rural population.

THE MANAGEMENT OF STORE CATTLE IN THE NORTH-EAST OF SCOTLAND.

J. A. SYMON, D.S.O., M.A., B.Sc. (Agric.).

THE North-East of Scotland has for the past century been pre-eminently a cattle rearing and cattle feeding district, and for that reason a great deal of attention has always been focussed on problems connected with the keeping of cattle. That great Aberdeen-Angus breeder, M'Combie, Tillyfour, the "Grazier King," as he was worthily titled, did a great service to agriculture when he placed on record in his book, "Cattle and Cattle Breeders," his ideas concerning the management of cattle. Rightly or wrongly, some of his ideas may not find favour to-day, but in the main they form a most valuable contribution to the literature on the subject. They are the outcome of the lifelong experience of a very acute observer, and it is interesting to note that to-day farmers as a result of scientifically conducted trials are in many instances veering round to some of M'Combie's views, although in the immediate past these views have not been favoured.

The main purpose of this article is to bring into prominence the question of the wintering and subsequent summer grazing of store cattle, and it may be interesting to have a resumé of some of M'Combie's views on the subject. Besides being a great Aberdeen-Angus breeder, M'Combie was a great dealer and a great feeder of commercial cattle. In his book he tells how for forty years he bought almost every grazing bullock in Morayshire. Before the age of artificial manures these cattle were wintered in the open grass fields, turnips being driven out to them. Animals wintered in this fashion he favoured. They retained their old coats; their feet were well prepared for long road journeys; but, above all else, they did well when put on to spring grass. Gradually the open court or strawyard replaced the field as a place for wintering the cattle. In course of time many of these open courts were covered, but M'Combie did not hesitate to condemn cattle intended for grazing which had been wintered in a covered court. They lost weight when they went to grass, comparing badly with straw or open yard wintered bullocks, which soon outdistanced them. He estimated that cattle kept in the open strawyard were worth £2 to £3 a head more to the grazier than those kept in close courts. Rather than graze animals wintered in covered courts he preferred to buy stores out of the Aberdeenshire byres, where it was customary to let them out for fresh air and water every day throughout the winter.

The evolution of the present system of winter management of store cattle can also be traced by reference to Robertson's "Agriculture of Kincardineshire," where we read that when Barclay of Ury introduced turnips into Kincardineshire he consumed the whole of his turnip crop (130 acres) by cattle and sheep going outside all winter. The tops of his cattle ate the turnips either carted out to the grass or where they grew (a certain proportion of the turnips having previously been carted off). The poorer cattle were kept in open strawyards to make dung or else were utilised to glean up the remains of the turnips after the tops had been over the ground. Store cattle treated in this way came to the market as early as June. It appears, however, that Barclay's system soon gave way to the straw or open yard system in order that dung might be obtained for the turnip crop. Later the open yard gave place first of all to the open yard with shelter shed attached, then to the covered court, and in Aberdeenshire to the byre system, which is undoubtedly more economical in straw than the court system. But even the byre system has been modified, for when it was first adopted in the North-East the cattle, as has already been mentioned, got a run out every day, a practice which has apparently been more or less discontinued for the past half century.

In these modifications it would appear that such considerations as the seeming comfort of the cattle, economy of food and in some cases labour, and the provision of facilities for making farmyard manure, were primarily responsible for the changes. The actual effect on the thriving capacity of the cattle does not appear to have been adequately considered. Within recent years, however, several farmers have entertained doubts as to whether cattle throve better during the winter under confined or under open conditions. Aberdeen-Angus and Shorthorn breeders had noticed that their young bulls did better in open stalls than in byres. Many farmers in the North-East, because of the increased stock carrying capacity of their farms as a result of the introduction of wild white clover, found that their tying-up capacity was insufficient, and had to accommodate cattle in open sheds attached to the open courts or erected in grass fields. It was found that these cattle did remarkably well. Incidentally it may be mentioned that between the years 1921 and 1929, according to statistics issued by the Department of Agriculture for Scotland, the cattle stock of Aberdeenshire had increased by 9 per cent., while in the same period the sheep stock had almost doubled. In Kincardineshire the increase in cattle during the same years was 11 per cent. and that of sheep 64 per cent. At the time of the outbreak of foot-and-mouth disease in Aberdeenshire some years ago some farmers isolated bought-in cattle by keeping them outside in the grass fields all winter, and were agreeably surprised to note the progress made by these cattle throughout the winter, and especially at the beginning of the grazing season.

The point, however, was not thoroughly investigated until, in the year 1927-28, an Aberdeenshire farmer, Mr. Maitland Mackie, North Ythsie, Tarves, commenced a series of experiments regarding the wintering of cattle at his farms of Eastertown and Westertown of Fyvie. In 1927-28 three lots of store cattle were experimented with. One lot was tied up in byres, being kept inside the whole winter; another lot was also tied up, but in order to test the effect of ultra-violet rays the byre was lighted by means of "vita" glass; the third lot was wintered in the fields, overhead shelter being provided. All animals received turnips and straw. The first two lots put on a small and almost equal increase during the winter period, but the lot going outside showed more than double this increase. In the year 1928-29 another trial was conducted, but this time only one lot was kept inside in byres, a second lot going loose in a half open court, while the third went outside in a field, overhead shelter being provided. The following table shows the results obtained for the period 3rd December 1928 to 26th March 1929 :—

	Byre	Half-open court.	Outside.
Number of cattle	18	14	46
Live weight increase per head	27 lb.	98 lb.	83 lb.

So encouraging were the results of this trial that it was repeated during the winter 1929-30.

Results of Trials at Eastertown. (*Irish Cattle.*)

Basal ration turnips and straw. No record kept of weights consumed.

Treatment.	Byre loose, open court all day. Jan. 17–May 7.	Open Court. Jan. 17–May 6.	Field and Shelter. Nov. 26–Apr. 22.
Number of cattle ...	30	36	30
Concentrated food given	1 lb. cake.	1½ lb. bruised oats.	*Nil.*
Live weight increase per head per day...	0·64 lb.	0·69 lb.	0·86 lb.

Results of Trials at Westertown, 1929-30.
Basal rations as above.

Treatment.	Lot 1. Irish, same as 3.	Lot 2. Black Cattle.	Lot 3. Same as 1.
	Byre tied. Nov. 21–May 8.	Byre tied. Nov. 21–May 16.	Byre loose, access to open court. Nov. 21–May 1.
Number of cattle ...	21	11	61
Concentrates ...	8 got 1 lb. oats. Jan. 17–Mar. 10	1¼ lb. bruised oats. Jan. 17–May 16.	*Nil.*
Live weight increase per head per day...	0·12 lb.	0·93 lb.	0·92 lb.
Loss per head start of grazing period...	May 1–May 8. 16 lb.	May 16–May 26. 27 lb.	Progress shown, but no figures available.

These cattle were observed by one of the Department of Agriculture's inspectors on June 12th, 1930. The lot of 21 byre cattle could easily be picked out from the remainder, and appeared to be not only lighter but of inferior breeding. Yet the same inspector observed all the lots on the 28th November 1929 and convinced himself that the different lots were equally divided as to size and quality. None of the lot of 21 cattle is away fat (Sept. 2nd). On the other hand 22 out of the 30 Eastertown lot, field and shelter, were away fat by that date.

In the autumn of 1928 the Governors of the North of Scotland College of Agriculture favourably considered a request by the Farmers' Union (Aberdeen Branch) to carry out an experiment on this question of outside *versus* inside wintering of store cattle. In the trial 20 six-quarter-olds were used. These were divided into two lots of 10, one lot being housed in a byre while the other lot was kept in a grass field provided with a shelter shed. Notes were kept of the quantities of turnips and straw eaten. The outside lot consumed much more turnips but slightly less straw. The following table gives details of the increases obtained during the period under observation :—

	Inside lot.	Outside lot.
	lb.	lb.
Average live weight increase ... ... Nov. 5–Apr 29.	132	179
Average live weight increase ... ... Apr. 29–June 1.	81	113
Average total increase	213	292
Turnips eaten per head per day	84	118

These trials corroborate those carried out by Mr. Mackie in that the cattle going outside all winter put on about an additional half cwt. live weight during the winter period. The trials also suggested that this difference is considerably increased at the beginning of the grazing period, the inside lot actually losing weight when first put out to grass, whereas the outside lot continue to put on weight all the time. A further point suggested by the results is that the outside lot ate considerably more turnips than the inside lot, though the latter were given all the turnips they could consume.

In the following winter this trial was repeated, but was further elaborated by a trial to determine the effect of concentrated feeding stuffs. Half of each lot received concentrates, viz. 3 lb. oats along with 1 lb. earthnut cake, for the period December 12th to March 30th. The following table gives particulars regarding the live weight increases and the quantities of turnips consumed :—

No Concentrates.

	Inside lot.	Outside lot.
	lb.	lb.
Increase per head Nov. 6–Apr. 30.	135	228
Increase per head Nov. 6–July 2.	260	369
Turnips eaten per head per day	59	121

Concentrates Dec. 12th to March 30th.

	Inside lot.	Outside lot.
	lb.	lb.
Increase per head Nov. 6–Apr. 30.	216	297
Increase per head Nov. 6–July 2.	264	421
Turnips eaten per head per day	59	123

Last year's results further indicate :—

(1) That in the winter period the outside fed animals put on about half a cwt. extra live weight increase as compared with those tied up.

(2) That this difference is increased to almost 1 cwt. during the first part of the grazing season.

(3) That fully double the quantity of turnips is consumed by the cattle going at liberty.

Another point which the above experiment would suggest is that both non-concentrate groups did much better than the concentrate groups during the first part of the grazing season, a result which had already been suggested by a cattle feeding trial conducted at Craibstone some years previously. It is interesting to compare this result with M'Combie's experience as expressed in the following quotations from his "Cattle and Cattle Breeders":—

> "I make it an almost universal rule (and I have never departed from the rule except with a loss), that I will graze no cattle except those that have been kept in the open straw-yard and have been fed exclusively on turnips and straw."
>
> "I do not mean to say that a few weeks of a little cake or corn will ruin a beast for grazing; but you may depend upon it, that the less artificial food given during winter the better."

The pros and cons of the outdoor system, as suggested by experiments so far carried out, seem to be as follows:—

The additional weight put on during the winter period, viz. about half a cwt., may be valued at about 25*s*., which counterbalances the value of the extra turnips consumed, viz. 2½ tons, if valued at 10*s*. per ton. When, however, it is taken into consideration that the outwintered cattle do so much better during the early part of the grazing season the balance is all in favour of the outdoor system. It should be noted, too, that cattle wintered in a field or in an open court require less labour than those wintered in byres.

Where cattle are outwintered in grass fields a certain amount of poaching of the grass will take place. In the case of the younger grass this may result in considerable damage being done, but in the case of older pastures, where there is any mat, winter poaching may actually be beneficial. It should be noted that when cattle are wintered in grass fields very little use may be had of the winter grazing for sheep.

The dung of cattle wintered in the fields, though not lost, is not available for application to certain crops to which it might be desirable to apply it. This disadvantage does not, of course, apply to the wintering of cattle in open courts.

Finally, economy in buildings may be considered. The present returns from agricultural land do not warrant the erection of the expensive buildings hitherto deemed necessary for the housing of cattle, and where byres or covered courts have gone out of repair the outdoor system may be particularly worthy of consideration.

While the trials so far carried out are certainly very promising and suggestive, there is need for more detailed information on the subject. Principally because there are relatively few covered courts in the North-East, there has been no attempt to compare the covered court system of wintering store cattle as against any other system. To meet this criticism the North of Scotland College of Agriculture is now making arrangements to test cattle under four different systems, viz. the byre with the cattle tied up; the byre with the cattle running loose as in a covered court; the open yard with covered shed; and the open field with shelter shed.

In another direction the trials suggest that definite information might profitably be obtained regarding the fattening of cattle outside under autumn and winter conditions. Already some information has been obtained on this point, but no definite comparative trials have been carried out. Mr. Mackie at his farms in Fyvie fed cattle going outside in the fields, a shelter shed being provided, during the period 8th September 1928 to 7th February 1929. The cattle started getting turnips on the 9th October and concentrates were given for the first time on 11th December. During the whole of the period under observation the cattle made an average live weight gain per head per day of 2·4 lb., a result which would be gratifying to any feeder.

In another and wider sense these trials are very suggestive. They emphasise the need of scrutinising every detail of our present day methods of farm management in the light of past experience. Systems that have been modified or scrapped might profitably be reviewed, as witness some of M'Combie's remarks. In the Transactions of the Highland and Agricultural Society, 1872, an account is given of an experiment in cattle feeding carried out by Mr. Moscrop, Olliver, Richmond, Yorkshire, where cattle were fed in byres, in boxes, and in sheds with open yards attached. There were four animals in each lot and the experiment extended over 14 weeks. The following table gives details of the results :—

	Total food consumed.									Average increase per head per week.
	Swedes.			Straw.			Concentrates.			
	tons	cwt.	qrs.	tons	cwt.	qrs.	tons	cwt.	qrs.	lb.
Byres	19	19	0	1	16	0	0	15	2	$17\frac{5}{8}$
Boxes	24	17	0	2	0	2	0	15	2	$20\frac{3}{8}$
Sheds with open yards	29	18	2	2	9	2	0	15	2	$20\frac{7}{8}$

In this experiment Mr. Moscrop reckons that the animals fed in sheds, with open yards attached, left least profit, but as values have altered considerably in the last fifty years this statement can only be accepted as true under the conditions then existing. But the experiment does indicate that the open air system has undoubted advantages over all others in so far as the thriving capacity of the animals is concerned.

Thanks are due to Mr. Maitland Mackie, North Ythsie, Tarves, to his manager, Mr. A. Cumming, Westertown, Fyvie, and to Mr. Wm. M. Findlay of the North of Scotland College of Agriculture, all of whom have freely given of the information they obtained for themselves and which has not yet been published.

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AGRICULTURAL SURVEYS.

(Continued.)

As stated in the first article of this series, the agricultural surveys which were carried out last winter embraced certain Highland parishes. Very diverse types of agriculture are found in the Highlands, and while surveys have been made of three distinctive districts there are other areas where the agricultural conditions and problems are quite different from those in the districts surveyed. In view of this diversity, therefore, it will be appreciated that any conclusions arrived at as a result of an investigation into the agricultural situation in one area may be of little value in considering the position in another area. With regard to the three districts selected we have, in the two parishes in Sutherland, crofter settlements or townships, situated in the glens and on the seaboard, with their common grazing land, while there are also large sheep farms and extensive tracts of deer forests; the parish in the Central Highlands comprises mainly high-lying sheep farms and large areas of deer forests, but with no crofter townships; in the Argyllshire parish a more varied type of husbandry mainly directed to sheep and cattle breeding and rearing is carried on, but, unlike both the districts in Sutherlandshire and the Central Highlands, there is no deer forest land in the parish.

In the present article a summary is given of the report on the parish in the Central Highlands, which for the purpose of this series will be designated *Parish D.* The survey was carried out during the winter of 1929-30.

Description and Extent of Parish.—This parish lies in the heart of the Central Highlands and extends to over 200,000 acres or about 350 square miles. By far the greater part of the land lies above the 1,000 feet level, there being a number of summits rising to over 3,000 feet. In the valleys, where the cultivated land is found, the surface sinks to some 350 feet, but in general even the arable land is well above this level. More than half of the entire area of the parish is devoted to deer forests, while according to the Annual Agricultural Returns there are about 90,000 acres of rough grazing land (exclusive of deer forests on which sheep may sometimes be grazed), about 2,000 acres of permanent grass land, and about 2,000 acres of arable land.

Estates and Holdings.—The land is practically all in the ownership of a few proprietors, whose estates range from about 4,000 acres to 70,000 acres.

The Agricultural Returns show that the agricultural land, including rough grazing land, is divided into 88 holdings. In several instances, however, two holdings are worked together, with one stock and one steading common to both. In classifying the holdings according to acreage the reporters have regarded such combined holdings as one, while they have also excluded a few returns of land used solely in connection with sport, e.g.

for grazing hill ponies. The reporters classify the holdings as follows :—

Acreage:	1–50 *acres.*	50–150 *acres.*	150–500 *acres.*	500–2,000 *acres.*	*Over* 2,000 *acres.*	*Total.*
No. of Holdings ...	32	11	12	10	14	79

The majority of the holdings in the 1 to 50 group are tenanted by persons who have means of livelihood other than those pertaining to the holding, the tenants being, for example, blacksmiths, roadmen, estate workmen and retired persons. In one district there are a few crofts consisting of scattered strips of land, sometimes not exceeding 5 yards in width. It was obvious that the division of the land into such narrow strips was very uneconomical from the holders' point of view and consolidation of the crofts would be decidedly advantageous. In the 50 to 150 acre group there are five farms with rights to graze a definite number of ewes on the adjoining deer forests, so that the stock of sheep kept is in excess of the normal stock in the group.

In the great majority of holdings the bulk of the area consists of rough hill pasture. In comparing the rentals of the larger sheep farms little is gained by attempting to make a classification on the basis of rental per acre, as the extent of these farms is generally given to the nearest thousand acres. A comparison on the basis of rental per ewe shows a variation from about 2*s*. to 6*s*. per ewe, this being dependent on a number of factors such as the quality and soundness of the grazing, the extent of arable land and the number of cattle raised, the method of taking over the sheep stock at entry, the winter risks of the farm, the reputation of the stock, &c. In the case of many farms the distance to the nearest railway station is 15 to 20 miles.

Tenure of Holdings. — A considerable proportion of the tenants of the farms which are let have no leases or are continuing on tacit relocation. This is a most unsatisfactory state of affairs to which reference will be made later in connection with various aspects of the management of the farms. It may, however, be mentioned here that in view of this circumstance the reporters considered it undesirable to classify the holdings in regard to the standard of management. It would obviously be unfair to stigmatise the management of farms when the occupier possesses neither the right nor the security required for the carrying out of improvements such as heather burning and draining, which are the main and indeed the only practicable methods of improving rough hill pasture of the kind found in this parish.

With reference to the observations of the reporters in connection with the question of security of tenure it should of course be kept in mind that these observations have reference solely to the peculiar circumstances and conditions obtaining in the parish and are not to be interpreted as being of general application.

Soil.—The soils consist chiefly of the weathered and much leached products of metamorphic and igneous rocks, mixed with varying proportions of peat. The soil reaction was determined by means of the " Soiltex " test. On the arable land a considerable number of tests was made, and almost without exception the soils were found to be acid or slightly acid, a condition that was indicated also by an examination of the flora. Finger-and-toe disease is fairly common in the turnip crops of the parish, particularly on farms where the acreage suitable for cultivation is small and where the rotation must necessarily be short. The non-arable land is so extensive that, although frequent tests were made, considerable areas were not sampled. Without exception all the non-arable samples were acid or very acid. As, however, the greater proportion of the non-arable land is so inaccessible that the application of lime, slag or other ameliorative agent is outwith the scope of practical economics, the only feasible method of treatment on these regions is the cutting of hill drains to remove the surplus water and so permit of aeration which would facilitate the oxidation of the harmful organic acids. There seems no question that much of the readily accessible land would benefit from the application of lime, but the cost of transport from Fife and Lanarkshire is so heavy that save under special circumstances, as where financial assistance is given by the proprietor, the practice of liming is very seldom carried out. The possible use of electricity is suggested in connection with the reopening of local lime quarries, and the establishment of lime grinding plant for the production of ground limestone.

Crops.—The rotation practised is that generally in vogue in the more high-lying districts of Scotland, viz. oats, green crop (mainly turnips and swedes), oats, hay, grass. This may be modified according to circumstances, and not infrequently two crops of hay may be taken and the field may be left several years under pasture before it is again ploughed up.

While in a few instances artificial manures are applied to the grain crop and particularly to the second oat crop, the bulk of the manure—farmyard and artificial—is applied to the green crop. Any farmyard manure surplus to the requirements of the green crop is generally applied as a top dressing to the hay crop. On the farms on certain estates generous provision is made by the proprietors in the leases to encourage the tenants to make use of artificial manures and of lime, a substantial proportion of the cost of manures and lime at a convenient railway centre being payable by the proprietor. On these farms manurial treatment is generally relatively liberal. In some instances farmers purchase manures as compounds; in other cases manures are purchased and mixed at the steading or applied separately.

Oats.—Potato oats, and occasionally Castleton, a variety of Potato oats, are generally grown. It has been commonly maintained that while some of the newer varieties of oats ripen earlier and give a higher yield of straw, the Potato variety gives by far the best class of straw for use as winter fodder to the breeding cows, and hence is better suited to the local requirements.

Turnips and Swedes.—Turnips almost invariably follow lea oats and receive the bulk of the manure for the rotation, basic slag, mineral phosphates and sometimes ground lime being applied in addition to such quantity of farmyard manure as the system of farming may permit. Because of the tendency to "finger-and-toe" the non-acid forms of phosphatic manures are preferred to the more soluble superphosphate. Practically the whole of the crops is consumed by cows and stirks. No turnips, of course, are fed to the hill sheep, though exceptionally with an abundant crop some may be used to fatten sheep that otherwise would be disposed of as store.

Potatoes.—The acreage under potatoes is comparatively small and is generally intended to meet the household needs of the farmers and employees, though in seasons when the price justifies the cost of transport small quantities may be sold either for seed or as ware. The chief varieties grown are Kerr's Pink, Sutton's Abundance and Arran Chief, and tubers of excellent quality for either purpose are produced.

Grass.—Seed mixtures are generally purchased as compounded by the merchant, though a few farmers order the seeds separately and make up their own compounds. Wild white clover is not included in the shorter rotation, and in some cases its value is not admitted even for the longer rotation. On the other hand the merits of cocksfoot are generally recognised, particularly because of its capacity for furnishing an early bite before and during lambing time, a property which in a high and exposed district can scarcely be overestimated.

Stock.—*Sheep.*—The mainstay of the agriculture of the parish is sheep farming, the vegetation on the hills, moors and corries constituting good mixed grazing for Blackface sheep.

Apart from a very few of the smaller farms, situated in the lowest part of the parish, where cast ewes are brought in and crossed with Border Leicester rams, the practice followed is that common to the hill district of Scotland where Blackface stocks are carried. Rams are purchased at the September sales at Stirling, Perth and Aberfeldy, and many of the best flocks in the country are represented in the sires used; though in a high exposed district like this there is a well-advised tendency to buy rams that have been brought out naturally in preference to those "forced" under artificial conditions to show and sale ring form. The rams are put to the ewes about November 22nd to 24th, those to the gimmers being sometimes withheld for another seven to ten days. In backward springs these younger ewes tend to be short of milk, and a delay of a week at lambing may be beneficial, as vegetation may then be far enough advanced to mitigate considerably lambing and nursing difficulties.

During winter, grazing is restricted to the lower reaches of the hills, but in open weather the stocks may be allowed to roam to considerable altitudes and to considerable distances from the farmstead. It is interesting to note that some farmers are guided by the wireless forecasts of the morning or of the previous night. If these are favourable the farmer or shepherd on his daily round merely sees that all is right, and makes a mental note of the position of each lot in the grazing; on the other hand, should the forecast be unfavourable, the flock is turned down to lower levels and concentrated on a smaller area, so that in the event of a snowstorm the sheep are more readily accessible and more easily brought into safety.

It is rather surprising to find that hand-feeding of stock during a snowstorm is rarely carried out, and indeed is practised only at times of exceptionally heavy snow. It is contended that once haying is commenced the stock give up foraging for themselves, and the result is worse than if no feeding had been given, unless under almost starvation conditions. This practice is at variance with that followed in certain neighbouring high-lying districts where the graziers contend that it never pays to allow their stock to get down in condition, and that they are compensated for the additional outlay by a lower mortality in ewes and lambs, by the ewes being in a better milking and nursing condition and by the greater crop of better lambs. The practice followed in the parish may partly be due to the remoteness of most of the farms from hay-growing districts and to the consequently high cost of transport.

As far as possible every endeavour is made to clear the lower ground during early spring with a view to allowing the pastures to clean before the ewes are gathered to this area for the lambing season. Lambing generally commences about 16th to 18th April, and the ewes are brought in two to four days prior to this. As the whole ewe stock must be seen three to four times a day, extra lambing shepherds are necessary, generally one extra for each hirsel, and these, with the regular hands, experience for the first month a very arduous time, commencing work at dawn and finishing at dusk, and having practically no leisure beyond time to snatch a hasty meal. As the " in-by " land at this time is too heavily stocked, the lambed ewes are shed out to the hill ground every seven to ten days.

The lamb crop is not very heavy; the returns made at the beginning of June show that the average proportion of lambs to ewes at that date is slightly above 80 per cent. Twins are never numerous. The chief factors influencing the percentage of lambs are :—

1. The weather conditions at the end of November and December when the rams are with the ewes.

2. The condition of the ewes at lambing time, which again depends on the weather conditions during late winter and early spring.

3. The weather conditions during lambing. Late blizzards of snow at this time, or heavy rainfall making mountain torrents of small ditches and drains, may lead to exceptionally heavy losses.

Ram lambs are castrated about the middle of June, and it is interesting to record that the bloodless Italian method (the Burdizzio method) is extensively employed and has proved very satisfactory. Ewe hoggs and yeld ewes are generally clipped about the same time, and the clipping of the ewes takes place about a month later. Lambs are weaned at the beginning of August and regular drafts are sent to market, generally Perth and Stirling. The great majority of the ewe lambs are required for stock purposes, those disposed of being mainly of an inferior class. In former days the wether stock was retained until two to three years old, but the modern taste is for smaller joints, and there is an excellent demand for wether lambs sold direct from the hill in August and September. In 1929 top prices ranged from 23*s*. to 27*s*. 6*d*.

Cast ewes are drawn towards the end of September, and disposed of in October at Perth, Stirling and Aberfeldy. During recent years excellent prices have been obtained for sheep of good character, and at last season's sales considerable rises were shown, caused no doubt by the slump in prices of arable produce, by the great tendency to lay down land to grass and by the desire to stock with a breed of sheep that can forage for themselves, and so dispense to a great extent with horse and manual labour. Prices for the best class of cast ewes in October 1929 ranged from 40*s*. to 45*s*.

Ewe lambs are sent to grass wintering about the middle of October and return at 1st April. This relieves the stocking of the home pasture for the winter, tends to reduce the death-rate, and to produce a better grown ewe. Wintering, however, is difficult to secure, and the reporters found that the ewe hoggs were distributed from Stirlingshire to the Moray Firth. A considerable number are sent to the counties bordering the latter, being travelled two to three days to a convenient railway station and then railed to their winter quarters. Including rail transport and accommodation for men and animals overnight when on the road, the cost of wintering amounts to 10*s*. to 12*s*. per head, and in the aggregate often equals and may even exceed the rent of the grazing.

Dipping is carried out in August and again in late autumn, an arsenical "fly" dip being employed for the former and a winter dip for the latter. Until recently, when pure carbolic dips were solely employed for winter use, it was customary, with a view to keeping the sheep clear of keds, to give another dipping in spring. The handling of in-lamb ewes, with the risk of injury in fank and tank and danger of chills and illness after immersion in a dip, even heated to blood temperature, in the very uncertain climate of upland glens never greatly commended itself to flockmasters. The discovery of the insecticidal properties or derris root, and the preparation of dips containing the effective constituent in this, have happily obviated any necessity to undertake the risks of spring dipping. The majority of flockmasters in the parish have now dispensed with it altogether, and find their sheep at clipping time infinitely cleaner with one dipping of the newer type of dip than with two dippings under the old conditions. A few farmers still cling to the routine of other days, but doubtless these will soon follow the general tendency.

During recent years Blackface wool has constituted a very important item in the income of the sheep farmer. The weight of clip varies somewhat with the season, but ewe hoggs will clip 4½ to 5½ lb. and ewes 4 to 5 lb. Prices last season amounted to 1*s*. per lb. at grower's station for clip of the very best character, while 11*d*. or over would generally be realised.

In general the grazings are reported as healthy, and the annual drafts of lambs and ewes sell on the basis of "high character." Fluke occurs on a few badly drained and marshy lands, an occasional case of braxy occurs, and there are a few farms where, in cold backward springs, trembling or louping ill causes comparatively high mortality. This last named disease occurs on farms which are particularly wet and much in need of draining and where heather burning has been extremely neglected, though the reporters do not specifically associate these conditions with the occurrence of the disease. Accidents, due in many cases to sheep wandering into forests and being drowned in unbridged burns or lost in moss hags, account mainly for the remainder of the mortality. Generally the loss was given as 3 to 5 per cent. of the ewe stock, but in one instance where trembling is common the average loss was put at 8 to 10 per cent., with one particularly bad year at 23 per cent. Occasionally very severe losses occur during heavy and sudden snowstorms when the flock may be caught unprepared on the higher ground.

Valuation of Sheep Stocks.—This question has always been one of much controversy and the reporters have some interesting observations to make in regard to it. With certain exceptions the practice in the parish is that the sheep are bound to the ground, and at the expiration of a tenancy are taken over from the waygoing tenant by the incoming tenant or by the proprietor. In the majority of cases the prices are to be fixed by arbiters on the basis of market value, but in a few instances stocks have to be taken over at acclimatisation values, i.e. an additional value is placed on the stock because they are "hefted" to the ground and therefore less likely to stray than a bought in flock, and, more important, because they are assumed to be acclimatised and to a certain extent immunised against certain forms of disease, local to the district, which might cause a heavy loss amongst an incoming stock. Originally this extra acclimatisation value was assessed at a few shillings, but the tendency has been for it to increase and now it may reach 20*s*. to 30*s*. above the market value. While some extra allowance for acclimatisation is justifiable, there is no question that the inflated values that have been in vogue for some time have been detrimental to the best interests of the industry. For instance, for a stock of 2,000 ewes and the relative number of ewe hoggs, the extra outlay would be £2,000 to £3,000, and this greater investment of capital would, of course, be reflected in the lower rent paid for the farm. Thus by this system the farmer is handicapped by tying up capital which might be utilised to greater advantage in the improvement of his stock, while the landlord loses in rent a sum which if applied to repairs and upkeep of the farm would frequently maintain fences, drains and buildings in much better condition than is usual under existing circumstances. In some cases landlords have " bought off " the valuation at acclimatisation values and have relet farms—at an increased rental—with the stock valued on a market value basis.

On one farm the sheep were bound to the ground at a fixed value. On a number of other farms an attempt has been made to meet the difficulty in respect of improvement or deterioration of stocks. On these the sheep are taken over at a fixed price, plus or minus 3*s*. per head, according as quality has improved or deteriorated, plus 2*s*. for hefting and acclimatisation. While this method is an improvement on that of an unvarying price, a tenant quitting at the present time would not receive anything like the full value of the stock.

The reporters suggest that the most equitable basis is market value at the November term, when as a result of the season's sales prices could be fixed on a reasonable basis. At Whitsunday the fixing of a reliable value is much more difficult, as comparatively few sheep really representative of hill stocks are then passing through the sale ring.

Cattle.—Black polled store cattle of the finest quality are bred in the glens of the parish, Aberdeen Angus bulls of superior quality being used. Some home-bred heifers are retained for breeding, but the general tendency is, as far as possible, to secure heifers of Shorthorn blood as dams to be crossed with the Aberdeen Angus sire. A strain of Ayrshire blood—not more than one-quarter and the remainder Shorthorn—is regarded by many of the breeders as providing dams that will prove good milkers and give the necessary substance to blend with the quality of the Aberdeen Angus.

The cows are wintered almost wholly on a home-grown maintenance ration, principally oat straw and turnips, with perhaps some meadow hay and a little bruised oats and purchased concentrates prior to calving and afterwards until grass is sufficiently advanced. As far as possible the calves are suckled, one to each cow, though a proportion are pail fed, and are mainly grazed during summer on old or rough pasture. Generally all, and certainly the best and most forward in condition, are sold at the September sales, but the younger and smaller animals may be wintered and sold at the February and March sales.

Labour.—Probably the bulk of the labour is provided by the farmers and their families. Most of the work is concerned with the tending of farm stock and the farmers and shepherds are expert stockmen. Wages of married shepherds range from £60 to £100, according to the nature and responsibility of the duties, with keep of one and in some cases two cows, 8 bolls of oatmeal, potatoes, and 4 tons of coal. The reporters were not impressed by the standard of the workers' houses, many of the dwellings being small, without indoor sanitation of any kind and without an indoor water supply.

Lambing shepherds are engaged for a few weeks at lambing time, and experienced and trustworthy men receive up to 50*s*. to 60*s*. per week with board and lodgings. Ploughmen are paid up to 35*s*. to 40*s*. with perquisites.

Buildings, Fences and Dykes.—While some fairly good steadings were observed, many consist of straggling buildings and are inconvenient to work—probably the result of the consolidation of holdings in other days and the adaptation of existing buildings to meet the needs of the larger farms thus formed. Many of the farm houses require to be modernised, as they lack the conveniences now deemed essential. These defects may, the reporters consider, be attributed in part to the " deer " policy. With the reduction of land available for both tillage and grazing it is perhaps thought that the comparatively small rents do not justify expensive repairs and readjustments.

Many of the larger farms are not ring fenced, marches being defined by burns, cairns and hill tops. Generally no objection is taken to this as it is recognised that where heavy snowstorms and deep drifts are apt to cause much damage, the construction and maintenance of long march fences constitute a heavy burden on the estate, and that the equivalent of this may with greater advantage be spent in other directions. In addition no objection is taken to a few of a neighbour's sheep trespassing; the balance in regard to trespass is generally fairly even, unless one of the parties is overstocking his grazing.

The conditions as to interior fences vary on the different estates. On some all interior fences are erected and kept in good repair by the proprictors. On others, while the fences belong to the estate, there is an understanding that repair work is to be carried out by the tenant while the proprietor is to provide the material. Many of the fences on farms of this category are not in a satisfactory condition. The tenants, in some cases, stated that they had great difficulty in securing the material, while on the other hand it was represented that the tenants were reluctant to undertake repair work. While there was probably some truth in both contentions, the reporters consider that the root of the trouble lay in the insecurity of tenure of many of the holders. Thorough and extensive repairs, even when material is provided by the estate, may cost a very considerable sum, and though in the long run such outlays might prove economical, the inevitable tendency under conditions of insecurity is to adopt makeshift expedients whenever possible. In a few instances part of the interior fences was the property of the tenant, and by the conditions of lease fell to be taken over at his outgoing by the successors.

Drainage.—Little advantage has been taken of the various drainage schemes administered by the Department of Agriculture for Scotland. Tile drains are confined to part of the arable land, the remainder of such land being of a comparatively light and friable character with good natural drainage. On certain estates the provisions as to tile drainage are exceedingly generous, the proprietors supplying tiles free of cost to the nearest station, cutting the drains and laying the tiles, while the tenants' contribution consists of transporting the tiles from the station and filling up the drains on completion of laying. On other estates practically no tile drainage was being done, at least on let farms, and wet strips and patches, due to the non-functioning of old stone drains, were not infrequent, and in the reporters' opinion were contributory causes to fields, or parts of fields, going out of cultivation.

While substantial parts of the steeper hills have adequate natural drainage, there is scope throughout the parish for very extensive hill drainage work. Comparatively little hill drainage has ever been attempted and the greater part of the land where old drains were observed is now under deer. Over large areas in the side glens, in the bottoms and flanks of the corries, and on the gentler slopes with sufficient depth of soil, drainage might be carried out to the greatest advantage of the sheep stock and of the grouse. Much of this land is too wet to carry any vegetation save a straggling growth of heather that gives insufficient cover and provides comparatively little food for birds, and is so difficult to bring under rotational burning in any systematic scheme of moor management that it constitutes a potential source of danger for grouse disease. Here again the reporters express the opinion that the lack of security, arising from year to year tenancies, is partly responsible for the want of enterprise in developing the grazing and sporting capacities of the moors. Some of the shootings were apparently let on very short leases. In other districts proprietors, shooting and grazing tenants, the last two having leases of insufficient length to induce more than an immediate interest in the subjects, have co-operated, sometimes with the assistance of drainage grants, to have the moors and hills drained throughout, with results that have been eminently satisfactory to all parties concerned.

On several farms meadows are subject to severe flooding when rivers are in spate, and it was found that in nearly all these cases the ditches previously draining off the water as the floods subsided had become silted up and were practically inoperative. The adjacent land had consequently become waterlogged, the pasture had deteriorated greatly, and conditions exceedingly favourable to the propagation of fluke prevailed. It was no surprise to learn from the tenants that losses in the sheep stocks from this disease had been heavy. It was pointed out to the reporters that the cleaning out of these ditches constituted a relatively permanent improvement, and that the work was not one to be undertaken by a tenant unless so secured in his tenancy as to be recompensed for his outlay.

Heather Burning.—As heather constitutes the dominant plant in the parish the question of moor management is of considerable importance. In regard to the general question the reporters state their views as follows:—"Under former systems of moor management, when shooting over dogs was the vogue, old heather was considered to be of considerable advantage as affording cover for birds; nowadays, when driving birds to butts is almost universal, it is generally recognised that the best grouse bags are obtained on moors where the heather is burned in a rotation of 10-15 years. The fatal grouse disease has been shown to be an indirect consequence of lowered vitality of the birds, due to insufficient food during the critical spring months, and it has been proved that the closely growing 6-15 year old heather, with a thick matted covering, affords the only feeding at this time of the year, while the older scraggy heather contributes practically nothing to maintaining them in healthy and resistant condition to the parasite that causes the disease. The same class of heather is best suited to the requirements of a sheep stock and hence the oft-quoted saying that, as regards heather, 'the interests of grouse and sheep are identical.'" The reporters go on to say that their survey of the parish confirms the view of the Heather Burning Committee appointed in 1919 to the effect that this statement constituted "a pious opinion rather than a regulative principle."

The right of burning is without exception retained in the hands of the estate and is generally delegated to the gamekeepers. In view, however, of the great extent of country involved and the limited number of gamekeepers, it is quite impossible for the keepers—even if they tried to undertake systematic burning, which is far from being the case—to burn the moors in accordance with modern requirements. Practically no burning is attempted in October, when sportsmen are still on the hills, and in March and April the weather conditions frequently make burning impossible.

The conclusion of the reporters is that burning could be carried out efficiently only if the right to do so were delegated to the grazing tenant and his employees. In the opinion of the reporters this is scarcely likely to occur voluntarily as the keepers guard their rights very jealously, not perhaps because they contemplate any injury to the sporting interest, but more probably because the retention of the right in their own hands means the retention of a local status for themselves which otherwise they would not enjoy. The grazing tenants, of course, have the option of applying for statutory authority to burn, but the fact that despite the many cases of grievance only two applications under the Heather Burning Act have been lodged with the Department from the whole of Scotland shows that little advantage has been taken of the protection afforded by the Act. In the parish under review this may be due partly to the fact that many of the tenants are without leases.

Bracken.—This plant is giving much trouble on a number of farms and is extending. On certain estates there is an arrangement whereby the tenant undertakes the cutting and the proprietors pay one half of the cost involved.

The reporters are emphatic in the view that unsystematic and neglected burning of heather is an important contributory factor in the spread of bracken. The following is an extract from their report :—" If heather is burned on a short rotation of say 10-15 years it springs quickly from the root and forms a thick dense cover of young heather, able to hold its own against the invasion of bracken or other weed. If, on the other hand, the heather is allowed to become old, individual bushes die out here and there and the creeping bracken soon establishes a footing in these gaps in the cover. There may be only occasional sporadic fronds, but when such heather is burned it does not spring from the root, but the area has to be re-seeded from heather in the vicinity and hence may lie ' fallow ' for several years. During this interval, however, the bracken, if present even in a very sparse condition, quickly establishes a thick cover, and unless cut most effectively prevents the growth of the heather." In view of the present interest in the subject of bracken the relationship between the growth of this weed and the burning of heather is a matter which should be kept in mind by proprietors and others.

Shelter Belts.—The reporters consider that in view of the exposed nature of the parish, the provision of belts of trees to provide shelter for stock would be an advantage of first-rate importance. In the district, woods have, in recent times at least, never been plentiful, and while a number of these were cut down during the war and post-war years, relatively little replanting has since been carried out. Practically all farmers readily admitted the potential advantages of judiciously placed shelter belts, and agreed that the loss of grazing land entailed in the earlier days of a plantation would be much more than balanced by the increased value of the adjacent land and by the shelter provided at stormy seasons and particularly at lambing time. On the other hand it was contended that too frequently woods and shelter belts became breeding places and refuges for rabbits that destroyed and poisoned surrounding pastures, and as the tenant had no right of access to the woods to effect the extermination of such vermin it became very difficult to control them.

The reporters consider that from the agricultural standpoint extensive planting on a large scale in the district would be a mistake. Such planting would necessarily be confined to the lower areas, and would thus materially reduce the proportion of low wintering grounds to high summer grazing. If the latter is to be utilised to the best advantage it is essential that the former should not be diminished. A policy that led to large scale afforestation in the district would, in the reporters' opinion, lead to the permanent establishment of deer on the higher hills, and thus exclude the possibility of developing sheep farming and of increasing the agricultural productivity of the district.

Damage by Deer.—Considerable loss is caused by the depredations of deer. On some farms ploughing was to be discontinued or considerably reduced because of the damage caused by deer to the growing crops. Not infrequently gardens of farmers and workers have to be surrounded by high fences to protect the vegetables grown for domestic consumption. On practically all hill lands, apart from those utilised solely for deer, the reporters found deer more or less abundant, and quite frequently observed herds of 50 to 150 on relatively small grazings, while on larger grazings greater numbers were seen. The reporters were informed that, while a proportion of these had probably migrated from the forests for the winter months, numbers remained on the grazings throughout the summer. Undoubtedly great damage is done by these raiders in winter and spring, particularly during severe weather. It is sometimes contended that the farmers are compensated by sheep being allowed into the forests in summer, but the reporters are decidedly of opinion that this view is incorrect. During the summer, when vegetation is at a maximum, the deer scarcely miss what may be taken by the sheep, but when food supplies are at a minimum, and herds of deer invade the lower wintering grounds of the sheep during the critical periods of winter and early spring, the results are disastrous from the standpoint of the flockmaster. The greater mobility of the deer enables them to travel much more rapidly over the ground than sheep can, and consequently they consume all that is best while the sheep must resort to the inferior herbage and suffer accordingly.

Deer Forests.—As already stated, more than half of the area of the parish is devoted to deer forests, the estimated extent being about 120,000 acres, some 40 per cent. of this land being under the 1,500 feet elevation. There is no doubt that owing to the conversion of land to deer forest the numbers of sheep in the parish have fallen considerably in the last fifty years, a very moderate estimate being 40 per cent. As a whole the forests provide comparatively little employment in the parish.

The reporters consider that agriculturally the land is not being put to the best purpose, and that by skilful management good sheep stocks could be maintained and reared on the land now devoted to deer. As previously mentioned much of the heather is at present of a type useless for both sheep and grouse, and the sheep carrying capacity could be greatly increased by thorough draining and systematic heather burning.

Under present circumstances, of course, the grazing value of such land would not be equivalent to its value as deer forest. On the other hand, from the point of view of value it appeared to be the opinion that deer were destructive of grouse interests, and the reporters express the view that if the grouse numbers could be increased by 50 to 100 per cent. the sporting value of the land would show little decrease, and that with the grazing rent the total income would be little, if any, below that yielded at present. To accomplish this state of affairs the reporters consider that the following steps would be necessary :—

(1) Deer must be replaced by sheep.

(2) Heather must be burned systematically and according to the most approved methods of moor management. This would secure a maximum production of food to birds in the critical spring months.

(3) Extensive drainage must be carried out. This would maintain healthier conditions for the birds and increase the area under good heather.

The reporters consider that a development of a policy on these lines would materially contribute to local and national wellbeing.

Conclusions.—The main conclusions arrived at by the reporters may be summarised as follows :—

1. In the parish the standard of farming is on the whole satisfactory, but is affected in many cases by tenants not having sufficient security of tenure.

2. The creation of deer forests has resulted in the reduction of a number of farms to small dimensions, sometimes of inferior land, which without the higher land previously available is incapable of being utilised to the best advantage. Further, the costs of maintenance of steadings, buildings, fences, &c., are heavy in relation to the rents received, and the tendency is to allow them to fall into disrepair.

3. While most of the soils are acid in character, the application of lime, apart from a small proportion of the area which is favourably situated, is economically out of the question. Amelioration of the condition of the hill land can be effected only by thorough drainage.

4. Simplification in the methods of valuing, and in stating values of sheep stocks, is desirable.

5. Deer are causing considerable damage on all grazings.

6. Draining and systematic heather burning require to be tackled vigorously.

7. The provision of small shelter belts on judiciously selected sites would be a decided advantage.

8. Notwithstanding the fact that the great majority of the farmers are fairly prosperous, the reporters consider that the agricultural interests are to a great extent sacrificed to those of sport.

9. Not less than 40 per cent. of the deer forest land lies under 1,500 feet and constitutes potential wintering ground for sheep, while the bulk of the remainder is suitable summer grazing land. So far as the reporters were able to ascertain all this forest land formerly carried sheep stocks. While under previous systems the higher ground would be under wethers, the reporters express the view that by judicious management these grazings could carry ewe stocks. They consider that the conversion of deer forest land to sheep grazings with attention to draining and

heather burning, and concurrent encouragement and development of grouse shooting, would probably occasion little if any reduction either in the income derived from the land or in its rateable value.

10. Under a policy of sheep and grouse the reporters consider that more labour would be employed than at present.

MILK FEVER.

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Although milk fever is to-day a disease of very considerable importance to the dairy industry, we possess no records of its occurrence until the end of the eighteenth century, for the first notice seems to be that of Eberhardt, who observed its occurrence in 1793. A few years later it was described by John Price in his "New Useful Farrier and Complete Cow Leech," and also by Skellet, another early English veterinarian who gave a good clinical description in a work entitled "A Practical Treatise on the Parturition of the Cow." We are probably on safe ground in assuming that the paucity of early records of the disease was due to the fact that the malady only developed to such an extent that it was recognizable as a clinical entity in the early years of the nineteenth century; otherwise so characteristic a condition could not have escaped observation and record. This is of more than historic interest, since it will be observed that its appearance corresponded with the commencement of the intensive breeding of the cow as a producer of milk.

The disease soon became generally recognised and was investigated by numerous authorities, but at this period milk fever was studied only in its clinical aspects, and it appears to have been frequently confused with septic puerperal affections until 1877, when Professor St. Cyr clearly differentiated the conditions.

It was at one time believed that milk fever attacked the cow exclusively, but it has since been shown that in some districts the ewe is commonly affected, and a few cases have been recorded in the milch goat and in the sow.

In the great majority of cases the cow is attacked within forty-eight hours after calving, although the disease may make its appearance while the act of parturition is actually in progress. A number of cases also occur during the last few days of pregnancy; in these last, however, it has been observed that the cow has always commenced lactation before the onset of the malady. Again, it is not uncommon to meet with a condition that appears to be identical with the parturient type of milk fever at any time during the lactating period and even in the dry cow, and there seems to be a special susceptibility to these late attacks during the periods of œstrum.

In ewes, milk fever (or "lambing sickness," as it has been called) has markedly increased in its incidence during recent years, and it may be said that the same general conditions of occurrence that are met with in the cow also obtain in the ewe.

The nature of the disease has long remained a mystery, and has been the subject of a large number of speculative theories which have been advanced from time to time by veterinarians throughout the world.

In 1897 Dr. J. J. Schmidt, a Danish practitioner, discovered that the injection of fluid into the mammary gland was followed in many cases by a rapid recovery. Schmidt quickly communicated his discovery to the veterinary profession, and upon the Schmidt treatment becoming generally adopted the mortality was reduced from 60 or 70 per cent. to 15 per cent. Later, upon the treatment being modified by Andersen of Skanderborg and others, mammary inflation replaced the injection of fluids, and the mortality was still further reduced. But, while a specific cure for the disease had been discovered, the cause of milk fever remained a mystery. Indeed, the very specificity of the cure rendered the nature of the malady all the more obscure.

So it came about that the veterinary profession was privileged to have presented for its solution a problem in etiology as intriguing, surely, as any which has confronted medical science. An apparently healthy, prime, milch cow, after performing successfully, and without mishap, a perfectly normal function, that is, parturition, is suddenly struck down by a serious disease, all cases of which present similar characters of occurrence and the same general train of symptoms; a disease from which she will probably die unless she be subjected to a simple mechanical process, whereupon she makes a recovery that is not only complete, but almost as rapid as was the attack.

The problem was the more attractive by reason of its apparent simplicity; we seemed to be confronted with an enigma. Could we comprehend the nature of the disease, the meaning of the dramatic recovery following mammary inflation should become evident; could we understand the action of the remedy, the nature, not only of milk fever, but of the group of eclampsias to which it appears to belong, should become capable of conception.

In 1924 Professor Henry Dryerre of the Royal (Dick) Veterinary College (now Physiological Biochemist at the Moredun Institute) and the present writer attempted the investigation of the problem, and as up to that time none of the experimental investigations had afforded any clue to the nature of the disease, we considered that a fruitful line of enquiry might be obtained by first submitting the whole problem to a process of reasoning.

Commencing with the fact that specific cure resulted, no matter whether antiseptic fluids, sterile water, oxygen or air were injected into the udder, it seemed obvious that the curative effect, whatever it might be, depended upon the mechanical distention of the mammæ.

We then premised that simple distention of the mammæ must act either :—

(*a*) by causing some endocrine disturbance, and/or

(*b*) by mechanically retarding or arresting milk secretion, and so preventing the loss in the milk of some substance vital to the organism.

That the disease was in some way closely associated with milk secretion was suggested by the facts that :—

(1) Its appearance as a clinical entity was coincident with the commencement of the development of the modern heavy milking strains.

(2) It was much more prevalent in dairy breeds than in beef breeds.

(3) It very commonly attacked those individuals which possessed specially deep milking qualities.

(4) The period of greatest susceptibility in the milking life of an individual cow corresponded to the period of greatest milk secretion. Cows with their first calf were very rarely affected.

(5) The rapid emptying of the udder by hand might precipitate the onset, while the practice of repeatedly removing small quantities of milk, or, alternatively, of permitting the calf to suck the cow for the first few days after calving, was recognised as a valuable preventive procedure.

The milch cow has been bred to produce an enormous quantity of milk; indeed, the quantity of her milk secretion may now be regarded as almost pathological.

The colostrum of the cow is rich in calcium, and it was considered likely that the onset of a profuse lactation might occasion a rapid reduction in the concentration of the blood calcium. This idea seemed to be supported by our further observation that the spastic seizures which often characterise the early stages of milk fever were tetanic in character.

We believed that the mere mechanical withdrawal of calcium from the blood as the result of the onset of a profuse secretion of milk could not in itself be regarded as the cause of milk fever, because if this were so every heavy milking cow would be subject to the disease.

For that reason we postulated that some other factor must act as a predisposing cause, and we suggested that such might be found in parathyroid dysfunction. The parathyroid, one of the glands which produce an internal secretion, possesses among other functions that of controlling the level of calcium in the blood and soft tissues.

The following, then, were the essential points in our hypothesis :—

(1) The nature of milk fever may be understood as a parathyroid deficiency, resulting in the accumulation of toxic

substances, such as guanidine, and a fall in blood-calcium, the fall in calcium being further accentuated by lactation.

(2) The curative effect of mammary inflation is due to

(*a*) the stimulation of adrenal secretion and the consequent oxidation of toxins, and/or

(*b*) the retardation of the formation of milk and the consequent prevention of further free exchange of calcium from the blood to the milk.

(3) The preventive value of a restricted withdrawal of milk from the udder after calving is due to this procedure conserving the concentration of calcium in the blood.

If our conception of the nature of the disease were correct, then it followed that the blood-calcium in milk fever should be below normal (hypocalcæmia). Analyses of seven samples of blood from as many cases of milk fever showed an average of 4·8 mgm. calcium per cent. serum; a marked reduction when compared with the normal—9 mgm. to 11 mgm. per cent.

While our subsequent work has amply confirmed our original view that acute calcium deficiency was an important factor in the production of the disease, there is now reason to doubt that the accumulation of guanidine bases plays an important part in its causation.

Our original view that mammary inflation possibly stimulated the secretion of adrenaline may also now be abandoned in view of the carefully conducted experiments of Auger, who was unable to note any rise in blood-pressure following inflation of the udder. (Adrenaline, another endocrine or internal secretion, by contracting the capillary blood vessels, markedly raises blood pressure.)

Later, in 1925, Little and Wright recorded the results obtained in blood-calcium determinations on twelve cases of milk fever. They showed that a considerable diminution in the blood-calcium (in mild cases 20 per cent. to 30 per cent., and in severe cases up to 60 per cent.) accompanied the onset of the disease, and they also found that the greater calcium reductions accorded with the more severe cases.

These and our own experiments therefore furnished considerable support to our hypothesis, and further work has amply confirmed the original conception that calcium deficiency is the primary cause of the disease.

The results of this experimental work may be shortly summarised as follows :—

(i) There is no difference between the calcium values in parturient cows and those in non-parturient cows and in bullocks.

(ii) The onset of milk secretion is accompanied by a transient but appreciable fall in the blood-calcium, which returns to normal after the crisis of initiation of lactation is passed.

(iii) In milk fever there is invariably a pronounced fall in the blood-calcium (82 cases examined). The degree of severity of the symptoms bears a distinct relation to the calcium level in the blood. From a series of observations made in one case, before and during the attack, the fall in calcium appears to be abrupt; it is coincident with the onset and corresponds with the progressive severity of the symptoms.

(iv) In an examination of 81 cases of diseased conditions in cattle other than milk fever, none was found to present a hypocalcæmia in any way comparable to that which obtains in that disease.

(v) Inflation of the mammæ of normal lactating ewes causes a rise in the blood-calcium (about 10 per cent.).

(vi) Inflation of the mammæ of the cow in cases of milk fever results in a pronounced rise in the blood-calcium. The rise is at first rapid, and the case usually shows definite signs of recovery when a level of about 6 to 7 mgm. of calcium per cent. has been reached.

(vii) Injection of calcium gluconate, exclusive of other treatment, elicits specific curative response in milk fever.

(viii) The subcutaneous injection of calcium gluconate can abort the milk fever attack. Evidence has been obtained which suggests that calcium injection immediately after calving and preferably reinforced by a second injection about 24 hours later would prove a preventive treatment.

(ix) The repeated oral administration of massive doses of vitamin D has been found to cause a marked rise in the blood calcium which can persist for about five days.

The observation suggests that the disease may also be prevented by this means by commencing the administration of vitamin D a few days before calving.

(x) The blood-calcium values of normal sheep were observed. It would appear that the normal variation of blood-calcium is greater in sheep than in cattle.

The association of acute hypocalcæmia with lambing sickness has been determined, and the identity of this disease with milk fever established.

The known curative effects of mammary inflation in lambing sickness are also correlated with a rise in the blood-calcium values. In many cases the curative effect of subcutaneous injection of calcium has been tested; the treatment has resulted in rapid recovery.

(xi) The calcium values of normal horses were found to be considerably higher than those of cattle and sheep. In an examination of two cases of transit tetany in mares a pronounced hypocalcæmia was found. In one case of transit tetany, mammary inflation, and in the other, calcium injection, was followed by complete cure.

Conclusions.—I. *The essential cause of milk fever is an acute blood-calcium deficiency.*

II. *The specific curative action of mammary inflation consists in raising the blood-calcium values.*

These conclusions are based on the following considerations :—

(1) Milk fever is invariably associated with an acute hypocalcæmia.

(2) The more severe cases correspond with the lower calcium values.

(3) The fall in calcium is approximately coincident with the appearance of the symptoms.

(4) Tetany is a symptom in severe cases of milk fever, and the occurrence of tetany is recognised as consequent upon pronounced hypocalcæmia.

(5) Mammary inflation raises the level of blood-calcium in a normal lactating animal.

(6) Mammary inflation elicits a marked rise in the level of blood-calcium in milk fever and cures the disease; the process of cure, as manifested in the disappearance of the symptoms, corresponds with the rise of the blood-calcium.

(7) Injection of calcium, exclusive of other treatment, raises the blood-calcium concentration and cures the disease.

(8) Milk fever in cows, lambing sickness in ewes, and transit tetany in mares are all rapidly cured by mammary inflation, and these are the only conditions in an examination of over 500 samples of blood in which an acute hypocalcæmia has been found.

The practical application of this work lies in the fact that a treatment other than that of the classic udder inflation has been discovered. The treatment is already widely practised in this country, and is becoming increasingly employed both in America and on the Continent of Europe. While its value as an alternative to mammary inflation can only be determined by experience, it would appear to possess the following advantages :—

As is well known, inflation of the udder is frequently followed by a considerable decrease in the milk secretion, which may continue for several days.

The calcium treatment, on the other hand, does not hinder milk secretion, and the cow comes to her normal lactation within a few hours after recovery, which is as rapid as that following mammary distension.

It is highly desirable that so important an organ as is the udder in the milch cow should not be interfered with. The dangers which attend mammary injection by unskilled persons are well known.

Since the nature of the disease is now known, it is possible to devise methods for its prevention. These might consist either in the administration of calcium immediately after calving, the treatment being preferably reinforced some 20 hours later by a second administration; or by the administration during the last days of pregnancy of a suitable preparation of vitamin D, which, as is well known, has the power to fix the calcium in the tissues,

FIG. 1.—Before treatment: Cow had been attacked for about eight hours; complete prostration; reported as being "practically dead."

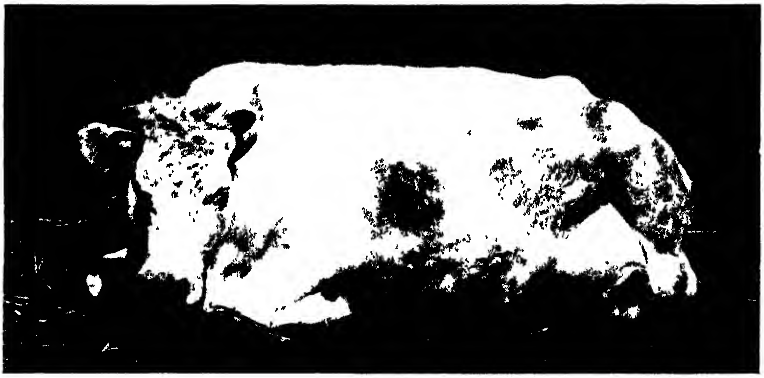

FIG. 2.—Two hours after subcutaneous injection of Calcium Gluconate: Consciousness restored; able to maintain normal recumbent position; in process of rapid recovery.

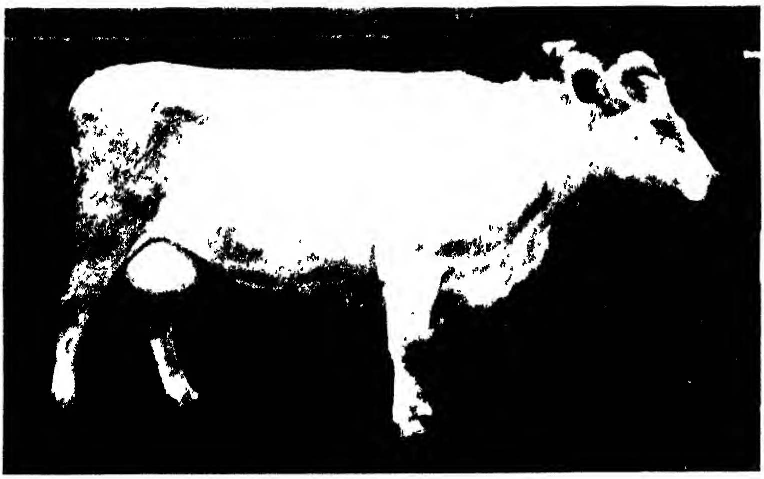

FIG. 3.—Photographed two days later.

and so prevent the rapid fall in the calcium level which is liable to occur during the initiation of lactation.

The disease known as lambing sickness, which has now been shown to be identical in its etiology with milk fever, exacts a heavy toll on parturient ewes, and indeed it is only in recent years that the extent of the losses from this disease have become appreciated.

It has now been discovered that the calcium treatment also acts with specific efficacy in this condition, and the investigation of means for its prevention is now being prosecuted.

THE BIOLOGIST on the FARM.—No. XXXIX.

Sir J. Arthur Thomson, M.A., LL.D.,
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A Sigh for St. Kilda.—Perhaps it is more humane that this remote island should be surrendered to solitude. For it was often inaccessible, and thus on the brink of tragedy. The conditions of human life were too strenuous, not to say desperate, and we have heard it said that the scanty pasturage was becoming badly exhausted. All of us will wish well to the three dozen inhabitants now taken from their old haunts, and hope that they will find a less exacting life in places like Skye and Morven. We hope that, wherever they go, they will not be harried by exposure to multiplied infection by microbes, to which, in their isolation, they have not become accustomed. It has often been noticed that explorers from the Arctic and the Antarctic have a succession of heavy colds when they return to the home country. We have dragged in the explorers lest it be thought for a moment that we are biologically patronising the transported St. Kildans. We are but wishing them well, with the thought up our sleeve that few of them will long after the flesh-pots of fulmar with which they have been so familiar for many years.

Our sigh is for the biological treasures that have to be left behind—the St. Kilda Wren, a unique species found on all the islands of the group; the St. Kilda Field Mouse, *Apodemus hirtensis,* which occurs on Hirta, Soay and Dun; and the St. Kilda House Mouse, *Mus muralis,* which used to be confined to the Post Office of Hirta. Besides these there may be two or three others, almost, if not quite, peculiar to the lone islands; and we cannot forget the interesting old-fashioned half-wild sheep of Soay, whose origin seems to be hidden in the mist.

Why should a remote island have a wren or a Field Mouse all to itself? Why is there an Orkney vole and a Fair Isle mouse? The answer seems to be that these insular species are derived from immigrants from the mainland, belonging to the species of Common Wren and Common Field Mouse; and that these immigrants varied, as many animals are always doing, and as children in a human family so often illustrate. New departures or individualities emerge from the germinal fountain of change, and if these new departures (variations or mutations) are not disadvantageous, or are in some little way advantageous, and if they find others like themselves to pair with, they will form a new sub-species or species which may supplant or exist alongside of the original stock. The reason for the not infrequent occurrence of these unique species on islands is simply that insulation or isolation lessens the range of intercrossing, and brings similar forms together as parents. In the famous case of the Galapagos Islands there are seven different species of Giant Tortoise now isolated on seven different islands of the archipelago, each island with its own treasure, except that the largest island, Albemarle, contains five species. The explanation must be that a great peninsula with one species of Giant Tortoise was submerged so that its volcanic peaks formed an archipelago, and that in the course of time, as variation continued and isolation persisted, many true-breeding distinct species arose on the various islands. Little can we wonder at young Darwin's exclamation at Galapagos, that he felt himself "brought near to the very act of creation." Scores of similar instances of peculiar species on islands are so cogent that we can understand why the older Darwin dropped the word *creation* (from the biological dictionary) and substituted the word *evolution*. It will be understood, of course, that if the word creation is used to mean " the emergence of the new " or " the Divine ordering of Nature by which the process of evolution came and comes about," no scientific investigator has, as such, any objection to offer.

We are getting a little far from the remote St. Kilda, though not so far from the biologist on the farm, but we take this opportunity of saying that no naturalist supposes that a mainland Field Mouse turns into a St. Kilda Field Mouse. That would be magic, not evolution. What happens is that in the course of generations novel variations crop up in the successive families, and it is the survival and success of these divergent variants that result in new species which may exist alongside of their originative stock.

There is no particular difficulty in the question of the original arrival of the immigrants. The mice and voles might come as stowaways on board fishing smacks or the like, and the little wren can fly far. In the case of the Galapagos archipelago, the non-swimming Giant Tortoises found themselves marooned by some geological change.

Intelligence of a Wasp.—An observant correspondent sends us a description of a wasp's effective behaviour. He saw it catch a bluebottle inside the window-sill and fly off with it to the top of the window, which was slightly open. But there was an incurrent breeze and exit was baffling, especially as the breeze caught the bluebottle's wings. Several times the wasp failed and the bluebottle tumbled on to the sill. After a few failures (the number not recorded) the wasp cut off the victim's wings and flew off successfully, having reduced the friction of its burden. Our correspondent asks whether such an instance does not prove Reason; and, if not, why not?

Our answer is that the use of the word Reason in such a case is much too generous, if we are to use words in a precise scientific way. Since Comparative Psychology became more exact it has been usual to keep the word Reason for the mental process of experimenting with general ideas or concepts, for "conceptual inference" in short. When a man builds a bridge in a difficult situation and works out a plan that requires some very clear-headed thinking—in many cases mathematical—he is illustrating Reason; but there is no convincing evidence than any animals ever rise to this level. The nearest approaches are on the part of anthropoid apes, horses, dogs and elephants; but the cleverest behaviour of the cleverest animals does not usually lead us to credit them with more than intelligence, i.e. perceptual inference, experimenting with mental images and the like. They do not work with general ideas or concepts. We ourselves in our everyday life are oftener intelligent than rational, and similarly, but more so, with the cleverest animals. They may show reasoning or inference, without attaining to Reason; just as they often have words without attaining to language. The marvellous skill exhibited at a sheep-dog trial is a supreme illustration of intelligent behaviour, but our admiration, to be just, is bound to take account of the education of the collie by the shepherd and by its own kith and kin. To return to the wasp and the bluebottle fly, it may be already plain that the biggest word we dare use is intelligent, and that it would be far too generous to speak of Reason. The scientific rule is to try to describe behaviour with the simplest hypotheses, and it is simpler to credit a creature with intelligence or perceptual inference than to assume the operation of reason or conceptual inference. It is plain, however, that the simpler interpretation will have to be rejected if it does not adequately describe what happens.

On a different line from intelligent behaviour is instinctive behaviour, which requires no learning or apprenticeship, and may be perfect from the very first. It depends on inborn nerve-and-muscle linkages or pre-arrangements which bring about very effective results. An instinct is an inborn power of doing apparently clever things, and while it is probably accompanied by some measure of awareness and endeavour, it is physiologically near a chain of intricate reflex actions, such as we illustrate in coughing or sneezing or swallowing, in drawing our finger away from a hot cinder, or in closing our eye at the approach of a missile. The routine of a flower-visiting insect is often like a chain of reflex actions, but there are reasons for crediting the ant or the bee with some mental activity, such as enjoyment and endeavour, associated with its busy automatism. Moreover there is ample evidence that instinctive routine may be sometimes interrupted by flashes of intelligence that save the situation, as when a spider adjusts its web to a particularly difficult situation.

Now it is well known that wasps, and hornets in particular, often cut off the wings of their insect booty. We have seen one biting off the wings and the limbs of a Daddy-Long-legs or Crane-fly, thus making the booty more manageable. Since this is a common piece of behaviour, it may perhaps be regarded as part of the instinctive repertory, and if so, the only spark of intelligence on the part of the wasp that we began with may have been in bringing the inborn predisposition into operation under somewhat unusual circumstances. Our verdict would be: *largely instinctive, but with a spice of intelligence.* But more observations are needed before we can interpret the case with a clear intellectual conscience!

Woodpeckers and Acorns.—By a roadside in California we saw a telegraph post covered with hundreds of little knobs. Some were so near the ground that we could scrutinise them—though our learned guide had previously let the cat out of the bag. We satisfied ourselves that they were acorns with the upper pointed end wedged inwards into a bored hole and the lower blunt end projecting. On one post there were two hundred, and on some oak trees near by there were many hundreds. This interesting occurrence has been very carefully studied recently by Professor W. E. Ritter of the University of California, one of the most thoughtful investigators of animal behaviour. He finds that the common Californian Woodpecker has developed this habit of storing acorns, inserting them firmly in niches of oak-trees or boring holes for them if that be necessary. Tens of thousands of acorns are thus kept in store in good condition, and some of them are used in days when fresh acorns are no longer available.

One cannot credit the woodpeckers with taking thought for the morrow; there are no serious risks of starvation. The theory that they store the acorns to allow of the development of a palatable grub, which they afterwards howk out, is not supported by Professor Ritter's data. Only a few of the stored acorns contain grubs. There may be something in the suggestion that fixing the acorns in holes, made or ready-made, prevents rotting and facilitates splitting off the hard envelope of the fruit. Yet it has to be remembered that the custom is local rather than general, and that many acorns are left unused. Perhaps a new concept or idea is required for this queer case of animal behaviour —the idea of "ploy." We mean an exuberance of half-playful activity beyond what is necessary or even advantageous. The birds in question have a strong foothold in the struggle for existence; they have plenty of time on their hands and plenty of food at their disposal; they are vigorous buoyant creatures, and so they make a sort of ploy of storing acorns instead of immediately devouring them. It is "good fun" to work so hard! We suspect that many animals exhibit these "ploys," which a wooden Selectionism finds it difficult to understand.

The naturalist-warden of the Yosemite Park told us that some of his woodpeckers stored lumps of suet—with obvious consequences. We had the good fortune to see the wooden shingles stripped off a shed, disclosing bushels of acorns which had been dropped into a slit irrecoverably by the playfully ploying woodpeckers. Life is not always on a serious note.

The Origin of the New.—Whether we breed animals, or test different kinds of plants in farm and garden, or simply study the novelties which are always turning up in Animate Nature, we come back to the question: What gives rise to the new? Year after year we have this problem to chew at: How is it that offspring are so often different from their parents? This is one of the central problems of Biology. An old answer was that circumstances are changeful, and that new conditions evoke new structures and habits. The sheep gets longer fleece in a cold country, and the peach tree becomes an evergreen in a genial one. But while this is true of individual living creatures, that they change with changes in nurture, we all know that there is little convincing evidence to show that these individually acquired novelties or modifications, directly due to peculiarities in surroundings, food or habit, can be handed on to the offspring, even in a slight degree.

Another suggestion is that there are in the history of the germ-cells—especially in their ripening and in the union of sperm-cell and egg-cell in fertilisation—various opportunities for shuffling the hereditary cards, by which we mean the germinal factors or initiatives ("genes," as they are called) which correspond to certain characters of the organism in question. An inheritance is usually a very complex bundle of possibilities, and at the very beginning of the individual life there may be novel permutations and combinations, evoking new patterns. A piebald pony may serve as a diagram, or a white blackbird which develops from a fertilised egg-cell that has somehow lost the hereditary "factors" for pigmentation. There must be something in this theory, for it has a strong experimental basis, but it does not satisfy us when we think of novelties that are much more than new patterns. Thus a human genius is more than a very happy combination of parental and ancestral features; and so was man as compared with his pre-human forebears; and so in the history of domesticated animals and cultivated plants. What is the origin of the qualitatively new,—of startling mutations, whether among kings or cabbages?

It is possible that it is of the very nature of living cells to re-arrange their constituents, as if unconsciously experimenting, just as it is of the very nature of the human mind to experiment restlessly with ideas and images, thus always becoming more or less new. When cerebral variability is very startling we say to ourselves: What an original fellow he is! But Science is always loath to say much about spontaneity, until the influence of outside stimuli has been thoroughly explored, and we cannot say that this has yet been done in regard to organic variations.

Thus the thoughtful biologist Weismann suggested long ago that deeply saturating environmental influences, e.g. of climate, and deeply penetrating changes of diet, e.g. those we now associate with vitamins, might serve as trigger-pulling stimuli to the natural changefulness of the germ-plasm, that is to say the inheritance-carrying living matter of the egg-cells and sperm-cells. The organism is shifted to a new climate and its body is slightly changed, but the novel influences may penetrate into the germ-cells and affect them along with the body,—affect them to this extent at least that their variability is prompted to expression. External changes seem sometimes to serve as the liberating stimuli of novelties or new departures.

As a particular case of environmental influence as a change-producer, we wish to refer to a suggestion made some three years ago by H. J. Muller, that radiations from the earth, or even cosmic rays, may have played a part in evoking new departures in organisms. Under the influence of X-rays and other radiations from radio-active substances in experimental conditions, Muller found that the crop of mutations in Fruit-flies was larger than usual. Normally there are some such radiations in natural conditions, and they may have been more abundant long ago when radio-active substances occurred in different proportions on the earth, or, in other words, before there was so much lead as there is now. For lead is a familiar end-product in the disintegration of radio-active elements such as uranium and thorium.

What Muller began has been carried a little further by Olson and Lewis, J. B. S. Haldane and others. Some recent experiments by Hanson and Heys, in California and Colorado, go towards showing that there is an increased rate of mutation in flies exposed to an unusually high degree of natural radiation. It is an idea worth thinking over and worthy of persistent experiment, that natural radiation may supply and may have supplied some of the mutation-grist for the Natural Selection mill.

Is Litter Size Heritable?—One of our friends once remarked that celibacy was hereditary in his lineage, and though there might be better ways of putting it, he probably expressed a fact. The more we know about heredity—the relation of genetic continuity between successive generations—the more clear it becomes that its laws hold not only for clear-cut characters like eye-colour and hair texture, but for subtle characteristics like longevity and fertility. Even the tendency towards sterility may show itself in related families for several generations.

Thus we welcome Mr. Buchanan Smith's question: Is litter size inherited? With reference to pigs he adduces evidence that the size of the litter is a heritable character, and so is the ability to produce the litters with regularity twice a year. It cannot be said to be a rule that the boar affects the size of the litter produced by the sow with which he is mated, but he is a transmitter (or might we say "continuator") of the character prolificacy, just as the dam is. He has an effect (probably in every way as great as the sow has) on the size of the litters produced by the gilts of which he is the father. Ten to twelve is about the ideal number for a litter.

But nurture counts as well as nature, for " in the improved breeds the hereditary factor is perhaps not the most important as regards litter size. Good husbandry is of prime importance. But equally important is good mothering ability on the part of the sow." And this also appears to be a hereditary characteristic.

This is very interesting to the general biologist, for " reproductive selection," depending on the numerical strength of the family, is believed to play a very important rôle in Nature's sifting; just as important, perhaps, as " lethal selection," which means the winnowing out of individuals handicapped by some disadvantageous feature. Then it is also refreshing to the general biologist to find experimental emphasis laid on " good mothering ability."

What is Manna?—The first part of the answer is that manna is not one thing but many. The second part of the answer is that all green plants are sugar-factories, and that manna represents some exudation of sugary substance which has been built up in the normal photosynthesis. Thus most modern manna (manitol) is obtained by making cuts on a kind of ash tree, but similar exudations (though without manitol proper) are obtained from many different kinds of plants, such as various species of oak, willow and eucalyptus. But the third part of the answer is that the co-operation of an insect is often required. Thus the sugary drops from the Tamarisk shrub, which solidify on the ground on cold mornings, are due to the punctures of a Coccus insect. This is probably the manna of the Old Testament.

Other insects besides Coccus insects may be concerned in manna-making; thus Professor F. P. Worley of Auckland has recently described a Manuka Manna produced by a sap-sucking plant-hopper; and in another New Zealand case the exudation came from branches bored by the grub of a longhorn beetle. It came out as a viscous syrup thicker than honey and crystallised into a fairly hard white mass.

THE NEED FOR SELECTION OF DAIRY BULLS.

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ONLY the exceptional dairy cow adds even three heifers to the herd in her lifetime, while bulls can sire hundreds of daughters. It can be seen therefore that it is essential that only good bulls be used if the production of dairy herds is to be increased or even maintained.

The majority of dairy bulls are still selected on appearance, and while it is essential if strength and constitution are to be obtained that conformation be given due consideration, selection on appearance alone is not enough if bulls capable of transmitting producing ability to their daughters are desired. Attention is now being given to pedigree and the producing abilities of related animals, and although this is of considerable assistance in the selection of dairy bulls, it cannot be the sole guide until breeding problems and the influence of heredity are better understood.

The best indication of the value of a bull to head a dairy herd is the relationship which exists between the production of his daughters and that of their dams. It is but seldom that bulls are selected on this basis.

Scope of the Investigation.—Milk recording was started in Scotland in 1903 largely through the efforts of the late Mr. John Speir of Newton. In the early years the work was carried on under the auspices of the Highland and Agricultural Society of Scotland, but at the end of 1907 it was taken over by a committee representing the Highland and Agricultural Society, the Ayrshire Cattle Herd Book Society and the local milk recording units. In 1913 the organisation became the Scottish Milk Records Association, and from 1914 onwards it has contained representatives from breed associations other than the Ayrshire Cattle Herd Book Society, the Scottish Agricultural Colleges and other interested bodies.

During the progress of milk recording in Scotland large numbers of milk records of individual cows have been obtained, and it was decided that the West of Scotland Agricultural College should make use of these in a study of breeding and management problems affecting the dairy industry. When the work was undertaken it was considered that the best procedure at first would be to take all available completed records from registered Ayrshire cows in a definite district for the 20 year period from the start of recording in 1903 to the end of 1922, the district comprising the three south-western counties Dumfries, Kirkcudbright and Wigtown being selected.

Milk recording was not continued throughout the year in all societies from the time they started, and it was decided that only data from societies which kept complete yearly records would be included. Some are almost complete, but it was deemed advisable to neglect these rather than attempt to put an arbitrary time limit on the records.

It was also necessary to limit the investigation to cows of known pedigree, that is registered animals, as it was only in this way that it was possible to trace the records of an individual cow from year to year with certainty, or to determine the relationship existing between different animals. As a consequence the only records used were those of cows entered in the herd books of the Ayrshire Cattle Herd Book Society or appendices thereof. These necessary limitations have reduced considerably the number of records available.

During the 20 year period there were 303,075 individual milk records completed in Scotland, and of these 149,892, or nearly half, were made in the three south-western counties. Though milk recording was started in this district in 1903 it was not until 1906 that it was continued from year to year, and not until 1912 that it was continuous throughout the year. From 1912 to 1922 there were 122,933 records made within the three counties, and of these 71,578 were made in herds tested throughout the year. Then again, of these only 22,714 were of Ayrshire cows the breeding of which could be determined from the record books, and so be of value for the present purpose.

Improvement in Milk Recording in Scotland.—It is generally recognised that where milk recording is carried on improvement in milk production occurs. It would be difficult to show all the improvement which has taken place since the beginning of recording work in Scotland, but from 1914 onwards a definite system of classifying all milk recorded cows has been in use, and a study of the groupings obtained gives an indication of the trend of progress.

All recorded cows giving not less than 250 lb. of butterfat in a year are put in Class I, while those giving less than 166 lb. are in Class III and intermediate animals in Class II. The standard for heifers with their first calf is not less than 200 lb. for Class I and not over 133 lb. for Class III.

In Table I the percentages of the recorded cows, in Scotland as a whole and in the three south-western counties, which fall into each of the grades are given from the beginning of grading in 1914 to 1922. For the first two years all cows are included, while for later years the relatively small number of cows in herds not recorded throughout the year has been excluded. The figures for Scotland as a whole have been taken from the reports of the Scottish Milk Records Association (5), while those for the three counties have been calculated.

TABLE I.

Classification of Recorded Cows.

Year.	Scotland.			South-Western Counties.		
	Class I.	Class II.	Class III.	Class I.	Class II.	Class III.
	%	%	%	%	%	%
1914 ...	39½	51½	9	33¼	56¾	10
1915 ...	46	48	6	44¾	49¾	5½
1916 ...	53¼	42	4¾	50	45¼	4¾
1917 ...	50	45¼	4¾	43¾	51¼	5
1918 ...	49	45½	5½	42¼	51	6¾
1919 ...	49½	46	4½	41¼	52¾	6
1920 ...	56¼	41½	3¼	48½	47	4½
1921 ...	58¾	37¼	4	53¾	41¼	5
1922 ...	63	35	2	59½	37½	3

That improvement in the milk production of the dairy herds of Scotland has taken place is evident from this table. For

Scotland as a whole the Class I cows increased from 39½ per cent. in 1914 to 63 per cent. in 1922, while for the three counties they increased from 33¾ per cent. to 59½ per cent. Then the Class III cows decreased from 9 per cent. to 2 per cent. in Scotland as a whole, and from 10 per cent. to 3 per cent. in the three counties.

This indicates a considerable improvement in production both in Scotland as a whole and in the three south-western counties, though the change in that section is rather less marked than is the average for the country. The slightly lower percentage of first class cows and slower rate of improvement in the three south-western counties as compared with the country as a whole is due to the difference in the size of the herds and consequent variations in methods of handling. It has been pointed out by M'Candlish and Cochrane (4) that in 1929 the milk recorded herds in the three south-western counties contained on the average 57 cows, while the average for the remainder of the milk recorded herds in Scotland was 32 cows, and for the country as a whole 41 cows per herd. Where the herds are large the greater portion of the work is done by hired labour, and the cows do not receive the individual care given to animals in smaller herds attended by the farmer and his family.

During the latter part of the world war there was a slowing up in herd improvement which is indicated in the table. This may be attributed to the scarcity of labour and the difficulty of obtaining purchased foods.

Causes of Improvement.—If it be admitted that there has been improvement in the production of the dairy herds of the three south-western counties of Scotland during the period under review, the question is, how was this brought about? Was it due to improved methods of feeding and management, to selection, or to the breeding policies pursued? This is a difficult question to answer, but the data available give some information on this point.

A Study of Sires.—When it was decided that the first question to be tackled in this investigation was that of the sires used, it was felt that the best way to do this would be to study them by periods. In this way any indication of improvement in the sires used, as breeding and testing work progressed, would become apparent. The first bulls to be studied therefore were those used in the district from the beginning of milk recording up to about the start of the world-war period.

For this purpose all cows registered by the Ayrshire Cattle Herd Book Society (1) up to 1915 were included and these animals were grouped according to their sires. In many cases it was found that only a few daughters of a sire were available, while again the records of the dams of these cows could not always be obtained. For the inclusion of a bull in this category the records of six of his daughters and the records of the dams of those daughters had to be available. This decision appears to be justified on the basis of the work of Davidson (2), who found that the first six tested daughters of a Jersey sire is the smallest number whose average production can be used as a means to measure the approximate breeding value of a sire.

There were ultimately available 79 bulls with six or more recorded daughters whose dams' records were also known. The total number of records for the 795 daughters of these bulls was 2,710, while the total number of records for the dams was 2,680 if each cow with two daughters be included twice and so on. There were 16 bulls with six daughters each, and the numbers of bulls decreased rapidly as the number of daughters per bull increased. The highest number of daughters for any bull was 27. The general distribution of the bulls with various numbers of daughters is given in Table II.

TABLE II.

Daughters per Bull.

Daughters per Bull.	*Number of Bulls.*
6 to 10	60
11 to 15	9
16 to 20	4
21 to 25	5
Over 25	1
Total	79

The daughters of the bulls had an average of 3·4 lactation records available, while the average for their dams was 3·3 records. However, as the records of a daughter were frequently made at different ages than those of her dam, it was felt desirable to bring all records to a common age basis before any comparisons were made. All records were accordingly corrected to the mature age of seven years as described by Kay and M'Candlish (3).

When the average age-corrected record for each animal had been obtained the daughters of each bull were compared with their own dams. This showed whether the daughters of the sires were better or poorer producers than their dams, and gave an indication of the value of the bulls in dairy herds.

The Results.—The dams used had an average production, corrected to maturity, of 7,549 lb. of milk at 3·61 per cent. of fat, or 272·6 lb. of fat, while their daughters averaged 7,180 lb. of milk at 3·77 per cent. of fat, or 270·8 lb. of fat. The results show very creditable production in both generations, but still are rather disappointing as they indicate that the daughters of the 79 bulls averaged 5 per cent. less milk and 1 per cent. less fat with a 4 per cent. higher butterfat content in the milk than their dams. Evidently in the district and period under review the improvement in production which occurred can not be attributed to the use of the sires.

The records included were made during the period 1912 to

1922 inclusive, but were all made by animals born not later than 1914. Recording started in the district in 1903, but was not continued throughout the year and from year to year until 1912. Nevertheless, though the early records were not absolutely satisfactory, from lack of completeness with all cows, they gave a fairly satisfactory basis for the selection of bulls according to the production of their daughters. The results, which are all based on complete records, should give some indication of what the conditions were among the bulls used in the early days of milk recording.

The daughters of the bulls studied, that is those in herds from some time after 1903 up to the end of the pre-war period, were on the average poorer producers than their dams. The variations in production between dams and daughters range from a decrease of 27 per cent. to an increase of 14 per cent. in milk yield, from a decrease of 26 per cent. to an increase of 18 per cent. in fat yield, and from a decrease of 6 per cent. to an increase of 14 per cent. in fat content. The numbers of bulls showing various degrees of alteration in the production of their daughters as compared with their dams are given in Table III.

TABLE III.

Distribution of Good and Poor Bulls.

Percentage Change.	*Milk Yield.*	*Fat Yield.*	*Fat Content.*
Decrease of			
26 and over	1	1	–
21 to 25	1	–	–
16 to 20	3	6	–
11 to 15	9	5	–
6 to 10	12	14	4
Up to 5	27	16	20
Increase of			
Up to 5	13	16	48
6 to 10	11	14	6
11 to 15	2	5	1
16 to 20	–	2	–
Total ...	79	79	79

From this table it is evident that there were great differences in the value of the bulls used and that more of them were doing harm than good. It is perhaps unfair, however, to label a bull good or bad when his daughters differ but little in production from their dams. In Table IV a different system of classification has been used.

TABLE IV.

Good, Bad and Indifferent Bulls.

Type of Bull.	Distribution.			Percentage Distribution.		
	Milk Yield.	Fat Yield.	Fat Content.	Milk Yield.	Fat Yield.	Fat Content.
A.—Good and Bad only.						
Good	26	37	55	33	47	70
Bad	53	42	24	67	53	30
B.—Good, Bad and Indifferent.						
Very Good	2	7	1	3	9	1
Good	11	14	6	14	18	8
Indifferent	40	32	68	51	41	86
Bad	12	14	4	15	18	5
Very Bad	14	12	...	18	15	...

First of all the bulls are simply classed as "good" or "bad" according to whether or not their daughters were higher or lower producers than their dams, no attention being given to the amount of change produced. On this simple basis of classification it is found that the daughters of 67 per cent. of the bulls produced less milk than their dams and only those of 33 per cent. showed an increase; in fat production those of 53 per cent. were poorer than their dams and those of 47 per cent. better; while in the fat content of the milk those of 30 per cent. were poorer than their dams and those of 70 per cent. better.

In the next grouping bulls with daughters showing a variation in production from their dams of not over 5 per cent. are classed as indifferent; those bringing about an increase of over 5 per cent. and less than 10 per cent. are good; and those 10 per cent. or over very good. Those showing decreases over the same range are called bad and very bad.

So far as milk and fat yields are concerned a very large proportion of the bulls fall in the indifferent group. The good, bad and very bad groups are about equal in size, while relatively few animals are classed as very good. The great majority of the bulls had little influence on the fat content of the milk. When these facts are looked at broadly they are very disappointing so far as improvement through the sires is concerned.

The three points in production being studied are the yields of milk and butterfat and the percentage of fat. The changes in the percentage of fat depend on the changes in the yields of milk and butterfat. As the milk yield and fat yield may vary independently there are several probable relationships in the results obtainable. In Table V are given the numbers of bulls whose daughters showed the various combinations of these changes.

[TABLE. V.

TABLE V.

Relationship of Changes in Milk and Fat Yields and Fat per cent.

Milk Yield.	Fat Yield.	Fat Content.	Numbers of Animals.	Percentage Distribution of Animals.
Increase.	Increase.	Increase.	19	24
Increase.	Increase.	Decrease.	5	6
Increase.	Decrease.	Decrease.	2	3
Decrease.	Decrease.	Decrease.	17	21
Decrease.	Decrease	Increase.	23	30
Decrease.	Increase.	Increase.	13	16

Here again the remarkably small numbers of bulls which have been of value is emphasised. There are almost as many bulls bad in all three characteristics as are good in all three.

Practical Problems.—Irrespective of the method of grouping the bulls, it is very evident that only a small percentage of them were of value in increasing the production of their daughters over that of the dams of those daughters, so far as either milk yield, fat yield or fat content of the milk is concerned. Apparently little was being accomplished during the period studied in the selection of bulls at the head of dairy herds. Milk recording in the district was not complete throughout the year in the period just before that for which the records used were taken, but it should have been sufficient to allow of some selection of the bulls.

Improvement in the production of the herds was taking place in the counties studied as well as over Scotland as a whole, but the improvement must be attributed largely to factors other than selection of the sires. No absolutely definite figures can be given at present for the years subsequent to the period covered by this study, but it would appear very probable that somewhat similar conditions still prevail, and that the selection of the herd sire does not receive sufficient consideration. Data from later periods and other districts are being collected and it is hoped that further results will be available soon.

Though everyone admits that the selection of the sire to head the dairy herd is important, it would appear that there are certain factors which have tended to limit activity in this direction. A very common practice has been to buy a young bull, use him for a year or two, and then dispose of him when his daughters begin to come into the herd or when he develops a bad disposition. The two great drawbacks to this are that a poor bull is used just as long as a good one and good bulls are disposed of long before their value is known.

At present the only real guide to the value of a dairy bull is the production of his daughters as compared with that of their dams, though a knowledge of the production of his dam and other closely related females may also be of some value. So long as these conditions remain, the only hope of generally increased production of dairy herds through the sires lies in a change in the present method of selecting and handling bulls.

To get satisfactory results some method of proving sires must be adopted. The most satisfactory method would be to use each young bull of promise on a few females and then retain him until the value of his daughters is known. If he proves worthless he should then be disposed of before he can do further damage, but if valuable he should be used until old age.

This may seem a difficult and expensive method, but some modification of it is being employed in many of the best herds to-day, and in the end it will be found to be one of the surest and least expensive methods of herd improvement. If suitable accommodation be provided in large herds for the handling of bulls, especially old bulls of bad disposition, it is quite easy to use this method of bull selection. When the time comes that a bull of value can not be used longer in a herd on account of close relationship of female breeding stock, he should not be sent to the butcher but should find his way into another herd where he can be of further service.

In small herds the difficulties are greater but not by any means insurmountable. It would become expensive in such cases to have bulls retained not in use until their value was known. Two lines which hold out possibilities in this connection in small herds are the use of sires which have been proved in larger herds, and the formation of bull associations among the owners of small herds. Here the bulls would be passed from farm to farm every few years. Then when the value of the bulls became known, those of real value would be retained in the association while those of no value would be replaced by others. Such associations co-ordinated with milk recording work would give remarkable opportunities for line breeding within a group of small herds.

These suggestions regarding the use of bulls are not a criticism of milk recording work but are simply an indication of how milk recording can be used to greater advantage. If the greatest advance possible is to be made in milk producing herds, the bulls must be selected. In this selection attention must be paid to the conformation and constitution of the animals and to their milking pedigree, but, most important of all, the bulls must be tested for their powers of transmitting producing ability. The animals which prove to be of value are then retained as long as possible, while the others are sent to the butcher.

Summary.—1. Milk recording has brought about considerable improvement in the dairy herds of Scotland.

2. A study has been made of Ayrshire herd sires in the counties of Dumfries, Kirkcudbright and Wigtown for the years immediately preceding the world war.

3. The production of the 795 daughters of the 79 bulls available was compared with that of their dams.

4. The average production of the daughters was 7,180 lb. milk at 3·77 per cent. fat, or 270·8 lb. fat, as compared with an

average of 7,549 lb. milk at 3·61 lb. fat, or 272·6 lb. fat for the dams of these cows.

5. This is a decrease of 5 per cent. in milk yield and 1 per cent. in fat yield with an increase of 4 per cent. in fat content for the daughters as compared with their dams.

6. Only 33 per cent. of the bulls had daughters higher than their dams in milk yield, and only 17 per cent. were 5 per cent. or more above their dams, and only 3 per cent. were 10 per cent. or more above their dams.

7. But 47 per cent. of the bulls had daughters better than their dams in fat yield, and only 27 per cent. were 5 per cent. or more better, and only 9 per cent. were 10 per cent. or more better than their dams.

8. While 70 per cent. of the bulls had daughters with a higher fat test than their dams, only 9 per cent. were 5 per cent. or more better and only 1 per cent. 10 per cent. or more better than their dams.

9. The greatest ranges of variation in production between daughters and dams were from a decrease of 27 per cent. to an increase of 14 per cent. in milk yield, from a decrease of 26 per cent. to an increase of 18 per cent. in fat yield, and from a decrease of 6 per cent. to an increase of 14 per cent. in fat content.

10. More attention must be given to the proving and selecting of herd sires if the greatest progress in milk production is to be made.

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WHIN-BRUISERS AND WHIN-MILLS.

RELICS OF SCOTTISH FARMING IN THE PAST.

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The use of Whins for Feeding Stock.—It must seem a strange thing to those familiar only with modern crop rotations that two hundred years ago whins were highly in favour as a crop sown and grown for feeding purposes. This " improvement " in farming, as it was called, came from Wales, where, it may be, farmers had learned from the closely cropped, bee-hive like bushes, trimmed by sheep on the wilder pastures, how much the soft shoots of the whin were relished by their stock. This simple observation, which the naturalist can parallel by his records of whin-bushes cropped and shaped by the nibbling of

rabbits, led to a closer scrutiny of the feeding values of gorse. It was found that the plant was equally good feeding for cattle or horses. Chemical analysis of a simple type suggested that its nourishing value was almost equal to that of clover hay and far exceeded that of turnips.

Here is an analysis taken from an agricultural manual, "extracted from tables compiled by Mr. Lawes and Professor Voelcker":—[1]

	Flesh-formers.	*Fat-formers.*
Furze	3·21 per cent.	9·38 per cent.
Clover hay ...	4·27 ,,	9·14 ,,
Turnips (common)	1·80 ,,	4·43 ,,

So impressed were farmers by the possibilities of whins that an agriculturist writing on 6th April 1725 could say: "The sowing of whins for feeding of cattle takes mightily about London just now . . . this improvement comes from Wales, where it has been practised these hundred years."

Methods of Cropping.—The crop was generally reserved for dry and light soil. The seeds were sown in drills in March, so that the shoots became ready for use in the autumn of the following year, and there was this great advantage over ordinary green crops that for several years in succession forage could be obtained from the original sowing. As to the bulk of the crop, it was reckoned that an acre would yield "2,000 faggots of green two-year-old gorse, weighing 20 lb. each," and poor land produced a crop worth £16 an acre, while from better land up to £40 an acre could be obtained.

It is unlikely that Scottish farmers ever took so mightily to whin cropping as did the Londoners. At any rate I have no evidence to show that whins took a place in the planting rotation of Scottish farms. Yet here also they were extensively used, but the gorse harvest was derived from the natural and abundant supply which flourished on the rough ground only too common on most of the farms of that day. The use of the native crop, however, entailed one great difference in method. Sheep and rabbits naturally feed only upon the tender shoots of the year, before the spines have developed. The annual cropping of young plants in the fields of England and Wales ensured also that the food material was tender and edible, but in Scotland, where general whin cutting included the more woody portions of the plant, provision had to be made for reducing stems and the dangerous spines to a mass fit for stock to feed upon with profit and without danger. So arose the need of implements for whin bruising.

The implements varied in nature from simple home-made affairs, which could be used on small farms by the occupant and his family, to complicated apparatus specially turned out by manufacturers for the specific purpose of whin bruising.

[1] *Illustrated Guide to Modern Agricultural Implements, Tools, Machinery, &c.*, by J. Woodward Hill, London, 1880, p. 565.

Although the progress in development is difficult to trace owing to the lapse of time since their introduction, I have no doubt that the simplest implements were the earliest, and that the demand for more efficient and more rapid bruising stimulated the improvements which finally resulted in the whin-mill and the furze masticator.

The Simpler Whin-Bruisers.—The simplest of all the whin-bruisers in origin, for it was but a modification of a universal farm implement of the day, was the flail. Formed of two lengths of wood, one the handle, the other the beater, hinged together by a leather joint, the flail was used to thresh the grain crop upon a hard floor, as I have seen it used in Portugal and as it is still sometimes used in this country to thresh turnip seed. But for whins something more severe was required, and accordingly the "beater" was reinforced by sharpened strips of hoop-iron, so that the heavy blows chopped the whins into small lengths more easily pulped.

On a small scale the pulping was carried out upon a wooden block, sometimes a rude log like an ordinary "hack-stock,"

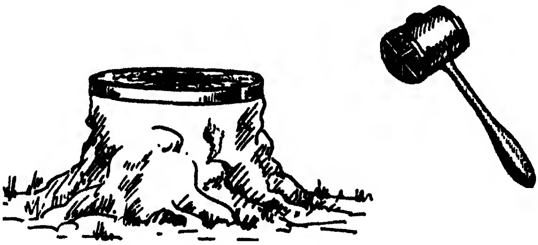

FIG. 1.
Whin Mallet and Block—*face of mallet shod with iron cutters.*

sometimes a short length of tree trunk strengthened by a band of iron round the upper edge (see Fig. 1). The pulping implement was a short-handled wooden mallet with which the whins, placed upon the block, were beaten into a mass till all the woody fibres and spines had been reduced to edible consistency.

It was a simple stage in progress for the wooden mallet to develop into a combined cutter and pulper (see Fig. 1). While one face remained plain for bruising, the other was set with edgewise strips of hoop-iron similar to those used on the flail. With this face the whins were chopped into short lengths ready for the final bruising. A great advantage of this "improvement" was its ease of manipulation. The wielding of a flail was a man's job, the mallet could be used by the children of the farm.

Sometimes instead of a wooden block a suitable block of stone was selected, and I mention this because, although the perishable wooden blocks have long since disappeared, a few of the whin blocks still survive. Such a relic may be seen at the farm steading of Upper Mills, about half a mile from Crathes Station on the Deeside Railway. It was used rather more than half a century ago by the tenant of the farm. A more elaborate stone block, with raised sides and back to keep the whins in place during the operation of bruising, lies in a very ruined condition in a small plantation near the carpenter's shop at Skene, Aberdeenshire.

A third simple implement was the whin-bruiser or rammer, illustrated in figure 2. It is described as a "shank of wood, 3 feet 8 inches in length, a bulged out part to give the instrument weight, and a base which is contracted into a square, and shod with an iron shoe embracing parallel iron cutters, 1 inch asunder and 3 inches deep and sharpened at their lower edge."

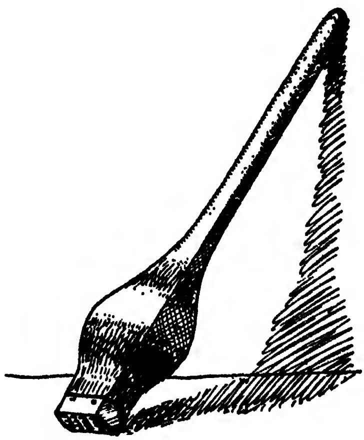

FIG. 2.

Whin-Bruiser or Rammer, with face shod with iron cutters.

The rammer was an efficient if clumsy tool, as is shown by the following account of its use by a Midlothian farmer. "That horses will thrive on bruised whins or furze I had considerable experience in the winter of 1826, after the summer had burned up the straw of all sorts of grain on light soil. Old whins, growing in a fir plantation, supplied young shoots from 1 foot to 3 feet in height, which were cut by a field-worker with a hook and led to a steading where it was (*sic*) bruised with a rammer . . . Every man bruised, with this implement, as much furze in the morning, on a stone floor, in 20 minutes, as served his pair of horses for the day. The horses relished the whins better than hay, and became remarkably fine in condition and coat. Machines to bruise or beat have been invented for the preparation of whins; but the simple rammer here represented, and used by hand, is better than any other for bruising whins." [1]

Whin-Mills: the Roller Type.—In spite of the claims made for the hand-rammer, it is obvious that where whin feeding was resorted to on a large scale, for cattle as well as horses, some

[1] Henry Stephens in his *Book of the Farm*, 3rd edn. 1871, vol. 2, p. 237.

more rapid method of obtaining large quantities of fodder was desirable. It is very likely that to meet this need the ordinary stone roller of the farm was first called into service, and that its efficiency in reducing the unruly furze by repeated rollings suggested the form of the specialised whin-mill.

Here the labour was transferred from man to his ox or horse, and by the simplest of arrangements large masses of whins could be bruised. In the centre of an open space a pivot stone was firmly embedded in the ground, and on this centre revolved a large, almost cylindrical stone, similar in appearance to a field-roller. A true cylinder, however, could not revolve with equal pressure upon the ground in so short a radius, and accordingly the whin-roller was tapered from a narrower diameter of about 1 ft. 6 ins. at the pivot end to a greater diameter of about 2 feet

FIG. 3.

Roller Stone of Whin-Mill, showing tapered shape; and, behind, pivot stone. At Brackla, Chapel of Garioch, Aberdeenshire.[1]

at the outer end (see Fig. 3). To this outer end was harnessed the horse or ox, and the animal moved round in a circle after the mode employed in working many old threshing mills.

To add to the efficiency of the bruising the circular path traversed by the roller, the "course," was paved with flat stones (see Fig. 4), and pulping was further aided by an occasional sprinkling of the mass of whins with water. The width of the paved course was almost 6 feet, giving ample cover for the roller, which was generally about 4 feet long.

Occasionally the roller of an old whin-mill may be seen used as a gate-post, but relics of this type of mill are rare. This may

[1] I am indebted to the President and Council of the Society of Antiquaries of Scotland for the use of the blocks of illustrations 3 to 6 from my father's paper in the *Proceedings* of 1924-5.

be due partly to the probability that the roller-mill was the more ancient form, and partly to the fact that it was less efficient and therefore less popular than the second type—the wheel-mill.

FIG. 4.
Paved Course for Roller of Whin-Mill at Blairbowie, Chapel of Garioch, Aberdeenshire.

Whin-Mills: the Wheel or Grindstone Type.—It is the occurrence and wide distribution of the grindstone type of whin-mill, more than any written evidence, which shows how general was the use of whins as fodder in earlier times. My father's investigation of the whin-mills of Aberdeenshire,[1] on which this paper is based, revealed the existence of remains of thirty-nine

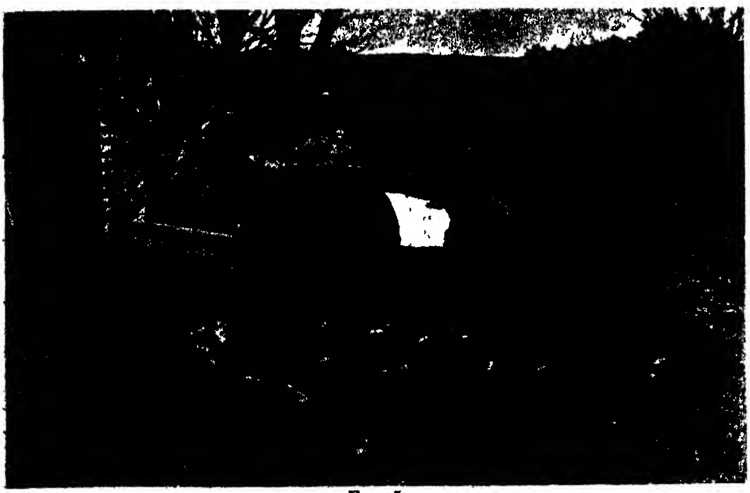

FIG. 5.
Whin-Mill in working order at Skatebrae, Auchterless, Aberdeenshire: showing central pivot, shaft with crushing stone, and narrow, stoned-lined "course."

[1] *Proceedings of the Society of Antiquaries of Scotland*, Series 5, vol. 9, 1925, pp. 128-142.

examples of this type, and it is certain that many in the county must have escaped notice, and that more must have disappeared entirely since they fell into disuse.

The distinct improvement embodied in the construction of this mill was the concentration of bruising power in a limited area, so that the pulping efficiency was greatly increased. The weight, which in the roller type was dispersed over 4 feet of length, was now concentrated in a crushing space of about 1 foot, and the whins were confined to this space by a new device in the construction of the "course."

The mill was worked after the same fashion as the roller-mill, but to the central pivot was attached a long shaft, usually about 14 feet in length, on which was fixed a wheel-shaped stone some 4 feet in diameter and about a foot thick (see Fig. 5). The course in which this stone revolved, unlike the flat paving of

FIG. 6.
Derelict Pivot Stone and Bruiser of a Whin-Mill at Burrels, Premnay, Aberdeenshire.

the more primitive type, was a circular channel rather wider than the thickness of the stone and about a foot deep, lined on sides and bottom with flat stones (see Fig. 5). In the channel the whins were placed, and during the operation of crushing water was sprinkled upon them from a watering can. The time taken to pulp a goodly supply of whin fodder with this implement was about an hour and a half.

There are few whin-mills, like that at Skatebrae illustrated in figure 5, which still stand as if in working order, but interested readers may see another, almost complete, near Gartly Railway Station, about five miles south of Huntly, on the farm of Whitelums. For the most part, however, the courses have been dismantled, as at Whitelums, and only an odd pivot stone or a derelict bruising stone mark the proximity of a former whin-mill.

Whin-Mills: "the Furze Masticator."—It would be an omission to neglect in this account of whin-mills an elaborate device which was invented and placed upon the market for the specific purpose of bruising whins. I have not seen this machine and I do not know to what extent it was used, but there is a picture and description of it in the *Illustrated Guide to Modern Agricultural Implements* (p. 565), already referred to, published 50 years ago. The "Whin, Gorse or Furze Masticator" or "Mackenzie's Gorse Masticator" was a compact machine of iron and steel with knives and rollers so arranged that furze was "cut up into short lengths by revolving knives, and is then passed between a pair of masticating rolls, which effectively reduce it to a soft pulpy condition, destroying all the prickles." Here was the final stage of the evolutionary process set in motion by the double-ended cutting and bruising mallet.

Conditions which favoured Whin-Mills.—The widespread use of whin-mills in former days and their subsequent total disappearance from the activities of the farm suggest a glance at the special conditions which favoured their use, the alteration of which brought about their neglect. I do not know exactly when whins came into use for fodder in Scotland, but the letter which I have quoted regarding their use about London was written in 1725. It is probable, therefore, that Scotland shared the practice in the eighteenth century, and that to the conditions of that period we must look for an explanation of the vogue of whins.

The backward state of farming in Scotland during that time has been well portrayed in the *Old Statistical Account* of Scottish parishes, and in more recent works largely based upon that rich source of information. So that we need only remind the reader that we are dealing with a period when the great problem of the farmer was to tide himself, his family and his stock over the winter and through the still more trying days of early spring.

The problem arose from many causes. In the first place there was little importation of foodstuffs from abroad, so that in bad seasons, when crops failed, starvation stared the country in the face. In the second place, conditions were rendered doubly worse because of the isolation of districts, for roads and means of communication were inefficient, so that the surplus of one district was not readily available for the needs of another. In the third place there was little in the way of root crops to supplement winter feeding if straw and grass happened to be poor. In Aberdeenshire, for example, turnips were almost unknown till the latter half of the eighteenth century, and at first they were regarded more as curiosities or as vegetables for the table than as essential provender for stock.

Two curious customs of the time will indicate the straits to which the country people and their stock were sometimes reduced before the new grass of spring brought a fresh lease of life. In years of great scarcity deaths from starvation were common, but to ward off the dread enemy it was customary to bleed living cattle, so that the blood mixed with a little oatmeal might be used as human food. The second custom was known as "cattle-lifting." It frequently happened, after a hard winter or delayed spring, that the cattle were so weak that they could not even walk from the byre to the new grass. Accordingly neighbouring farmers combined to visit one farm after another in order to carry the helpless cattle from their stalls to the pasture.

In such conditions any fodder which could be used during the hard season was a godsend, and whins and the whin-mill must have tided many a farmer over the shoals of ruin. Even when root crops had obtained an established place in the rotation of the farm, the abundance and cheapness of whins and their excellent feeding qualities ensured that they should still be widely used. In the richer counties they disappeared from use long ago, but in poorer districts they survived till the latter half of last century. It is astonishing to learn that the whin-mill at Skatebrae, Badenscoth, in Aberdeenshire, illustrated in figure 5, was in regular use till about 1890, and that it was actually used in 1910 for crushing a supply of whins to be fed to the horses in order to rid them of worms.

What were the changes which brought the whin-mill into disuse? There was the improvement in the nature and cultivation of crops, which made an additional supply of winter fodder less necessary, and to this must be added the invention of feeding cakes and the importation of foodstuffs. There was the improvement in farming generally and the breaking in of rough land to cultivation, which reduced the quantity of whins available for use. But above all there was the increasing scarcity and cost of labour, which made the expense of cutting and preparing whins in the old way exceed their value as food.

It is unlikely that conditions will ever arise to create again the need for the use of whin fodder, but if they do, we can be sure that more efficient and labour-saving machinery will be employed in pulping the whin shoots than the mallets, rammers and whin-mills of a farming day that is gone.

INSECT PESTS.—No. IX.

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

BEETLES OR SHEATH-WINGED INSECTS.

BEETLES belong to the Order *Coleoptera*. Their common name of the sheath-winged insects is given because the flying hind pair of wings are covered and protected, when the adult insects are at rest, by a chitinous or horny front pair of wings (Fig. 1).

True Beetles [1] have a complete metamorphosis. From the egg comes a larva or grub totally different in appearance from the

[1] The word Beetle is ambiguous; the Cockroach for example is known as the Black Beetle, although it is not black, nor is it a real beetle.

adult flying beetle; this larva has a horny head and eleven or twelve body-joints. As most beetle larvæ lead a somewhat hidden life, not feeding in the exposed way of so many butterfly and

FIG. 1.

The Stag-Horned Beetle from nature. The male is to the left, the female to the right.

moth larvæ, their colour is not a gay one but white or dingy. There are various type forms of beetle larvæ, e.g. :—

(*a*) An elongated grub with biting jaws, a pair of legs on the first three joints behind the head, and often a muscular projection at the hind end, of service in progression or support, e.g. the larvæ of the ground beetles (Fig. 2), the

FIG. 2.

Larva of a Ground Beetle. Magnified about 3½ times.

wireworms, the lady-bird larvæ and the larvæ of the so-called turnip-fly.

(*b*) A jawed grub with six legs and curled wrinkled body, e.g. the larvæ of chafer and dung beetles.

(*c*) A jawed grub with wrinkled body but legless, e.g. weevil larvæ.

(*d*) A jawed grub with six very short legs or legless, with the body joints well marked, and tapering slightly from front to rear, e.g. the larvæ of the long-horned beetles.

The feeding larval stage is followed by a quiescent pupal stage when no food is taken, and during which the changes are being completed which result in the flying and reproducing adult stage of the insect; this pupa may be naked or may be under cover of a protecting cocoon of variable material; whether naked or inclosed in a pupal covering the wings and limbs are not glued down to the body, as is the case with the pupæ of butterflies and moths.

The Order of Beetles has great importance for the farmer, the fruit grower and the forester. The Cotton-boll Weevil and the Colorado Beetle have a literature of their own; while tea and coffee and sugar cane have beetle enemies which rank as major pests. Beetles also are amongst the worst enemies of pulses and stored cereal grains.

The damage done in the various cases is sometimes due to the adults, sometimes due to the larvæ, and is sometimes caused by both adult and larva.

All beetles are not vegetarian and harmful to the cultivator; some are scavengers; some live curious lives in ants' nests dependent on the ants; others are predaceous and carnivorous; while some are parasitic upon other insects. We sometimes speak of the carnivorous species as useful, and examples of these are the ladybirds.

Ladybirds (Family *Coccinellidæ*).—Ladybirds form a big family of their own comprising more than 2,000 kinds, of which 40 species are found in Britain. They are characterised by small head and convex shaped body flattened on the under surface, and by their 3-jointed feet.[1] Most have a conspicuous colour, yellow or red with dark spots or black with red spots; and we distinguish the kind of ladybird by the number of spots, e.g. the 2 spotted, the 7 spotted, the 24 spotted, and so on. The species, however, may vary, and hybrids between one species and another may cause confusion. A ladybird on being irritated or disturbed withdraws its legs and, from the joints of these, exudes an unpleasant fluid; the exuded drops have an unpleasant smell and are a protection against a hungry enemy.

The larva of the ladybird is also easy to recognise; the head is small with the mouth parts sloping downwards; the mandibles are toothed; very careful looking may reveal extremely minute antennæ and small simple eyes; the body is elongated, somewhat flattened and fleshy, broadest behind the head and narrowing as one passes backwards; on the upper surface of the body are warts and hairs, and the colour of these may contrast with the grey or blue-grey or brown-grey of the body; from the warts or swellings a fluid can be exuded resembling what has been described for the adult; there are six legs and at the hind end of

[1] There are really four joints to the feet, but one of them (the true third joint) is so small that, unless under considerable magnification, it is overlooked.

the body a muscular tip. Both adult and larva are carnivorous in diet, the food being green flies or aphides, and scale insects, mealy bugs and such soft-bodied forms. Both adult and larva are voracious, capable of destroying from 50 to several hundred young aphides in a day. As aphides quickly come to maturity and have excessive powers of multiplication and can be very destructive to plants, it is easy to understand how ladybirds are described as useful insects, and are not only spared and protected but have been deliberately bred and introduced to other countries as a natural method of fighting certain insect enemies of cultivated plants.

The commoner ladybirds are not difficult to rear, given favourable conditions of food and temperature. In breeding the two-spotted ladybird eggs in clusters were freely laid on leaves and branches offered. The ladybirds had been sent to me on leaves of apple where they had been feeding on apple aphides. Aphides from ivy leaves were offered as food and greedily taken. In our experiments the egg clusters were laid sometimes on the under surface of the leaves, sometimes on the upper surface; the number of eggs to a cluster varied from 8 to 17 (a female ladybird may lay 200 and more eggs in the course of her life); the eggs hatched in a week; the larvæ from the eggs, in bright warm weather and with abundance of food offered them, completed their growth in 13, 14 and 15 days. The full-fed larvæ, having attached themselves to leaves by their hind end, moulted; the moulted skin was wriggled backwards till it lay huddled against the leaf, and the pupa was revealed. In eight days the first adult beetle crawled from the pupal skin; at first the distinctive coloration was not observable and the two spots were invisible. Four hours later the two spots were quite clear and the typical colour of the body had been assumed.

With our common ladybirds there is more than one generation in the year. The winter is passed in the adult stage in some shelter place and under cover. I have found them under lead labels on trees in a Botanic Garden, and collected behind the shutters at the top of a window.

From what has been stated above these ladybirds and their larvæ should be spared and encouraged. Space does not allow one to dwell on the kind common name which the ladybird has in many countries, or to interpret the nursery rhyme :

"Ladybird, ladybird, fly away home,
Your house is on fire, your children will burn ;

or to attempt to explain the old practice of throwing the ladybird from cottage windows by way of their carrying good luck to some neighbour.

In spite of the carnivorous habit of the ladybird family there are two very troublesome vegetarian species, each a distinct pest in its own way, namely, the Bean Ladybird of the United States, destructive to leaf and flower and pod, and a South African species, an enemy of cucumbers and water melons.

Recently in Britain, Donisthorpe has shown that *Coccinella* *distincta* is usually, perhaps only, found associated with the ant *Formica rufa*, in and about and near the nests of this ant; and Marriner has described how our eleven-spotted ladybird feeds and lays in pads of dung in meadows by the seashore.

Other Carnivorous Beetles.

There is a well known section of beetles, with five joints to the feet, that are flesh-eating. This section includes land forms like the Tigers and the Ground Beetles with legs fitted for running, and an aquatic family with legs flattened and modified for swimming.

Tiger Beetles (Family *Cicindelidæ*).—The Tigers have a broad head, prominent eyes and long slender antennæ. The jaws are long and sharp. The adult beetles fly well, and are active and alert; the larvæ live in a dug-out or burrow. Both adult and larva are carnivorous. One of the Tigers common enough in various parts of Scotland is *Cicindela campestris* (Fig. 3). The beetle may be found from May onwards through the

Fig. 3.
Cicindela campestris. Natural size.

summer; its prevailing colour is grass green with a few white or yellow-white spots on the wing-covers; the under surface is violet blue and the legs are copper red. The beetle feeds upon insects which are caught.

After pairing, the female proceeds to lay her eggs, choosing sandbanks, sandy soil at the edges of sandy roads, peat, and it may be cattle tracks where the heather has been worn away. The beetles have a long life, in the course of which the female may lay at least fifty eggs in a season, to reappear, it may be after hibernating, in order to continue her egg laying.

The grub on hatching proceeds to make a shaft or burrow more or less at right angles to the surface. The full-fed grub measures about an inch in length; the body is yellowish-white and fleshy; the head is flat; the mouth parts are well-developed, especially the sickle-like mandibles; the first three joints behind the head carry each a pair of legs; the upper surface of each of these joints is strengthened by a dark plate; the eighth joint of the body has a hump on the upper surface armed with two bent hooks. The burrow of the larva is considerably deeper than the length of the larva, but the grub climbs easily, and its position, when its head is at the top of the burrow, is retained by the aid of the hooks on the hump, which are pushed into the sand or soil.

The mouth of the shaft or burrow is round and regular and is closed neatly by the head of the grub, which is on the *qui vive* for prey. Passing insects are seized, taken down into the den and destroyed. The larva lives for several years, closing up the burrow in autumn and opening it up again after the winter's rest. The full grown grub pupates at the bottom of its closed-up burrow and the beetle when ready comes to the surface.

Our other Tiger species is *Cicindela sylvatica;* it is bronze brown in colour and the wing covers have light spots; the under surface has pale hairs.

Ground Beetles (Family *Carabidæ*).—This family takes its common name from the fact that most of them live on and in

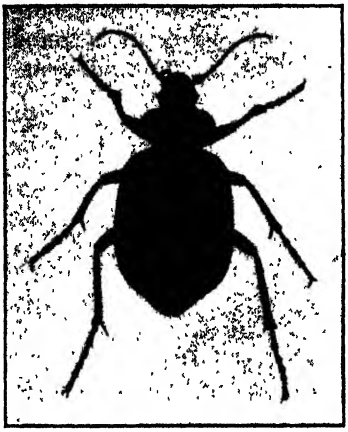

FIG. 4.
Calosoma sycophanta. Natural size.

the ground, flying wings being absent or rudimentary; the hard horny wing-covers are often not separable but serve for protection in the forms that may burrow. The Ground beetles come near in relationship to the Tigers; their head, however, is not as broad as the front part of the body (thorax) (Fig. 4), and the antennæ arise at the side of the head (in the Tigers the antennæ spring from the front of the head, above the base of the mandibles). While some species of Ground beetle run about in the sunshine, many are nocturnal in habit and have an inconspicuous colour. The larva (Fig. 2) lives in the soil and in general has the following characters: elongated body; prominent mandibles, sharp and calliper-like; six legs; the foot ends in two claws; the end joint in addition to a central muscular projection may have on each side a longer bristle-like projection.

The majority of Ground beetles both in the adult state and as larvæ are carnivorous, feeding upon insects and other small animals found in the soil. *Calosoma sycophanta* (Fig. 4), a handsome Central European species with blue black head and golden green wing-covers, was, a number of years ago, imported to the United States and then bred in numbers in Massachusetts and set free in order to help to keep down extremely harmful caterpillars of the Gipsy Moth. The experiment has justified itself. The beetles adapted themselves to their new environment; the introduced species multiplied and spread, and both the adults and their larvæ have proved of service.

In Britain a few species of Ground beetle have shown themselves enemies of crop plants. The accused species are *Zabrus gibbus*, *Steropus madidus*, *Pterostichus vulgaris* and *Harpalus ruficornis*, the plants attacked being corn, mangolds and strawberries. *Harpalus ruficornis* (Fig. 5) has been found damaging strawberries by biting away the little achenes. This beetle is black or dull brown with reddish legs; the hind angles of the thorax are sharp and projecting, and the dull wing-covers have lines running down them. A point worthy of note is that this species has functional wings. *H. ruficornis* is found in Scotland, up to the Moray Firth. It has come to me as occurring in large

FIG. 5.
Harpalus ruficornis. Natural size.

numbers in raspberry plantations, but without complaint of damage to the rasps.

Aquatic Diving Beetles (Family *Dyticidæ*).—This family, near the last two in relationship, is aquatic in habit. The family has no economic importance for the farmer but is full of interest for an observer, e.g. the shape of the beetles and how adapted for swimming; the hind legs modified as paddles; the method of breathing—the beetles floating to the surface tail end uppermost and taking a supply of atmospheric air before diving again; the beetles can fly excellently, as well as swim; the hatching of the grubs and their aquatic life; the method by which the grubs obtain air; the markedly predatory habits of the insects which make them a terror in a pool; how the larva must leave the water for pupation in the soil, the pupa not being adapted for respiration in water.

Chafer Beetles (Family *Lamellicornia*).—The section of flesh-eating beetles embracing the Tigers, the Ground beetles and the aquatic diving beetles agree in having thread-like antennæ. We now, though still keeping to beetles with five joints to the feet, reach a well known set of beetles where the antennæ instead of being elongated and thread-like have their end joints flattened out into leaf-like or fan-like expansions (Fig. 6). Such beetles are known as the Leaf-horned beetles or Chafers; of these perhaps the best known to our readers—by name at least—is the Cockchafer; but we also have the Stag-horned beetle (Fig. 1), and its allies whose grubs live in decaying wood; the Green Rose Chafer (*Cetonia aurata*), and *Serica brunnea*, a small red-brown chafer sent to me now and again for determination; in this group come also the dung beetles, and the dung ball-rolling beetles of warmer countries, like the sacred Scarabs of Egypt, worshipped by some and ill-omened to others.

The Leaf-horned beetles contain species troublesome in forestry and in agriculture. We must here limit ourselves to a notice of the Cockchafer (*Melolontha vulgaris*), the Summer Chafer (*Rhizotrogus solstitialis*) and the Garden Chafer

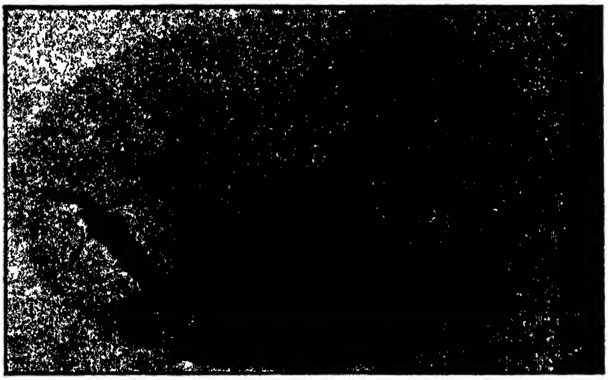

FIG. 6.
Head of male Cockchafer. Magnified to show the seven "leaves" or expansions of the end joints of the antennæ.

(*Phyllopertha horticola*); with a few notes on one of our larger dung beetles.

The three chafers named are easy to distinguish in the winged state.

Melolontha vulgaris is about an inch long, with the head and front part of the body black; the wing-covers are reddish-brown, and have five raised lines on each; along each side of the abdomen are five white triangles; the body ends in a naked curved part; the end joints of the antennæ may look club-like, but if one is handling a live beetle or is closely inspecting a dead one, the club is seen to be made up of leaf-like expansions, seven in the case of the male (Fig. 6), six in the case of the female. In Scotland and the north of England we get also *Melolontha hippocastani*, which can be recognised by the narrow black edging to the red-brown wing-covers.

Rhizotrogus solstitialis.—The Summer Chafer is smaller than the last, measuring up to two-thirds of an inch in length; the general colour is reddish-brown, and fresh specimens are distinctly hairy, more so than in Melolontha; the wing-covers have each four raised lines; the club at the end of the antennæ has three leaves, both in male and female.

Phyllopertha horticola.—The Garden Chafer measures from a quarter inch to a half inch in length; the front part of the body is glossy blue-green; the wing-covers are reddish-brown; the upper surface of the beetle is hairy.

The larvæ of the leaf-horned beetles are jawed grubs with horny heads and a series of wrinkled joints; the front three joints of the body bear each a pair of legs. The differences in size of the three chafers named above indicate that the full grown grubs of the three are distinguishable by their size. It can be confusing, however, if one has to name the larvæ when owing to difference of age the larvæ of the allied species may have about the same size and when to the unaided eye they can look so alike. It is for practical reasons important to distinguish the three at any size or age, but some trouble has to be taken. By aid of the microscope the following differences can be made out :—

Larva of *Melolontha.*	Larva of *Rhizotrogus.*	Larva of *Phyllopertha.*
The under or inner side of each mandible (removed and cleared for examination) has a granulated or roughened area where the light and dark parts meet.	The whole of the under surface of the mandibles is covered by minute granulations.	The under side of the mandible shows a small oval pale patch that has file-like ridges.
The first pair of legs shorter than the other two pairs, but the claw longer; claw of second pair of legs longer than claw of third pair of legs.		Claw of first pair of legs shorter than claw of second pair of legs; claw of second pair of legs shorter than claw of third pair.
On the under surface of the last joint, towards its tip, is a number of red-brown bristles; two vertical rows of spines[1] run half-way up the joint, reaching beyond the red-brown bristles.	On the under surface of the last joint, towards its tip, is a number of bristles; two vertical rows of spines run up the joint, but only for a third of its length, and they do not project beyond the bristles.	

Life-history of Melolontha.—The beetles are found in flight in summer from the end of May onwards; they rest in the daytime on trees, and fly towards evening. After pairing the females lay their eggs in the soil, several together; between 50 and 100 eggs can be laid during the life of the female. The eggs hatch in some weeks and the larvæ do not do much harm in the first year of their life when they are small; later, as they grow, they can prove very destructive at the roots of grasses and agricultural and horticultural crop plants; they can be very destructive too in nurseries of young trees; the roots are not only gnawed but can, with young plants, be eaten right across. The grubs are found at varying depths according to the season and to the plant attacked. In the spring and summer they are found typically in the surface

[1] Forestry Commission Leaflet No. 17.

layers two and three and four inches deep, but in winter the grubs go much deeper for protection and are out of reach for collecting. The larva has at least a three years' life in the soil, and then, full-fed, it pupates under cover of a large earthen cell. The new beetles come to the surface in early summer.

The adult beetles feed on the leaves of trees and on blossom, and the insect is always most numerous and destructive in fields that are not far from trees. The grubs can be very destructive to grass land, and a crop following the breaking up of such land often suffers severely. The late Professor Theobald in 1925 recorded a very bad attack on grass in Kent; most of the attacked grass land was in the neighbourhood of oak woods; one field of 4½ acres of grass examined in July had at least two acres dead in the centre of the field, and by September no green grass was visible on four of the acres. The attacking grubs were nearly all Melolontha (only a few Rhizotrogus were present), the average number being about 25 to the square foot. In a somewhat loose soil cockchafer grubs can move from plant to plant in a way one would not expect from the general appearance and build of the larva. Puster, a continental authority, has estimated that two cockchafer larvæ, per 11 square feet, in the third year of their development are sufficient to destroy all the young plants of a nursery.

In Britain the length of the life cycle is four years, an average for temperate Europe; in the colder parts of Europe the cycle is lengthened out to five years and in warmer Europe is reduced to three years.

The Summer Chafer has a similar round of life but takes less time to complete its life cycle.

The Garden Chafer (*Phyllopertha*) has a yearly cycle and the beetles fly in sunshine, often in swarms. The adults eat the leafage of orchard and other trees; the leaves and flowers of roses; and also bite pieces out of fruits. I have June records of their swarming over apples, pears, raspberries, currants, strawberries, broad beans and beet.

The larvæ are troublesome at the roots of grass—especially may upland pasture suffer—and also to clover, cabbage and garden plants. I have described elsewhere, from Perthshire, an attack on grass and clover. The damage was to old lea, the colour of the withered plants calling attention to the pest and also the busy feeding of birds. Cattle walking over infested patches in wet weather sank two or three inches in the soil. Roots had been eaten across, so that when a cut was made with a spade one could roll the turf up like a scroll of music and the soil below was soft and fine as if it had been harrowed. I have also written on another case from the West of Scotland, where the Garden Chafer grubs had destroyed the roots of a lawn of very old grass. A sign of something amiss was when the crows began to tear up large portions of the lawn; the crows were seen at work first in October and then again in the following March, when large numbers of grubs were found.

Taylor and Thompson [1] have given an account of attack on grass land 500 feet above sea-level in Yorkshire; the grubs had been found at depths of one to six inches, and as a result of what seemed to have been an annual attack the fields had become unsightly; the finer grasses had died out and had been replaced by a sward of coarser and inferior quality. Observation showed Phyllopertha adults to be present in numbers in June feeding on the flowers of buttercup, docken, clover, and greedily taking the young fronds of bracken (two of the common names of Phyllopertha are the June bug and the Bracken-clock).

Control measures.—Collecting the beetles in a swarm year for Melolontha and the Summer Chafer, and in the swarming month (June) for the Garden Chafer. With our less settled and very variable weather the collection is more difficult and more protracted than on the Continent, where it is a regularly practised and successful method of control.

In a State forest of pine, larch, beech and oak in Germany 22 million cockchafers were collected on an area of 4,330 acres. The method adopted was to leave here and there in the different woods isolated trees or groups of trees, with a sunny exposure, the trees chosen being small in size but with well-developed crowns. At swarming and mating time the cockchafers chose these trees to rest on in the daytime. Capture gangs are arranged for. The leader of each gang does the "spotting" for his section of the wood and the resting beetles are shaken down (the beetles fall easily—I have brought a rain of them down by the not too rough shaking of a young lime tree)—on to spread cloths and are then gathered up. The collected beetles after being gassed are sold as manure.

Taylor and Thompson found the collecting of Phyllopertha quite successful. The Garden Chafer drops when disturbed, and if cloth or paper covered with tanglefoot be spread below, the fallen beetles are trapped. Taylor and Thompson proved very successful with a collecting apparatus they invented for Phyllopertha, viz. a wide-lipped scoop in which the falling beetles were caught to be at once shaken down into a box fixed to the other end of the scoop.

It is not easy to fight the grubs in the soil. Advantage must be taken at times of breaking up and preparing for new cultivation. In nursery work especially, hand collecting justifies itself; in one nursery 3,000 larvæ were so collected.

In experimental nursery work it was found that the females did not lay their eggs if the soil were covered with quicklime (16 cwt. to the acre) in dry weather. In wet weather or soon after rain the lime was not a preventive, as the females burrowed through the upper layer into the soil for their egg laying.

Naphthalene applied broadcast to grass land has given vary-

[1] A Garden Chafer Attack. By T. H. Taylor, M.A., and H. W. Thompson, M.Sc. Annals of Applied Zoology, vol. xv, May 1928.

ing results, and more detailed experimental work is called for with details of cost.

While the evidence as to the insecticidal value of naphthalene as against the grubs at grass roots is scant there is experimental evidence of the value of naphthalene as a deterrent against egg laying. In the beginning of a swarm period crude powdered naphthalene was tried at the rate of 1 oz. to 10 square feet. The experiments were done in France. Where the powdered naphthalene was placed on the surface in dry hot weather the repellent odour did not last for more than six days. When the naphthalene was raked into the soil and the soil well watered then the egg-laying females were repelled for fourteen days.[1] A warning note is added that as the flavour of naphthalene is retained by plants for some time, the naphthalene should not be applied to vegetables that are to be harvested at the time of oviposition.

The injection of bisulphide of carbon as a means of destruction of larvæ in the soil is successful but too expensive.

Crows, starlings, lapwings, gulls take the larvæ greedily; so do poultry and pigs.

Dung Beetles.—The section of beetles we have been dealing with is rich in species that infest dung, some living more on the surface, others with a burrowing habit. A genus of the former, rich in British species, is the genus *Aphodius;* the beetles and their larvæ are scavenging in habit; it is possible that certain species may be proved to have some importance as intermediate hosts of parasites.

Of the burrowers the well-known Dor-Beetle may be taken as an example. Not infrequently this beetle is sent to me with inquiry as to its habits. The technical name of the Dor-Beetle is *Geotrupes stercorarius,* which being translated means "the dung-born beetle that pierces through the earth." The beetle is a useful scavenger, "a burier of manure and a sanitary expert." Many people in the country know the beetle by sight and by the sound it makes as it flies in the gloaming. This is the beetle referred to in the line of Gray's "Elegy":—

> "Save where the beetle wheels his droning flight";

and is also the beetle of Shakespeare's "Macbeth":—

> "The shard-borne beetle, with his drowsy hums,
> Has rung night's yawning peal."

This Dor-Beetle is black or blue-black on the upper surface and violet coloured below; punctured lines run down the wing covers. The grub is suggestive of that of the cockchafer, but it can be recognised (apart from its habitat) by the very short hind legs as compared with its second pair (in a cockchafer grub the hind pair of legs is the longest pair).

The life-history is interesting, and to Mr. Sano and Mr. Hugh Main we are indebted for details. The beetles come from their

[1] Review of Applied Entomology. Agricultural Series, July 1927.

winter quarters in the soil in spring. Male and female work in pairs. A vertical shaft is made in the soil under a patch of manure—horse manure or cow dung. The depth of the shaft varies with the nature of the soil. Whether the boring be straight down or sloping or somewhat irregular depends on what obstructions may be met with. Of two shafts measured by me when the beetles were working in the summer one was 6 inches deep, the other 8 inches. Dung is carried down the shaft. Small side galleries are made that run from the main shaft and these are filled with the carried-down dung, on which the grub, on hatching, nourishes itself. Mr. Main has shown that the female is the skilled worker, the male fetching and carrying. The female rounds off a horizontal gallery and dung is pressed into the end; then a little cave strengthened by a wall of clay and dung is formed; an egg is laid in this and the cavity closed. A horizontal side gallery is made for each egg laid. I have watched Geotrupes at work on and below patches of horse dung offered experimentally to the beetles and have recovered eggs from the side galleries; the eggs are white and surprisingly large. Pupation of the full-fed larvæ takes place in the soil.

If the male becomes lazy and does not carry down dung speedily enough to the more diligent female the male " hears " about it, being called to more activity by a stridulating rasping noise made by the female. Many of the larvæ of the leaf-horned beetles can make a grating noise, known as stridulation, due to friction of one hard part of the body against another. Mr. Hugh Main by the aid of ingenious apparatus has been able to get the stridulating noise or call note of the Geotrupes beetle broadcast over a wide area. Mr. Main's broadcast talk had the happy title of " Lecture on Geotrupes, with remarks by the beetle."

NUTRITIVE REQUIREMENTS OF POULTRY.

VII. GROWTH IN CHICKENS—III.

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Introduction.—The results of investigations on the food requirements of poultry, already reported in this Journal, have showed that a ration consisting entirely of cereals or cereal by-products does not contain sufficient of all the minerals required. The addition to such a ration of either a foodstuff rich in minerals, such as fish meal, or certain mineral mixtures, is followed by an increase in the number and weight of eggs and also, if the mixture be of the right composition, in the rate of growth of chicks. As there was little definite knowledge regarding the requirements of fowls for different minerals, the mixtures used in these investigations contained every mineral of which a deficiency in the cereal ration was thought to be possible. They consisted of substances giving chiefly calcium, phosphorus, sodium and chlorine, with in addition small amounts of sulphur, iron and iodine. While the results of feeding trials showed that these empirical "grape shot" mixtures improved the cereal ration, there was nothing to show whether all or only some of the ingredients were necessary to produce the effect. It was decided therefore to pursue these investigations further to ascertain whether all the ingredients which had been used were necessary.

It is intended that experiments both on growth and laying shall be carried out at different centres, and it will therefore be two or three years before the tests are completed. But the results obtained in the first year are so definite that it has been decided to publish this preliminary note. The data are not sufficient to warrant the drawing of final conclusions, but they will be of interest to the increasing number of poultry keepers who are carrying out feeding trials.

Experimental Data.—Groups of closely related chicks were housed under the same conditions and fed upon the same basal ration. To the ration of one of the groups there was added a "complete" mineral mixture known to improve the basal ration. In the case of each of the other groups, one or more of the ingredients were omitted. The rate of growth and health of the birds in these groups, compared with the group getting the complete mixture, showed whether the omissions affected the nutritive value of the ration. The preliminary experiments were done only at Aberdeen and Belfast.

Aberdeen.

Six groups each of 78 white Leghorn chicks were used. For the first nine weeks the chicks were allowed out on runs in which there was almost no grass. They were then transferred to houses with runs rich in clover. In each case the runs occupied by the different groups were the same, so that whatever was obtained from the pasture by one group was obtained by all the groups.

The basal ration consisted of :—

Bran	4 parts.
Sharps	2 ,,
Maize	2 ,,
Ground oats	1 ,,
Soya bean meal	1·5 ,,

The complete mineral mixture was one found in experiments in Belfast to accelerate the growth of chickens when added to a basal ration such as the above. Its composition was as follows :—

Steamed bone flour ...	...	40 parts.
Sodium chloride ...	...	6 ,,
Potassium chloride ...	...	8 ,,
Potassium iodide ...	...	0·04 part.
Ferric oxide	...	0·4 ,,
Sulphur	...	1 ,,

The complete mixture was fed to the first group at the rate of 4 per cent. of the ration. The mixture was then altered by omitting for one group sulphur; for the next sulphur and ferric oxide, and so on, omitting one more in each case until the sixth group received only steamed bone flour. The following table shows the results obtained.

Mixture fed in different groups.	(1) Bone Meal. Salt. Pot Chl. Iodine. Iron. Sulphur.	(2) Bone Meal. Salt. Pot Chl. Iodine. Iron.	(3) Bone Meal. Salt. Pot. Chl. Iodine	(4) Bone Meal. Salt. Pot. Chl.	(5) Bone Meal. Salt.	(6) Bone Meal.
Weight: *						
Av. gain, gms.						
9 weeks ...	498	545	545	566	632	423
15 weeks ...	1020	1076	1039	1045	1155	982
Mortality: * %						
1st 6 weeks ...	10·3	12·8	11·5	6·4	7·7	12·8
Pullets only ...	2·5	*Nil.*	*Nil.*	11·8	*Nil.*	20·0
Egg-Laying:						
Time to 1st egg:						
Days	125	.. †	131	133	125	159
Av. no. of eggs per pullet at						
22 weeks ...	5·6	..	5·4	7 1	7·0	1·7
26 weeks ...	20·0	...	20·6	19·7	24·9	12 8
Food consumed per lb. live weight increase in 15 weeks:						
lb.	6·3	6·5	5·1	5 6	5·3	7·4

* After 6 weeks pullets and cockerels were separated. From that time results refer to pullets only.

† Group 2 was abandoned at the end of the growth period owing to lack of accommodation for other experimental work.

Growth.—The experiment falls naturally into two parts. At the end of the first nine weeks, during which the supply of grass was very small, the first five groups, all receiving salt, were roughly comparable as regards gain in weight. The sixth group, without salt, made much smaller gains, the average being 423 gms. as compared with an average of 557 in the other groups, a difference of 24 per cent.

The sixth group, without salt, was also very much inferior in general condition. During the first six weeks there was no outstanding difference in percentage mortality between salt and no-salt groups, but, after separation of the pullets, mortality was higher in the no-salt group, totalling 20 per cent. to the end of the growth period, as compared with 11·8 in Group 4, 2·5 in Group 1 and none in the other groups.

Many of the deaths in Group 6 occurred under almost identical conditions. The birds looked listless and ill, with drooping wings and combs which gradually became black and shrunken. Post-mortem examination showed no signs of disease, but the intestines of dead birds usually contained a black mass of undigested material.

During the next six weeks, when the birds were on runs with grass rich in clover, the gains in weight of all the groups were similar. The average gain in the no-salt group was 559 gms. as compared with an average of 510 in the other groups. Birds that were in very poor condition at the end of the first period rapidly recovered on grass, but the general condition of the no-salt group did not reach the level of the other groups.

Egg laying.—Egg laying commenced in the salt groups at from 125 to 134 days, as against 159 in the no-salt group. The number of eggs laid in the no-salt group to the end of the 22nd week was less than in the other groups, 1·7 on an average as against 6·3 per pullet in the other groups, but when they had been continued for a further period of four weeks on grass there was no significant difference between the records.

From these results it appears that, while any or all of the five elements omitted from the mineral mixture, except salt, can be left out without greatly affecting the gain in weight or health of the birds, the omission of salt results in a low rate of growth with impaired health and relatively high mortality. Food consumption per unit increase in weight is increased.

Belfast.

Four groups of white Wyandotte chicks, housed under similar conditions, were fed on a cereal ration supplemented with soya bean meal and a mineral mixture as described above. Group 1 received the complete mixture and one or more of the constituents were omitted from the feed of the other groups. The following table gives the results.

Mineral mixture fed to different groups.	(1) All ingredients.	(2) Steamed bone flour omitted.	(3) Iron, sulphur and iodine omitted.	(4) Salt and potassium chloride omitted.
Av. gain in gms. in 103 days	1479	1458	14'0	·756
Av. gain in 103 days: Cockerels	1617	1565	1633	Sexes not distinguishable with certainty.
Av. gain in 103 days: Pullets	1326	1314	1252	
Av. gain in 119 days ... (Pullets except in 4)	1495	1289	1493	940 (both sexes)
Mortality over 103 days	18·8%	10·2%	15%	49·5%
Lb. food per lb. live weight increase ...	5 05	4·7	5·2	9·3

Growth.—In this experiment the omission of iron, sulphur and iodine seemed to have little effect on the nutritive value of the ration. The omission of steamed bone flour seems to have had some effect in the later stages of growth, i.e. between the 103rd and the 119th day. The omission of chlorides (sodium and potassium) had a very marked effect. The rate of growth during the first 103 days was little more than half that in the other groups, while the mortality was trebled and the food consumption per lb. of increase almost doubled.

Laying.—The following table shows the results of the laying trials, which continued from August 1929 to April 1930 :—

Mixture fed.	*Eggs per bird.*
Complete mixture	132·9
Do. less iron and sulphur ...	128·9
Do. less iodine	135·9
Do. less salt and potassium chloride	91·7

The same effect is again evident. Omission of iron, sulphur and iodine had no effect on egg yield. Omission of salt and potassium chloride caused a considerable reduction in the number of eggs.

Discussion.—It has been commonly believed that salt has a toxic effect on chicks and that the administration of even small doses may be fatal. It has, however, been shown by Mitchell, Card and Carman (1926) that salt may be fed to chicks to the extent of about 8 per cent. of the food without any serious injury. It has also been shown by Mitchell and Carman (1926) that a ration of ground maize, supplemented with casein, chalk and cod liver oil is deficient in both sodium and chlorine, and that the addition of salt to the extent of 1 per cent. of the ration results in increased retention of these elements and of nitrogen, and in a 50 per cent. increase in rate of growth.

In the present experiments the very marked difference in rate of growth and in health between salt and no-salt groups in both sets of results indicates that the basal ration of cereals and soya bean meal is deficient in sodium or chlorine or both. Further work will be required to determine the exact nature of the deficiency and the optimum level of feeding the deficient element or elements.

It is of interest to note that, in the Aberdeen experiment, the transference of the birds to good pasture corrected the deficiency. Good pasture contains from 20 to 30 times as much chlorine as an amount of either maize or wheat yielding the same number of food units. It also contains much more sodium than these products. Hence it would tend to make good a deficiency of either element. This is in agreement with work on calves at the same centre (Orr, Crichton and Shearer, 1929), in which it was found that a mineral supplement to a compound ration was of value during the winter while the animals were deprived of grass, but had no effect when fed to calves on good pasture. Similarly it has been found by Miss Haldane (unpublished data) that the feeding of mineral mixtures to poultry on free range has little effect on rate of growth or health.

Conclusion.—A supplement of salt (NaCl) is essential for adequate growth and health in chickens fed on a ration of cereals and soya bean meal.

Under the conditions of these experiments, sulphur, iron oxide and potassium iodide can be omitted without any bad effect. It is, however, possible that under different conditions, or in different districts, a different result might have been obtained. Consequently it will be necessary to repeat the tests at different centres.

The results on egg-laying are suggestive, but it would be premature to draw conclusions until more extensive trials have been made.

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AN EELWORM DISEASE OF POTATOES CAUSED BY HETERODERA SCHACHTII.

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E. G. Prentice, B.Sc.

Heterodera schachtii (Schmidt), first recognised in 1859 by Schacht as a parasite on sugar beet in Germany and now known to be the cause of " beet sickness," has been shown in recent years to be as serious a pest of the potato crop, both in Britain and on the Continent. In England its occurrence has been recorded in Lancashire, Cheshire, Lincolnshire, Hertfordshire and Yorkshire; while in Scotland we know of its presence in Ayrshire, Kirkcudbrightshire, Dunbartonshire, East Lothian and Ross-shire. Our experience, however, of the potato eelworm has been obtained mainly from a study of the Ayrshire early potato growing areas.

Symptoms of the Disease.—(a) *Foliage Symptoms.*—The first indication of eelworm attack is the slowness with which the potato sprouts appear above ground. Growth continues to be backward throughout the season and the haulms remain thin, spindly and few in number. The foliage of the whole plant assumes a dull unhealthy appearance with a tendency to wilt, especially in the lowermost leaves, which eventually hang down on the haulms, wither and drop off. (Plate I, fig. 2.) The younger leaves are at first not so affected, and in consequence of the loss of the lower leaves form a tufted head to the bare stem. In the field, diseased plants have a characteristic appearance, looking like so many feather dusters, sticking head upward out of the soil. (Plate I, fig. 1.)

It is about this stage that circular diseased patches become evident in the field. Even at a distance these patches may be detected, not only by the sickly colour of the foliage but by the general dwarfing of the plants and their failure to meet in the drills. Occasionally the diseased patches are not well defined and a gradual transition occurs between them and the healthy areas.

In any one plant the disease runs a well defined course, the lowermost leaves first showing the symptoms, the upper ones becoming affected later. The central and youngest leaves remain healthy for a long period and give the head of the shaw the tufted appearance. (Plate I, fig. 2.)

In the individual leaf, however, the disease progresses in the opposite way, namely, from above downward. The terminal leaflet of each leaf becomes brown at the tip, forming a triangular (Plate II, fig. 1) or diamond-shaped area (Plate II, fig. 3), according as the withering develops on one side or equally on both sides of the leaflet midrib. Other brown areas soon appear along the margins of the leaflet. These become confluent and the browning continues inward towards the centre until the whole leaflet withers and dies. (Plate II, fig. 2.) About this stage the tips of the first pair of leaflets begin to turn brown and withering proceeds as in the terminal one. (Plate II, fig. 3.) The other leaflets are attacked in regular succession. A useful diagnostic feature is that the withering margin always rolls upward and inward and the dead parts are crisp and dry. One leaf-characteristic remains to be noted—the leaflets on one side of the midrib almost invariably begin to wither before those on the other side. One side indeed may be completely withered, while the other side is still green. (Plate II, figs. 4 and 5.)

(b) *Root Symptoms.*—It is to the roots of the potato plant that one must turn to ascertain the true nature of the disease, for the root is the part of the plant which harbours the parasite. In the roots the females of *Heterodera schachtii* may be found in all stages of development. In their final stage they burst through the cortex and appear as small white pear-shaped bodies on the outside, ready to be fertilised by the males. After fertilisation they swell up into yellowish, and finally brown, resting cysts which still remain loosely attached to the roots. (Plate III.) They look, both in size and colour, like poppy seeds. The undeveloped cysts will generally be found on actively growing young rootlets, while those more fully developed are usually abundant on the thicker root fibres. This distribution can be accounted for by the growth of the rootlets subsequent to attack since the position of the females on the roots is constant throughout life.

The cysts are more or less numerous according to severity of attack. On the roots of a plant showing slight infection 200 cysts may be found, while on badly infected plants as many as 20 mature cysts may be detected on one linear centimetre of root. As each cyst contains from 250-300 eggs and larvæ, the amazing capacity of the eelworm for rapid increase may be estimated.

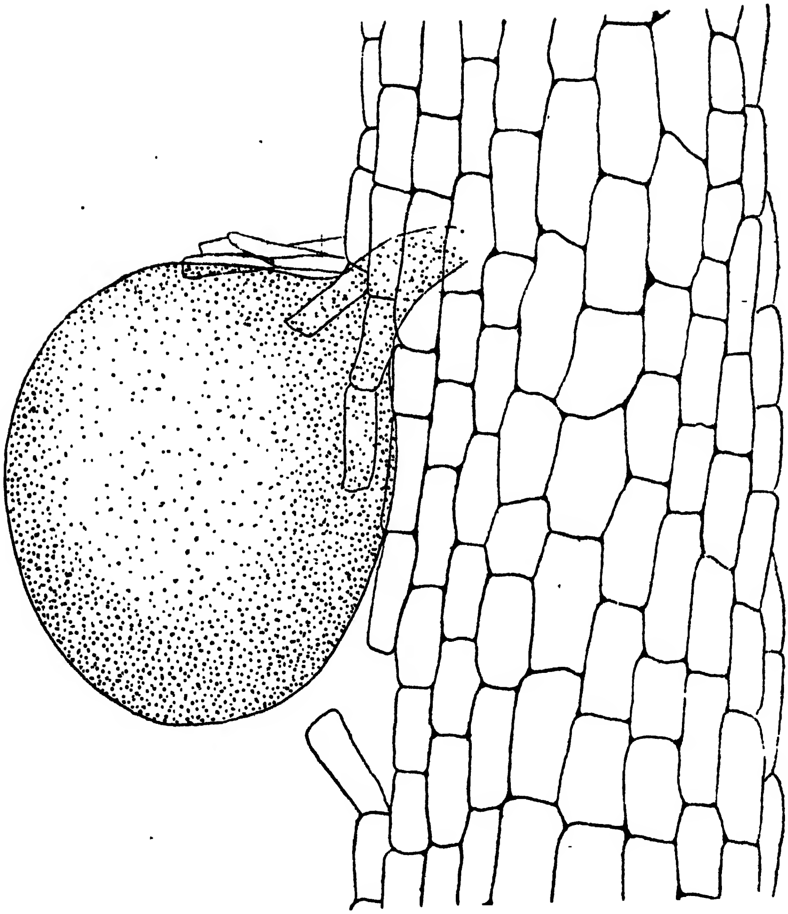

PLATE III.

Swollen female protruding from rootlet—65 days. (× 90.)

It is characteristic that in the early stages of the disease an infected plant shows an abnormal development of fibrous roots. These have been described by Markinowski on sugar beet as "hunger-roots." They are not only long but profusely branched, giving a feathery appearance to each single rootlet. Of this beard-like mass, the finer branches already rendered functionless by the nematodes are of a dry brittle nature and readily break to pieces in the hand. By delicate handling it will be found that the outer layers of each root fibre are loosely attached and can be pulled off, like a sheath, leaving the central woody cylinder intact. This results from the destruction of the cortical layers of the rootlets by the eelworms. To the eye the plant appears to have a good root development, but this is not so. The finer roots are no sooner produced than they are killed by the invading nematodes. The root mass observed is to a large extent composed of dead and dying fibres of no use to the plant in absorbing food materials. Such food as the plant can manufacture is used, not in the production of foliage and tubers, but in the formation of new roots. These new roots are formed above the point of attack by the nematodes, and are only to be found in plants which have been attacked for a long time and appear as a ramifying mass immediately below the surface of the soil. This production of new roots cannot go on indefinitely and eventually the plant dies of starvation.

Secondary infection of the Potato Rootlets.—The death of a potato plant attacked by eelworms is hastened by the action of secondary parasites. The chief of these is the fungus *Rhizoctonia solani*, which invades the potato roots and rootlets and causes their decay. It also parasitises the stolons and stems of the plant, and on occasion damages the outside of the tuber. When it does occur in association with the eelworm, its attack upon the root tissue is generally subsequent to invasion by the eelworms.

In infested fields certain areas will often be observed on which the plants are most unhealthy. Many of them die off prematurely, while others are very stunted in growth and have few foliage leaves. These areas have been termed "nematode nests," and according to Baunacke, are the result of heavy eelworm infestation along with strong secondary infection. In Ayrshire these nests tend to occur on the light sandy "knowes," which are dotted throughout some of the fields or on the braefaces. On these parts the soil is low in organic matter, and, on that account, the plants, even when free from parasitic infection of the roots, will tend to suffer from drought; but when the root system is inefficient owing to eelworm attack extreme dwarfing of the plant ensues. Further, owing to their low organic matter content, these areas are very easily warmed in the spring and the larvæ become active at a much earlier date than in the surrounding soil with a higher organic matter content. The result is that the plants in the former area are attacked at an earlier stage than those in the latter and therefore tend to suffer to a greater extent.

It has been frequently noted that the cyst content of the soil within the " nematode nest " is usually lower than that outwith the nest. This is probably due to the ability of the larvæ to select as their host mainly those plants which are still vigorous and healthy, and which have not been heavily attacked in the early stages of growth, i.e. those outwith the " nematode nest." The cyst content within the "nest " is further lowered owing to many of the roots, in which larvæ have begun their development, succumbing to the attack and thereby bringing about the death of the enclosed larvæ.

The Yield from infected Plants.—Attack of the potato rootlets by the eelworms leads to a more or less serious reduction in yield, according as the season is favourable or unfavourable for potato growth. The weather in the months of March and April determines to a great extent the influence of the eelworms upon the crop yield. Should these months be moderately cool but favourable for growth, the plants will be well established before they become heavily invaded by the eelworm larvæ. But an unduly dry period, especially in April and May, is very harmful, as the scarcity of moisture in the soil is aggravated by the lack of healthy rootlets uninvaded by larvæ.

In Ayrshire, early potatoes resist the effects of eelworm attack much better than lates. In badly infested soil the yield from the former may be from two to three tons per acre, and from the latter only one ton. This difference in resistance as between early and late varieties is probably due to the optimum temperature for the hatching of the larvæ from the cysts never being attained during the growing period of the early crop, viz. from March to June. During these months the soil temperature rises from 3° to 14°C., whereas the optimum temperature for the hatching of the larvæ as determined by us is 18°C. Tubers from infected plants are perfectly sound and show no injury or gall formation, although encysted females can generally be found attached to the surface either free or in the adhering earth.

Briefly reviewing the effect of the eelworm on the potato plant, it may be said that *Heterodera schachtii* acts as a true parasite and makes the living plant serve for its nutrition and development. By continued withdrawal of nutriment from the plant, growth is inhibited, and, as the plant expends its energies in the production of lateral roots, little or no reserve food material is stored in the form of tubers. The eelworm injures the plant secondarily by weakening its resistance to external conditions, such as drought, and by leaving behind wounds which render it liable to secondary infection.

Life History of the Parasite.—*Attack on the Host.*—The larvæ of *H. schachtii* can be demonstrated actually entering the rootlets or completely inside the rootlet tissue of potato plants, which have been growing for about 17 days in infested soil. (Plate V, fig. 2.) The invasion continues throughout the growing season

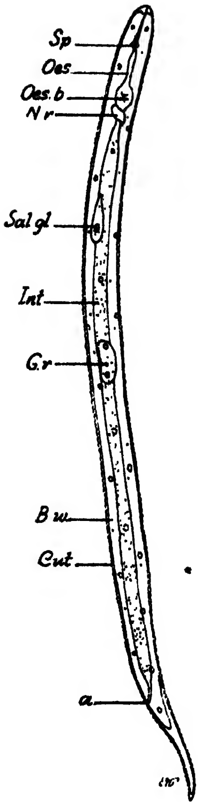

Fig. 1.

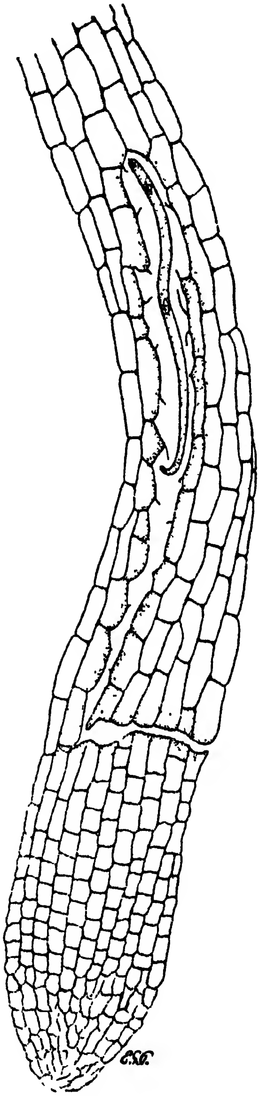

Fig. 2.

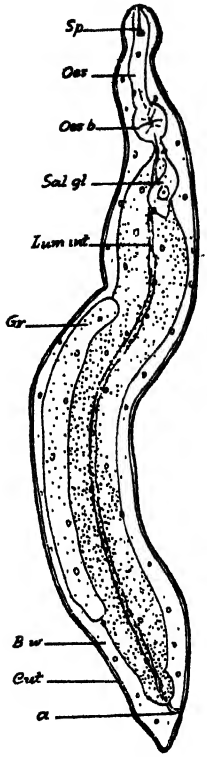

Fig. 3.

PLATE V.

Fig. 1.—First stage larva newly hatched from egg. (× 180.)

Fig. 2.—First stage larva within rootlet drawn in optical section. Note track of larva among the ruptured cortical cells. (× 90.)

Fig. 3.—Mature second stage larva. (× 180.)

or as long as the plant continues to produce new rootlets. The larva appears to bore its way into the root by the action of its mouth spear and the point of entry is usually sub-apical. Once inside the root it confines itself to the cortex and moves away from the root tip towards the parent root, killing the cortical cells through which it passes. Secondary parasites follow very quickly on the track of the larva through the hole by which it gained entry to the root. The distance which a larva travels within a rootlet before settling down, prior to feeding and moulting, varies greatly, but seems to depend upon the diameter of the rootlet and the number of larvæ within it. Generally, however, the distance travelled does not exceed 1 cm. The damage which a single larva produces on an infected rootlet is the destruction of the cortical cells in its neighbourhood and the subsequent death of the distal or apical part of the root. In the more common type of invasion—where several larvæ enter one rootlet and then pass into the main root—the same kind of damage is done, but it involves and destroys the whole rootlet from its origin to its tip. The larvæ, having become stationary, proceed to undergo the various stages of post-larval development. During this period they cause little obvious damage to the root tissues in their immediate vicinity until they become sexually mature. Thereafter they burst through the cortex, the male escaping directly into the soil (Plate VI. fig. 3), the female remaining attached to the rootlet only by its headward end, while the rounded posterior part protrudes through the rupture. (Plate III.) Within the root tissues, however, the larvæ set up serious disturbances which are believed to be related to their mode of feeding. On coming to rest within the cortex, they orientate themselves in a direction parallel to the root, and with their heads abutting on the endodermis enter upon a feeding period which varies from about 25 days in the case of the male to over 60 in that of the female.

The immediate reaction on the part of the host is confined to the tissues lying within that part of the endodermis adjacent to the head of the nematode and apparently originates in the parenchyma cells, the elements of which become replaced by a series of very large cells to which Nemec has given the name "giant cells." (Plate IV.) Each giant cell is richly granular and contains many large nuclei. As the complex of giant cells develops, it presses upon and actually displaces the xylem. It seems to act like a wedge which breaks or seriously inhibits the conduction of nutritive materials by the xylem vessels. Consequently very little water can pass from the absorptive rootlets to the aerial part of the plant, and conversely no plastic substances can pass downward to the growing stolons and roots. The plant, in an endeavour to rectify matters, produces fresh rootlets above the point of attack, which are no sooner formed than they too are invaded and rendered functionless. The results arising from the blocking of the vascular bundles by the giant cells are (*a*) an inhibition of growth at the apices of

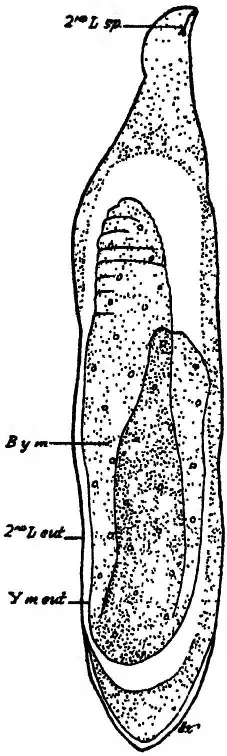

FIG. 1.

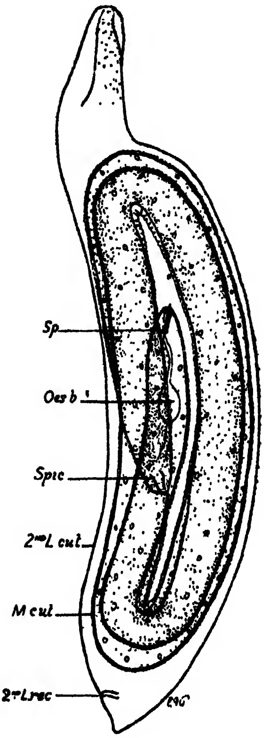

FIG. 2.

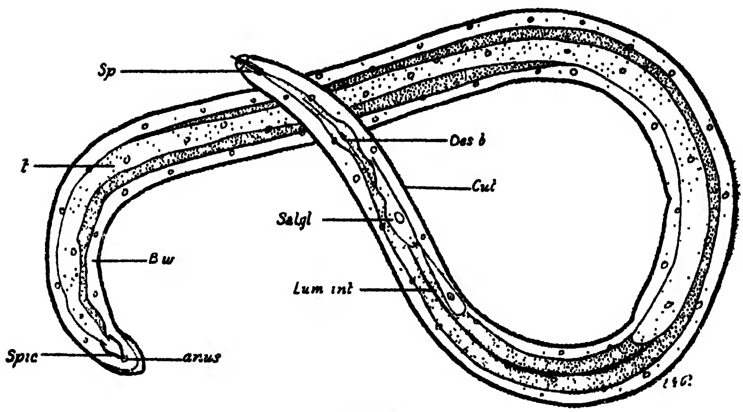

FIG. 3.

PLATE VI.

Fig. 1.—Early stage in development of male. The body beginning to lengthen folds upon itself. (×180.)

Fig. 2.—Mature male coiled within the second larval cuticle. (×180.)

Fig. 3.—Mature male as it occurs in the soil. (×180.)

invaded rootlets; (*b*) a profusion of lateral rootlets; (*c*) an insufficiency of water supply to the stem and leaves; (*d*) an insufficiency of mineral nutrients to the whole plant. It is believed that the group of giant cells constitutes a sort of gland which furnishes a ready supply of food to the developing nematode. They are a direct result of nematode activity, and are probably due to salivary or excretory products of the nematodes passing into the tissues. E. F. Smith has shown that giant cells and plant tumours in general result from the liberation into the tissues by the parasite of weak acids and alkalies. The leaf symptoms of eelworm disease already noted have possibly their origin in these same toxic substances. When carried to the leaves in the transpiration stream they will tend to concentrate there and cause the death of the cells of the leaf, especially round the edge where transpiration is most active.

The first stage larva newly hatched from the egg is about one-sixtieth of an inch in length. (Plate V, fig. 1.) It bores its way into one of the potato rootlets (Plate V, fig. 2), and, after feeding there for about 14 days, moults and emerges from the old cuticle as a second stage larva, which differs very little in size or shape from the first stage larva. The second stage larva feeds and grows and in about 10 days is fully developed. (Plate V, fig. 3.) From this point onward male and female larvæ undergo a different course of development.

Development of Male.—The fully grown second stage larva shrinks from its cuticle and then, gradually lengthening, folds upon itself within the old cuticle (Plate VI, fig. 1), until in about 14 days it becomes fully mature (Plate VI, fig. 2). Then it bursts out of the second larval cuticle, makes its way out of the root tissues and passes into the soil. (Plate VI, fig. 3.)

Development of Female.—A new cuticle forms underneath that of the mature second stage larva, but as the larval body does not shrink as it does in the case of the male, the presence of the two closely apposed cuticles is not easily detected. Meanwhile the larva has been continuing to feed. It soon becomes pear shaped (Plate VII, fig. 1), and with further absorption of food the rounded posterior portion bursts through the cortex and protrudes from the root. The organism is now sexually mature and is fertilized by the male, which is to be found in the soil at this time. After fertilization the female, being still attached to the root by its headward end, continues to feed and soon swells into a white bladder-shaped cyst full of undeveloped eggs. (Plate VII, fig. 2.) Later the cyst changes in colour through yellow to dark brown and at the same time its wall becomes hard and tough. Meanwhile the eggs within the cyst have also been proceeding with their development and will now be found to contain fully formed larvæ. (Plate VII, fig. 3.) The yellow or brown cysts, being about $\frac{1}{25}''$ in diameter, are readily seen loosely attached to infected potato roots. (Plate III.) When the potato crop is lifted they drop off into the soil and remain dormant there until a potato crop is grown again, when

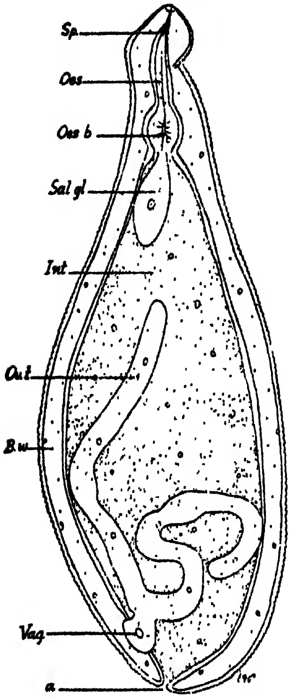

FIG. 1.

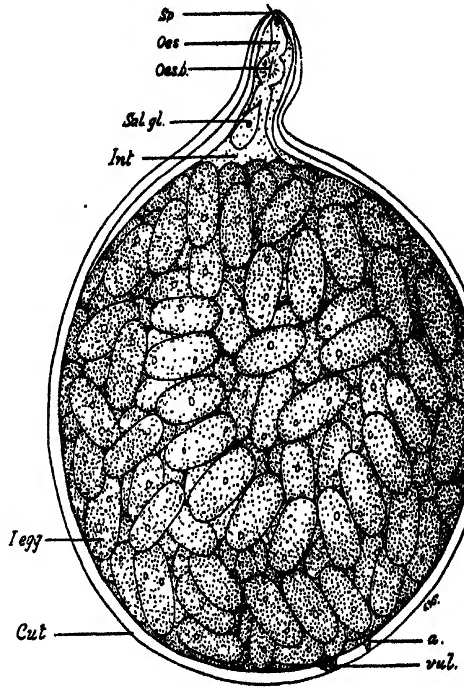

FIG. 2.

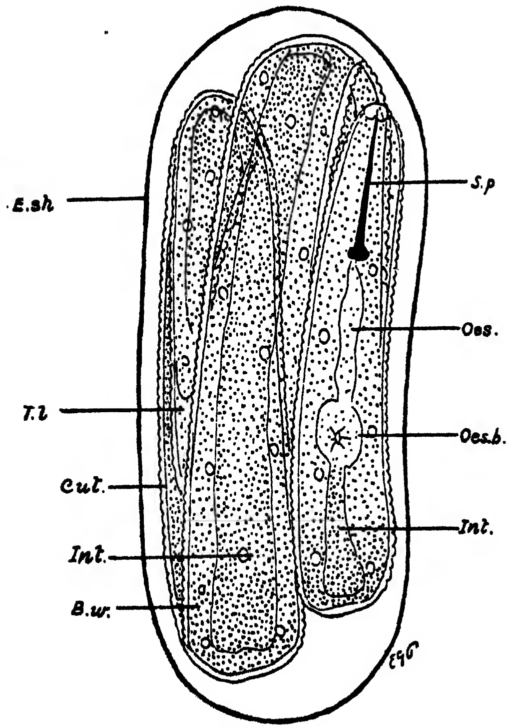

FIG. 3.

PLATE VII.

Fig. 1.—Early stage in development of female.—Body pear shaped. (×180.)

Fig. 2.—Later stage of same in which the body of female has grown into a spherical cyst containing immature eggs. (×100.)

Fig. 3.—Egg containing a fully formed larva. (×690.)

the larvæ hatch out and attack the roots. Under normal field conditions in the West of Scotland the mature brown cysts can be found on the potato roots about the one-hundredth day after planting. This applies to early potatoes planted towards the end of February.

Biology of the Larvæ.—The larvæ of the potato strain of *Heterodera schachtii* will not hatch from the cysts when the latter are incubated at soil temperature in distilled or tap water or in soil extract. Under such conditions the cysts merely become attacked by fungi. But when incubated in water containing the washings [1] from growing potato roots the larvæ hatch out from the cysts in great numbers. It would appear, therefore, that the brood in the cysts is activated by excretions from the growing potato roots. So far as the potato eelworm is concerned this action of root excretion is peculiar to potatoes. The other farm crops such as beet, rape, lupins, chicory, mustard and oats have no stimulating effect whatsoever on the larvæ within the cyst.

The rate at which the larvæ hatch from the cysts when incubated in potato root excretion is at first slow, then it rises to a maximum, after which it dwindles to zero. That this cessation of hatching—which occurs about the twenty-eighth day of incubation—is not altogether due to a peculiarity of the larvæ remaining in the cysts, but to a change (a staling) of the root excretion, is proved by the fact that larvæ will still hatch readily from these cysts when they are put into fresh root excretion, but little hatching will occur from fresh cysts when put into the stale excretion. The optimum temperature for hatching in watch-glasses to which no fresh root excretion is added during the 28-day incubation period is about 18° C.; but a different optimum may rule in the soil where fresh root excretion is being continually produced.

Cyst content of Soils.—It has already been noted that the female eelworm after fertilization becomes converted into a brown walled cyst which protects the eggs and larvæ within, and that these cysts, being loosely attached to the potato rootlets, readily fall off into the soil and remain dormant until the next potato crop is planted.

An examination has been made of the soils where potatoes are grown in close sequence in our area with a view to determining their cyst content. The method adopted is as follows:—In order to obtain a representative sample of the area under test, 10 bores of the soil to a depth of 9 inches are taken with a soil sampler. The soil is then air dried and passed through a 2-inch sieve in order to remove the larger stones, &c. From this sieved soil 10 cc. are taken and shaken up in a graduated half litre flask partially filled with water. It is then filled almost to the 500 cc. mark with water and allowed to stand until the cysts float to the top. Finally the flask is filled to the very lip with

[1] These washings may be obtained by Rensch's method, i.e. by growing potatoes in a filter funnel containing clean sand to which a mineral solution has been added. Leachings from the sand can be taken as desired.

water and the cysts decanted on to a filter paper (Rensch's method modified by Morgan). The filter paper is then spread out and the number of cysts on it counted. Ten determinations are made from each sample.

Counts from some of the soils from various districts in Ayrshire showed that the number of cysts per 10 cc. in the top 9 inches of soil varied from 141·5 to 1·0, with an average of 57·6. These figures are alarming when it is remembered that *each fresh* cyst contains on an average 300 eggs and larvæ. As 10 cc. of these soils has an average weight of 0·406 grams, 1 lb. of a soil such as the sample first quoted above would contain 5,591 cysts and a potential 1,677,300 eelworms. But it is of importance to note that all the larvæ in freshly formed cysts even under continuous stimulation by potato root excretion will not become activated and hatch out. Many of them remain within the egg and hatch out only at some future date. In view of this the estimation of the number of potential eelworms in such a soil being based on the assumption that all the cysts are fresh, i.e. newly formed, is much too high. Many of the cysts have been lying in the soil for several years and contain only a few larvæ, while still others contain none at all. Fuchs actually made counts of the number of larvæ within old cysts and found that in the case of those which had been lying in the soil for four years 25 per cent. were empty, 9 per cent. had less than 30 eggs, 60 per cent. had between 30 and 45 eggs, and 6 per cent. had over 45 eggs. It is obvious, therefore, that cyst counts of different soils as an index of larval numbers are comparable only in those cases where infection has been introduced at the same time and where potatoes have been grown in the same years.

Depth of Infection of Soils.—The greatest number of cysts are found in the top 9 inches of soil and the numbers rapidly decrease below that depth. In the case of the Ayrshire early potato soils, the subsoil is in the nature of a coarse gravel and few of the soils extend to a greater depth than one foot. It is to be expected therefore that the number of cysts below a depth of 9 inches will not be large. The following table shows the numbers found :—

Sample.	No. of Cysts per 10 cc. of Soil at various depths.			
	0″–9″	10″–18″	19″–27″	28″–36″
19	141·5	24·9	2·4	...
13	106·9	36·3	15·0	...
7	80·7	0·4	0·5	0·1
25	59·0	1·5	...	...
1	22·5	4·0	0·4	...

The maximum depth of 36 inches at which cysts were found to occur is comparable with the figure of 30 inches given by Thorne and Giddings in America, and 31·5 inches given by Baunacke in Germany for the cysts of the beet eelworm. The question of the maximum depth at which cysts occur is of great importance when the question of the methods of controlling or eradicating the eelworms is being considered. While it might be feasible to consider methods of sterilizing the surface soil either by chemical agents or by heat, yet it would be impracticable from an economic standpoint to sterilize the soil by any method to a depth of 36 inches.

The effect of Soil reaction on the severity of the Disease and on Cyst concentration of the Soil. — Preliminary work on the Ayrshire early potato soils suggested that a relationship existed between the severity of eelworm disease and the acidity of the soil, and further work indicated that plants growing in soils with a pH between 4·2 and 5·0 tended to suffer less from eelworm attack than those growing in soils of pH outwith these limits. It is probable, however, that the reaction of the soil influences not the activities of the eelworm, but the vigour of the plant itself. For instance, we have found a potato crop to fail completely in a soil of pH 3·8 but to be remarkably successful on the same soil when its pH had been raised to 5·5 by the addition of ground lime.

The evidence regarding the effect of soil reaction on cyst concentration is very conflicting. Here again it is probable that soil reaction influences the cyst content of the soil only through affecting the vigour of the plant.

Power of adaptation of Heterodera schachtii.—*Heterodera schachtii* is a parasite of a great number of weeds and cultivated crops. Among others, it has been recorded as attacking sugar beet, mustard, cabbage, lettuce, wheat, barley, rye, oats, peas, beans, potatoes, nightshade, dandelion, chickweed, marram grass and couch grass. But whenever intensive cultivation is practised an opportunity is afforded to the eelworm to specialize on one particular crop, as for instance on sugar beet in Germany, or early potatoes in Ayrshire. In this way distinct strains of *Heterodera schachtii*—a beet strain and a potato strain—are evolved. The peculiarity of such strains is that they will attack only the host plant on which they have specialized, e.g. the potato strain is almost entirely confined to the roots of potatoes and the beet eelworm to the roots of beet. But the specialization is not truly permanent. It holds only so long as the selected host plant is available. In its absence the larvæ gradually adapt themselves to the most suitable plant offered. In Germany, for example, Goffart has been able to get the larvæ of the potato strain eventually to attack sugar beet when potatoes were not available.

Spread of the Disease.—The rate of spread of *Heterodera schachtii* in the field has been determined experimentally at Kilmarnock as follows. A level piece of uninfested ground was inoculated at the centre with soil containing eelworm cysts. Potatoes were grown in the plot every year and accurate records taken of the rate of spread as determined by examining the roots for cysts and noting the distance from the point of inoculation at which infected roots occurred. Under such conditions the rate of spread was found to be about 9 feet per annum. On sloping ground a much higher figure may be obtained owing to the cysts being carried downward by surface water.

Original infection of a clean piece of ground may be due to the cysts being carried by drainage water, streams or wind, or by man or beast or implements; but the most serious source of infection is from cysts carried on seed potatoes. On one of the samples of seed examined the average number of cysts per "sett" was 15.[1] An acre of ground planted with such seed 12 inches apart on 27 inch drills would receive an initial infection of 300,000 cysts; but as this represents only about $\frac{1}{320}$ cyst per 10 cc. of soil, it is of importance only in these cases where a crop rotation is not practised, as for example in gardens, allotments and in districts where potatoes are grown more or less without a break. In these the increase from the initial infection will be so great that potato growing will become unprofitable in a few years.

Control Measures.—(a) *Chemical control.*—Chemical control measures against *Heterodera schachtii* have met with little success so far, and effective control seems to be attainable only by the application of enormous doses of the most potent soil disinfectants. For instance, Thorne, in America, states that about 14 cwt. per acre of calcium cyanide are necessary, while Goffart in Germany finds that by using the same compound, effective control can be obtained only at an expense of £300 per acre.

At the West of Scotland Experiment Station, dressings equivalent to 6 cwt. per acre of calcium cyanide and to 1½ cwt. of uspulun gave no apparent increase in yield of potatoes nor significant reduction in number of cysts.

The experiments of Edwards in Lincolnshire, however, indicate that drained creosote salts have some beneficial effect on potatoes grown in soil infected with *Heterodera schachtii* and *Rhizoctonia solani;* but whether the beneficial result is due to the action of the creosote salts on the eelworms or not is not stated.

(b) *Biological control.—The effect of Chicory.*—Rensch states that, by growing chicory on beet-sick soils, the eelworm content of the soil can be reduced considerably, since the excretions from the chicory roots stimulate the larvæ to hatch from the cysts, but in the absence of their host plant—sugar beet—they die of starvation.

It was thought that chicory might have a similar effect on the potato eelworm, and an experiment was laid down on one of the badly infested Ayrshire soils. The chicory seed was sown in drills on May 15th, 1929, and soil samples taken at the same time by the method already described. The soil was again sampled on 9th September (on which date the chicory was lifted)

[1] The method adopted to determine the "cyst content" of the sett was to wash the individual tubers thoroughly in water and then to decant the supernatant liquid on to a filter paper on which the cysts were retained and counted.

and again on 29th August 1930 after a crop of potatoes had been grown and harvested. The following table, showing the cyst counts obtained, indicates that the cyst content of the soil was not reduced by growing a crop of chicory on it.

Date of Sampling.	No. of Cysts per 10 cc. of Soil.	
	Ground not under Chicory.	Ground under Chicory.
May 19th, 1929	87·4	78·0
September 9th, 1929	87 2	69·2
August 29th, 1930	98·4	114·0

Another series of experiments was carried out in watch glasses to find if chicory root excretion (obtained by the method already described for potato root excretion) would induce the larvæ of the potato eelworm to hatch from the cysts. Each experiment was run for 28 days, and the average number of larvæ that hatched per cyst during that period was found to be one. Indeed, instead of stimulating the larvæ, the chicory root excretion appeared to have a detrimental effect on them, since, when the cysts were transferred to potato root excretion, the number of larvæ that hatched out per 15 cysts in the 28 day period was on the average only 743 as compared with 1,149 in the control.

The effect of Mustard.—We were induced to try the effect of a crop of white mustard in eradicating the potato eelworm since we learned that at one time this crop was grown with advantage after early potatoes. The mustard seed was sown broadcast on 10th July 1929 at the rate of 20 lb. per acre after a crop of potatoes had been lifted and the cyst content of the soil determined at that date. The mustard crop was ploughed in in January 1930, and on August 29th, 1930, after the crop of early potatoes had been lifted, the soil was again sampled. The following table shows the results obtained.

Time of Sampling.	No. of Cysts per 10 cc. of Soil.	
	Ground not under Mustard.	Ground under Mustard.
July 10th, 1929	7	46
August 29th, 1930	31	69

The smaller increase in the cyst content of the mustard plot as compared with the control plot may be significant.

Triffitt, from pot experiments carried out in Lincolnshire, records that she found very few cysts on the roots of potato plants growing in infested soil where mustard was growing along with the potatoes or where it had been grown in the pots previous to the potatoes. On the other hand in the control pots—those in which no mustard was growing or had been previously grown—there was a larger number of cysts present on the roots of the potatoes.

Watch glass experiments carried out by us show that mustard root excretion

(a) does not induce the larvæ to hatch from the cysts;

(b) *may* cause a reduction in the number of larvæ that do hatch from the cysts under the stimulation of potato root excretion;

(c) has no lethal effect, at least within a 28 day period, on the larvæ within the cysts.

(c) *Biological and Chemical control.—The effect of Lupins, Melilot and Stinking Animal Oil.*—Reinmuth in Mecklenberg has recently published a paper showing that the potato eelworm may be controlled by the growing of catch crops on, and the application of animal oil to, the infested ground. The procedure adopted by him and by which he gets a great decrease in the cyst content of the soil and a marked increase in the yield of potatoes in the next year is as follows. (1) As soon as the potato crop is lifted, the green shaws are cut up into small pieces and incorporated with the soil. (2) The ground is immediately seeded, either with sweet clover or with lupins, and a catch crop grown which is ploughed in early in September. (3) Then the ground is immediately top dressed with stinking animal oil at the rate of 6 cwt. per acre. For convenience of application the oil is absorbed in sawdust.

Reinmuth does not vouch an explanation of what effect the catch crops have on the eelworm, but he indicates that the animal oil may first act as a stimulant to induce the larvæ to hatch, after which it becomes a " lethal " agent and kills them.

Watch glass experiments carried out by us have shown that no hatching whatsoever takes place in lupin root excretions and the larvæ within the cysts do not seem to be injured in any way, since on being transferred to potato root excretion after 28 days, the average number of larvæ that hatched out per 15 cysts was 1,845 as compared with a control of 1,149.

Other experiments were set up to demonstrate the effect of animal oil on the larvæ within the cysts. Fifteen cysts were taken as usual and put into watch glasses each containing 2 cc. of potato root excretion plus a varying number of drops of a 1·6 per cent. solution of animal oil in water.

In a series of experiments over a 28-day period a marked inhibitory action of animal oil even in very weak concentration was demonstrated. But the action is only inhibitory; it is not lethal. The larvæ which do hatch out in presence of the animal oil remain active for long periods. Moreover the animal oil has no injurious effect on the larvæ within the cysts. When the latter were transferred to potato root excretion, 980 larvæ were found, on an average, to hatch from 15 cysts, as compared with 1,149 from the control.

Fig. 1. Fig. 2. Fig. 3.

PLATE 1.

Fig. 1.—Potato plant in early stages of infection, showing "feather duster" appearance and leaf roll symptoms.

Fig. 2.—A plant badly infected. Lower leaves have all withered. Upper leaves unhealthy and of a yellowish green colour.

Fig. 3.—Plant showing final stage of disease with only four withered leaves still attached.

FIG. 1. FIG. 2. FIG. 3.

FIG. 4. FIG. 5. FIG. 6.

PLATE II.

LEAF SYMPTOMS.

Fig. 1.—Triangular shaped withered area at apex of terminal leaflet.

Fig. 2.—Whole apical leaflet withered. The leaflets on the right side of the midrib shew symptoms, while those on the left side are still healthy.

Fig. 3.—Diamond shaped withered area at apex of terminal leaflet. Withering occurring on the leaflets on both sides of the midrib.

Figs. 4-6.—Later stages in the destruction of the leaf.

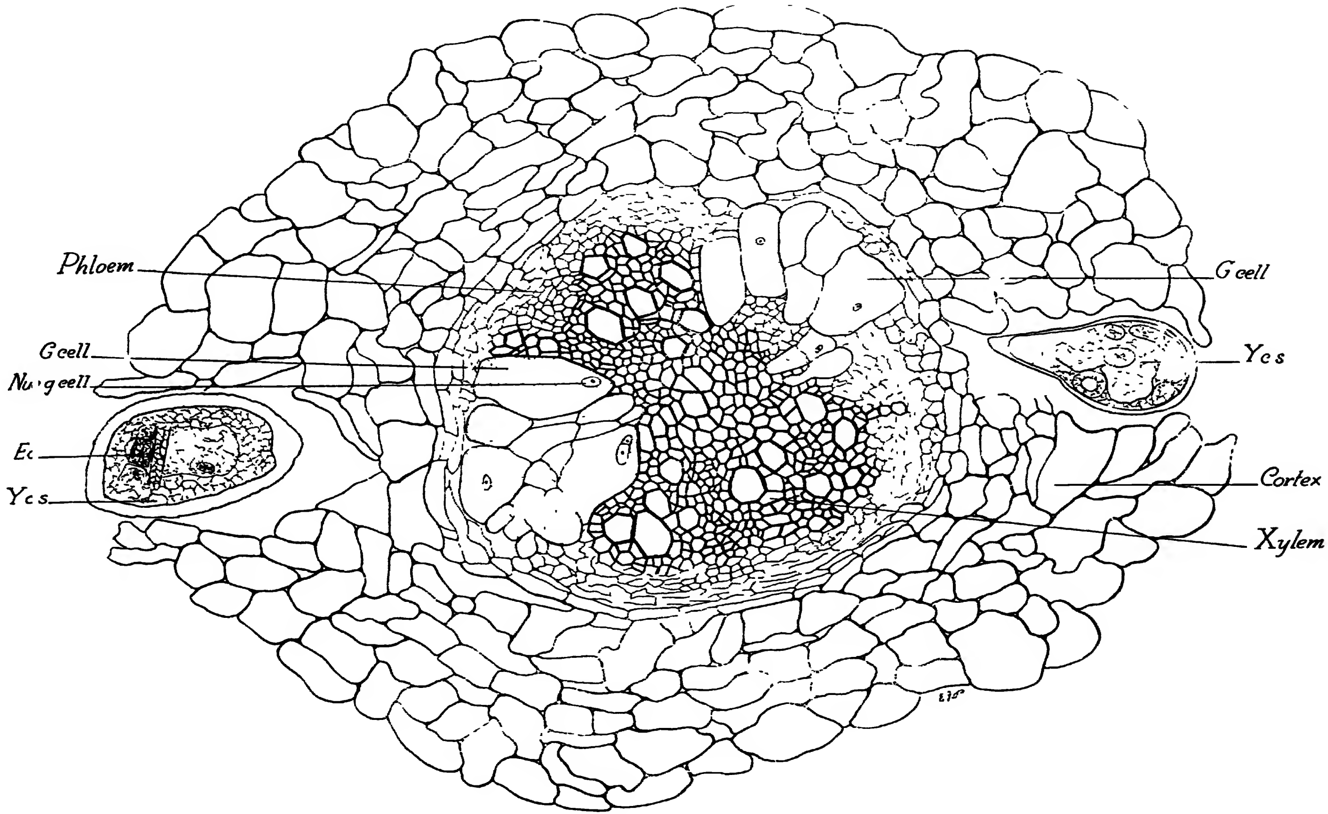

PLATE IV.

PLATE VIII.

FIG. 1.
Dung applied in drill at time of planting of potatoes

FIG. 2.
No dung applied but liberal application of artificial manures given
Note margin of dunged plot on left.

On both areas dung had been applied in the two preceding years

We have been unable to note any reduction in the cyst content of the soil following an application of animal oil. A plot heavily infested with eelworm cysts received a dressing of 6 cwt. per acre of animal oil at the end of December 1929. The soil was sampled on 13th January 1930 and again on 29th August 1930 after a crop of potatoes had been grown and lifted. The following table gives the cyst content of the samples.

Time of Sampling.	No. of Cysts per 10 cc. of Soil.	
	Untreated.	Treated with Animal Oil.
January 13th, 1930	63	91
August 29th, 1930	126	165

(d) *The Adoption of a rotation.*—It has already been indicated that *Heterodera schachtii* causes marked injury only when potatoes are grown year after year on the same soil, but where a rotation is practised the damage done is considerably reduced. In Germany, Zimmermann records very good results from withholding potatoes from badly infested soils for three years. On some of the Ayrshire soils marked results are obtained even by withholding potatoes from the field for one year. Unfortunately in Ayrshire the adoption of a rotation is practically impossible as these light sandy soils are of little use for ordinary cropping purposes.

(e) *The effect of Early Lifting.*—As the lifting of the potato crop begins early in June in Ayrshire, the eelworm cysts have not yet matured. They have just appeared externally on the roots and are still yellow or white in colour. The drying action of sun and wind is therefore very harmful to them, and a high death-rate occurs especially among the white cysts and earlier stages. But the yellow cysts are able to reach maturity and find their way into the soil. It might be of some benefit therefore to burn all the shaws as soon as they are lifted. But the advantage could only be slight, as, during the actual lifting of the potatoes and the subsequent shaking of the roots to dislodge the tubers, the majority of the cysts drop off into the soil. Much depends, however, on how long the potatoes have been allowed to grow before lifting. If raised very early and before the developing females have emerged from the roots, the practice of burning the shaws would be of considerable benefit, but where lifting is delayed until the females are visible externally, the effect would not be appreciable.

This early lifting might be extended to a second potato crop, planted after the ordinary crop had been raised. In order to save expense, chats might be broadcasted on the soil and ploughed in. When the plants have reached a fair stage of development and before any cysts are visible on the roots—about 50 days after planting—they could be grubbed up and gathered immediately into a large heap where they might rot. The whole aim would be to uproot the potatoes before the females are fertilized, as the females once fertilized can develop their eggs and larvæ without being attached to their host plant (Wilfarth).

This method of control is in reality a modification of the trap-plant method of Kühn. The principle of this method is to sow a quick growing susceptible crop on the infested soil and to uproot it after it has been invaded by the eelworm larvæ but before the females have become sexually mature. Rape was the trap-plant used by Kühn. It was quick growing and was very susceptible to attack by the beet eelworm.

(g) *The effect of applying Farmyard Manure in the Drill.*—The most promising preventive measure we have tried is to apply a heavy dressing (20 tons per acre) of farmyard manure in the drill at the time of planting of the crop. (The farmyard manure is normally applied on the flat before ploughing.) It seems that the adoption of this practice prevents the eelworms attacking potato plants until they are fairly well established. Ultimately, however, they are invaded, but as already mentioned, when potatoes are attacked late in the growing season, the damage is not nearly so great as when they are attacked early.

The following trial carried out at the West of Scotland Experiment Station is of interest. A plot heavily infested with the potato eelworm was chosen, and half of it received a dressing of 20 tons per acre of farmyard manure in the drill; on the other half 12 cwt. per acre of a complete artificial fertiliser was applied. In the autumn, when the potatoes were lifted, the dunged plot yielded a crop equivalent to 6 tons 3 cwt. per acre, while on the other none of the tubers were of ware size and the total yield was only 1 ton 11 cwt. (Plate VIII.) The increase in yield of potatoes was not accompanied by a reduction in the cyst content of the soil.

In conclusion we wish to thank those early potato growers who have assisted us in carrying out these investigations.

EXPLANATION OF LETTERING ON PLATES.

a.	Anus.
B.w.	Body wall.
B y.m.	Body of young male.
Cut.	Cuticle.
Cut fem.	Cuticle of young female.
E.sh.	Shell of egg.
Ex.p.	Excretory pore.
1st L.cut.	Cuticle of first stage larva.
G.o.	Genital organ.
G.r.	Genital rudiment.
I.egg	Immature egg.
Int.	Intestine.
Lum.int.	Lumen of intestine.
M.cut.	Cuticle of male.
N.r.	Nerve ring.
Oes.	Oesophagus.
Oes. b.	Oesophageal bulb.
Ov.t.	Ovarian tube.
Rec.	Rectum.
R.oes.b.	Rudiment of œsophageal bulb.
R.sp.	Rudimentary spear.
R.spic.	Rudimentary spicules.
R.vag.	Rudiment of vagina.
Sal.gl.	Salivary gland.
2nd L.cut.	Cuticle of second stage larva.
2nd L.rec.	Wall of rectum of second stage larva.
2nd L.sp.	Spear of second stage larva.
Sp.	Spear.
T.	Testis.
T.l.	Tail of larva
Vag.	Vagina.
Vul.	Vulva.
Y.m.cut.	Cuticle of young male.

Craibstone.

Notes from Agricultural Colleges.

Grasses and Clovers, 1930.—The hay crop of 1930 in this district was generally under average, largely due to a lack of red clover. Although red clover does not weigh for its bulk, nevertheless its presence or absence has a considerable effect on the weight of the hay. There are three likely reasons for this deficiency of red clover—(1) the dry weather during and after seeding time in 1929, (2) the exceptionally heavy grain crop last year, and (3) the dry spell this year at a time when the red clover should have been developing. Examples of all these have been observed in different fields.

In most seasons there is usually more red clover on bare knolls than in the rest of the field, due to the grain crop being poorer there. As the soil deepens the grain crop becomes heavier and the red clover lighter. This year, however, there was practically no clover on the knolls on some fields, but the amount gradually increased with increasing depth of soil, due to the improvement in moisture conditions.

In another case the grass seeds at one side of a field were sown a few days earlier than at the other side. The soil was light and the weather during the intervening period was dry, so that the soil gradually got drier. There was much less red clover on the late sown part than on the earlier sown part, obviously due to a lack of moisture at the time of brairding.

On light soils the precaution should be taken, especially during dry weather, to sow the grass seeds as soon as possible after the grain crop is sown so as to make the most of the available moisture.

In another case where the dung was applied and ploughed in after the root crop was taken off, the red clover was much more plentiful than where the dung was applied in the drill for the root crop. This may have been due to the dung keeping the soil moister.

The grain crop of 1929 was probably a record, both grain and straw being generally greater than in any previous year. A heavy grain crop always adversely affects the future hay or pasture, especially red clover, but this may be obviated to some extent if the crop is cut early. The following examples obtained this year will serve to show the effect of heavy crops.

Grain crops are usually found to be heavier after turnips than after potatoes, the conditions and manuring being otherwise the same. This heavier grain crop in its turn acts adversely on the red clover and reduces the amount in the hay.

Hay crop where root crop was—

	Clover. cwt	*Grasses.* cwt.	*Total.* cwt.
(*a*) Potatoes	21·2	24·8	46
(*b*) Turnips	10·7	30·3	41

Nitrogenous manures applied to the grain crop act on the red clover in the same way. Last year two plots of oats after roots were manured with 1½ cwt. superphosphate, 2½ cwt. ground mineral phosphates and 1 cwt. muriate of potash, while one of them got 1 cwt. sulphate of ammonia in addition.

The yields of grain and straw per acre were as follows :—

	Grain. cwt.	*Straw.* cwt.
With 1 cwt. sulphate of ammonia ...	33·7	49·9
No nitrogen	28·4	41·6

This year samples of the hay were taken and separated into grass and clover and the following result was obtained :—

	Per acre.		
	Grass. cwt.	*Clover.* cwt.	*Total.* cwt.
After 1 cwt. sulphate of ammonia to oats	19·2	1·3	20·5
No nitrogen	16·6	14·0	30·6

There was also a corresponding difference in the amount of clover in the aftermath.

In many fields where red clover was deficient in the hay it was plentiful in the aftermath. This would seem to be due to the moisture and temperature conditions in spring being unsuitable for the development of the red clover.

Trials with different samples of red clover showed distinctly that the Late-flowering type was much superior this year to Broad-leaved. Even the best stocks of English Broad-leaved, although considerably better than Chilian and French, were poorer than they usually are. Where red clover was plentiful in fields seen in the country, it was mostly Late-flowering that was present.

Among the different nationalities of Late-flowering, American Mammoth was distinctly inferior. A plot of Suffolk was outstandingly better and much more vigorous than the later types from Montgomery and Cornwall and also from Sweden, while Russian and Ural were very poor.

	Cwt. per acre.		
	Grass.	*Clover.*	*Total.*
American Mammoth ...	31·4	7·8	39·2
Cornish Marl	23·6	19·8	43·4
Montgomery	21·2	22·8	44·0
Russian	31·9	3·6	35·5
Suffolk	22·3	36·2	58·5
Swedish	20·8	21·7	42·5
Ural	30·4	7·1	37·5

At the time the Suffolk, an early late, commenced to grow in spring, the conditions were evidently suitable for it; whereas when the others started later the conditions may not have been so suitable for them. When sown alone in rows the Russian and Ural were much slower in starting and later in flowering than any of the others. It may be stated that these were seen this year at three different places in the south of Scotland and appeared to be very vigorous, indicating that the conditions there in spring suited them much better than at Craibstone, and showing very definitely that what may suit one district may not necessarily suit another.

In 1928 seeds of Chilian, French and English Broad-leaved and Montgomery and Polish Late-flowering were saved and sown in rows in 1929. The results this year show that each sample of the once-grown seed had kept its respective vigour, the Chilian, French and Polish being much less vigorous than the English and Montgomery.

This result agrees with a case we had a few years ago when an English sample was much poorer than other English samples alongside. Enquiry was made and it was found that the English farmer who grew the seed had sown a mixture of Chilian and French seed. No doubt this is the reason for some of the poor results from English seed. It is safe to sow only true acclimatised English seed of Broad-leaved red clover in the north of Scotland.

The depressing effect of the early, quick-growing, broad-leaved Italian ryegrass on clovers and timothy was well demonstrated in a trial with mixtures for one year's hay. The different ingredients in the hay were separated out and the following results per acre obtained :—

	Seeds Sown.						Crop per acre.					
	1.	2.	3.	4.	5.	6.	1.	2.	3.	4	5.	6.
	lb.	lb.	lb.	lb.	lb.	lb.	cwt.	cwt.	cwt.	cwt.	cwt.	cwt.
Perennial Ryegrass ...	20	10	...	15	...	10	26·8	21·0	...	24·9	...	20·3
Italian Ryegrass ...	...	10	20	...	15	5	...	13·8	40·3	...	37·4	11·0
Timothy	...	...	...	5	5	5	...	...	...	8·3	3·3	6·0
Clovers	5	5	5	5	5	5	26·0	12·0	4·8	22·0	6·9	14·1
Weeds	...	...	...	...	..	...	0·9	1·2	0·6	0·8	0·4	1·0
							53·7	48·0	45·7	56·0	48·0	52·4

Attention may again be drawn to the use of timothy in mixtures for one year's hay. In nearly every trial made here during the last few years No. 4 plot has produced the heaviest crop, and there has always been an appreciable amount of timothy present, the amounts varying from about 6 to 10 cwt. in different seasons. Timothy has also the advantage that it stands well. Perennial ryegrass on the other hand is somewhat weak. Italian ryegrass also stands up well, and for this reason it may be an advantage to include a small amount in the mixture even although the crop may be somewhat less. In second year's, and in several cases even in third year's, pasture there appeared to be more red clover than is often the case. This was mostly Late-flowering, Montgomery, Cornish Marl, English and Swedish, all being better than American and Polish.

Many who sow wild white clover in their seeds mixture also include ordinary white. In previous years a mixture which included 1 lb. ordinary white had been sown, but it showed very few plants of clover either in the first, second or third year. In order to give ordinary white a thorough test, in a field where a half lb. wild white clover was included in the mixture two plots were laid down with 2 and 5 lb. of ordinary white respectively, the seed mixture being otherwise the same. While the field has a very thick covering of white clover there are very few plants in the ordinary white plots, even where the 5 lb. were sown.

The beneficial effect of the wild white on the grasses was well demonstrated, the leaves of perennial ryegrass, cocksfoot and timothy being fresh and green, and at no time during the summer has any of these grasses gone into ear, whereas where the ordinary white was sown the plots have a withered appearance and there is a considerable quantity of the stalks of these grasses. The covering of wild white prevents the soil from drying up and keeps the surface moist, and the nitrogen it takes from the air is passed on to the grasses.

A number of plots were also sown with different samples of what were sold as wild white clover. Several of these are very poor, the amount of white clover being small, and the grasses have a more or less withered appearance. Complaints are made by some farmers that wild white does not do so well the second time it is sown in a field, and the likely reason is that an inferior sample has been sown. The seed of these inferior samples all gave either a weak or negative chemical reaction.

A year or two ago several samples of wild white clover were sown in rows and seed was saved off each row. This was sown the following year, so that at the present time there are growing alongside each other plants from the original samples and "once-grown" or "cultivated" plants from each of the different samples. Two points are very noticeable. (1) Where the original sample was good the once-grown is also good, and where the original is poor the once-grown is also poor, and (2) all the once-grown flowered earlier and much more freely than the original, showing very markedly the deterioration that takes place even when good samples from old pastures are sown for the purpose of seeding.

The reason for this deterioration is that even the best samples of wild white contain a proportion of early-flowering plants, and these would, of course, be much more prominent in the cultivated field. To illustrate this point, a few years ago several plants from a good sample of wild white were planted separately, 4 ft. apart each way. At the present time (August) some plants show the withered flower heads, some show withered flower heads and flowers, while other plants show only flowers. No doubt it will be increasingly difficult to get good samples of wild white as the old pastures get used up.

Several samples of New Zealand and Amercian white clovers were also sown in the field but, although some samples of the

New Zealand were quite fair, none were so good as English, while all the American were very poor.

In trials with Late Flowering perennial ryegrass there was considerable variation in different samples, some being little better than ordinary commercial stocks. When the stock was good, however, the plants were vigorous in the pasture.

Danish and German cocksfoots grew much faster in spring than the Late Flowering types and were first eaten by stock, but they went into ear early. The Late Flowering types produced much more leaf, lasted much longer, were well eaten down, and did not go into ear at all.

Guide to Current Official Statistics, Volume VIII.

THE eighth volume of the *Guide*, dealing with statistical publications issued during the year 1929 by Government Departments in Great Britain and Northern Ireland, has recently been issued. The *Guide* consists of two sections—an elaborate subject index covering statistical matter of all kinds and a numbered list of publications arranged under the names of the Departments responsible for them. Agriculture, education, industry and labour, public finance, trade and transport are a few of the many subjects dealt with. 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*. 5*d*.

Scheme for the Inspection of Growing Crops of Potatoes.

REFERENCE is made to the last issue of the JOURNAL, in which this scheme was explained and particulars given of the results of the inspection of potato crops during the last six years. The work of inspection of the 1930 crop of potatoes has now been completed and the appropriate certificates and reports regarding the purity of the crops issued to the growers. Full particulars as to acreages inspected, &c. cannot be given at present, but it may be stated that, as was anticipated, owing to the slump in the potato market last season, there was a marked decrease both in number of applications and acreages as compared with recent years. The Register of potato crops of immune varieties inspected in 1930 and certified by the Department to have been found true to type and of a standard of purity of not less than 99·5 per cent. is under preparation and will be issued early in November. This Register will be obtainable from the Department, price 2*s*., post free.

With a view to the possible extension of the scheme to include the inspection of potatoes for health as well as for purity the Department arranged this year that their inspectors should carry out, in addition to the work of the ordinary inspection, trial inspections for health in the various districts in Scotland. The information thus collected includes the percentages of the diseases of Leaf Roll, Severe Mosaic and Blackleg, and also of "Wildings" and "Bolters," found in the various crops inspected. An analysis of this information is at present being prepared, and it is hoped that a pronouncement on the matter will be given before the end of the year after the Department have reviewed the subject in consultation with the various agricultural bodies and others interested.

Scottish National Mark Publicity.

WITH a view to fostering public interest in the Scottish National Mark, the Department of Agriculture for Scotland arranged by means of a grant provided by the Empire Marketing Board for a motor demonstration van to tour the east and north-east districts of Scotland.

The van, which carried a representative selection of Scottish produce, including Scottish National Mark eggs, tomatoes, malt extract and potatoes, was constructed in such a manner internally as to enable the various commodities to be exhibited to advantage. Through the co-operation of the Ministry of Agriculture and Fisheries the opportunity was taken to include in the display English National Mark apples, pears and canned fruits.

The tour commenced on the 20th August and extended to the 11th September. Great interest was taken in the exhibit, and at each place of call the general public was given the opportunity of purchasing samples of the various commodities at a nominal price.

The Department have also prepared a booklet entitled "The Scottish National Mark" which describes in an attractive form the objects of the National Mark, and contains particulars of the commodities to which the National Mark applies. Approximately 8,000 of these booklets have been distributed to the public, press, agricultural associations and colleges.

Scottish Egg Laying Test.

ARRANGEMENTS have been made for the seventh of the series of egg laying tests conducted by the Department of Agriculture for Scotland at Seafield, Roslin, Midlothian, to commence on 15th October. The test extends over a period of 48 weeks, and there is accommodation for 100 pens of pullets and 19 pens of ducks, each pen comprising six birds. More than sufficient entries have been received for the pullet section but there will be some vacancies in the duck section.

In the forthcoming test there will not be as formerly in each pen a reserve bird which was substituted in the event of the death of one of the five competing birds. Under the new arrangement all the six birds in a pen will be competing, although the awards will be determined by the total score value of the five best birds in each pen.

Agricultural Conditions.

THE weather during June was mostly dry and sunny, and the growth of crops was checked to some extent on light land by lack of moisture. The rain which fell towards the end of the month was beneficial to all crops, although, in some cases, it came too late to help the hay crop. In Berwick, Inverness and Nairn conditions were abnormally dry throughout the month. Live stock generally throve well. The weather continued warm and dry in most districts during the first two weeks of July, but the remainder of the month was wet and unsettled, retarding the hay harvest and causing damage to the hay crops in a few districts. Cereals filled well, but lodging of crops was reported from some areas. In the Outer Hebrides, Skye, North Argyll and Orkney, however, the weather was suitable for crops and live stock throughout the month. Live stock generally did well, but in Dumfries they suffered to some extent from the wet conditions. The weather during August was very broken; heavy rain was frequent and there was comparatively little sunshine. Conditions were detrimental to both cereal and hay crops in most parts of the country; grain, particularly oats, was laid and twisted, rendering harvesting difficult. The only districts from which favourable reports were received were Harris and Uist. Live stock generally made only moderate progress.

Wheat has generally made good progress during the period under review. In a few districts the crop was rather thin and patchy in places at the end of June, and many fields in South-East Perth were thinned by wire-worm; in this area the crop was reported to be ripening prematurely by the end of July. On the whole, however, the crop was vigorous and healthy at the end of August, especially in the south-western districts, although in some fields the straw was discoloured owing to the wet conditions. In a number of areas lodging was reported; some fields in Central Perth suffered badly in this respect and were sprouting. The crop was generally well ripened by the end of the month, and cutting was then in progress in several north-eastern and south-eastern districts; it was not general, however, until early in September. The estimates of produce generally indicate a full average crop, but in Central and South-West Perth and Berwick it is estimated that the yield will be somewhat below the normal.

Barley generally has matured well. In several north-eastern areas the crop, where sown late or on dry land, suffered from drought in June. The crop was reported to be more or less laid by the heavy rains towards the end of July in several districts, while in South-East Perth the crop tended to ripen too quickly. At the end of August plants were healthy and vigorous, but in many areas, particularly in the north-eastern counties, the crop was badly lodged and twisted. A good beginning was made with cutting in most districts by the end of the month, and the harvest was practically completed early in September. Estimates of yield are, on the whole, satisfactory. In North-East Aberdeen, North, East and South-East Perth, Kintyre and Bute a yield of about 10 per cent. above the average is expected, while in North-East Banff, Kincardine, South-West Angus and North Argyll it is estimated that the yield will be about 5 per cent. above the normal. In Central Perth, Inverness and Nairn, however, the yield is expected to be about 10 per cent. below that of an average season, and in Moray, South-West Banff, Clackmannan, Kinross, South-West Fife and Berwick the yield will also probably be somewhat below the normal. The reports on bere were satisfactory, and in several districts the yield is expected to be from 5 to 10 per cent. above the normal. Cutting was in progress at the end of August in most districts where this crop is grown.

The reports on oats were, on the whole, less satisfactory than those for wheat and barley. Except in the Western Islands and in several south-western districts, the crop was generally badly lodged and twisted by the heavy rains in August, while second growth was prevalent in a number of fields in Central Perth, North-East Fife, Stirling and Kirkcudbright. Harvest was in progress in most districts at the end of the month, but has proved difficult on many farms. The estimates of produce show considerable variation; in North-East Banff, South-West Angus, North and East Perth, the Western Islands, North Argyll, Kintyre, Bute and South Ayr the yield is expected to be about 10 per cent. above the normal, but in Central Perth, the Lothians, Peebles, Berwick, Inverness and Nairn it is expected to be below the average by from 5 to 10 per cent.

The reports on beans were uniformly satisfactory. The crop suffered little or no damage from the lack of rain in June; in most districts plants have podded well and good crops are expected, especially in South-West Perth and Stirling.

Potatoes have made good progress. There was little or no sign of disease until towards the end of August; blight was then reported to be more or less prevalent in a number of north-eastern areas, especially among the earlier varieties, and there were also signs of disease in some south-western areas. Estimates of yield are generally satisfactory. In Lewis the produce is expected to be about 15 per cent. above the normal, and in most of the other districts yields of from 5 to 10 per cent. above the average are expected. In Clackmannan, Kinross and South-West Fife, however, it is anticipated that the yield will be somewhat below the normal. It should be borne in mind that while the yield per acre will, on the whole, probably be heavier than usual, the area under the crop, according to the Preliminary Statement of the Agricultural Returns for Scotland, is less than in 1929 by about 15,000 acres.

Turnips and swedes generally made satisfactory progress in June, but in many northern and north-eastern districts and in a few other areas a considerable amount of resowing was necessary, and in several instances second resowings had to be made. Fly was prevalent in parts of North-East Aberdeen, Berwick, Inverness, Nairn and Dumbarton; in South-West Angus spurrey was troublesome, and some fields were attacked by the turnip flea beetle. Pigeons caused much damage in Central Perth. The crop was slow to braird in many areas. By the end of July the crop on the whole had made fairly satisfactory progress, but was backward in several districts. There were complaints of finger and toe from a few areas. Reports for August showed considerable variation. In the north-western and south-western districts the crop was healthy and vigorous, with little sign of disease, but in the north-eastern counties, although fair improvement was noticeable, finger and toe was more or less prevalent and many fields were patchy. In Caithness, Islay, Jura, Kintyre and Bute it is expected that the produce will be about 10 per cent. above the normal, and in a number of south-western districts the estimated yield is about 5 per cent. above the average. In many north-eastern areas, however, the yield is expected to be from 5 to 15 per cent. below that of a normal year, while in North-East Angus the deficiency is estimated to be as much as 20 per cent. Reports on mangolds were generally satisfactory. In the Lothians and Berwick and some south-western districts the produce is expected to be from 5 to 10 per cent. above the average, but in Central Perth it is estimated that the yield will be about 10 per cent. below normal. Sugar beet was generally reported to be healthy.

In a few areas small fruits were somewhat forced on by the dry hot weather in the earlier part of June. The harvest was practically over by the end of August and the yield in most districts was unusually good, but trade was dull and a proportion of the crops was left on the growers' hands; in North and East Perth quantities of raspberries were left unpicked. Despite the lack of sunshine in August, tree fruit generally made fairly good progress. Plums, however, were reported to be a poor crop in North-West Lanark and South-East Perth, while in the latter district apples and pears were smaller than usual. In Dumfries some damage was done to fruit crops by stormy weather.

Pastures, which were somewhat bare in a few areas during June, benefited by the rain which fell towards the end of the month, and were generally in good condition by the end of July; pasturage was still plentiful in August but deteriorated in quality in some cases as a result of the continued wet weather. Grazing cattle generally throve well, although in several north-eastern districts they were adversely affected by the weather conditions in August. Dairy cows made satisfactory progress generally, but in a few areas extra feeding was required. Considerable loss was reported among calving cows in Dumbarton owing to mammitis ("weed"). The milk yield was generally well maintained. Sheep on arable farms were generally in satisfactory condition, but foot rot and maggots were prevalent in a few areas. The death-rate among hill sheep was reported to be high in some parts of Kirkcudbright in June, but at the end of

August stocks had made satisfactory progress, although lambs were leaner than usual on many farms.

No reports were received of disease among bee stocks, which generally throve well. In most districts the yield of honey was a good average, but in a few areas, notably South-West Angus, the produce was light. In South-East Perth, however, the produce was much above the normal.

The supply of both regular and casual labour was generally adequate for requirements; in some north-eastern districts further labour was required to cope with the harvesting of lodged cereal crops.

Agricultural Returns, 1930.

THE Preliminary Statement of the Agricultural Returns taken in Scotland on 4th June 1930 shows that the total area under crops and grass amounts to 4,645,000 acres, comprising 3,086,000 acres of arable land and 1,559,000 acres under permanent grass. The total acreage is the smallest recorded since 1876, while the area of arable land is the smallest recorded since the Returns were first taken in 1866, being less than in 1929 by 19,000 acres. The area under permanent grass has, however, increased by 11,000 acres, and the diminution in the total area under crops and grass is thus 8,000 acres.

The area under rotation grasses and clover, 1,500,000 acres, has increased by 1,000 acres, while the area under other specified crops is 21,200 acres less than in the preceding year.

The total decrease, 37,200 acres, is accounted for by oats, potatoes and vetches, tares, &c., for fodder, while all other specified crops, except peas, mangolds, and small fruit, show increases totalling 16,000 acres.

The outstanding features of the crop returns are a decrease of 22,000 acres, or 2·5 per cent. in the area under oats, and a decrease of 15,000 acres, or 10·3 per cent. in that under potatoes. The area under oats, 867,000 acres, is the smallest on record, while that under potatoes, 130,000 acres, is the smallest recorded since 1916, when the figure was about the same. Wheat, with 53,000 acres, shows an increase of 2,000 acres, or 3·9 per cent., and barley one of 8,000 acres, or 8 per cent., while the area under turnips and swedes is greater by 2,000 acres. Sugar beet, which in 1929 was grown on only 600 acres, now covers 1,400 acres, showing an increase of 133 per cent. Peas, mangolds and small fruit are unchanged. Minor crops for which returns are made, but which are not separately shown in the accompanying table, all show slight increases in area, except onions, which shows a slight decrease.

Of the area under permanent grass, 176,000 acres were cut for hay and 1,383,000 acres were grazed, while of the area under rotation grasses and clover 409,000 acres were cut for hay and 1,091,000 acres were grazed. The areas under permanent grass for mowing and under rotation grass for mowing were greater than in 1929 by 8,000 and 1,000 acres respectively; the total area cut for hay is thus increased by 9,000 acres.

The live stock returns show that horses and pigs have diminished in number, while cattle and sheep have increased.

Horses used for agricultural purposes, numbering 120,600, are fewer by 2,700, the total being the smallest on record. Unbroken horses of one year and above are fewer by 400, or 2·6 per cent., but foals show no change on last year's figures. The decrease in horses of all kinds is 3,800, or 2·4 per cent.

The total number of cattle, 1,233,100, is practically unchanged. Cows in milk and calves are fewer than in 1929 by 5,000 and 500 respectively, but the remaining classes show increases. Cows in calf but not in milk and heifers in calf are more numerous by 300 and 2,900 respectively. Bulls being used for service show an increase over 1929 of 100, and both classes of feeding cattle (yearlings and two years and above) show increases of 2,300 and 100 respectively.

The total number of sheep, 7,622,100, shows an increase of 66,600, or 0·9 per cent., as compared with the total in the preceding year. All classes have increased; ewes, which number 3,313,500, exceed the record figure of 1929 by 32,400, while the total of lambs, 3,236,300, shows an increase of 27,300 on 1929. Rams and other sheep, one year and above, have increased by 3,200 and 3,700 respectively.

Pigs, which total 141,800, show little change on last year's figure of 142,200. The numbers of sows and boars have increased 1,400 and 300, but other pigs show a decrease of 2,100.

The returns of labour employed (excluding occupiers of holdings, their wives and domestic servants) at 4th June 1930 are as follows. The figures for 1929 are also given :—

	1930.	*1929.*
Regular Workers—		
(*a*) Males, 21 years old and over ...	59,000	60,603
(*b*) Males under 21 years old ...	20,300	21,471
(*c*) Women and girls	18,400	19,009
Casual Workers—		
(*a*) Males, 21 years old and over ...	6,000	6,186
(*b*) Males under 21 years old ...	3,000	3,335
(*c*) Women and girls	7,200	7,430
Total ...	113,900	118,034

The total shows a decrease of over 4,100, in which all classes share. Regular male workers over 21 are fewer by 1,600, and those under 21 by 1,170, while regular women workers show a decrease of 600, and casual workers a total diminution of 750. Probably, however, the revision of the tabulation will modify these figures more extensively than the figures of crops and stock.

AGRICULTURAL RETURNS FOR SCOTLAND, 1930.

PRELIMINARY STATEMENT for 1930, compiled from the Returns collected on 4th June; and comparisons with 1929. *The figures for 1930 are subject to revision.*

CROPS AND GRASS.

Distribution.	1930.	1929.	Increase.		Decrease.	
	Acres	*Acres.*	*Acres.*	*Per Cent.*	*Acres.*	*Per Cent.*
TOTAL AREA (excluding WATER)	19,069,007	19,069,007	..	..	..	..
TOTAL ACREAGE under all CROPS and GRASS (*a*)	4,645,000	4,653,000	..	..	8,000	0·2
ARABLE LAND	3,086,000	3,105,000	..	..	19,000	0·6
PERMANENT GRASS (*a*) — For Hay ..	176,000	168,000	8,000	4·8	..	..
PERMANENT GRASS (*a*) — Not for Hay ..	1,383,000	1,380,000	3,000	0·2	..	..
PERMANENT GRASS (*a*) — TOTAL ..	1,559,000	1,548,000	11,000	0·7	..	..
Wheat	53,000	51,000	2,000	3·9	..	..
Barley (including Bere)	108,000	100,000	8,000	8·0	..	..
Oats	867,000	889,000	..	..	22,000	2·5
Mixed Grain	1,700	1,200	500	41·7	..	..
Rye..	3,200	2,900	300	10·3	..	..
Beans (to be harvested as Corn)	3,400	2,900	500	17·2	..	..
Peas	400	400	..	..	..	..
Potatoes	130,000	145,000	..	..	15,000	10·3
Turnips and Swedes	373,000	371,000	2,000	0·5	..	..
Mangolds	1,200	1,200	..	..	..	..
Sugar Beet	1,400	600	800	133·3	..	..
Cabbage	4,600	4,200	400	9·5	..	..
Rape	10,300	8,800	1,500	17·0	..	..
Vetches, Tares, Beans, Peas, Mashlum, etc., for Fodder	10,900	11,100	..	..	200	1·8
Small Fruit	8,000	8,000	..	..	..	..
RYE-GRASS and other ROTATION GRASSES and CLOVER — For Hay	409,000	408,000	1,000	0·2	..	..
RYE-GRASS and other ROTATION GRASSES and CLOVER — Not for Hay ..	1,091,000	1,091,000	..	..	..	..
RYE-GRASS and other ROTATION GRASSES and CLOVER — TOTAL	1,500,000	1,499,000	1,000	0·0	..	..
OTHER CROPS	3,400	3,200	200	6·3	..	..
BARE FALLOW	6,500	5,500	1,000	18·2	..	..

LIVE STOCK.

	No.	*No.*	*No.*	*Per Cent.*	*No.*	*Per Cent.*
Horses used for Agricultural purposes (including Mares for Breeding)	120,600	123,300	..	..	2,700	2·2
Unbroken Horses (including Stallions). — One year and above ..	15,000	15,400	..	..	400	2·6
Unbroken Horses (including Stallions). — Under one year ..	5,100	5,100	..	..	..	..
TOTAL	140,700	143,800	..	..	3,100	2·2
Other Horses	16,500	17,200	..	..	700	4·1
TOTAL OF HORSES	157,200	161,000	..	..	3,800	2·4
Cows in Milk	350,600	355,600	..	..	5,000	1·4
Cows in Calf, but not in Milk	47,100	46,800	300	0·6	..	..
Heifers in Calf	54,200	51,300	2,900	5·7	..	..
Bulls being used for Service	17,100	17,000	100	0·6	..	..
Other Cattle :—Two years and above ..	215,700	215,600	100	0·0	..	..
,, ,, One year and under two ..	303,500	301,200	2,300	0·8	..	..
,, ,, Under one year	244,900	245,400	..	..	500	0·2
TOTAL OF CATTLE	1,233,100	1,232,900	200	0·0	..	..
Ewes kept for Breeding	3,313,500	3,281,100	32,400	1·0	..	..
Rams to be used for Service in 1930	93,700	90,500	3,200	3·5	..	..
Other Sheep :—One year and above . ..	978,600	974,900	3,700	0·4	..	..
,, ,, Under one year	3,236,300	3,209,000	27,300	0·9	..	..
TOTAL OF SHEEP	7,622,100	7,555,500	66,600	0·9	..	..
Sows kept for Breeding	17,500	16,100	1,400	8·7	..	..
Boars being used for Service	2,100	1,800	300	16·7	..	..
Other Pigs	122,200	124,300	..	..	2,100	1·7
TOTAL OF PIGS	141,800	142,200	..	..	400	0·3

(*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, Department of Agriculture, York Buildings, Edinburgh.

CROPS AND SEEDS.

Dry Rot of Swedes: Some Field Observations and Experiments on Control. *By J. C. Neill, Field Mycologist, Plant Research Station, Palmerston North, N.Z. Journal of Agriculture, Vol.* 39, *No.* 2, *August* 1929.—In a Bulletin "Dry-Rot of Swedes and Turnips: Its Cause and Control," by G. H. Cunningham, it was demonstrated by laboratory methods that the disease was carried in the seed, and that such seeds could be disinfected by soaking them for one hour in a 0·25 per cent. solution of Semesan.

During the last three years swede seed had been treated with Semesan from approximately 200 crops scattered over New Zealand. Most of the treated seed was tested for disinfection by Cunningham's method of plating on media, 10 samples of 100 seeds from each treated lot. In the aggregate some 95,000 treated seeds have been tested, but not one dry-rot infected seed has been found. Nevertheless the large majority of these crops developed dry-rot, and where comparisons could be made, dry-rot developed in the same seed treated to the same extent. This showed that either the seed had not been completely disinfected and that the laboratory tests failed to disclose the fact, or that crops had become infected from some other source. Other possible sources of infection apart from the seed were (*a*) a previous crop of swedes grown or fed on the same land; (*b*) infection by wind-borne spores from distant centres of the disease; (*c*) continued existence of the dry-rot fungus in the soil for two or more years in the absence of its normal host plant; (*d*) presence of the fungus in other hosts than crop brassicas; (*e*) carriage by the spores of the disease to healthy plants by insects, birds &c.

The field evidence appears to confirm Cunningham's contention that the main primary source of dry-rot is in the seed, but at the same time it suggested that the seed was not thoroughly disinfected by the method advocated by Cunningham.

In the present article certain results are given of a series of treatments on one sample of high grade English swede seed carried out during the past season at the Plant Research Station, Palmerston North, New Zealand.

No definite evidence was obtained as to the success or otherwise of disinfection by the various methods tried, on account of the doubt as to whether the first dry-rot lesions arose from seed sown at those particular spots or not. The chief information yielded by the experiments was that it provided a record of the spread of dry-rot infection in a crop and gave indications as to the lines of future work.

Selected bulbs are now being grown both under glass and in the open in an endeavour to obtain or produce free and heavily diseased seed heads.

It is concluded that treatment of swede seed by soaking for one hour at 50° to 60°F. followed by dipping for five to ten minutes up to 135°F. both in a 0·25 per cent. solution of Semesan, did not prevent the appearance of dry-rot in the field. With the five minutes dip field germination was seriously affected only above 135°F.

It was not practicable to free a swede crop from dry-rot by eliminating diseased plants.

In an early sown swede crop which has been well grown and properly thinned and cultivated, dry-rot infection may spread from a very few original sources of infection over the entire crop before the winter.

Late sowing, lack of thinning, and poor cultivation with consequent poor crop of small crowded bulbs, appear to reduce greatly the incidence of dry-rot.

Investigations on Yield in Cereals, VII. *By F. L. Engledow, M.A., and K. Ramiah, M.Sc. School of Agriculture, Cambridge. Jour. Agric. Science, Vol. XX, Part* 2, *April* 1930.—The writers studied the comparative development in yield in three wheat varieties during four seasons. Amongst the factors discussed are the influence of spacing on the development and yield of the three varieties; the varietal development under field conditions; inter-plant and inter-variety competition; and the germination and plant survival of wheat. The problem of increasing average yield per acre for the whole country without substantially increasing the cost of production is a national one. The two main lines of attack are:—improvement in the practices of husbandry and improvement of cereal varieties by breeding.

Breeding by selection and hybridisation is many centuries old. Difficulty is frequently experienced in selecting single plants of "high yielding capacity" in the second (F_2) and subsequent generations. The morphological and physiological factors of yield are not known. Success in selecting single plants depends, in large measure, upon intuitive judgment.

Crop husbandry is in the same position as plant breeding. The responses of the crop to the external yield factors must be better understood before direct clues to improvements in method are reached.

It was found that early tillering was an important index to yield. Some 60-90 per cent. of the seeds sown in experimental plots and 50-80 per cent. of the seeds sown in the field normally produced harvest plants. The casualties occurred mostly within three months of sowing. On very rough ground germination might be very slow. Rivet wheat is of lower germination capacity and is more tardy in germination than Squarehead's Master or Yeoman. Seeds which germinate late grow into plants of normally low yield.

DAIRYING.

The Effect of Heat (Oestrum) on Butter-fat Percentage and Milk Yield. *By Lynn Copeland*, 1929. *Journal of Dairy Science, Vol.* 12, *pp.* 464-468.—The data for this work consists of 2,025 Register of Merit records completed and accepted by the American Jersey Cattle Club. Official testers indicated on each report whether the cow was in season during the period of supervision. A large proportion of the cows showed no effect either in food percentage or in milk yield due to "heat." An appreciable proportion showed a marked decrease in the yield and a corresponding increase in the butter-fat yield. Another small, but significant, proportion showed an increase in milk yield and a decrease in butter fat percentage. From the data it would appear that the effect of "heat" on yield and butter-fat percentage is quite limited. As a rule the slight difference exhibited seems with most cows to be towards a small decline in milk yield and equally limited increase in butter-fat percentage. It would appear as though certain strains of cows showed a greater lactation to "heat" than other strains, but until the physiology of this complicated subject is better understood it is unwise to come to definite conclusions.

Effect of Abnormal Weather Conditions on the Quality of Milk. *By Harold T. Cranfield. The Jour. of the Ministry of Agric., Vol.* 37, *No.* 4, *pp.* 347-350.—It is an ill wind that blows nobody any good. The long drought which took place in England last summer has provided scientists with an opportunity of studying the effect of drought on the quality of milk. Since the primary effect of a drought is to decrease the yield of milk, and since a decrease in total yield is usually accompanied by an increase in butter-fat percentage, it was not surprising that this fact occurred. The graph which the writer of this paper publishes illustrates the variation in the monthly average percentage of non-fatty solids in a herd of 35 Shorthorn cows. Although this herd received a supplementary ration during the drought period, the fall in the percentage of non-fatty solids was most marked, and only the general high average quality of the milk from this herd saved the percentage from falling below 8·5 on all except three occasions. Other figures from fifty herds in Nottinghamshire showed that nearly half of the September samples fell below the presumptive limit of 8·5 per cent. in non-fatty solids.

The writer suggests that dairy farmers should be cognizant of the effect of weather conditions on the composition of milk, and should include this remarkable drought factor in the list of unavoidable causes which from time to time may bring the quality of their milk under suspicion of adulteration in the eyes of their customers and of local authorities.

ANIMAL BREEDING.

Cattle.

Meat Consumption in the United States. 1930. *Armour's Monthly Letter, Vol.* 11, *No.* 3.—During 1929 beef production in the United States was approximately at the bottom of the production cycle, while the marketing of pigs was likewise starting to move downwards in the cycle swing. At the same time the sheep cycle was approaching a production peak, but its influence on total meat consumption appeared to be ineffective. This is probably due to the fact that mutton and lamb make up such a small proportion of the total volume of meat in the American diet.

The number of people in the United States has been growing steadily from one decade to another. According to estimates the population in the year 1960 may be expected to reach a figure of approximately 160,000,000, an increase of 40 million in thirty years. Meat consumption has, in the past, mounted almost as rapidly as have the population figures. It would appear that the amount of meat in the diet of the average American is not diminishing appreciably.

Clearly the United States is approaching a balance between imports and exports of meat. Consequently, if meat production continues only at its present rate of growth, meat consumption may fall behind the pace set by the population figures unless the barriers which protect the American farmer are raised. Indeed the point has practically been reached already, and on the basis of the present trend of meat production the average person in the United States during future years may need to be content with less meat or else the importation of meat must be begun upon an extensive scale. This action may perhaps be delayed for eight years since there is now evident in the United States a tendency for meat production to increase. At the moment the American livestock farmers appear to regard the prospects as rather bright. If, however, they are not able to keep up with the demand of the consumers in that country, and the consumer has power enough to guard against the increased prices that will result, then there is a possibility, perhaps somewhat remote, that the existing barrier may be lifted, in which case things would look considerably brighter for the British cattle raiser.

The consumption of lamb and mutton, although showing a steady growth for the past seven years, has failed to keep pace with the population in the United States. The outlook in America for the producers of these also appears bright.

Secondary Sex Ratio in a Group of Dairy Shorthorn and Welsh Black Cattle. *By E. J. Roberts.* 1930. *Jour. Agric. Science, Vol.* 20, *Part* 3, *pp.* 359-368.—The information which formed the basis of this investigation was obtained from private herd books. Herds ravaged by contagious abortion were excluded. Five dairy Shorthorn herds are included in this survey and thirteen herds of Welsh Black cattle. The sex ratio obtained was 99·3 bull calves to 100 heifers born. It could not be said that there was much difference apparent between the two breeds, since a large fluctuation was found in the sex ratio from herd to herd. In one farm at the University College of North Wales two herds, one of Shorthorns and one of Welsh Blacks, have been kept for seventeen years, and the management of these two herds has been as nearly identical as possible. No difficulty has been experienced in maintaining the numbers of the Shorthorn herd without purchasing cows or heifers, but largely owing to the preponderance of bull calves in the Welsh Black herd, females have been purchased nearly every year.

There appear to be fluctuations in the sex ratio due to seasonal variation. From March to August the ratio is 94·8 males per 100 females, while from September to February it is 106·0. No definite figures were obtained concerning the effect of age upon sex ratio. This paper includes an interesting discussion and full references to the subject.

Goats.

The Inheritance of Cryptorchidism in Goats. *By J. L. Lushk, J. M. Jones and W. H. Dameron. Texas Agric. Exp. Sta. Bull. No.* 407.—Rigs are not uncommon in horses and also occur in cattle and sheep. There has been every reason to believe that this condition is hereditary, and this is confirmed by the results published in this paper. Male goats with an undescended testicle are especially frequent in the Angora breed. Breeding experiments have shown that this condition is inherited, but the exact manner has not yet been discovered. At least two Mendelian factor pairs must be involved. There are, however, certain indications that some cases may not have a definite hereditary basis. The practical recommendations arrived at by the author bear repeating, since they can be applied to every form of farm live stock :—

" Never use a ridgling for a sire. Even though it may be true that this characteristic is not always hereditary, yet it has so often been found hereditary that the breeder cannot afford to take the chance of using a ridgling sire. Be extremely reluctant to use a sire which has any ridgling brothers or half-brothers. Cull from the flock all does which produce as many as two ridglings. This may not go far toward solving the problem, but it is a step in the right direction. Does which have produced only one ridgling may perhaps be retained in the flock if they are especially desirable in other respects, but it does not seem wise to retain any of their sons for use in registered flocks. Bucks which sire more than the normal percentage of ridgling sons should be discarded. Whether it would be practical to discard all bucks which sire even one ridgling son is not yet certain."

Horses.

The Genetics of the Horse. *By F. A. E. Crew and A. D. Buchanan Smith.* 1930. *Bibliographia Genetica, VI, pp.* 123-170.—This is a complete, but rather technical, review of the inheritance of those characters of the horse concerning which data are available. The greater part of the paper is devoted to the inheritance of coat colour, but there are some interesting references to certain defects. The attention of the veterinary practitioner is drawn to this last point since much of the information here published has been gleaned from the work of veterinary surgeons who have a knowledge of the science of genetics. References are included to the ass, mule and zebra. There is a full bibliography which has been largely compiled by the Imperial Bureau of Animal Genetics.

Pigs.

Pig Testing in Scotland. *First Report on the Pig Testing Station. By A. D. Buchanan Smith and A. Calder, Animal Breeding Research Department, University of Edinburgh.* 1930.—This is the first report of the first Pig Testing Station to be established in Great Britain. The following is a summary of the main points of value so far derived from the scheme :—

1. The late maturing, heavy boned type of pig is unsuitable for bacon production for the following reasons :—

(*a*) this type of pig cannot be finished ready for the bacon market at the weights for which the trade pays the best price per lb.;

(*b*) the lower price per lb. received for the overweight pig is not, as is frequently believed, compensated by greater economy in live weight gain of the heavyweight pig:

(*c*) the strong-boned, late-maturing pig as a rule consumes considerably more food per lb. of live weight gain than does the early-maturing light-boned type. The explanation would seem to lie in the fact that the making of bone creates a heavier demand on food than does the making of flesh;

(*d*) because this type has a high proportion of bone, the percentage bacon to dead weight is usually very low—a point of great consequence to the curer;

(*e*) because of its late maturity this type of pig produces a class of bacon which lacks delicacy, is inclined to be coarse in grain and tough rather than crisp. The bacon from this class of pig, however, is usually suitably mixed with fat and without excess of fat along the back.

2. Certain tested pigs of well-known and reputed strains showed a marked tendency towards late maturity and heavy bone. This emphasises the need for paying more attention to the keeping of our pedigreed stocks in line with trade requirements.

3. Early maturity and quick growth are advantageous in every respect both to the producer and to the curer for the following reasons :—

(*a*) early maturing pigs, provided growth is rapid, are usually economical feeders;

(*b*) the early maturing type usually gives a very good percentage bacon to dead weight, but not necessarily a good percentage dead to live weight. From the point of view of the Ayrshire trade the former percentage is the more important;

(*c*) apart from the fact that the rolls from pigs of early maturing type marketed at trade weights are of the most saleable size, the bacon is more delicate and tasty;

(*d*) the early-maturing pig, if of suitable type, is dual purpose, as this class of pig is well suited for bacon purposes and for the requirements of certain sections of the pork markets.

4. Firmness and quality are not merely a matter of feeding, as is widely believed; breeding appears to have a very considerable influence on quality.

5. Worm infection is much more prevalent and causes much greater loss than

is generally believed to be the case. Steps should be taken to inform pig breeders and feeders how to keep their herds free from worms.

6. Infectious scour wipes out from 30 to 80 per cent. of young pigs in a large number of herds during the winter and spring months.

In addition figures are given concerning the cost of running a pig testing station, &c. Of the 35 litter groups which have completed the test 19 were "placed" and 16 "unplaced." Of the 19 placed 12 proved to be "first grade," and five of these achieved the distinction of "excellent."

A list of the rules and regulations governing the Testing Station is also included in the report, copies of which will be sent to anyone applying to the Animal Breeding Research Department, West Mains Road, Edinburgh.

Pig Recording in East Anglia. *By A. W. Menzies Kitchin, University of Cambridge, Department of Agriculture. Third Report*, 1930.—This is the third report of the East Anglian Pig Recording Scheme and is full of interesting points for the pig breeder. Perhaps most interesting of all is the wide variation which has been found to exist between herds. This should prove an incentive to breeders, since there is no doubt that there is room for considerable improvement. For instance the writer of this report states that one herd which was specially well managed compared with average herds saved 32*s*. 8*d*. per pig, a very large figure indeed.

The importance of paying attention to the suckling pig is emphasised in this report. The figures published, however, would seem to show that East Anglian farmers are better than the average in this respect. While the average number of pigs born per litter is 9·8, the average alive six weeks later is 7·9.

The effect of time of year on the number farrowed has been calculated on the basis of 892 litters. While the average number of pigs born alive per litter shows practically no seasonal variation, there is a difference in the average number of pigs alive at six weeks. A higher percentage of pigs farrowed during the April to September period survives at six weeks than of those born during the remaining six months of the year, the survival being an average of one pig per litter greater.

The distribution of breeds is interesting. 73 per cent. of the litters were sired by Large White boars, 12 per cent. by Middle White boars and 5 per cent. by Large Blacks. The breed distribution of the sows shows that the Large Black is the most popular breed, representing 34 per cent. of the test, while of the remainder 22 per cent. were Large Whites, 17 per cent. Middle Whites, with 11 per cent. cross breds, and the remainder was made up of Saddle Backs, Berkshires, &c. As in previous years, the commonest cross was the Large White boar with the Large Black sow.

Sheep.

Fleece Analysis for Biological and Agricultural Purposes: 1. The Average Fineness of a Sample of Wool. *By J. A. Fraser Roberts.* 1930. *Journal of the Textile Institute, Vol.* 21, *No.* 4.—In this paper the writer describes the methods of analysing the fleece. It is essential to have an accurate method of analysis before breeding or feeding experiments can be conducted upon the fleece. Fineness is one of the most important characteristics of wool, and in connection with observations on the sheep the average fineness of a sample or portion of the fleece is the most important figure to be obtained. It was found that fineness may vary within an extremely wide limit over extremely small areas of skin. Accordingly the laboratory sample actually analysed is made up of a large number of very small pieces taken from all over the main sample. The method gives simply a mean figure without any measure of the variability of fibres. Length and weight are much simpler attributes of fibres than diameter, hence there are fewer pitfalls in connection with technique. In the second place fibre length is very much less variable than fibre diameter, and in order to attain the same accuracy fewer measurements are therefore required. The authors point out that at the same time as fineness is measured a number of other important attributes of the fleece can also be analysed, with very few modifications, during the course of the same procedure.

Colour Inheritance in Sheep (*Two Papers*). *By J. A. Fraser Roberts and R. G. White.* 1930. *Journal of Genetics, Vol.* 22, *pp.* 165-190.—Mr. Fraser Roberts and Professor White are to be congratulated upon this work, which applies Mendelism to the sheep, and for the clever way in which they have been able to reduce the inheritance of coat colour in that animal from chaos to order. To attempt to summarise all their conclusions might be misleading. The colours dealt with are white, which is shown to be dependent upon the presence of a dominant inhibitor in the absence of which the coat may be either black or brown, the inter-relation of which two colours does not seem to be quite clear as yet. Badger-face and reverse badger-face, two uncommon patterns, are traced out in detail. Data are given in the second paper on the inheritance of the dominant black of the Black Welsh Mountain breed. The writers conclude that it appears possible that more than one factor exists which can produce a dominant black. This paper concludes with a brief summary of the present stage of knowledge regarding the genetics and goat colour in sheep. Perhaps the most interesting conclusion of all at which the authors arrive is that under the cloak of the inhibitor modern white-fleeced sheep possess colour factors that can have been little affected by artificial selection.

Entropion or Turned-in Eyelids in Sheep. *Ohio Experiment Station. Annual Report for* 1928-29, *p.* 153.—There are two kinds of turned-in eyelids. The one which appears in the new-born lamb from which it makes a spontaneous recovery or yields to simple treatment. This has a definite hereditary basis.

The other kind of turned-in eyelids (entropion) appears after the lamb becomes older, and apparently is due to the chance location of a small skin wrinkle reaching the base of the eyelid. Merino sheep may have either or both infantile and Merino entropion.

Cryptorchid or Ridgling Rams. *Ohio Experiment Station. Annual Report*, 1928-29, *p.* 154.—During recent years all the ridgling rams dropped in the Ohio Station flock have been sired by one ram or by one of his sons or grandsons in the experimental breeding flock. Two ridgling rams have sired 17 lambs, 9 of which were rams. Only one was a ridgling. His mother was also the mother of another ridgling sired by a normal ram. This is the only one of the dams which had any history of ridgling production or relationship. While this is probably inherited in sheep as it is known to be in Angora goats, a second generation is needed to give definite information on the question.

STATISTICS.

PRICES of AGRICULTURAL PRODUCE, FEEDING STUFFS and FERTILISERS in June, July and August 1930.

LIVE STOCK : Monthly Averages of Prices at certain representative Scottish Markets.

(*Compiled from Returns received from the Department's Market Reporters.*)

Description.	June.			July.			August.		
	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 ...	59 0	52 2	43 0	60 6	53 9	44 2	61 1	54 4	44 0
Cross-bred (Shorthorn)	55 6	48 7	39 0	56 9	49 5	40 7	56 7	50 3	39 9
Galloway	57 2	52 9	...	56 10	51 7	..	55 5	51 0	...
Ayrshire	51 3	43 9	33 3	53 10	42 7	33 5	53 0	42 9	33 3
Blue Grey	57 9	...	...	64 6	59 0	...	63 10	58 4	44 0
Highland	...	...	...	55 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	9	...	16	9	...	16	9	...
	Hoggs under 60 lb.	60 lb. and upw'd.	Ewes.	Hoggs under 60 lb.	60 lb. and upw'd.	Ewes.	Hoggs under 60 lb.	60 lb. and upw'd.	Ewes.
†SHEEP—	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.
Cheviot	14	12¾	10	13¾	12¼	9½	13¾	11¼	9
Half-bred	13¾	12½	9¾	13½	12¼	9¼	13½	11¾	8¾
Blackface	13¾	12¼	9¾	13¾	12	9½	13¾	12	9¼
Greyface	14	12¾	10	13¾	12½	10	13¾	12	9¾
Down Cross	13½	12	9	13½	11¾	9	13¾	11¾	9¼
†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 5	11 8	...	12 9	12 0	..
Porkers	13 6	12 6	..	13 4	12 4	...	13 7	12 9	...

* Live weight. † Estimated dressed carcase weight.

Live Stock: Monthly Averages of Prices at certain representative Scottish Markets—(*continued*).

Description.	June.			July.			August.		
	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 4	14 17	12 5	17 10	13 5	11 19	17 17	13 12	11 7
Two-year-olds ...	23 17	19 8	15 18	22 17	18 14	15 8	23 4	18 10	15 18
Cross-bred (Shorthorn):									
Yearlings	17 3	13 16	10 19	15 4	12 14	10 18	15 13	12 9	10 3
Two-year-olds ...	22 14	17 16	14 8	20 19	17 4	14 8	21 19	17 15	14 15
Galloway:									
Yearlings	14 9	11 5	...	14 9	...	...	14 14	12 5	...
Two-year-olds ...	22 0	17 13	...	19 13	17 5	...	...	...	...
Ayrshire:									
Yearlings	11 14	...	...	11 17	11 15	...	...	...	...
Two-year-olds ...	13 8	...	...	18 3	14 18	...	...	...	...
Blue Grey:									
Yearlings	14 0	11 0	...	...	...	...	...	...	...
Two-year-olds ...	22 3	18 0	...	...	...	...	...	...	...
Highland:									
Yearlings	11 7	9 3	8 5	9 4	7 13	5 15	...	7 0	...
Two-year-olds ...	17 6	14 3	11 7	13 19	12 4	10 5	...	...	...
Three-year-olds ...	19 0	17 5	14 15	...	11 0	...	...	...	...
Dairy Cows—									
Ayrshire:									
In Milk	26 1	17 19	12 0	29 2	20 0	12 5	28 19	19 11	12 0
Calvers	26 14	18 1	14 1	28 7	19 10	14 12	28 8	18 19	14 5
Shorthorn Cross:									
In Milk	31 2	22 19	24 0	32 12	24 7	19 5	33 2	23 13	21 0
Calvers	29 0	20 14	17 2	30 13	21 15	17 1	30 13	21 12	17 3
Sheep—	s. d.	s. d.	s. d.	s. d.	s. d.	s. d.	s. d.	s. d.	s. d.
Cheviot Hoggs ...	50 7	43 1	...	...	...	...	...	...	...
Half-bred Hoggs ...	58 11	45 1	...	57 6	48 0	...	58 6	...	...
Blackface Hoggs ...	40 7	30 11	...	23 6	20 0	...	...	...	...
Greyface Hoggs ...	56 1	46 8	...	55 2	46 8	...	53 8	46 6	...
Down Cross Hoggs	...	...	...	...	...	...	...	...	...
Pigs—									
(6 to 10 weeks old)	55 7	39 9	...	49 4	34 11	...	48 10	35 6	...

DEAD MEAT: Monthly Average Prices at Dundee, Edinburgh and Glasgow.

(Compiled from Returns received from the Department's Market Reporters.)

Description.	Quality.	June. Dundee.	June. Edinburgh.	June. Glasgow.	July. Dundee.	July. Edinburgh.	July. Glasgow.	August. Dundee.	August. Edinburgh.	August. 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	8¾	8⅝	9⅝	8¾	9	9⅝	9	9⅛	10
	2	8¼	...	8½	8¼	...	8¾	8½	...	9½
Bull	1	7¼	7⅛	6¾	7¼	7⅝	7	7½	7¼	7⅛
	2	6¾	...	6⅛	6¾	7	6½	7¼	7	6½
Cow	1	6	5⅞	6⅝	6	6⅜	6⅞	6½	6¼	7
	2	5½	...	6	5½	...	6⅛	6	...	6¼
Irish—										
Bullock or Heifer ...	1	...	...	8½	...	...	8¾	...	...	8¾
	2	...	...	...	...	...	...	...	...	8⅛
Argentine Frozen—										
Hind Quarters ...	1	...	7¼	...	...	7½	...	6	8	...
	2	...	6⅛	...	...	5⅞	...	...	5¾	...
Fore ,, ...	1	...	4⅜	...	...	4⅜	...	4⅛	4½	...
	2	...	3⅞	..	...	3⅞	...	...	3⅞	...
Argentine Chilled—										
Hind Quarters ...	1	7⅜	7¼	6⅝	8¼	8¼	8	8⅝	8½	8⅜
	2	6½	6¼	6⅛	7½	7½	7¼	...	7⅜	7⅞
Fore ,, ...	1	4⅛	4⅛	3⅞	4⅜	4¼	4	4¾	4⅞	4⅞
	2	3⅞	3⅝	3½	...	3⅝	3⅝	...	4⅜	4⅝
Australian Frozen—										
Hind Quarters ...	1	...	...	5¾	...	...	5¾	...	...	5¾
	2	...	...	...	...	...	...	...	...	...
Crops	1	...	...	3¾	...	...	3¾	...	...	3¾
New Zealand Frozen—										
Hind Quarters ...	1	..	...	5¾	...	...	5¾	...	...	5¾
	2	...	...	...	...	...	...	...	...	...
Fore ,, ...	1	...	...	3⅝	...	...	3⅝	...	...	3⅝
MUTTON:—										
Hoggs, Blackface ...	under 60 lb.	12½	12½	13	12½	12⅜	12¾	13	12⅝	12½
	60 lb. & over	11½	...	11½	11½	...	11⅜	12½	...	11
,, Cross	under 60 lb.	12½	12½	13	12½	12⅜	12¾	13	12⅝	12½
	60 lb. & over	11½	...	11½	11½	...	11⅜	12½	...	11
Ewes, Cheviot	1	...	7⅞	9½	...	8⅜	9½	...	7½	8½
	2	...	...	8⅞	...	...	8¾	...	...	8
,, Blackface ...	1	10½	7⅞	9½	10½	8⅜	9½	10	7½	8½
	2	9	...	8⅞	9	...	8¾	9	...	8
,, Cross	1	8	7⅞	9½	8	8⅜	9½	8	7½	8½
	2	7	...	8⅞	7	...	8¾	7	...	8
Argentine Frozen ...	1	...	...	4	...	...	4	...	...	4
	2	...	...	...	...	...	...	...	...	...
Australian ,, ...	1	...	5½	4	...	5⅛	4	...	5⅝	4
	2	...	4¼	3¼	...	3⅜	3¼	...	3⅛	3¼
New Zealand ,, ...	1	...	...	3¼	...	...	3¼	...	...	3¼
	2	...	...	3	...	...	2¾	...	...	2⅞
LAMB:—										
Home-fed	1	18	16¼	16	14⅝	14½	14¾	14½	14¼	13¾
	2	...	...	14	13⅝	...	13¼	14	...	12⅜
New Zealand Frozen ...	1	...	9⅝	9½	...	9⅜	9½	...	9⅝	9½
	2	...	9	8¾	...	8¾	8¾	...	9	8¾
Australian ,, ...	1	...	...	7⅜	...	...	7½	...	...	7½
	2	...	...	...	...	...	...	...	...	...
Argentine ,, ...	1	...	...	7⅜	...	...	7½	...	...	7½
	2	...	...	...	...	...	...	...	...	...

Eggs: Monthly Average Wholesale Prices at Aberdeen and Glasgow.

Provisions: Monthly Average Wholesale Prices at Glasgow.

(Compiled from Returns received from the Department's Market Reporters.)

Market.	Description.	Quality.	June.	July.	August.
			s. d.	s. d.	s. d.
Aberdeen.	Country ... ... per doz.	1	1 2	1 3	1 8
		2	1 1	1 2	1 7
	Duck .. ... ,,	1	1 3	1 4	1 9
		2	1 2	1 3	1 8
Glasgow.	Country .. ... per doz.	1	1 4	1 6	1 8
	Irish ... ... per 120.	1	11 4	15 6	16 8
		2	10 1	12 4	13 11
	,, Duck ... ... ,,	1	9 6	10 7	11 11
	Belgian ... ... ,,	1	10 1	12 1	13 2
		2	...	11 8	...
	Chinese (Black) ... ,,	1	...	...	8 4
	Danish ... ... ,,	1	...	11 9	13 0
	Dutch ... ... ,,	1	...	11 4	11 6
	,, Duck ... ,,	1	...	...	11 3
	Polish (Blue) . ,,	1	7 8	7 10	9 0
		2	7 1	6 8	7 2
	,, (Red) ... ,,	1	6 9	...	...
	Swedish ... ... ,,	1	...	12 0	13 0

Description.	Quality.	June.	July.	August.
		s. d.	s. d.	s. d.
BUTTER:				
Irish Creamery ... ... per cwt.	1	132 3	141 10	140 0
Australian ... ... ,,	1	134 6	138 0	137 6
Danish ... ... ,,	1	138 6	151 7	150 9
,, (Unsalted) ... ,,	1	143 6	155 10	154 9
New Zealand ... ... ,,	1	137 0	142 5	141 9
,, (Unsalted) ... ,,	1	144 8	148 10	152 0
Swedish ... . ,,	1	134 3	149 5	144 0
CHEESE:				
Cheddar ... ... ,,	1	88 0	85 2	86 6
	2	80 0	77 2	78 0
Cheddar Loaf ... ... ,,	1	...	...	86 0
Dunlop ... ... ,,	1	86 0	76 10	77 0
	2	79 0	73 10	75 0
Canadian... ... ... ,,	1	87 0	87 2	86 6
New Zealand (Coloured) ,,	1	91 6	88 7	89 9
,, (White) ,,	1	86 3	85 0	85 9
HAMS:				
Irish (Smoked) ... ... ,,	1	193 3	192 0	192 0
	2	175 0	175 5	183 0
American, Long Cut (Green) ,,	1	112 0	112 10	110 0
American, Short Cut ... ,,	1	103 0	113 5	102 3
BACON:				
Ayrshire (Rolled) ... ,,	1	142 0	133 2	134 0
Irish (Green) ... .. ,,	1	128 0	117 7	116 0
,, (Dried or Smoked) ,,	1	135 0	124 10	125 6
,, (Long Clear) ... ,,	1	125 6	117 0	125 6
Wiltshire (Green) ... ,,	1	134 0	120 10	127 0
,, (Dried or Smoked) ,,	1	142 0	129 5	134 0
Danish, Sides ... ... ,,	1	109 6	102 5	100 0
Dutch, Green (Wiltshire Style) ,,	1	102 0	93 7	90 0
American Long Clear, Middles (Green) ,,	1	101 6	96 7	96 0
American (Short Clear Backs) ,,	1	100 0	96 10	96 0

FRUIT AND VEGETABLES: Monthly Average Wholesale Prices at Glasgow.

(Compiled from Returns received from the Department's Market Reporter.)

Description.	Quality.	JUNE.	JULY.	AUGUST.
FRUIT:—				
Apples—		s. d.	s. d.	s. d.
British—				
Lord Derby per ½ barrel (56 lbs.)	1	...	...	10 0
Other Cooking ,, ,,	1	..	...	10 0
Imported—				
Australian .... per case (40 lb.).	1	13 1	11 5	...
Tasmanian ... ,, ,,	1	...	11 4	...
New Zealand ,, ,,	1	12 8	10 3	9 10
American ... ,, ,,	1	...	...	11 6
Pears—				
Australian ... per case (40 lb.).	1	14 6	...	...
French ... ,, (20 lb.).	1	...	...	9 6
Californian ... per box (46 lb.).	1	...	...	25 3
Gooseberries, British per lb.	1	..	0 1¾	0 1½
,, Imported ,,	1	0 2	0 1	...
Strawberries, Scottish ,,	1	...	0 9	0 9¾
,, English ,,	1	1 0	0 5½	...
Currants, Black ... ,,	1	...	0 5	0 4
,, Red ... ,,	1	...	0 3½	0 3
Raspberries ... ,,	1	...	0 5	0 4
Greengages, British ,,	1	...	...	0 3
,, Imported ,,	1	...	0 6¼	0 4½
Plums, British—				
Egg ... ... per lb.	1	...	...	0 1½
Czar ... ... ,,	1	...	...	0 1½
Monarch ... ,,	1	....	...	0 2
Prolific ... ... ,,	1	...	...	0 4
Victoria ... ,,	1	...	...	0 3
Louvaine ... ,,	1	...	...	0 1¾
VEGETABLES:—				
Beans, British ... ... per stone	1	..	2 6	3 0
,, Imported ... per lb.	1	...	0 3	...
Beet ... ... per cwt.	1	4 0	4 0	6 0
Cabbage, Coleworts ... per doz.	1	1 0	1 7	1 4
,, Red ... ... ,,	1	3 0	...	2 6
Carrots, British ... ... per cwt.	1	7 0	9 0	6 9
,, Dutch ... ... ,,	1	*3 8	8 0	4 6
Cauliflowers, British ... per doz.	1	4 0	4 11	5 3
,, French ... ,,	1	3 0	...	...
,, Dutch ... ,,	1	2 6	2 10	...
Celery ... ... per bunch.	1	...	...	2 9
Cucumbers ... ... per doz.	1	5 3	5 0	5 3
Leeks ... ... per doz. bunches.	1	2 0	...	4 8
Lettuce, Cos ... ... per doz.	1	1 11	1 2	1 0
,, Cabbage ... ,,	1	...	1 1	1 0
Onions, *Valencia* per case (9 stone).	1	7 8	8 2	8 2
,, *Egyptian* per cwt.	1	8 5	8 0	...
,, *Dutch* ... ,,	1	...	7 0	6 5
,, *Spring* ... ... per bunch.	1	0 3¾	0 6	0 5¼
Parsley ... ... per cwt.	1	10 0	16 10	13 0
Parsnips ... ... ,,	1	4 0	...	10 0
Peas ... ... ,,	1	†8 0	18 0	25 0
Radishes ... ... per doz. bunches.	1	1 5	1 6	1 6
Rhubarb ... ... per cwt.	1	2 0	2 0	2 0
Spinach ... ... ,,	1	23 0	24 0	26 0
Tomatoes, *Scottish* ... per lb.	1	0 9¼	0 7	0 5¼
,, *English* ... ,,	1	0 8¼	0 7	...
,, *Channel Islands* ,,	1	0 7¼	0 5¾	0 3¾
,, *Canary* ... ,,	1	0 8¼	...	...
,, *Dutch* ... ,,	1	0 5¾	0 4¼	0 3
Turnips ... ... per cwt.	1	2 6	*4 2	4 5
Vegetable Marrow ... per doz.	1	...	...	3 4

Per dozen bunches. † Per 40 lbs.

POTATOES: Monthly Average Wholesale Prices at Aberdeen, Dundee, Edinburgh and Glasgow.

(*Compiled from Returns received from the Department'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. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.
JUNE.							
Aberdeen, per ton	1	...	...	...	...	...	1 9 5
Dundee ,,	1	...	...	...	...	...	1 5 0
Edinburgh ,,	1	8 5 0	...	...	...	5 5 0	...
Glasgow ,,	1	9 17 6	...	6 0 0	...	4 10 0	1 10 9
JULY.							
Aberdeen ,,	1	6 6 8	...	...	...	...	1 6 11
Dundee ,,	1	6 4 0	...	...	...	...	1 5 0
Edinburgh ,,	1	6 2 0	...	...	...	...	...
Glasgow ,,	1	5 18 0	...	...	...	4 10 0	1 8 11
AUGUST.							
Aberdeen ,,	1	6 5 0	5 0 0	...	...	...	..
Dundee ,,	1	5 0 0	4 10 0	...	...	...	...
Edinburgh ,,	1	4 18 9	...	...	...	...	...
Glasgow ,,	1	4 15 0	..	...	...	...	...

ROOTS, HAY, STRAW AND MOSS LITTER: Monthly Average Prices at Aberdeen, Dundee, Edinburgh and Glasgow.

(*Compiled from Returns received from the Department'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.										
* Aberdeen, per ton	1	...	...	...	65 0	...	...	...	25 0	...
‖ Dundee ... ,,	1	...	...	10 0	105 0a 90 0b	...	54 5	...	54 5	52 6§
¶ Edinburgh ,,	1	...	...	...	92 6a 92 6b	...	47 6	...	47 6	...
‖ Glasgow ,,	1	...	...	...	82 6	90 0	52 6	...	47 6	34 1§§
JULY.										
* Aberdeen ,,	1	...	...	..	60 0	...	...	...	25 0	...
‖ Dundee ... ,,	1	...	...	...	105 0a 90 0b	...	60 0	...	60 0	52 6§
¶ Edinburgh ,,	1	...	...	...	91 0a 91 0b	...	47 6	...	47 6	...
‖ Glasgow ,,	1	...	...	...	76 0	81 0	51 0	...	45 6	33 9§§
AUGUST.										
* Aberdeen ,,	1	...	...	...	68 9	...	...	...	25 0	...
‖ Dundee ... ,,	1	...	...	...	105 0a 90 0b	...	60 0	...	60 0	52 6§
¶ Edinburgh ,,	1	...	...	...	85 0a 85 0b	...	47 6	...	47 6	...
‖ Glasgow ,,	1	...	...	...	80 0	85 0	45 0	...	42 6	33 9§§

* Loose, ex-farm. ‖ Baled straw, delivered. ¶ Bunched straw, delivered.
§ Foreign, ex quay. §§ Home (in 1½ cwt. bales). *a* Baled and delivered.
b Loose, delivered.

Feeding Stuffs : Monthly Average Prices at Glasgow and Leith.

(Compiled from Returns received from the Department'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	9 19 8	9 10 0	9 5 3	9 1 0	9 17 6	9 11 3
Foreign	9 12 6	...	8 18 9	...	9 6 11	...
Décorticated Cotton Cake	9 5 0	...	8 17 6	...	8 16 11	...
Undecorticated do.—						
Bombay (Home-manufactured)...	...	4 11 3	...	4 7 0	5 7 6	4 12 6
Egyptian (do.)	5 5 0	5 0 0	5 5 0	5 0 0	5 11 3	...
Palmnut Kernel Cake	8 5 0	...	7 11 0	...	7 9 5	...
Soya Bean Cake ...	...	9 5 0	...	9 0 0	...	9 11 3
Coconut Cake ...	9 15 0	..	8 19 0	...	8 13 9	...
Groundnut Cake, Undecorticated—						
(36-37 per cent. Oil and Albuminoids)	6 16 3	6 15 0	6 10 6	6 11 0	6 8 9	6 5 0
(39-40 per cent. do.)	6 13 9	6 19 5	6 7 0	6 15 3	6 10 0	6 10 0
Maize Germ Cake—						
Home	8 5 0	...	7 17 0	...	7 8 2	...
Foreign	8 0 0	...	7 16 0	...	7 16 7	...
Maize Germ Cake Meal	6 18 9	..	6 10 0	...	6 15 4	...
Rice Meal	5 5 0	5 5 0	4 19 6	...	5 5 8	4 15 0
Bean Meal	10 2 6	9 13 2	9 13 6	9 6 6	10 2 6	9 8 9
Barley Meal ...	7 10 0	...	7 0 0	7 0 0	6 15 8	7 0 0
Fish Meal	19 2 6	19 0 0	19 1 0	19 0 0	18 16 11	19 0 0
Maize Meal—						
Home-Manufactured	8 1 11	7 6 3	7 8 6	7 4 6	8 2 2	8 5 0
South African—						
(Yellow) ...	6 19 5	7 1 8	6 10 9	6 15 0	7 0 8	6 18 9
(White) ...	6 17 6	...	6 8 0	...	6 15 11	...
Locust Bean Meal (Fine)	7 14 5	6 6 11	7 5 0	5 19 6	6 15 0	5 15 0
Maize Gluten Feed (Paisley) ...	6 10 0	...	6 2 0	...	6 3 9	...
Maize—Plate ...	6 17 2	6 10 0	6 19 3	6 17 0	7 17 10	7 12 6
Do. African, Flat	7 8 2	6 10 0	7 4 0	...	7 10 0	...
Do. American ...	8 1 3	...	7 9 6	...	7 15 0	...
Oats—Home ...	6 17 6	6 11 3	7 0 6	6 4 0	7 9 8	6 13 9
Do. Plate ...	5 8 2	...	5 4 3	...	5 16 3	5 13 9
Do. Canadian No. 2	...	...	...	...	4 19 0	...
Barley Feeding (Home)	8 0 0	7 12 6	8 0 0	6 12 6	8 0 0	...
Do. Bran ...	7 3 9	..	7 0 0	...	6 12 6	...
Wheat—						
Home	8 16 11	8 3 9	8 13 3	8 4 0	9 5 11	8 10 0
Poultry	8 8 9	7 15 0	8 6 0	8 2 6	8 18 5	8 10 0
Imported... ...	8 11 7	...	8 11 6	...	9 1 7	...
Middlings (Fine Thirds or Parings)	6 12 1	5 5 0	6 8 6	5 7 0	7 2 6	5 18 9
Sharps (Common Thirds) ...	4 19 1	4 13 9	4 13 6	4 10 0	5 6 11	5 6 3
Bran (Medium) ...	4 15 11	4 6 7	4 12 6	4 2 6	5 5 4	4 17 6
,, (Broad) ...	5 0 0	5 2 2	4 15 0	4 17 6	5 9 5	5 12 6
Malt Culms... ...	4 11 3	3 15 0	4 10 0	4 0 0	4 10 0	3 15 0
Distillery Mixed Grains—Dried	...	5 15 0	...	6 6 0	6 3 4	6 7 6
Brewers' Grains—Dried	5 0 0	5 0 0	5 0 0	4 17 0	5 5 8	4 6 11
Distillery Malt Grains—Dried	5 18 5	...	5 17 6	...	6 0 0	...
Crushed Linseed ...	24 0 0	...	23 18 0	...	23 10 0	...
Locust Beans, Kibbled and Stoned	6 7 6	5 10 8	6 0 0	5 10 6	5 18 2	5 0 0
Beans—China ...	9 6 7	9 5 0	9 0 0	...	9 4 1	...
Do. Sicilian ...	9 11 7	...	9 2 9	...	9 5 8	...
Do. English ...	9 10 0	...	9 3 6	...	9 5 0	...
Feeding Treacle ...	7 0 0	7 0 0	6 17 0	6 14 10	6 6 7	6 7 6
Linseed Oil, per gall.	0 4 2	...	0 4 0	...	0 4 0	...

FERTILISERS : Monthly Average Prices at Glasgow and Leith.

(Compiled from Returns received from the Department'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	10 2 0	10 2 0	10 2 0	10 2 0	9 7 0	9 12 0
Sulphate of Ammonia (Neutral and Granular) § ...	N. 20·6	10 2 0	10 2 0	10 2 0	10 2 0	...	...
Nitrochalk	N. 15½	§9 19 0	...	‖9 19 0	...	‡10 2 6	...
Calcium Cyanamide ‖	N. 20·6	9 6 0	...	9 6 0	...	...	...
Superphosphate ...	P.A. 13·7	2 15 0	2 17 6	2 15 0	2 17 6	2 15 0	...
,, ...	,, 16	3 1 3	3 2 6	3 1 3	3 2 6	3 1 3	...
,, ...	,, 17 4	3 6 3	...	3 6 3	...	...	...
,, ...	,, 18·3	...	...	..	...	3 6 3	...
Ground Mineral Phosphate (*a*)	P.A. 26	2 6 6	...	2 6 6	...	..	...
,, ,, ,, (*b*)	,, 26	...	2 6 6	...	2 6 6	...	...
,, ,, ,, (*c*)	,, 26	2 9 0	2 9 0	2 9 0	2 9 0	...	...
,, ,, ,, (*d*)	,, 2 6	...	...	...	...	2 10 0	...
,, ,, ,, (*b*)	,, 34	...	3 9 0	...	3 9 0	...	...
,, ,, ,, (*c*)	,, 34	...	3 11 6	...	3 11 6	...	...
,, ,, ,, (*d*)	,, 34	...	...	...	...	3 10 0	...
Kainit (in bags) ...	Pot. 14	3 7 6	3 2 6	3 7 6	3 2 6	†3 3 3	...
Potash Salts ...	Pot. 20	3 17 6	3 12 6	3 17 6	3 12 6	†3 12 3	...
,, ,, ...	Pot. 30	5 5 0	5 0 0	5 5 0	5 0 0	†4 17 3	...
Muriate of Potash... (on basis of 80 per cent. purity)	Pot. 50	9 12 6	9 2 6	9 12 6	9 2 6	†9 2 6	...
Sulphate of Potash (on basis of 90 per cent. purity)	Pot. 48·6	11 15 0	11 5 0	11 15 0	11 5 0	†10 18 6	...
Steamed Bone Flour	N. 0·8/1·0 P.A. 28/30	5 15 0	5 5 0	5 15 0	5 0 0	5 15 0	...
Bone Meal (Home)	N. 3·29 P.A. 23	7 15 0	8 10 0	7 15 0	8 10 0	7 15 0	...
,, ,, (Indian)	N. 4 P.A. 19½/23	9 0 0	8 10 0	9 0 0	8 10 0	8 15 0	...
Potassic Mineral Phosphate ...	P.A. 18 Pot. 5	3 7 6	...	3 7 6	...	3 2 6	...
,, ,, ,, ...	P.A. 18 Pot. 10	3 15 0	...	3 15 0	...	3 15 0	...
Basic Slag * ...	P.A. 11	...	...	...	...	2 0 6	...
,, ,, * ...	,, 12	...	..	...	...	2 3 0	...
,, ,, * ...	,, 13	...	...	...	...	2 6 0	...
,, ,, * ...	,, 14	2 7 6	...	2 7 6	..	2 7 6	...

Abbreviations :—N. = Nitrogen ; P.A. = Phosphoric Acid ; Pot. = Potash.

* F.O.R. Glasgow.
† Less 5*s*. 6*d*. ex-quay.
‡ Ex store.
§ Carriage paid in 6-ton lots.
‖ Carriage paid in 4-ton lots.

a = 75 per cent. fineness through prescribed sieve.
b = 80 per cent. fineness through standard 100-mesh sieve.
c = 85 ,, ,, ,,
d = 90 ,, ,, prescribed sieve.

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INDEX TO VOL. XIII—1930

Date of issue.	Date of issue.	Date of issue.