THE

BOOK OF THE FARM

DIVISION V.

Wherefore come on, O young husbandman!
Learn the culture proper to each kind.

VIRGIL.

THE

BOOK OF THE FARM

DETAILING THE LABOURS OF THE

FARMER, FARM-STEWARD, PLOUGHMAN, SHEPHERD, HEDGER, FARM-LABOURER, FIELD-WORKER, AND CATTLE-MAN

BY

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IN SIX DIVISIONS

DIVISION V.

WILLIAM BLACKWOOD AND SONS
EDINBURGH AND LONDON
MDCCCXC

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DRAUGHT HORSE,
(1840)

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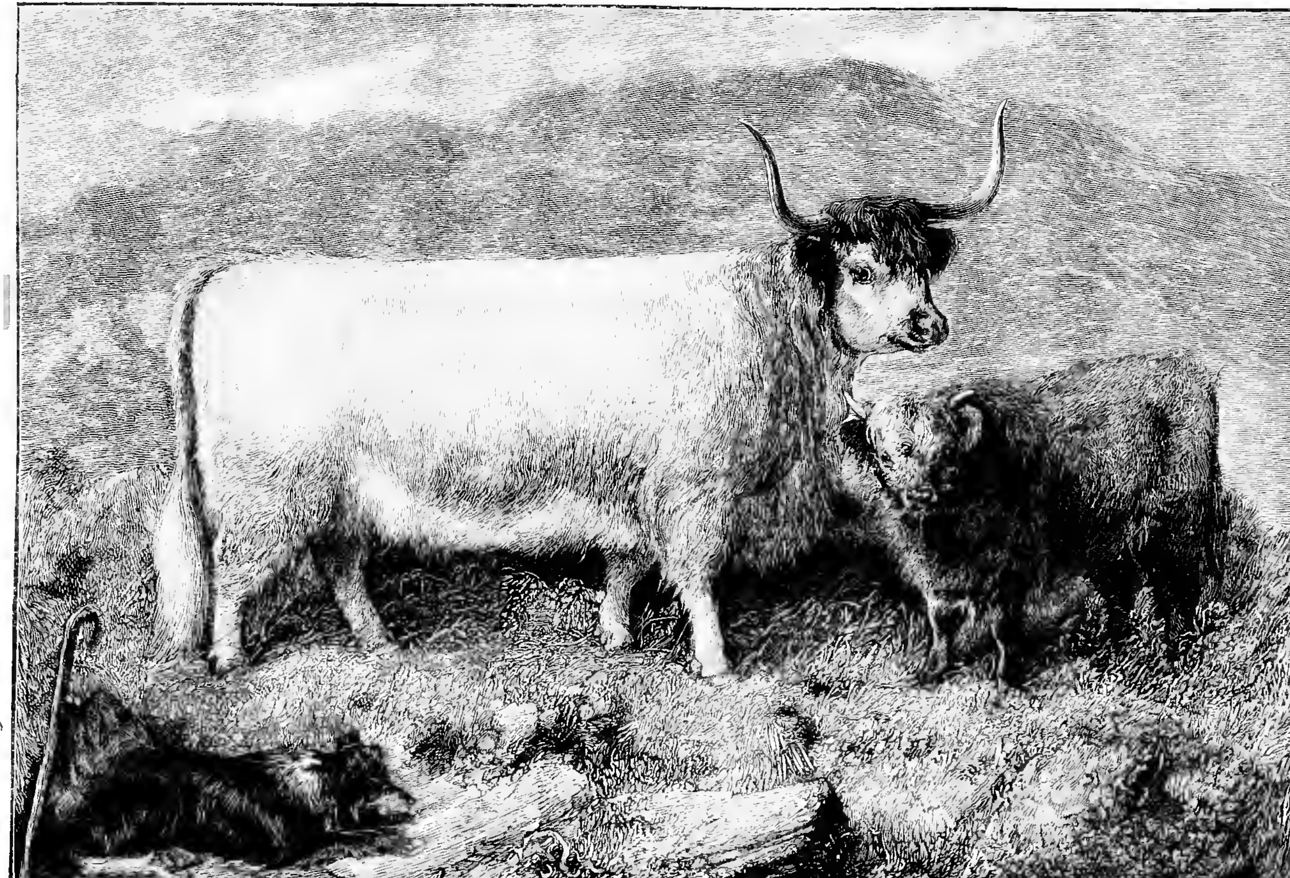

WEST HIGHLAND COW AND CALF.

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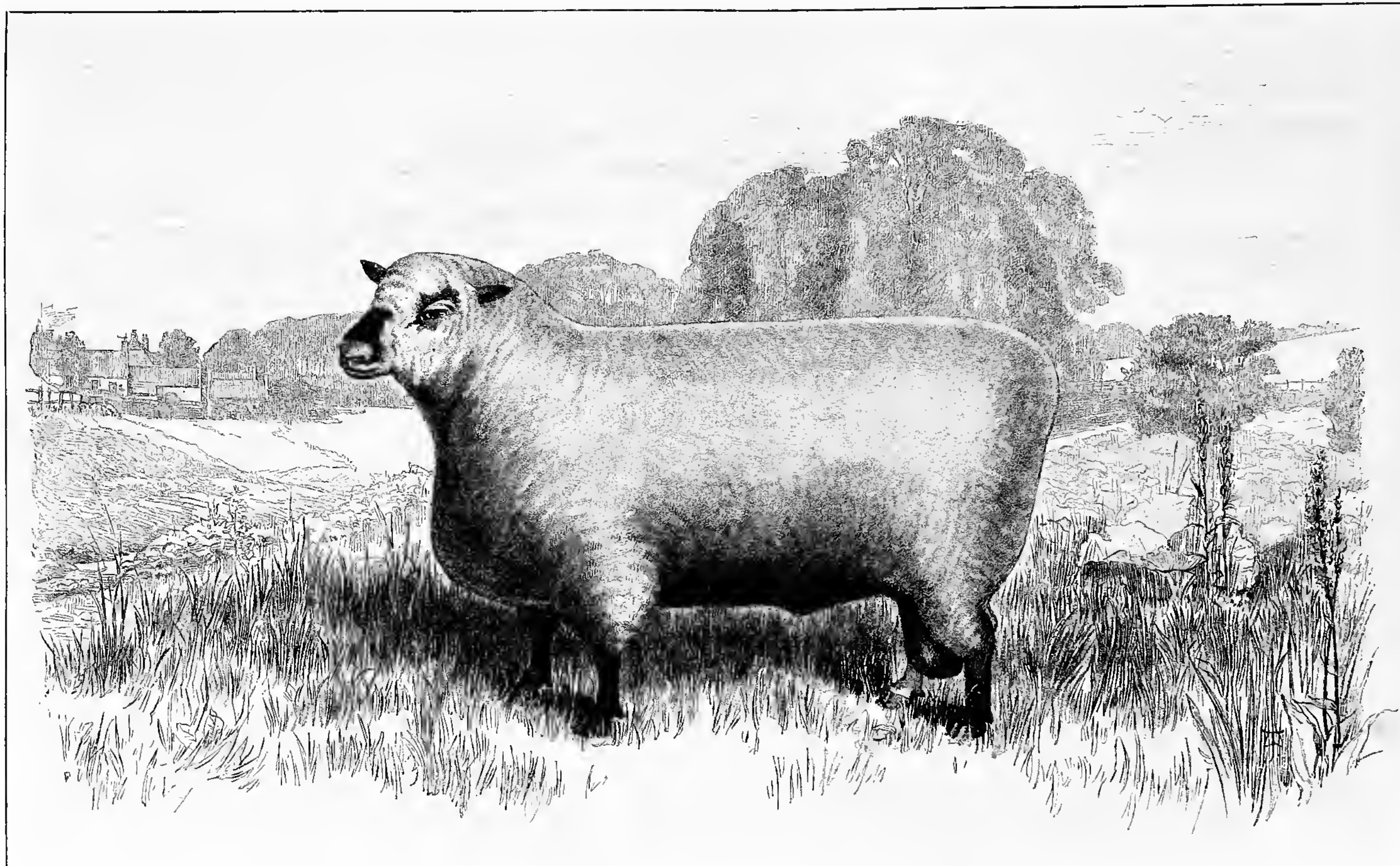

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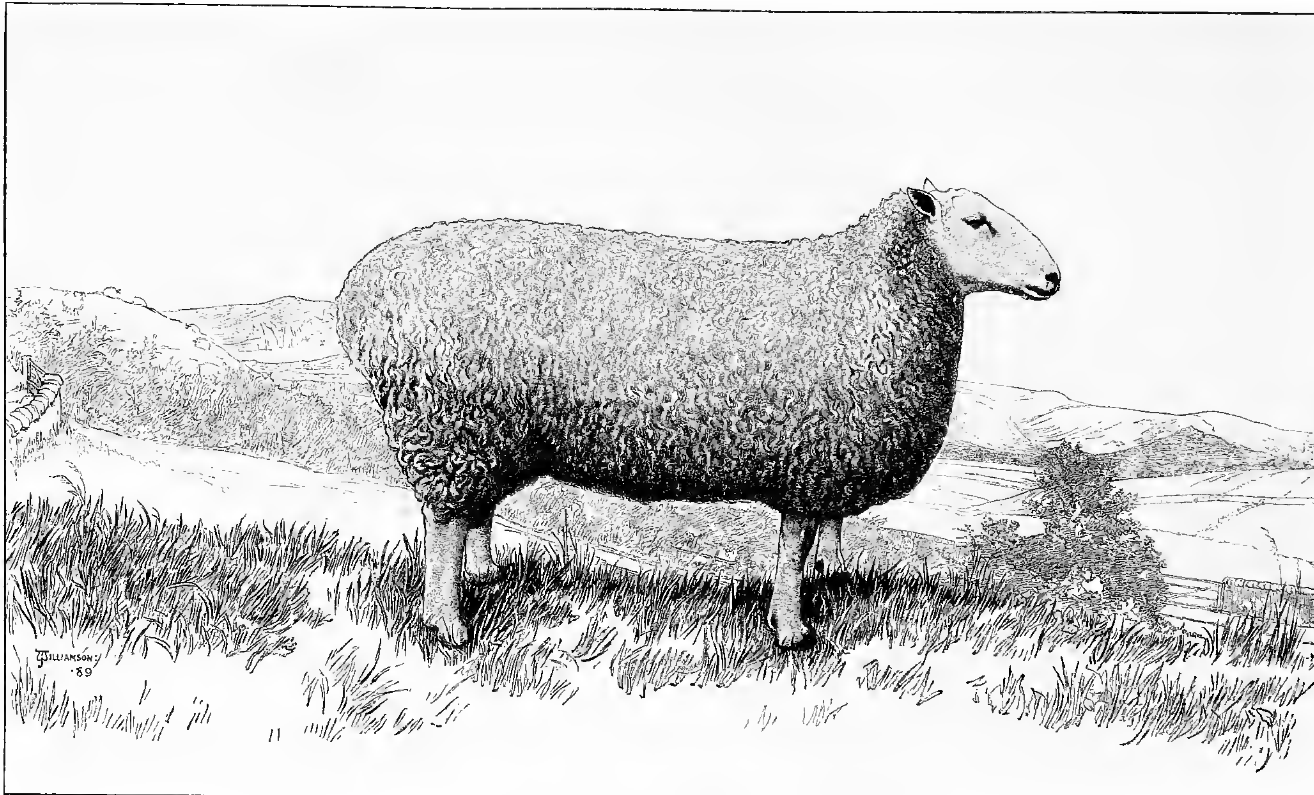

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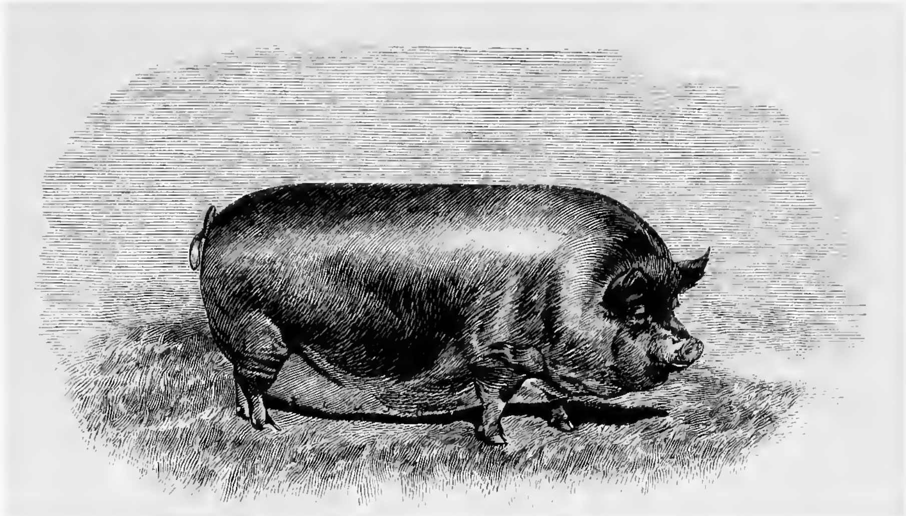
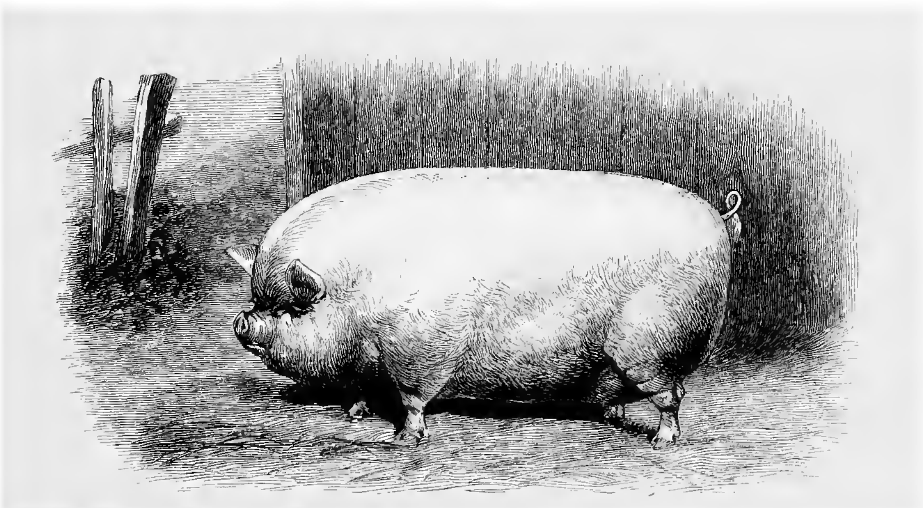


BLACK SOW.

BRED BY JOSEPH A. SMITH, ESQ., RISE HALL, AKENHAM, IPSWICH.



SMALL WHITE BOAR.

THE PROPERTY OF HER MAJESTY THE QUEEN, AND BRED BY THE RIGHT HON. LORD MORETON, TORTWORTH COURT, FALFIELD, GLOUCESTERSHIRE.

THE

BOOK OF THE FARM.

HAYMAKING.

THE converting of fresh grasses and clovers into hay by the drying influences of sun and wind is an operation of great importance to the British farmer.

Object of Haymaking.—Haymaking is the handmaid of stock-rearing. As stock-rearing increases or diminishes, so in all probability will haymaking. Haymaking is the means by which the farmer endeavours to preserve for the winter feeding of his stock the class of food which they pick up for themselves on the fields in summer. The quality and feeding value of this preserved grass much depend upon the manner in which it has been transformed from the green to the dry condition. It is thus of the utmost importance that the process of haymaking should be conducted on the best method known and attainable. We say "attainable," because in our precarious climate the best-laid schemes of farmers are often upset by tantalising outbreaks of unfavourable weather.

Weather and Haymaking.—Haymaking is peculiarly subservient to climatic conditions. It goes without saying that hay cannot be made in wet weather. Even the proverbial injunction to "make hay while the sun shines" is not without limitation. By the too industrious "making" of hay, under clear scorching sunshine, the quality of the food may be considerably impaired. To expose the fresh grass to such drying influences as will preserve it with the least possible loss in its bulk and nutriment necessitates the exercise of the utmost skill and care.

It is therefore desirable that the various methods of haymaking pursued in different parts of the country should be discussed fully.

Varieties of Hay.—There are three main varieties of hay: (1) hay made from grasses and clovers sown in the preceding year; (2) hay made from sown grasses which have endured for several years; and (3) "meadow-hay," or that made from natural meadows, the herbage of which consists of plants which have grown up at nature's own sweet will. The first is the variety most general where arable farming prevails, notably in Scotland and the north of England. The last abounds chiefly in the south of England and in certain districts in Ireland. The second variety is found here and there throughout the United Kingdom.

The chief principles of haymaking are alike applicable to all classes of hay. Several modifications desirable for particular varieties of grasses, and for certain localities, will be noticed presently.

The process of haymaking may, for the purposes of description and study, be conveniently divided into three sections—(1) cutting, (2) treatment between cutting and carrying, and (3) carrying and stacking.

Time for Cutting.

An important preliminary is to decide when the crop is ready for cutting. For the moment we will leave the probability of unfavourable weather out of consideration, and assume that the weather is all the most ardent haymaker could desire. The precise time at which it is most desirable to cut down the crop will depend upon the object in view.

Hay for Seed.—If it is intended to obtain seed from the crop, then of course the plants must be left until the seeds have matured. This is easily determined. A few heads may be rubbed lightly in the hand, and the seeds and the heads examined. A common plan is for the farmer to sweep his hat smartly along the heads of the plants, and note the seeds it catches.

Hay for Feeding.—But if the object is to raise good hay for feeding, and not to procure seed, then the cutting should take place at an earlier stage. It is well established, though the fact has not in all cases its due consideration in practice, that the production of seed and the securing of the maximum feeding value in the hay are incompatible. This is not due to the mere loss of the seed in the food, but rather to the fact that the seed is matured at the expense of the nutrient juices of the plants. It is the soluble ingredients of the hay—those soluble in water—which are chiefly valuable for feeding. Nearly all grasses and clovers contain the greatest quantity of these soluble ingredients when they are in full flower, and before the seed has been formed. The formation of the seed and the general ripening of the plants have a strong tendency to increase the proportion of woody fibre, and thus lessen the nutritive properties of the hay.

In timothy, cocksfoot, and one or two other natural grasses, the order of development of the ingredients would seem to be somewhat different, for these do not reach their maximum feeding value until the seed is nearly ripe. These, however, are exceptions.

Best Stage for Cutting.—The stage, therefore, at which hay (from which seed is not to be taken) should be cut is when the plants are in full bloom, or at latest within a few days after the bloom or flower has disappeared. Many farmers delay cutting in the belief that any little loss by the maturing of certain of the plants will be more than made up by the increase which they imagine they obtain by growth of the under or bottom grass. This, however, is often fallacious.

Aftermath.—Moreover, the subsequent cutting or aftermath should be kept in view. The longer the first crop is left on the ground the poorer—as a rule—will be the after-growth. If the plants are left uncut until their stems become withered at the bottom, the roots may be so much impaired as to seriously lessen after-growth.

To ensure the greatest possible quantity of feeding matter in the course of the year—and this in the great majority of cases will be the object of the farmer—the best plan is to cut the first crop early rather than late.

Tax upon the Soil.—Another point worthy of consideration is that the ripening of the seeds makes a much greater demand upon the fertility of the soil than the growing of the stalks and leaves of the plants.

All things considered, therefore, it will be admitted that it is far more common for farmers to lose by delaying cutting too long than by cutting too early.

Premature Cutting.—Yet it is well to bear in mind the fact that the cry for early cutting may be carried too far. The agricultural chemist has shown clearly that the nutritive ingredients of grasses are not fully elaborated until the plants have reached the flowering stage,—in a few cases not indeed until the seed has been nearly ripened. Water is the principal constituent of young grasses, and it is not until they have reached the full stature of the flowering stage that the feeding properties are fully developed.

Thus the farmer should wait for the bloom before putting the mower into the hay-field. But when the flower appears he should have everything in readiness, and begin operations as soon as the weather justifies him in doing so.

Study the Weather.—In the foregoing remarks upon the time to begin cutting, we assumed that the weather was favourable. Unfortunately, however, inclement weather has often to be contended with by the haymaking farmers of this country.

In the hay harvest the farmer must study the weather indications with unceasing care. In this he would do well to procure the aid of an efficient barometer, which can now be purchased for a very small sum.

Notwithstanding all that has been said as to the advantages of cutting the crop before the seed is formed, it will, as a rule, in the case of wet unsettled weather, be safer to delay the mower for a few days, until more settled weather sets in, than to cut down the hay and get it spoiled in the swathe by drenching rains. In contingencies of this kind, which are of frequent occurrence, the prudent farmer will choose the least of the evils which afflict him. There is no operation on the farm which demands more constant and careful attention or better judgment than haymaking. At best, in unfavourable seasons, it will often be a matter of compromise, involving not a little of the experimental element. Yet there are certain known conditions and influences which the haymaking farmer should bear in mind. It is our object here to set forth these, leaving the farmer to apply them to his own individual circumstances.

Hay Injured by Wet.—One consideration which the farmer should bear in mind is that rain is much more injurious to cut than to uncut hay. No nutriment is washed out of the stalk or blade of a grass while it remains in life, no matter how heavy the rainfall may be. When the plant is dead, however, every shower of rain to which it is exposed is liable to dissolve and wash away a certain portion of its most valuable feeding ingredients.

The warmer the weather the greater the loss from the wasting of hay by rain—this for the reason that warm water is, as a rule, a more powerful solvent than cold water.

Hot and Cold Rain.—The difference in the influence of hot and cold rain upon half-made hay is very noticeable in September, when a second cutting of grass is made into hay. At that season it is observed that the half-made hay will bear with impunity double the quantity of rain it would stand in June or July.

When wet weather sets in at the beginning of the hay harvest, it is not wise to go on mowing, in the expectation that the hay will be easily made safe when dry weather returns. Before the return of dry weather the cut grass may be dead, and the hay very seriously damaged by the drenching rains to which it is subjected.

It is better policy to delay cutting until the weather has become favourable. If there are indications of more rain at hand, the mowing should be prosecuted slowly, and then, when there is reason to believe that a spell of dry weather has set in, the order to all hands should be "full speed ahead."

Cutting Rotation Hay.—The two first varieties of hay mentioned above, those made from sown grasses and clovers, are roughly classed as rotation hay, as distinguished from hay made from natural meadows that lie permanently in grass. First year's hay, that grown from seeds sown in the previous season, as a rule consists chiefly of perennial or Italian rye-grass and clovers, or it may be all three. Perennial rye-grass and clovers are most largely used. If the weather is favourable, the mowing of this hay should be begun when the rye-grass has been in flower for a day or two. If the breadth of hay to cut is great in comparison with the available force of labour, begin early, so that the main bulk of the crop may be cut down at the right time. In case of wet weather, delay a little as advised above.

Cutting Early and Late Grasses.—In hay from subsequent years' growth (as in meadow-hay), several of what are known as natural or permanent grasses are included in varying proportions. Of these permanent grasses cocksfoot and foxtail are among the earliest, and when these are plentiful, the crop should be cut as soon as they go out of bloom. In a piece of meadow-land, having a variety of grasses, it is bad policy to lose the substance of the earlier grasses in waiting for the flowering of the later plants, more particularly if it should happen that the early varieties predominate. Here again it is erring on the side of safety to begin cutting early.

Ill-suited Mixtures.—Early and late grasses, so advantageous for grazing purposes, are not well suited for companionship in the hay crop. A certain amount of variation in this respect is practically unavoidable. It would be well, however, to guard against the association of extremes. For instance, it is imprudent to sow timothy and cocksfoot together for a hay crop. When the latter is ready for cutting, the timothy is not nearly at its best; while, if cutting were delayed till the timothy attained its greatest value, the cocksfoot would be deteriorated by over-ripeness. When timothy is sown for hay, which is extensively done, it is best sown by itself, as none of the other principal plants grown for hay ripen at the same time as it ripens.

Clover, Sainfoin, and Lucerne.—Many experienced farmers consider it desirable to cut clover and sainfoin as soon as the first traces of the flower appear. Lucerne is often cut even earlier. In dry hot seasons its growth seems to cease before the flowering stage is reached, and in that case it is the practice with many to cut it down at once.

Preparing to Cut.

The prudent farmer will have the mowing-machines looked out and put into the pink of condition before the day arrives for the commencement of cutting. Any necessary repairs will have been effected at the end of the previous season. No judicious farmer would think of laying up a machine or implement of any kind for the idle season until the needed repairs have been attended to. It is very bad practice indeed to delay such matters until the time arrives for the active employment of the machine or implement.

These general remarks apply with special force to preliminary arrangements for hay-cutting. See that all preliminaries are attended to beforehand, so that when the work of cutting begins there may be no avoidable delay.

Method of Cutting.

Mowing-machine.—To ensure satisfactory work, the mowing-machine must be in good order. Have the knives well sharpened, and see that they work smoothly and close to the face of the fingers.

It is advisable to use a good set of knives for cutting the hay crop, more particularly if the crop is heavy or contains a large quantity of soft grass in the bottom. Half-worn knives, although good enough for cutting oats or wheat, often make very unsatisfactory work in soft grass. Whenever cutting has begun, see that the cutter-bar is as near level as possible. In many cases the outside end is by far the closest—in fact, so close that the knives are often considerably damaged—while the inside end is so high that far too much of the crop is left on the ground.

Close Cutting.—Moderately close cutting is no doubt advisable on account of the greater weight of produce ob-

Fig. 457.—*Reaper knife-sharpener.*

tained than by higher cutting. Very close shaving, however, is very doubtful policy. Indeed most good farmers regard it as decidedly undesirable. It incurs greater risk of delays and breakages in cutting. Then it is also observed that when the plants are cut excessively close to the ground, they are, as a rule (rye-grass and clover especially), unusually long in springing up again. In very hot dry weather the roots may be injured by undue exposure to the sun.

Sharp Knives.—Keep the knives as sharp as possible, as low-cutting and easy-drawn mowers cannot be had without sharp knives. Where two or more mowers are kept going, it is advisable to keep one man sharpening knives, as then they are always in good repair, and cutting goes on more smoothly and rapidly than when the driver has to look after not only his horses but his mower and knives as well.

The most common method of sharpening the knives of reapers is with a fine file supplied for the purpose. Machines for sharpening are now in use, however, one of the most successful of these being shown in fig. 457, made by Harrison, M'Gregor, & Co., Leigh, Lancashire.

Mower *v.* Scythe.—The mowing-machine is now almost universally employed in cutting hay. Except in the case of holdings too small to employ horse labour, the advantages which the mowing-machine possesses over the scythe are so decided and great that the time-honoured scythe has been relegated to quite a secondary position.

Types of Mowers.—In the section on the harvesting of the grain crops, the

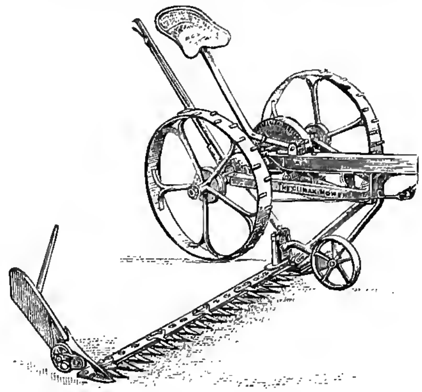


Fig. 458.—*Howard's mower.*

introduction of the mowing and reaping machine will be referred to more fully. Here it will suffice to say that this most useful appliance has reached a very high state of efficiency, and that this improvement in the working of the machines has been accompanied by the further

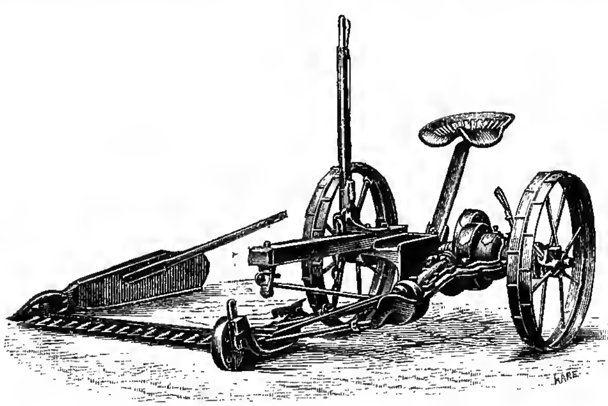


Fig. 459.—*The "Munster" mower.*

advantage of a reduction in price. A very large number of firms are now extensively employed in manufacturing mowing (and reaping) machines, and farmers have the privilege of selecting from a very ample collection of different "makes" and patterns, nearly all efficient, durable, and cheap, some of course better suited than others for certain localities and other conditions.

Excellent mowers are represented in figs. 458, 459, 460, and 461, made respectively by Howard, Bedford; Keane, Cappoquin, County Waterford; Pierce & Co., Wexford; and Harrison, M'Gregor, & Co., Leigh, Lancashire. The last named is the famous "Albion" mower, shown at work in fig. 461. The combined reaper and mower is a popular and most useful machine. Some of the best forms of these are mentioned and illustrated in the section on the harvesting of grain. The Caledonian Buckeye mower and reaper, made by Jack & Sons, Maybole, Ayrshire, and held in high esteem, is shown here in fig. 462.

All-round or Side Cutting.—The greatest speed is of course, as a rule, attained by working the machine in a continuous course all round the field. This, however, is not always practicable or advantageous.

If the crop is moderate, and mostly standing, it may be cut round about

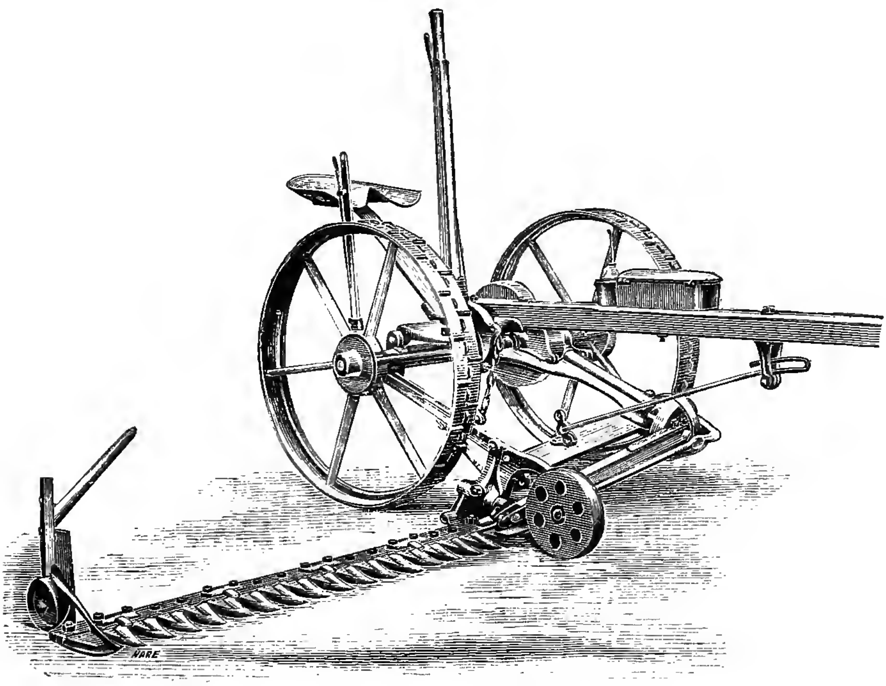


Fig. 460.—*The "Victor" mower.*

where the field is no larger than can be cut in one day. Should the field be large, however, it will be advisable, even in a moderately standing crop, to rather cut two ways only, after having thoroughly opened up the field by taking five or six swathes round the outside. The field may then be cut into breaks about 50 or 60 yards wide, and the horses driven through the crop where a beginning is desired to be made. The crop, flattened by the horses' feet and the wheels of the machine, should be cut on the return journey, as the fingers then get easily in below it, and cut it clean. Unless the crop is very light, a narrow track should, before coming back, be cleared by the rake for the inside wheel, otherwise it and the shoe are apt to get blocked up by loose hay. The trouble is very little, and much neater work can be done. The cutting may then be proceeded with till the breadth cut is equal to what remains between the first beginning and the side of the field, after which the mower should go round the remaining part.

By cutting in this manner very little unnecessary time is lost at the turnings. Many fields, if inclined to be laid, or if heeled over by the wind, can be easily enough cut in this way, while they would be anything but pleasant to cut round about. Moreover, by the cutting being done from one side or end of a field right forward, the crop can be much readier coiled and ricked afterwards, more particularly if the work is interrupted by bad weather.

Laid Patches.—Where for any reason

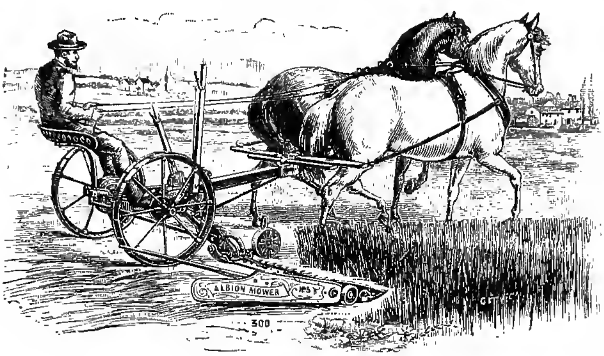


Fig. 461.—*The "Albion" mower.*

it is desired to cut a field round about, and patches here and there are lying in the wrong direction, it is the custom in some districts to turn such back by hauling a heavy plank broadside over the crop in the opposite direction to that in which the mower is moving, and a swathe or so in advance of it. A horse is yoked by a pair of plough-chains to the centre of the plank, a boy then gets on the horse's back, and drives it where required.

Cutting Laid Crops.—If the crop is very heavy and laid, it, as a rule, can be

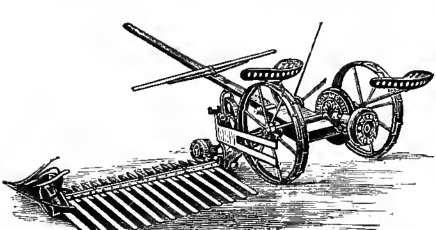


Fig. 462.—"*Caledonian Buckeye*" *reaper and mower.*

cut only in one direction. In this case a beginning is generally made at that side of the field which admits of the mowing-machine going almost right against the direction in which the crop is laid.

Direction to Cut.—In choosing the direction in which to cut, it is always advisable to let the crop lie, if anything, against the divider instead of falling towards the horses' feet, as by doing so the face of the standing crop remains more erect and clean than where the opposite course is followed.

Clearing Swathe Ends. — Where the crop is moderately heavy, it is a great convenience to the person in charge of the mower to have a boy or girl along with each machine, or one for two machines, who, with a rake, can clear a small space at the entry to each swathe, and draw back the cut hay after the first swathe and before the second; and when the finishes are not parallel, rake the cut crop out of the way, so as to allow a free passage out and in.

Head-ridges.—If the head-ridges are much laid or twisted, it may be impossible to cut them satisfactorily by the mowing-machine. In this case, the scythe will have to be resorted to.

With the exceptions here mentioned, no other hand-labour need be used during the cutting process.

One-way Cutting.—If mowing is done one way only, the horses should always travel back in the clear spaces between the swathes, and the wheels of the mower should straddle the swathe of cut-grass. By so doing the grass lies much more open, and dries quicker and more regularly than where it is carelessly trampled on and pressed close to the ground.

Loosening Lumps.—The boys or girls who are keeping the ends of the swathes clear, or the man who sharpens the knives, should also come behind, and regularly throw out any unusually thick pieces of grass which have been pulled together by the bar of the mower, raked up by the boys, or from any cause whatever are gathered into a thicker part than usual.

"MAKING" THE HAY.

The operations between the cutting and the carting or stacking of the hay may be conveniently described under the above heading. Indeed these operations may be said to constitute the "making" process.

Variations in Practice.—In this, which is really the chief part of the work of the hay harvest, practice varies greatly throughout the country. To a large extent, no doubt, these variations have no other grounds for their existence than the peculiar tastes and notions of the farmers themselves, who, it may be frankly confessed, own a full share of the contrarieties and perversities of human nature.

Grounds for Variations.—In very many cases, however, the differences in the methods of haymaking are accounted for by variations in the soil, climate, system of farming, and the purposes for which the hay is intended. In particular, the making process must be varied with wet and dry seasons, heavy and light crops, and with the particular class of hay.

There is thus good reason for variety in the practice of haymaking; and while we append notes descriptive of methods which we know to be pursued with success on widely separated parts of the country, and in different conditions of soil, climate, and system of farming, we deem it right to say that it is not presumed that these are positively the best methods for all circumstances.

In haymaking, as in most farm practices, each individual farmer must think for himself. The prudent farmer is eager to know the methods which are pursued with success by others. Having acquainted himself with these, he must carefully consider their adaptability to his own peculiar circumstances. He will not hesitate to adopt such features of these methods as seem to improve upon his practice hitherto, yet he rightly deems it wise to introduce radical changes in a tentative way.

Haymaking controlled by Weather.—Haymaking, beyond almost every other farm operation, is incapable of being conducted with success upon any definite or hard-and-fast system. It is so thoroughly within the control of the "clerk of the weather," and that important "functionary" is so fickle, that every season, nay, even every week, may demand treatment peculiar to itself. The farmer must watch closely these uncertain and shifty conditions, and be prepared at any moment to vary his practice to suit them.

This very fact renders it all the more important that the farmer should acquaint himself as fully as possible with the various methods of haymaking pursued with success throughout the country, so that he may have the greater resource in battling with untoward circumstances as they arise.

English Methods.

In England, speaking generally, the prevailing methods of haymaking are somewhat different from those most largely pursued in Scotland. As a body, Scotch farmers are not so highly accomplished in the art of haymaking as are their English brethren. Less experience and less encouragement are mainly accountable for this. There is only a very small extent of Scotland really well suited for hay-culture, while in many parts of England the hay crop plays quite a leading part in the economy of the farm.

We have many a time observed and contemplated with delight the care, intelligence, and methodical precision exhibited on well-conducted English farms in the harvesting of hay. The practice would seem to be reduced almost to the nicety of a fine art, and it is conducted with the enterprise and forethought happily characteristic of British agriculture.

Meadow-hay.—The making of natural or meadow hay—hay grown from permanent grasses—is, as a rule, slightly different from the making of rotation or clover hay. The former abounds largely in England and Ireland. With this class of hay chiefly in view the late Mr James Howard, of Bedford, read an admirable paper on haymaking before the London Farmers' Club in 1886. In that paper Mr Howard gave much useful and reliable information, which, to a large extent, is applicable to all parts of the country.

Haymaking Machines.—The tedding or haymaking machines are largely used in England, and to a smaller extent in Scotland and Ireland. Types of these useful machines are represented in figs. 463, 464, and 465. The first two are popular English machines, made respectively by Howard, Bedford, and Jeffrey & Blackstone, Stamford. The last of the three is an ingenious Ameri-

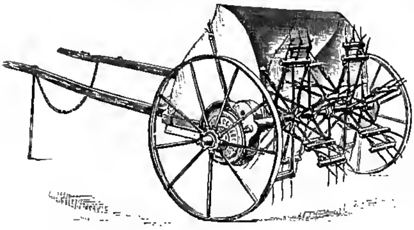


Fig. 463.—*Howard's haymaker.*

can invention, introduced into this country by Messrs Lankester & Co., London, and highly spoken of by British farmers for lightness and efficiency.

Tedding.—Opinions differ somewhat as to the tedding of hay. In favourable weather and with a good crop cut by the mower, most farmers set the tedder to work to scatter the swathes as soon as a few acres have been cut down. Others think it better to leave the swathes to wither for a day or two before being disturbed; but Mr Howard argued that if the forward action of the tedder were used for spreading, the greener the grass when tedded the better, inasmuch as less loss of leaf and seed takes place in the green stage than when partially made. Moreover, if the weather is favourable, time is lost by the delay, as

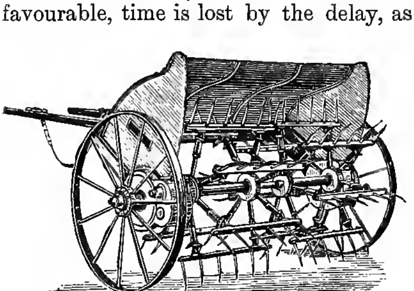


Fig. 464.—*The "Taunton" haymaker.*

the grass will be withered or dried more quickly and uniformly when spread than when it lies as left by the mower. Obviously grass which lies in a thick swathe gets withered and dried on the upper side, while the portions on the lower side remain fresh and damp.

On many farms the crop is immediately turned a second time by the haymaking machine, the back action being usually employed after the first turning.

Forward and Backward Tedding.—Tedders are made with both a forward and a backward action. By the first the grass is carried forward below the machine right over the top, and then scattered behind. In the backward action, the tedder merely picks up the grass and gives it a less or more vigorous "kick" backwards. The former movement is of course much more violent than the latter, and many farmers are opposed to it in the belief that the hay is thereby injured, seeds dashed out, and the leaves and stems bruised and broken.

Mr Howard believed that incalculable damage has been done to our hay crops

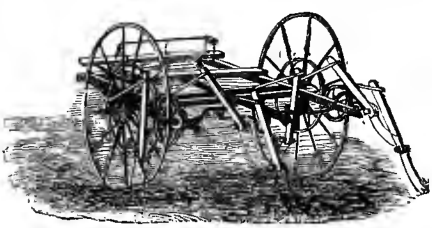


Fig. 465.—*The "Acme" haymaker.*

by the unjudicious use of the forward action of haymaking machines, and this under the impression that when in the back action the machine does not move the hay sufficiently. It is well known, however, that while fresh grass may be injured by too much knocking about, this is doubly true of half-made hay. Mr Howard would never resort to the forward action when the backward action would accomplish what is necessary. In no case could he conceive the necessity for using the forward action twice on the same crop.

Experiments in Tedding.—An important point in working the haymaking machine is the speed at which it revolves. In a series of experiments which Mr Howard made, he found that the barrels with the slowest speed for the back action made the best work, the crop being left looser and more hollow; the higher-speeded machines, owing to the greater violence of the throw, left the crop flatter on the ground.

Speedy Haymaking.—With a light crop the back action will be quite sufficient for spreading the swathes. Indeed, Mr Howard stated that, in favourable weather, he had crops of a ton or more per acre, cut by a machine one day, the swathes left untouched until the next, when they were simply drawn into windrows by the horse-rake, shaken out by the haymaker in the back action, then raked together, and carted in capital order the same day.

Tedding with High Wind.—High wind may be troublesome in haymaking. During a strong wind it is desirable to arrange for working the haymaker, when used in the forward action, sidewise to the wind; this may often be done by working obliquely across the swathes. It is, however, desirable to avoid using the forward action when the wind is troublesome, inasmuch as the crop becomes very unevenly spread.

Tedders injuring Clover-hay.—Hay in which clover forms a considerable part is very liable to injury by the use of the haymaking machines. The leaves of the clover become so brittle that the violent motion of the tedder breaks them in pieces, and thus causes loss in the crop. Easy back action may be employed in fresh clover-hay with impunity, if it is done carefully and at a slow pace. Turning with the hand-fork, however, is safer for clover-hay.

Collecting Hay.—In collecting the hay after it has been scattered for drying, manual labour has to a large extent given place to horse-labour and mechanical appliances. The horse-rake is an excellent labour-saving machine, and is now universally employed. By it the partially withered grass is drawn into "windrows." The rake is started at the side of the field first cut, and emptied at intervals, regulated according to the carrying capacity of the rake and the weight of the crop. The rows of gathered hay thus formed are called windrows. In these rows the hay lies loosely, and in this condition, with favourable weather, it dries speedily.

Unless the weather is dry and quite settled, no more hay should be gathered into windrows than can be cocked in the same day. As will be readily understood, a fall of rain upon the windrows would cause more delay than a similar fall of rain upon hay in the swathe or thinly spread as by the tedder, for in this case the windrows would again have to be "spread out to dry." In dry, settled weather more freedom may, of course, be exercised in these all-important operations.

"Cocking" Hay.—As soon as the hay is in a fit condition for putting into cocks, the horse-rake is run along the windrows, drawing the material into heaps, which by the hand-fork are speedily formed into cocks.

The practice in the cocking of hay varies greatly in different parts of the country, and is likewise modified to suit the weather at the time.

Large and Small "Cocks."—In the greater part of England, the half-made hay is usually collected into very small cocks, often containing no more hay than a man could lift by the hand-fork at two or three turns, sometimes even less. In Scotland, Ireland, and the north of England the more general practice is first to put the hay into very small and then into larger heaps. In discussing the merits of large and small cocks or coils, the late Mr James Howard said that in a damp climate, or in cases where the hay has to be carted a long distance to the homestead, these big cocks may be desirable; but for districts similar to Bedford, or where expedition is the order of the day, he failed to see any advantage in the method. "That it is attended with waste, through long exposure of so large a surface, seems to be obvious; nevertheless, reasons in favour of the system for moist climates are advanced for those who adopt it. For instance, in the north it is alleged that turnip-hoeing and haymaking press for attention at the same time; that as the whole of the hay crop intended to be put in a stack cannot be got ready in one day, it is safer and more convenient to draw into large heaps that portion which *is* ready, in order to secure it against danger until the remainder of the crop is also fit, and in order that as much expedition as possible may be used in finishing the stack when once begun. It is also maintained, that if these large cocks are properly formed, an excessive amount of rain must fall to penetrate more than an inch or two; that the loss from exposure is not discernible, and that the liability to heat in the stack is considerably diminished through the sweating the hay has received in the cock."

Differences in Methods.—Although it is convenient to treat of English and Scotch customs separately, it should be stated that no very distinct line can be drawn between the practices of the two countries. On each side of the Tweed nearly all the methods of haymaking known in this country are pursued to a lesser or greater extent. Certain methods are more prevalent in the north than in the south, but the differences lie in degree more than in principle.

The hay made from permanent grasses can be tossed about with greater freedom than clover-hay. The former is thus, by the use of the tedding-machine, effectually spread out to the drying influences of sun and wind, so that it can usually be stacked sooner than is, as a rule, possible with the rotation hay in the more precarious climate of the north.

The English custom of taking the hay right from the first small cock or coil into large stacks or hay-sheds has the effect of saving time, and of inducing amongst the hay in the stack or hay-shed a certain amount of fermentation, which is regarded as rendering the hay more palatable to stock.

Scotch Methods.

In Scotland and the north of England first year's hay—that grown from grasses and clovers sown in the previous year—is the variety most general. Hay of this kind, especially when it contains a considerable proportion of clover, must be handled more tenderly in making than hay from permanent grasses, as the former is more liable to injury by breaking and bruising. This circumstance is in a large measure responsible for the distinctions between the methods of haymaking most prevalent in England and Scotland respectively.

Rotation Hay.—A light crop of ryegrass and clover, if cut before mid-day in clear dry weather, may be in condition to "coil" or "cock" by the afternoon of the day following. A heavy crop, however, even in good weather, will require a clear day between cutting and coiling; while an extra heavy crop, or one including a large amount of clover, will most likely require two clear days. If the weather be dull, damp, or wet, the process of coiling may be of necessity delayed an indefinite time.

Turning Clover-hay.—It has been explained that the turning of the swathes of hay grown from permanent grasses is usually performed by the haymaking or tedding machine. Rotation or clover hay, on the other hand, is generally turned by a small hand-rake or by the hand-fork, such as is shown in fig. 466 (Spear and Jackson, Sheffield). The reason for this difference in practice is, as already explained, that the rotation or clover hay is more easily bruised and broken than the softer and tougher produce of the permanent grasses.

Fig. 466.—*Hand hay-fork.*

Process of Turning.—In the forenoon of the day on which it is considered that the grass should be ready to coil, the swathes should be turned over by rakes, so as to expose the under surface to the sun, and allow the wind to easily play through the whole mass. This it cannot do if allowed to lie one or more days in the condition in which it was left by the mower, as the longer it lies it claps the closer to the ground, and although the upper surface may be hard and dry, the underlying stalks and leaves will be wet and damp.

The turning-over process should, if at all practicable, be done early in the forenoon, so that as long time may elapse as possible between the turning and coiling, without allowing it to lie exposed to the dews of another evening, and the risk of rain on the day following.

The operation of turning is best performed by the person walking in the cleared space left by the mower on the side of the swathe furthest from the turned-over part, and then by catching the folded-over part of the swathe with the teeth of the fork or hand-rake, and sharply pulling it towards him, the whole under surface is brought to the top. The work is more easily performed when the operator walks in the same direction in which the mowing-machine went. Several persons generally go together when turning-over is being done, the one following at a yard or two behind the other.

Care should be taken to turn the whole swathe upside-down, because if the work is slovenly done, the near side of the swathe will not be turned over at all, and, of course, when the hay is gathered together, those parts may in that case be quite damp, while the bulk of the hay may be in good condition.

Fit for Coiling.—If after mid-day the grass is withered and free of all positive damp or wet, even although it should have a raw feel, it will be in condition for coiling. Should the crop have lain on the ground for several days, and there be damp or wet parts in it which have not been exposed to the sun and air, it is a good plan to rake it together an hour or two before coiling begins. By doing so the rake on being relieved turns the hay upside-down, so that any damp parts are exposed to the sun, and have a chance of getting dried before being covered up in the coil.

Again, it may be remarked, that so much depends on the crop, season, and weather that it is utterly impossible for any one to properly describe what are the requisite conditions of dryness suitable for coiling. It is not difficult to learn, but can only be learned by practice and experience.

Collecting the Hay.—It having been considered that the requisite dryness has been obtained, the crop may be gathered together by the horse-rake, preparatory to coiling. The best rakes are the self-relieving ones, as the man can then devote all his attention to his horse and machine, and put off the rows more nearly straight and regular. By raking across the rows, as left by the hand-rakes, a small or "grown-in" crop of hay may be more cleanly gathered, but under most circumstances raking with the rows is speedier.

Arranging the Force.— According to the thickness of the crop, the length of the swathe, and the speed at which the horse travels, from four to eight coilers will be required for each rake. Some farmers allow the rake to be started some time before the coilers begin; the latter then take a row each, which they finish before they begin with another. Most farmers, however, consider the best system is to start the rake and coilers at the same time, each coiler getting the same number of rows to coil. By this arrangement, if the number of coilers be properly regulated, according to the weight of the crop, and speed and width of the rake, each person will do more work than where each begins at the one end of a row and follows it right on to the other end.

By beginning with the rake, each person gets a direct reminder, every time the rake goes past, whether or not he or she is keeping abreast or falling behind with his or her work. This manner of doing the work necessarily entails more travelling than the other; but the relief obtained in travelling from one row to the next more than makes up for the time lost in doing it, and in the end more work will be done in a given time than by the other arrangement, which is often a matter of very great importance.

Coils or Cocks.—Coils or cocks are small conical heaps of half-dried hay, put together of such a size and shape as to admit of the hay continuing the drying process, and yet preserving it from serious deterioration by rainfall. According to the class of crop, the climate, and dryness of the hay at the time, coils range in size from a foot in diameter and a foot high to 3 feet in diameter and 3 feet high.

On the hillsides and higher-lying farms, where the principal hay grown is obtained from water and other meadows, the coils are at first made very small, often from a foot to 18 inches in diameter. In such situations the grass is, as a rule, naturally soft, the climate is often wet, and the season frequently late.

Hollow Coils.—Under such adverse circumstances, in a trying season the coils are occasionally made hollow instead of solid, so that the wind easily plays through them, while the rain at the same time is thrown off. This class of coil is generally called a lap-coil or lap-cock, and is made in the following manner: A moderately sized armful of hay, as straight as possible, is taken, and if not naturally straight it is partially made so by putting the foot on the one end and then on the other, and pulling out the loose and tangled grass. The armful is then put down in such a position that the ends lying on the left arm lie flat on the ground. With the right hand the other ends of the bundle are brought over and laid on those first put on the ground, the bundle having now the appearance of a rough tube or globe of hay with a hole through it. In this form the grass very readily dries, and is not easily soaked through. The process is by no means so slow as might at first be imagined. Indeed, several of these hollow coils might be made during the time it has taken to describe the operation.

This class of coiling was much more common when grass was cut by the scythe than now, the mowing-machine and hay-tedder putting the practice out of date.

Forming Coils.—Ordinary coils, as a rule, are about 3 feet in diameter, and when newly erected a little more in height. Many contend that they are best made by the hands, unassisted by graips or forks. An armful of hay is taken as left by the horse-rake, and roughly shaken and allowed to drop on itself as regularly as possible. A second armful is then put on the first, being, however, a little more carefully shaken or spread, and kept within as little space as possible, so as to leave the top narrow. A third and smaller armful should now be taken and, more carefully than the previous two, shaken over the top. The coil will now present the appearance of a blunt-pointed cone widened at the base.

Pulling and Topping Coils.—The base is now narrowed by pulling all the loose hay out and spreading it carefully over the top. In pulling the coil, the person advances with outstretched arms, and, bringing the hands together, takes hold of the loose ends of the hay projecting from one-third to one-fourth of the coil. This, when caught hold of, is suddenly jerked out, because if pulled slowly and steadily the coil might be drawn over. This handful of hay, when pulled out, is comparatively straight, and when spread over the top of the coil, assists very materially in throwing off wet. The whole base of the coil is gone round in this way, generally three or four stretches of the arms being necessary. The handfuls of straight hay are carefully spread on the top, each in a contrary direction to the one previous.

Well-made Coils.—The protection of the hay from damage by rain in the coil very much depends on the carefulness with which the bottoms or bases are pulled, and how the pullings are spread on the top. The operation is comparatively simple, yet many farm-hands do it very badly; and while a properly-made coil is proof against any moderate rainfall, a badly-made one may be much damaged by a single heavy shower.

Badly-made Coils.—The great faults of badly-made coils are portions of the hay being put into the heap in a doubled-up condition, which holds the rain instead of throwing it off; the one armful being put on the top of the other without being properly shaken out, which allows the rain to go down the division between the two, and admits of the top half being easily blown off; and neglect of pulling the bases, causes the loose hay round the bottom to easily get wet, and when once wet it is difficult to dry—a well-pulled coil drying at the base in half the time required by a badly-pulled one. Neglect of pulling at the base also leaves the top of the coil unprotected, for the straight hay carefully spread over the top acts very much as thatch to an ordinary stack. It leads the rain from the top to the side, down which it readily flows, while without it the rain would run right down the centre of the coil.

Fork-made Coils.—In most parts coiling is now done by forks or light graips. Few can make such a perfect coil with these tools as by the hand, although for a strong man they make the work much easier as well as speedier. If rain-proof coils are desired to be made where coiling is done by the fork, greater care than usual should be exercised in pulling the base of the coils, and in spreading it regularly over the tops.

Small Coils.—If the hay is not in thorough condition for coiling, and the weather looks as if rain were about to fall, the crop may be secured in smaller coils than usual, which will act as a partial protection against the rain, and yet be small enough to allow the wind to blow through them, and in part complete the drying.

Remaking Coils.—As soon as the weather has become bright again, the coils should be remade; and if the crop is now in moderately dry condition, two heaps may be put into one. Should the crop have been put together too green, the coils may be shaken out in the sun a few hours before being remade; but on no account should coils be shaken out to any great extent, unless the weather is such as to give a reasonable assurance of their being rebuilt before rain again falls.

Avoid Over-working.—At this stage it may be mentioned that rye-grasses and clovers are rarely improved by much shaking out and remaking. Hay from these plants, indeed, as formerly indicated, should always be secured with as little knocking about as possible.

Timothy-hay.—Timothy, like natural meadow-hay, will stand a good deal of shaking. Timothy is the easiest secured of all the grasses, owing to the small proportion of leaves which it contains, and the length and strength of its seed-stalks. A heavy crop of timothy can often be cut the one forenoon and coiled the afternoon of the day following, whereas a similarly heavy crop of rye-grass and clover would require two or three days to get ready for coiling. The great preponderance of stalks which this crop contains over all others keeps it so open, that, in the coil, it dries much quicker and more efficiently than any other grass. Owing to the length of the stalk, timothy coils have generally to be made much larger than coils of other classes of hay. But its openness in texture, although an advantage in drying, is also a disadvantage in case of heavy rains. On account of its exceptional length and strength, timothy is probably the worst to coil of all the grasses, and in consequence it often is the worst coiled, the result being that heavy rains damage the crop very badly by running down through it.

Thunderstorms and Haymaking.—Coils, although a fair protection against moderate showers, are often little protection against heavy thunderstorms. Where thunderstorms are frequent and heavy, the system is therefore little resorted to for open crops such as clover.

Securing Wet Coils. — During a heavy thunder-shower, or light continuous rain for one or more days, as occasionally happens, the rain often runs under the coils, and so wets them that only in exceptional cases could they ever be expected to dry if allowed to remain in their original position. After such rains the probability is that in a few days it will be found that, while the very top of the coil is dry enough, three or four inches further down it is quite wet. If the weather is settled, and the centre of the coil is sufficiently dry to enable it to be put into the field-rick, or tramp coil or cock, the tops (which will likely be damp with the morning dew) may be taken off and laid to one side, while the body of the coil is taken away and secured in the rick, the bottoms also being left alongside the tops. These, if carefully spread out in the sun for an hour or two, very soon dry, and can ultimately be gathered up with the rakings.

If, however, the body of the coil is not dry enough to admit of being secured in the field-rick, the top should be taken off to well under the damp portion, and a new coil made, the tops and bottoms being loosely spread over the top. In this way the damp material very soon dries, unless the quantity of it has been all the greater, while at the same time the operation can be performed without exposing the crop to further damage from the elements.

Hours for Coiling.—As a rule, the dew prevents coiling early in the morning. In most cases coiling is done between eleven o'clock in the forenoon and evening, the bulk being done after midday.

Raking.—As soon as possible after the coiling is finished, the land should be raked clean between the rows of the coils, before it gets any rain if at all possible. These rakings are in some cases carefully spread over the tops of the nearest coils, and in others coiled by themselves. The rakings become soaked very easily, and if once wet are very difficult to dry, more particularly if they have been put on the top of the coil without being methodically shaken out. Great care should therefore be taken to see that only a few are put on each coil —if put there at all—and that these are thoroughly shaken out.

Coiling in High Wind.—If a good breeze should be blowing during the operation of coiling, considerable annoyance is often caused by the tops being carried off. Under such circumstances, the hay should be built well to the windy side of the coil, the operator always standing on that side, with his or her back to the wind. In this manner the coils can be built so that they are less liable to be blown over. After the field or plot is finished, the whole should be again gone over, and the damaged ones repaired, as when rain falls on them in this state they are liable to be seriously injured.

Time for Field-ricking.—The time hay should stand in the coil before being transferred to the field-rick is regulated solely by the dryness of the crop and the weather at the time. Where the crop is light, and has been well dried before being put into the coil, it occasionally may be ricked the day following, should circumstances and the weather permit. In fact, during very dry and settled weather it often is not coiled at all, although in most parts of Scotland, unless under exceptional circumstances, the practice is not considered a good one.

The stage at which the crop will keep in the rick without loss of colour or excess of fermentation is one which must be seen to be learned, as it cannot be described in words. When, however, the hay is considered in condition to rick, no time should be lost in making it secure if the weather is at all favourable, for hay can never be considered anything like secure until it is in the field-rick.

Field or Temporary Stacks.—In districts where it is customary to sell hay and cart it direct from the field to the consumers' premises, the ricks are usually made about one ton in weight, more as a matter of convenience for loading the carts than for any other reason. In other districts, however (and they are the most numerous), where the hay is consumed at home, the field-ricks are generally made to weigh from 10 cwt. to 15 cwt. If put into the smaller size of field-ricks, there is much less risk of damaging the hay by ricking it too soon. As a rule, hay can safely be put into a 12-cwt. or 14-cwt. rick a day or two earlier than it would be judicious to put it into one weighing a ton. This alone is no mean consideration, for every additional hour the hay stands in the coils, the greater will be its risk of damage.

Rick "Kilns" or "Bosses."—For the purpose of saving one or two days' exposure in the coil, it is customary in some districts to use triangles, "kilns," or "bossings" for the centres of the ricks. According to the district, these are usually from 7 to 10 feet high, and are made of thinnings of plantations or other suitable wood. Some farmers have a supply of such permanently bolted together at the top and nailed by spars at the sides, while others form them as required out of the ordinary supply of stackyard props. In the latter case they are usually tied at the top with a piece of stack-rope, which is made very tight, no side-spars being used at all. Used in this way, stack-props serve a double purpose, and as single props they are more easily handled and stored away when not in use than are permanently made triangles. The labour of setting temporary triangles up is also very little, as a man can tie the three props together and set them up in a minute or two; and if there is likely to be little time for such while ricking is going on, they can often be made and erected in the morning before the dew is off the hay. Still the permanent "kilns" are in some respects more convenient.

Situation of Ricks.—In some localities it is the custom to build the ricks anywhere over the field, wherever hay can be got, while in others the usual method is to build a row of ricks across the rows of coils. If the rows of coils are short, say under 150 yards long, the ricks are built at the middle, and the crop brought in from both sides. If, however, the rows are longer, two or more rows of ricks may be required.

Hay-sledge.—For the purpose of hauling the hay from each end of the row to the rick, several methods are in common use. The best known and most efficient method is the hay-sledge. This sledge has two runners, which are usually straight or nearly so on the upper edge, and more or less curved on the under one. Across these are fixed four cross-bars, on which are nailed thin boards running the whole length of the sledge, which may either be fitted closely together or have spaces between each strip. The sledges may in size be from 7 feet to 9 feet wide, and say from 8 to 11 feet long. They are inconvenient if made wider than can easily pass through an ordinary field-gate. For the smaller sizes one horse will be sufficient to draw all that can conveniently be put on, while for the larger sizes two horses will be required.

In working, the sledge goes to the end of the row furthest from where the rick is to be, the coils being loaded on it as it moves nearer the rick. If the crop is light and the rows short, the whole row between the end and the rick will be cleared by one sledgeful. If longer and heavier, two loads may be required.

Loading the Sledge.—One person, usually a boy, will be required to lead the horse in the sledge, while one, two, or more boys, women, or men lift on the coils with light steel graips or forks, the former being preferable, as by the graip or spade handle the workman prevents the load from turning round in his hand, an accident which is frequently happening with the ordinary fork. Two persons, particularly women or boys, work best together, as they have then quite sufficient strength to lift between them a full coil each time. In this way fewer rakings are left, the hay is not unnecessarily tossed about, and is in consequence easier forked at the rick, while more can be put on the sledge than if each coil has been lifted at two or three times.

Unloading the Sledge.—On arriving at the rick, two or more persons put their forks into the front part of the load, against which they throw their whole weight, when the lad moves forward the horse, thus pulling the sledge out from under the load. If the sun is bright and the hay dry, the load of hay is shoved off with very little exertion. In fact, in going up even a very slight incline the load may sometimes come off of its own accord; but if the sledge has been wetted by rain or dew, or by dampness from the bottoms of the coils, it is sometimes very difficult to get it removed.

Other Methods of Hauling.—Besides the method of bringing in the hay by the sledge here described, there are several other ways in which the same operation is performed. The most primitive is to carry it in by forks, or as occasionally has to be done on very soft meadows, by thrusting two poles under each coil and then carrying it off by two persons, after the manner of a double-handed barrow. This system is of course adopted only where the land is too soft to safely carry a horse, or where wages are very small.

Another method is to join the chains from two horses by a pair of stout ropes, travel a horse along each side of a row of coils, catch the coils by the rope connecting the horses, and sweep all that can be caught into the rick.

American Method.—The Americans have invented a machine to attain the same result in an easier way for both man and horses, and with less damage to the hay. This machine is about 12 feet wide, and rests on three light wheels, one on each side and another a few feet behind. To the under side of the framing of the machine twelve teeth 5 feet long are bolted. These teeth are of wood and pointed with iron, and are fixed about a foot above the ground. The driver, sitting on a seat above the hind wheel, can raise or lower the points of the teeth, whether loaded or unloaded, until they are a foot above the ground. On the outside of the apparatus, at each side of the teeth, a pole is placed, outside of each of which a horse is yoked to a plough-tree at one end of the pole and by a breast-strap or chain at the other. The points of the teeth being lowered in front of a windrow of loose hay or coils, and the horses guided down each side, the teeth slip under the hay until a load is gathered, when the driver lifts the points of the teeth from the ground, turns round his horses if need be, and carries off his load to the rick. Here he drops the teeth of the apparatus on the ground, backs his team, when the breast-straps of the horses pull the apparatus from under the load of hay, the points of the teeth are again raised, and the team move off for another load.

This apparatus is called a "Monarch Sweep" rake, is very light, being built almost entirely of wood, and very strong. It is said to be able to gather and carry from 4 cwt. to 7 cwt. of hay; but as yet its adaptability to this country has not been thoroughly tested.

In 1889, Mr John Speir, Newton Farm, Glasgow, procured a "Monarch Sweep" rake, but unfortunately it arrived too late for trial in the ordinary hay crop that season. In the month of September a trial was made with some hay made from a second crop of Italian rye-grass; but either owing to the softness and dampness of the hay or some other unnoticed cause, the hay did not slip well up the teeth. Before trial it was expected that some boarding would require to be put up at the back of the machine to keep the hay from running over the top of it; but the difficulties experienced were all the other way, as the hay repeatedly stuck on the points of the teeth and would not slip up, after which the rake slipped over the top of the crop. It is hoped, however, that with ordinary hay in an average season, this defect may yet be avoided. Thousands of this giant rake are said to be in use in America, where they have a species of horse-fork which lifts the whole load at one time on to a waggon or stack, without being touched by hand at all.

Preparing for Stacking.—If there is any dampness worth speaking of on the bottom of the coils, they should be turned upside-down an hour or so before ricking is commenced. In turning them over, they should be turned so that the bottom faces the sun, and if the day is cloudy, the bottom should be turned to the wind. As it is never advisable, even in good weather, to turn up a great many coils at one time, no more should be done than will just allow them to dry before being removed, an odd person going in front turning the coils over at or about the same speed as the crop is being ricked.

It often happens that mere turning of the coils upside-down is not sufficient to make the crop dry enough for ricking. In this case the rows of coils must be thoroughly shaken out, the space occupied by the spread hay depending very much on whether or not the crop requires much or little drying.

If the day is dull, or the crop more than usually damp, the coils not only require to be shaken out, but to be turned over with rakes or forks, in much the same way as the swathes are turned upside-down, before it is brought into the rick. Soft grown meadow-hay often requires to be treated in this way, although it is very unusual to do so with timothy or clover and rye-grass. Where hay has been thus spread out, it should be gathered into narrower rows by hand rakes or forks, or by the horse-rake, before beginning to rick, as the time thus spent is saved when ricking is begun, while the crop is drying all the time. If one or more persons can be spared to collect the scattered hay, this may be done as the ricking proceeds.

Ground for Ricks.—For the row of ricks, as dry and level a portion of the field should be chosen as possible. If the foundation be damp, the hay in the bottom of the rick is often considerably damaged, and if the land is not level, it is difficult to build the rick so that it will not ultimately lean over to the low side.

Owing to soft places being in many meadows, it is also advisable to see that the ricks are placed in such a position that no difficulty will be experienced in getting the load out of the field. The position of the gates and water-courses must also be considered in selecting the positions of the ricks. These different obstacles, in the case of water meadows particularly, often necessitate departure from the rule already laid down as to building the ricks in a line across the rows of coils, and an equal distance from either end.

Work with the Wind.—Unless there is some reason for doing otherwise, a beginning with ricking should always be made at that side of the field from which the wind is blowing, as what is left after each rick is completed, and the rakings and dressings from it, can much more easily be conveyed to the next rick, when going with the wind, than when they have to be taken against it. Again, by this plan, hay which blows off the ricks in course of being built is carried towards the next rick, whereas if building were continued in the opposite direction, the wind would always be blowing the loose hay on ground which had quite recently been raked, thus causing unnecessary work.

Foundation for Ricks.—The position of the ricks and the direction in which they are to be built having been fixed on, and a sledge-load of hay having been deposited, the building of the rick should now commence. In districts in which wheat-straw is comparatively plentiful, it is a good plan to place a couple of sheaves below each rick, as it prevents the natural dampness of the soil from injuring the lowest layers of hay. If tied up carefully and put into stooks when the hay is removed, the wheat-straw is not much the worse, and the labour caused is not very great. If the two sheaves are laid on the rick foundation with their heads touching, and each then spread regularly round in half a circle, with the band under, the whole may very easily and tidily be gathered again when the rick has been removed.

Building Field-ricks.—The straw bottom having been laid, the triangle should be erected, if one is to be used, after which forkfuls of hay should be laid round what is intended to be the bottom of the rick. This completed, the centre should be well filled in to a higher level than the first laid outside ring. Another row of forkfuls is now laid on round the outside, and the centre filled up as before. The forker should always drop his load as near as possible to where the builder is working, and the latter should lift it in his arms all in a piece, and, before placing it in position, give it a swing, so as to throw the ends of the hay well out, by which means, when the armful has been placed in position, none of the hay shall be doubled up, but all the ends, at least near the outside of the rick, pointing outwards. It is a more troublesome, but a preferable plan to thoroughly disentangle the hay and scatter the forkfuls thinly over the rick.

In this manner the building is continued, care being taken to always keep the centre well filled, because, should such not be attended to, the water, as it trickles down the sides during rain, would be conveyed into the centre of the rick, instead of being always kept to the outside.

As soon as a few courses have been built, the rick should be tightly pulled at the very base, either by some one there for that special purpose or by the forker. As a rule, there are always one or more persons, generally women, to rake up the leavings of each rick; these persons suit very well for pulling the base, as building then goes on uninterruptedly. When the base has been pulled, this person may also pull off any loose hay which is hanging round the side, and probably give it a stroke down with the rake also.

Little taper should be given to the rick until four-fifths or five-sixths of the whole quantity intended to be put in the rick have been built. The rick may now be rapidly tapered, the forker or some other handy person in the meantime roughly smoothing down the rick with a rake. The rake should now be given to the builder, who, during the operation of building the head, should keep constantly raking it down, by catching the rake by the end of the handle and shoving it from him. As the apex is reached, he should watch and put the hay only under his feet, and not at the sides, so as to have the centre as high and firm as possible. The top having been reached, two ropes of hay, straw, or coir-yarn are thrown over the top, the one at right angles to the other, the ends of each being firmly fastened to the hay at the base of the rick. The builder now gently slides down, or is assisted down by a small ladder, after which he carefully rakes the rick down all round, being most particular about raking off, or pulling out by hand, any portions of hay which are hanging out, doubled, or bent, so that no obstacles shall be put in the way of the rain running easily and quickly off. While the builder is doing so, the forker should be erecting another triangle, or making a new bottom.

Where two men work together, they generally fork and build alternately; but in some districts, more particularly where ricks of from 8 cwt. to 12 cwt. are built, it is the custom for the ricks to be built by women or boys, the forking of course being done by men, as it is too heavy work for either of the former.

In some cases, where the hay is not in good condition, the ricks are built without any one being on them—all the hay being placed in position by forks alone. To build ricks in this manner, two men working together make better work than where each works alone.

In early and dry localities the field-ricks, as a rule, are made much wider in proportion to their height than in higher and later districts. In the latter it is difficult to get the crop dry enough to keep well even in a narrow and very high rick. The shapes of ricks, like many other points in haymaking, vary in different localities.

Haymaking by Stages.

Whenever the first portion of hay has been secured in the rick, an opportunity is offered, if the weather is favourable, for advancing one stage further the different sections of the remaining work. To prevent hay being any longer exposed to the elements than is necessary, only as much should be in each stage as the available force of the farm can advance a stage further in a full day's work. Thus, if the weather were moderately favourable, and the crop from its nature could in the most of cases be coiled after exposure to the sun for from two to two and a half days, we would have the hay cut, say, on Monday, lying undisturbed in the swathe on Tuesday, turned on Wednesday morning as soon as the dew disappears, and coiled during the afternoon. On Wednesday night there would thus be a portion of the crop in three different stages of manufacture—viz., one portion cut that day, another partially dried which had been cut the day before, and a third in coil.

Unless the hay has been in all the better condition when coiled, it is rarely it can be put into the rick without standing at least one day and a half; and if the weather is dull or showery, it is quite uncertain how long it may have to stand.

Presuming, however, for the sake of illustration, that the weather has been favourable, this section of the hay crop which was coiled on Wednesday afternoon might be put into the rick on Friday afternoon or Saturday forenoon.

In the meantime an equal area should be cut and another coiled each day, and on Friday afternoon or Saturday three different sections will be advanced a stage—one will be cut, another coiled, and a third put in the rick; while of the other three remaining sections which have been cut during the week, and which are not touched to-day, one will be drying in the swathe, and two in the coil.

As soon as any one stage is ready to move on to the next, no time should be lost in advancing it, as every stage the crop is moved forward it is the more secure. In a wet day the crop is always less damaged in the coil than had the same crop been in the swathe; and in the rick it may, practically speaking, be considered safe, although absolutely not so, as isolated persons occasionally find to their cost.

When the ricking stage of the process of haymaking has been attained, no more should be cut than there is a reasonable prospect of getting coiled on an early date. It is well to have little more in coils than can reasonably be ricked in from two to three days, as should unsettled weather set in, the intervals during which hay can be handled are often so brief, that where a small piece can be easily secured, a large area may be completed spoiled.

Look to the Stacks.—On damp days or dull mornings all ricks, as soon as they have stood one or two days, should be examined, and those in any way inclined to lean to one side straightened up, and the ropes of all tightened. During the first day or two occasional ricks are apt to tumble, particularly if carelessly or hurriedly built, or if the hay has been in good condition and the sun strong when they were being built—narrow or very high ricks being, of course, the most liable to fall. Where at all possible, these should be put up at once, as they often get badly spoiled by a night's rain. If the top has been blown clean off, the damage to a well-hearted rick may not be great; but if the half of the rick tumbles over, the layers of the hay remain on edge, and if heavy rain falls on it in this position, it very often runs through it to the very bottom. Such hay should be shaken out in the first suitable day, and dried before being rebuilt.

PERMANENT STACKING.

Again it is impossible to fully describe in words the conditions which qualify hay for removal from the field-rick to the larger rick. It must be seen and handled to be learned, for without both seeing and handling, it cannot be taught. So much depends on the original crop, the state in which it has been harvested, the weather for the time being, the size of the field-rick, and the size of the large rick, that any fixed rules likely to be suitable for one set of circumstances may be quite unsuitable when applied to others.

If from 10 to 12 cwt. field-ricks have been built, and the hay has been put up in moderate condition, the weather has not been more adverse than usual, and the large ricks are not over 6 tons, stacking may often begin in about a fortnight after ricking; but if the field-ricks have been larger, say, up to a ton or over, and the hay-stack is intended to contain from 10 to 15 tons of hay or more, the stacking can rarely be safely begun in less than three weeks, even with favourable circumstances.

Premature Stacking.—Hay stacked in too green a stage readily heats, occasionally moulds, and in many cases it loses its aromatic flavour and green colour, getting changed to a light-brown colour, with a musty sickening smell. The aromatic smell of hay may be preserved even where much heating occurs (as under the English system of haymaking), but in that case it must not have been stacked and dried in the field-rick—it must be taken direct from the coil or windrow. The same aromatic smell is often preserved in well-made silage under the heated or "sweet" silage process; but in this case it has a sweet flavour added to the original aromatic one. By many this flavour is supposed to be caused by sweet vernal grass; but well-made hay generally has it, although in many cases it may not contain a single blade of vernal.

Preserving partially dried Hay.—It appears, however, that hay may be put into the stack in a much damper condition than has generally been regarded as safe. During the summers of 1886, and three following years, Mr W. T. Haig, Dollarfield, Dollar, made some experiments in the preservation of hay, which are worthy of being recorded here. His hay, which was grown from a mixture of natural grasses, was cut and coiled in the usual way; but instead of building it in field-ricks to complete the drying process as formerly, he carted it directly from the coil to his Dutch barn, which is close at hand. There it was built in mows or divisions in the usual way, between each row of pillars, with this difference, however, that wires under heavy strain were put across each division whenever building was suspended for the day. The wires were put across every 15 feet of the length of the shed, with planks stretching from the one to the other, so as to equalise the pressure.

By means of this pressure from these wires, it was found that the partially dried hay could not only be excellently preserved, but that the pressure could be so regulated that fermentation could be kept in check, and that in consequence the green colour of good hay need not be destroyed. The wire pressure used was that known as Johnson's Silage Press, which has been found to satisfactorily do the work for which it is intended. See fig. 122, Divisional vol. ii. p. 314.

Preserving the Aroma.—It need not in this way surprise any one that partially dried hay can be preserved, when we remember that even green grass is preserved in a silo or silage stack. It will, however, surprise many to learn that by this method the original aroma and colour of the hay can be retained. The preservation of grass in a silo and half-dried hay in a stack appear to be attained by the very same means—viz., the exclusion of the oxygen of the air by subjecting the mass to pressure of any kind.

Improved Pressure.—Mr Haig's crop of 1887 was as well preserved in colour and aroma as the most fastidious could desire, but the crop of 1888 was scarcely so good. He believed this was mainly to be accounted for by insufficient pressure being used, owing to the great distance between the wires. In 1889, the top planks were done away with, extra wires and drums being substituted for them, just as in a silage stack. By this means the pressure is certain and can be depended on, which in the other case it could not. As a result of the change, the hay of 1889 was the best he had ever made.

Utility of the System.—By this system, a considerable portion of the risk incurred by hay while in the field is done away with; but whether or not the system is capable of being largely extended, remains yet to be proved. The labour of carting to the stack is greater than to the field-rick, while at the same time one handling is entirely saved. Whether or not this saving of one handling of the crop will be sufficient to compensate for the extra time taken up in carting the crop to the stack during the intervals of sunshine, experience alone can tell.

In view, however, of the recent improvements in rick-lifters and horse-forks, it is questionable if the gain is so much as it at first appears to be.

Early *v.* Late Stacking.—There is now a pretty general consensus of opinion to the effect that it is better to be on the early than the late side with the stacking—that is, that of the two evils of early and late stacking the latter is the greater. This was the view urged by the late Mr James Howard, who pointed out that "with the aid of an elevator, a stack which may get too warm may very readily be transferred from one side of the rickyard to the other, and thus cooled down."

Straw and Hay Mixed.—The practice of interspersing imperfectly dried hay with layers of dried straw is pursued with good results in some parts, chiefly in wet districts. There is a twofold advantage in this plan. The excess of moisture in the hay is absorbed by the straw, and the interchange is beneficial to both the hay and the straw. The former is thus prevented from injury by heating, while as food for stock the straw is rendered more juicy and palatable. The proportions of this mixture may be 1 ton of straw to from 3 to 6 tons of hay, according to the condition of the hay as to moisture.

This plan is often adopted with advantage in saving aftermath.

Hay-barns.

In some districts it is the custom to put the hay crop, in whole or in part, in

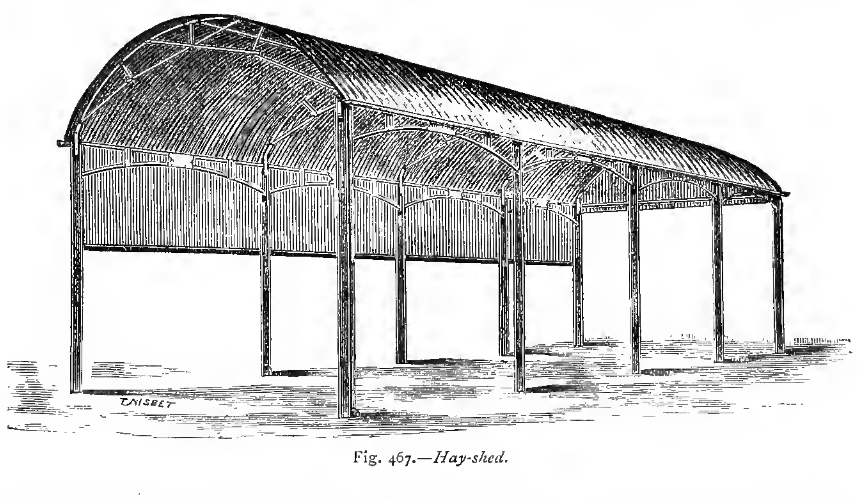


Fig. 467.—*Hay-shed.*

Dutch barns or sheds. These are usually buildings without sides, the roofs of which are supported on pillars, set wide enough apart to allow a cart loaded with hay to readily pass between them. Where the hay is to be used for the daily food of the stock of the farm, as it must be on the majority of farms, it is always advisable to have a considerable portion of the crop stored in sheds. For convenience, these sheds should be situated as close as possible to the byres, feeding-boxes, or other buildings in which the stock are kept. Stored in such buildings the crop is always accessible in all kinds of weather, and is safe from injury from storms. The floor of the shed should be raised a few inches above the surrounding surface, and if possible filled with some dry material such as furnace-cinders, small stones, or gravel; and before any hay is laid down the bottom should be covered with some old dry straw, fern, or other rubbish, failing which, rough boughs and branches of trees do well for keeping the hay off the damp ground.

The value of these hay-sheds, where large quantities of hay are grown, can hardly be overestimated. They have been provided very extensively in Ireland, where, upon medium and large holdings, the greater portion of the hay crop is preserved in this manner.

The hay-barns are now, as a rule, constructed entirely of iron, the roof consisting of sheet-iron, corrugated and galvanised. They are remarkably durable, and, in view of the great storing capacity afforded, the outlay is indeed very moderate. An excellent sample of the improved hay-barn (erected by A. and J. Main & Co., Glasgow, Dublin, and London) is represented in fig. 467.

Hay-stacks.

Where hay-sheds have not been provided, the hay may be stored in round or oblong ricks or stacks.

Foundation of Stacks.—A good, dry, level foundation for the hay-stack is a point of considerable importance. It is a good plan to have the ground upon which these stand permanently marked off by being raised a foot or so above the surrounding surface. In mining districts furnace-cinders are the best and cheapest material available for the bed of the hay-stack. Gravel and road-scrapings, or burned clay, are also suitable, and where neither of these can be easily obtained, the foundation may be raised by digging a small gutter round the base, and throwing the cleanings into the centre. Over this may be placed old pieces of wood, which, if covered with some old straw, prevent the hay from being spoiled to any appreciable extent. Branches of trees in the bottoms of stacks of grain are often objected to, on the score of their forming a harbour for vermin, such as mice or rats. These, however, rarely do any damage in a hay-stack, and tree branches are surpassed by few other materials as stack foundations.

Bosses or Flues.—In permanent as well as temporary stacks it is a good plan to have ' bosses," "kilns," or flues in the centre. Unless the hay has been thoroughly well made, this provision for internal ventilation will be advantageous. "Bosses" or "kilns" may be made of timber, as described on page 15. In many cases the flue is formed by building round a well-filled sack, and drawing it up as the stack rises. The late Mr James Howard deemed it prudent, unless very sure about the condition of the hay as to dryness, to have two flues made with the sack in this way, in the centre of each nine feet from the centre of the oblong stack. It is necessary, to prevent its being closed by the sinking of the stack, to have the flue perpendicular.

Size of Stacks.—On small farms, where the available power for forking is generally not over plentiful, round ricks of 12 feet in diameter will often be found large enough. If the hay is quite dry, it undoubtedly remains more palatable in a larger rick; but then the large rick entails extra labour and delay in forking. This is a drawback to building very large ricks on small farms which cannot well be avoided, at least if the forking is to be done by hand-power. Moreover, there are other disadvantages in large ricks, for although there is less waste by them in the sides and tops, and less thatching to be done, still, when the top is taken off, the space to be covered is very large, requiring tarpaulins of unusually large dimensions, which, owing to their extent and unwieldiness, are liable to be damaged by wind or rough handling.

The larger size of round ricks are usually made from 15 to 18 feet or even 20 feet in diameter, which, if of a corresponding height, are of twice or thrice the capacity of the smaller size of ricks, with a corresponding decrease in outside waste. In the spring and early summer, when small ricks get dried to their very centre, the hay-stalks become almost as brittle as dried twigs. Those of larger ricks retain almost their original proportion of moisture.

The oblong form of stack is very general in England. The dimensions vary in the main, in accordance with the extent of the holding, or rather with the area under hay. A common and convenient size is 10 to 12 yards long, and 5 to 6 yards wide, while in height stacks range from 8 to 16 feet—to the eaves when settled down.

It is a common practice in many parts of the country, in England especially, to increase the width or diameter of the stack as it rises in height. One advantage of this is that wet dropping from the eaves falls on the ground clear of the sides of the stack.

Force in Building Stacks.—The size of the rick having been arranged in accordance with the power at the farmer's command, a beginning may be made in building. To keep the builders and others at the rick constantly employed, at least two hay-waggons or carts with harvest frames must be employed. Hay-waggons are much to be preferred to carts. Being longer and lower they are much easier loaded. An excellent hay-waggon, made by the Bristol Waggon Works Company, is shown in fig. 468. Where the field is close to the stackyard, or other place of ricking the hay (it occasionally being ricked in the field in which it grows), one forker in the field will be able to keep both horses going, for while the one is loading the other is unloading. One builder will be required on the rick, who may have the assistance of three or four men, women, or boys to tramp or pack the hay, and throw it to him from the side on which the forker deposits it. Where another man can be spared, one should be put on to act as guide to the builder, who, while keeping the rick in proper shape as it is being built, also assists the carters to get their ropes unloosened, throws up any loose hay, and may or may not put on the top on one rick while the builder is making the bottom of another.

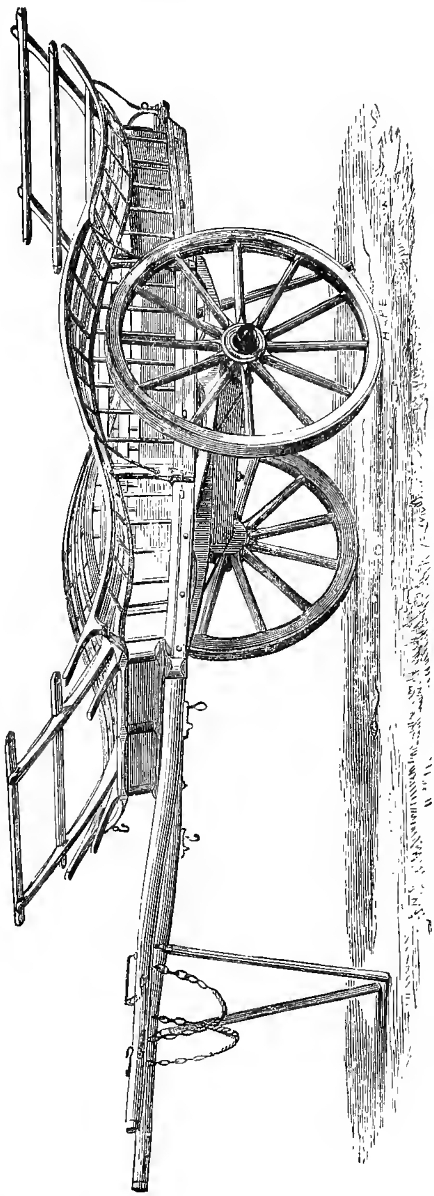


Fig. 468.—*Hay-waggon.*

High-forking by Hand.—When the rick gets too high for the forkers to be able to put up the hay, and no horse-fork is available, a forking-stage of some sort must be provided. The following simple plan is pursued in some parts. The extra man mounts a ladder set against the rick, and taking the loaded fork out of the hands of the carter, at as great a height as the latter can hand it to him, he is enabled to fork it several feet higher than can be done by the man on the cart.

To enable the second forker to get a good footing on the ladder, and yet to keep the latter as nearly straight up as possible, a stout plank about 8 or 9 inches wide and 4 feet or so long, should be thrust through the spars of the ladder, above the spar where the man is intended to stand. By lowering the end of the plank nearest the rick, thrusting it through until it meets the hay, and then putting downward pressure on the outward end, it is brought into an almost horizontal position, which is quite safe and easy to stand on. Standing on the plank, with his back to the ladder, a man can hoist an ordinary forkful of hay without any danger of falling.

If the plank is not used, the inclination of the ladder must be much flatter so as to allow the man to stand on it easily and safely, and, in this case, his weight against a rick of any moderate size would almost certainly cause it to lean to the opposite side.

The use of the horse-fork or elevator, to be noticed presently, obviates all this difficulty.

Process of Building.—In building the rick the hay is first regularly laid in fork-loads over the whole bottom, the builder then puts on a ring of forkfuls all round the outside, taking care to throw the ends of the hay well out. While he is doing so, his assistant may put in other forkfuls of hay behind those he lays down, so as to form an inner circle, the forkfuls of the inner circle lying partially on the outer one, and holding them in position. The second row being finished, the centre should now be filled level with the outside circle, and on no account should it be kept hollow. The second and third courses should always project well over the first, after which the others should only project a very little. By following this plan less has to be pulled off the base to make it firm.

The trampers scatter the forkfuls of hay evenly over the surface of the stack, and the more carefully and thoroughly this scattering is done, the more substantial and symmetrical will be the stack.

In this way the building continues until the eaves of the rick are reached, the person acting as guide all the while pulling off by his hand or the rake any hay which is loose or too far out. When the top is being formed, the person acting as guide will in all probability now require to go on the ladder and fork, as the top of the rick will be beyond the power of the carter to pitch the hay on to it.

Forking from Different Parts.—To prevent the rick leaning to one side, the forking should be done from as many positions as possible. By the continual dropping of the hay on one side, and the weight of the persons removing it always pressing down the hay at that place, the stack becomes more solid there than at the other side, with the result that when the rick settles down, no amount of propping will keep it from leaning over in the opposite direction.

Heading Stacks.—Before the top is begun to be formed, the whole outside ring should, as a rule, be made as level as possible. If the ground is slightly sloping (a position which should be chosen as seldom as possible), or if the forking has of necessity been all done from one side, then the eaves-ring on the opposite side should be left just a trifle higher than the other. In all other circumstances the eaves-ring should be level. The first ring of the top should be only slightly

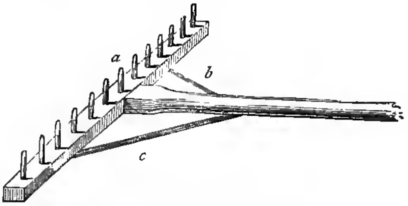


Fig. 469.—*Hay hand-rake.*
a Wooden teeth.
b c Iron stays.

drawn within the eaves-ring, the second a trifle more, and the third a little more still, after which the decrease in width should be regular. As soon as the third ring and hearting have been completed, the builder should go round the whole top with a rake (fig. 469), head downwards, and rake the head into proper shape. This done, the finishing of the top may be continued.

As the apex is approached, all should leave the top of the rick except the builder, who even alone will have barely room to stand. After laying on every couple of courses or so, he should carefully rake the roof. Towards the end the forker should be careful to put up only very small forkfuls, and at the finishing touches only mere handfuls. It is very desirable that this should be attended to, as in the building of a rick few things are more harassing or provoking to the builder than to have large forkfuls sent up, when there is not sufficient room for them.

The apex having been reached, the builder should carefully clear away any loose hay lying on the roof.

Roping Hay-stacks.—A couple of ropes should now be passed at right angles to each other over the top, and a half-brick hung to each end. Weights of any kind, hung to the end of the ropes, are much to be preferred to tying the end to the side of the rick. When the rick settles down, the tied rope becomes slack and does little good, whereas by the other method the strain on the rope is always the same.

Form of Stackhead.—When the heads of ricks are built as already described, the top should have the outline of an open umbrella: it should be flattest from the apex two-thirds down, and then more steep, because from the apex until half-way down the roof, the thatch has little more rain to carry off than falls on that particular part, whereas further down the thatch has not only the rain which falls on itself to convey, but likewise the rain that has fallen on the part above.

By making the roof of this form, another gain is obtained. There is much less hay, proportionately speaking, in the narrow part under the apex, and as this part is often more injured by drying than any other portion, the form recommended reduces the loss to the minimum.

Large Stacks.—The building of large ricks is, of course, very similar to that of smaller stacks. Where more forkers than one are employed in the field, of course more carters will be required, as well as more persons on the rick to receive it from them. As a rule, however, there is only one main builder, who puts on the outside courses, while there may or may not be another, who attends to the second or inside rings, while others spread and throw the hay across.

Building Oblong Stacks.—Oblong ricks or stacks are, as a rule, built in sections, in length usually from two to three times the breadth of the stack.

Propping Stacks.—In building either round or oblong stacks, particularly those small in diameter, short props should be put in whenever a height of 6 or 7 feet has been reached, and another set as soon as 10 or 12 feet is attained.

Height of Stacks.—The height of the haystack may be arranged to suit the taste and convenience of the farmer. It is contended by some that, as a rule, the eaves when built should be in height at least twice the diameter of the stack at the ground. Most farmers make their ricks much lower than this, because they are not possessed of sufficient power to put them higher; but when it is remembered that a high stack may contain twice as much hay as a low one, while the thatching is almost the same, the gain of having moderately high stacks will be obvious. This is more particularly the case when the extra height can be obtained at little or no extra cost, as where the horse-fork is in use.

Improved Hay-stacking Appliances.

Important improvements have lately been made in the vicinity of Glasgow in the methods of carting and stacking of hay.

Rick-lifters.—For several years prior to 1886, what are termed rick-lifters had been use in the uplands between Strathaven in Lanarkshire and Stewarton in Ayrshire—appliances for lifting ricks in the field and bringing them entire into the stackyard. These consist of a flat body, with shafts and tipping arrangements (similar to those in use on a tip-cart), mounted on two wheels 2 feet in diameter. Across the front of this low, broad, and flat cart is placed an iron roller, with lever and ratchet-wheel attached to one end. To the centre of this roller the ends of two stout ropes or light chains are attached, at the outer end of which are hooks for joining the one to the other.

When it is desired to put on a rick on this apparatus, the tipping arrangement is unlocked, the back end dropped on the ground, and the horse then backs it close into the rick. Meanwhile the attendant raises the hay forming the base of the rick from the ground, to permit of the edge getting better under it: the ropes are now unwound from the roller and passed round behind the rick, where they are joined and made firm, about 9 inches above the ground. The lever and ratchet are then brought into play, and the rope coiled on the roller. As the strain becomes greater on the roller, the edge of the rick-lifter is gradually pressed in under the rick. At about a foot or 18 inches under, it remains stationary, and as the attendant continues to wind in the rope, the rick is seen to move, and from that forward to glide gently up the incline until the front of the roller is reached, by which time the weight is generally heavy enough in front of the wheels to cause the body of the apparatus to drop down on the shafts, where it is locked.

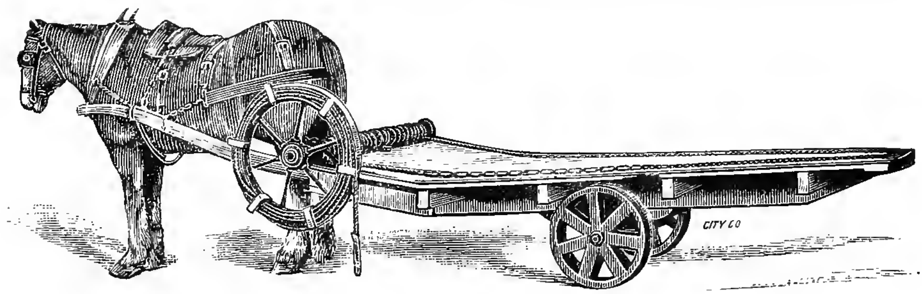


Fig. 470.—*Wallace's hay-sledge, empty.*

Rick-lifters made by John Wallace & Sons, Graham Square, Glasgow, and A. Pollock, Mauchline, Ayrshire, are shown in figs. 470, 471, 472, and 473.

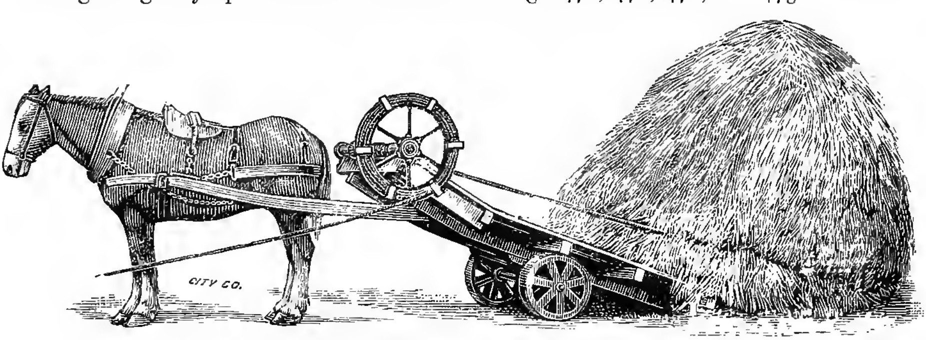


Fig. 471.—*Wallace's hay-sledge, in the act of loading.*

This apparatus, if carefully worked, generally lifts all the rick without any trouble, brings it to the stackyard in its original position, and there, by unlocking the tipping arrangement, drops it in its former upright position. With this apparatus the bottom of a stack could be much more easily built than by first building the hay on carts, because from five to seven minutes is all that is required to draw a field-rick on to the lifter.

Defect in the System.—When, however, the stack became so high that one man could with difficulty pitch the hay on to it from the ground, it was found that no advantage was gained, because two were required to fork in the stack-

Fig. 472.—*Wallace s hay-sledge, with loaa*

yard; whereas with carts, and one man in the field and the carter in the stack-yard, an equal height could be attained. For this reason, therefore, the original

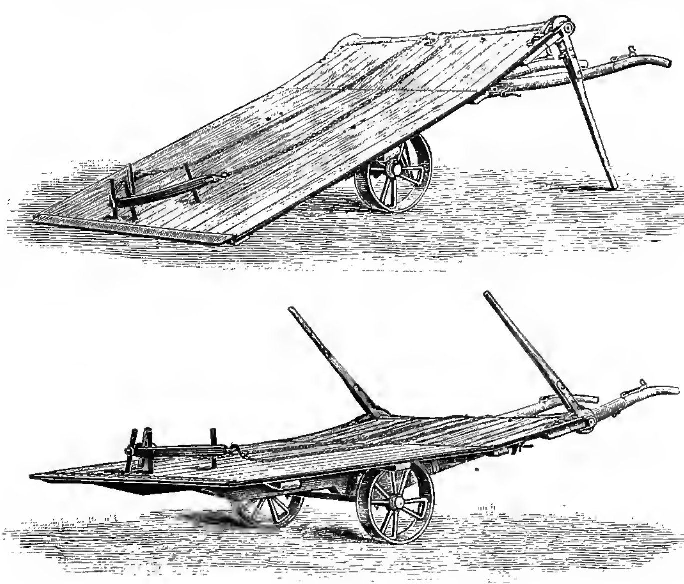


Fig. 473 —*Pollock's hay-sledge.*

rick-lifters made little progress, and were to be found only on isolated farms.

Horse-forks.—In the spring of 1886, it occurred to Mr John Speir, Newton

Farm, Glasgow, that this defect might be removed if this apparatus were strengthened and improved and used in connection with one of the many classes of horse-forks or elevators so largely used in America, and also employed on many farms in England and elsewhere in this country. He believed that double the value would be got out of each apparatus when combined that was possible when used separately, because the horse-fork could only do the forking in the yard, leaving that in the field to be done as formerly. With the rick-lifter, the field-forking was done away with, and with the horse-fork that in the stackyard was reduced to a minimum. Arrangements were at once made for procuring a couple of rick-lifters and a horse-fork of the most improved pattern, and after thorough trial, the results fully justified the anticipations which had been formed.

Types of Horse-forks.—Horse-forks are of various patterns. Most of them fairly well answer the purpose for which they were designed, but they are often found unsuitable where the circumstances are altered. A horse-fork, to raise hay from ricks brought in by the rick-lifter, must be so designed that it will easily and speedily enter the solid hay of the rick; and if it is to be used for working inside a hay-shed, it must, besides, be small in size. Thus forks which were specially designed for working loose hay were found useless for solid ricks. Few forks are so perfect as to work equally well under all circumstances, so that some care is required in purchasing these most useful articles. The most serviceable fork is one suitable for either outside ricks or sheds, and capable of lifting from the solid field-rick.

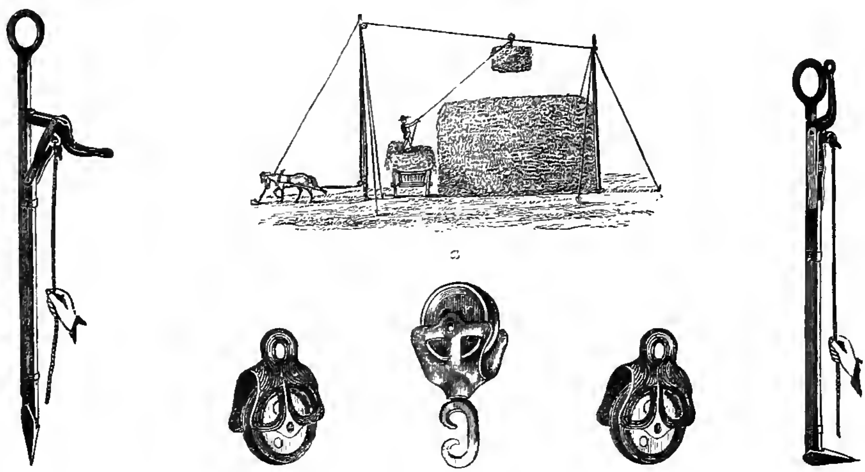


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Fig. 474.—*Horse-pitchfork.*

a At work. *b* The fork ready for pushing into the hay. *c* The fork ready to lift the hay. *d* Pulleys.

The construction and working of one of these horse-forks—the single harpoon-fork — made by Coleman & Morton, Chelmsford, are well shown in the accompanying illustrations, fig. 474.

Working Directions.—The following are the directions for working this fork and elevator: Fix two rick-poles, one considerably higher than the other, firmly in the ground (and well stayed by guy-ropes), the shorter at the end of the stack, the other at a sufficient distance to allow of the waggons being unloaded midway between the two.

Fix one pulley at the top, the other near the bottom of the high pole. The rope, which should be seven-eighths of an inch in diameter, must pass through these two pulleys, then through the swivel-hook pulley, which is to carry the fork and stretch across to the other pole, on which it must be made fast, so that when tight it inclines toward the stack.

A whippletree for a trace-horse is attached to the other end of the rope.

In unloading the hay the sliding pulley is drawn down to the top of the load; the man using the fork presses it into the hay as far as possible by the lever; the lever is then brought into a perpendicular position, so that the point of the fork forms a right angle (see fig. 474, *c*); the fork is hooked to the pulley, and the horse being started, the hay is raised sufficiently high for the pulley to slide along the rope to the desired spot over the stack.

While the fork is thus elevated, the hand-cord attached to the small eccentric lever must be pulled by the man in the waggon, when the hay will be instantly discharged upon the stack. See fig. 474, *a*.

There should be a difference of about 10 feet between the height of the two poles when fixed.

In unloading, the fork should be inserted alternately in the back and front part of the load.

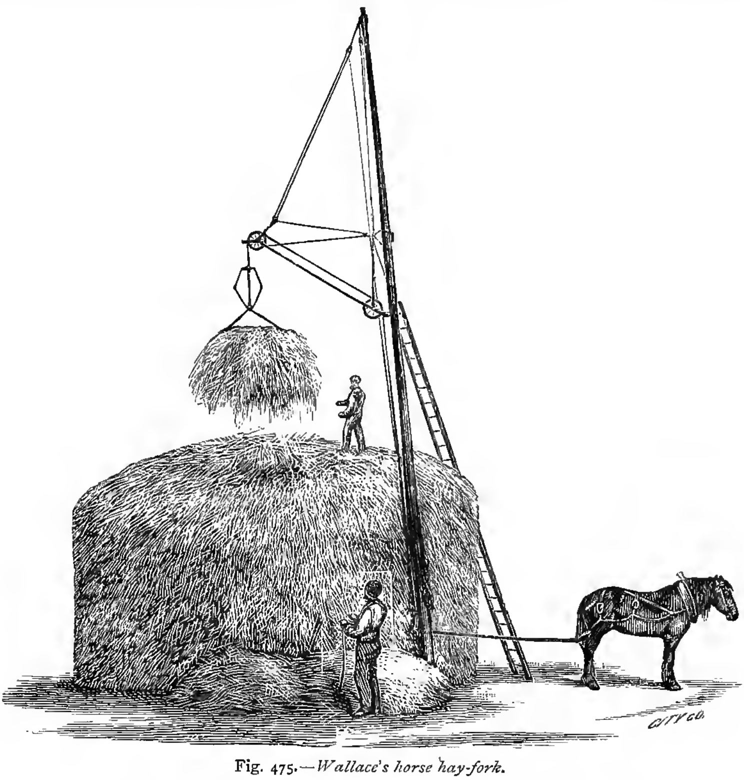


Fig. 475.—*Wallace's horse hay-fork.*

Double harpoon forks, like an inverted U, are largely used in America.

Clip-fork.—For lifting hay from solid ricks some prefer what is known as the clip-fork, the principle of which is the same as a mason or quarryman's shears for lifting stones by a crane, except that while the mason's shears have only one prong on either side, the hay-fork has two or three. When dropped open on to a portion of hay, the mere matter of the horse raising it forces the points together, a firm hold of the hay being thus secured. An arrangement exists by which the prongs can be pulled asunder at any instant by a person standing on the ground, so that the load of hay can be instantaneously dropped anywhere and at any time.

The working of Wallace's hay clip-fork

is shown in fig. 475—John Wallace & Sons, Graham Square, Glasgow.

Elevating Apparatus.—A simple and convenient arrangement for hoisting the hay is to have a pole about 35 feet high, which is held in upright position by three or four guy-ropes from the top of the pole to iron pins driven into the ground. A short "jib" or "gaff," 10 feet long or so, is arranged to slide up and down the pole, being worked by pulleys from the ground. The fork is attached to an inch rope which passes over a pulley at the point of the jib or gaff, thence down the upper surface of the gaff to its lower end, where it passes over another pulley, from which it runs down the side of the pole to about 3 feet from the ground, where it passes through the pole and under a pulley fixed in it, where it is attached to the tree or chains by which a horse draws up the forkful, as shown in fig. 474, *a*.

The pole is set up with a slight lean to the rick which is being built, so that as soon as the ascending load has been raised above the portion already built, the gaff or jib with its load always swings round over the top of the stack, where it can be dropped on almost any part of even a large stack.

Hay Elevator.—Many prefer the web-elevator to the horse-fork in the stacking of hay. The working of this elevator is shown in fig. 174, p. 452, Divisional volume ii. It is there drawn in connection with a steam threshing-machine, but its adaptability to the stacking of hay will be readily understood from the illustration. In stacking hay the web or carrying apparatus may be worked by a single-horse gear. The hay is thrown on to the bottom of the elevator and carried in a continuous stream to the desired height, the elevator being constructed so that, in telescope position, its length may be curtailed or increased.

Advantages of the Horse-fork.—The great speed in forking is not the only merit of the horse-fork. Stacks built by the horse-fork are more easily kept perpendicular than those built from hand-forking. With the horse-fork the forkfuls are regularly discharged only where they are wanted, and where the builder is working for the time being, so that the stack has not the same tendency to settle down at one side more than another, as it would have if the hay were forked by hand. A certain number of persons can also distribute regularly over the stack a much greater quantity of hay when forked by the horse-fork than by hand, because it is always dropped just where wanted, and they do not require to spend their time carrying it from one part to another.

A Good Day's Work.—The horse-fork can quite as easily lift hay from an ordinary hay-waggon or cart as from the ground; and where there are not as many rick-lifters as will keep it going, a portion of the hay, if desired, may be brought in by carts. On a moderate-sized farm each rick-lifter will bring in from 10 to 15 field-ricks per day, even where each may weigh from 15 cwt. to 20 cwt., the load being pulled on all the newer patterns by the horse instead of the man. Going a moderate distance, therefore, each carter may be supposed to be able to bring in about 10 tons of hay daily; and three rick-lifters, although they will be sufficient to bring in the hay of most farms, will not keep the fork going if there are sufficient people on the stack to build it. If three rick-lifters are in use, at least one man building, and three women or men spreading, will be required on the rick, one man will be necessary to act as guide, another will be required at the fork, and a woman or boy to lead the horse, while an extra woman will be required in the field to rake up the bottoms and assist in putting on the ropes. There are thus engaged six men and six women, who may bring from the field and build in the rick from 25 to 30 tons or over of hay daily—this, too, with very little exertion to any of them compared with what would be necessary were the hay lifted by hand-forks. A single horse-fork has been known to put up 50 tons of hay in one day.

Horse-fork Working in Sheds.—Where the hay is stored in sheds, and it is desired to use the horse-fork, a different arrangement from that already described must be adopted. A stout wire, one half-inch in diameter, is stretched tightly about a foot under the apex of the roof, from the one end of the building to the other. On this wire runs a small carriage on two wheels, under which is a pulley. The rope from the horse comes in at one end of the shed, passes up between guide-pulleys to the pulley under the carriage, over which it passes. In this case a pulley of a peculiar shape must be attached to the top of the fork, and the rope from the carriage passes under this pulley and back to the carriage, to which it is knotted. When the fork has been loaded, and the horse moves forward, the load is raised perpendicularly until the top of the pulley over the fork strikes a spring on the carriage, when a catch which has hitherto held it in position is relieved, and the carriage, with its load hanging from the under side, is pulled along the wire until any particular division of the shed has been reached, whereupon the attendant drops the load, and pulls back the fork. The arrangement is very neat, and admirable in working.

Although some modification of it is in use in almost every hay-barn in America, very few are yet employed in this country. Since, however, the combination of the rick-lifter and horse-fork was adopted in 1886 by Mr Speir, Newton, its use has extended rapidly. Mr Speir first used his combination of the rick-lifters and horse-fork early in the hay harvest of 1886, and before the end of the season another set was introduced. In 1887 about ten sets were working; these were probably doubled in 1888, and probably again doubled in 1889.

Horse-forks for Small Farmers.—In this country the capabilities of the horse-fork are as yet only partially understood. It has only been on the largest farms where as a rule they have been introduced; yet as a matter of fact they are a much greater gain to the small farmer than the larger one. The small farmer could bring in the hay with one rick-lifter, unyoke his horse, and fork it up with the assistance of another person to lead the horse or build, as the person who leads the horse can easily enough work the fork also. Or, if more convenient, the small farmer may bring in two or three ricks, place them down as conveniently as possible, and then fork them afterwards. With the assistance of four persons in all, he may keep two rick-lifters going, have one person building and another at the fork, and neither of them need be able-bodied. The builder, indeed, is the only person requiring to exert much strength, as the horses now load the rick-lifters as well as fork the hay.

Dressing Stacks.

After a hay-stack, or the hay stored in a shed, has been standing for three or four days, the sides should be carefully hand-pulled. Before beginning, all props should be taken away, so that the work may be more accurately done. The bottom or base of the stack should be pulled as firmly as possible, as the hay gets damaged very quickly if it is allowed to rest on the damp ground. Any parts of the sides which have a greater projection than the rest should be pulled down until the whole is alike. If the stack has been well built at first, and has not been allowed to lean over to one side, the pulling is neither a difficult nor a tedious process. If, however, the stack has been badly built, is too far out at one part and too far in at another, or leans over in one direction, almost no amount of pulling will make it a good one. At most all that can be made of it is to give it a fairly respectable appearance, and reduce its outside waste as far as possible.

If stacks are not pulled after they have consolidated, there is such an amount of loose hay on the outside that by exposure to the weather it becomes so badly damaged as to be almost useless. On the other hand, if the stack is well built and carefully pulled, the loss is reduced to a minimum. After pulling, such a number of props should be returned as are necessary for the stack, considering its width, height, and accuracy of build. No more should be used, however, than are absolutely indispensable.

Other Methods.

Besides the methods of harvesting hay just described, many others, differing from these in a lesser or greater degree, are pursued throughout the country.

Irish Haymaking.—In Ireland, where a very large area is occupied by the hay crop, there is great variety in the systems of haymaking. The moist climate prevailing there compels the Irish farmer to resort to many devices to secure his hay crops in safety. In the natural meadows the tedder is employed freely, and as soon as at all possible this hay is put into tolerably large cocks or coils, and thence into the hay-barn—a valuable institution, nowhere in this country so fully appreciated or so largely utilised as in the Emerald Isle. Rye-grass and clover hay is made, for the most part, as already described.

Very often in Ireland the hay has, on account of the prevalence of drizzling rain and the absence of good drying weather, to lie long on the fields after it has been cut and before it can be stacked or stored in sheds. In this way more hay is unavoidably lost or injured in Ireland than in England and Scotland put together. By the employment of more expeditious and improved methods of handling the hay, and the introduction of the hay-barn for the storing of it, the loss in the fields has been very considerably curtailed. The hay harvest, however, is still a time of great anxiety to Irish farmers.

Fifeshire Practice.

The system of making and stacking hay — principally rye-grass and clover hay — pursued in Fifeshire and many other parts of the country, is described below by Mr William Morton, North Lambieletham, St Andrews.[1]

Making the Hay.—"After being cut, the grass is allowed to lie one day in swathe. On the second day, if a very heavy crop and thick with clover, it is turned over by passing a hoe or fork handle below the thick side of the swathe. This allows the thick part of the swathe to be exposed to the sun. Half-a-dozen hands soon turn over a large breadth of hay, and using blunt implements avoids breaking the fibre of the hay. Should the weather be very fine, this hay will be ready for tramp-coling in the afternoon or next morning, whenever the dew is off the grass. A little natural moisture does hay no harm, rather good; but to put it together with either rain or dew on it is very injurious. In the days of the scythe it used to be run into win-rows by women with graips, and put into small hand-cocks and then into tramp-ricks; but the introduction of mowers and the American tilting-rake has lessened the manual work in the hay-field.

Stacking.—"When the hay is ready for ricking, one of these American rakes is started about an hour earlier than the others, to get some hay gathered into win-rows. In this district—and I think the practice is more common north of the Forth—hay is put into tramp-ricks of 80 to 120 stones of 22 lb., with a *kiln* in the centre.

"A kiln or boss is three sticks 10 feet long, bolted at top, and making a triangle at foot, with sides at least 3 feet long, and kept firm by three straps on each side. As many of the bosses as will be required are laid out over the field at regular intervals, and are set up by the stackers.

"A very good practice is to spread a large bunch of straw below each rick. This saves the hay from getting damp or mouldy.

"A second American rake is used to draw the hay to where the rick is to be formed, and when the rick is bottomed, the builder gets on the stack and builds the rick in the shape of a cone. Two American rakes, one win-rowing, the other drawing to the stacks, will keep two builders and six forkers going, and an ordinary horse-rake will be required to rake behind—the American rake collecting these as the work proceeds.

"The ricks are carefully and firmly raked down and tied with ropes, and are left for three or four weeks before being put into large stacks or 'hay-sows' as fancy dictates.

Heating.—"Although we do not approve of heating hay, as is usual in England, we think a little fermentation does it no harm if caused by the natural sap; and we would rather put up hay green than over-dried.

Tramp-ricks *v.* Cocks.—"The advantages of putting hay into tramp-ricks at once instead of into hand-cocks first and then into the tramp-ricks, or direct into stacks after standing a longer time, are that it saves twice handling, and leaves much less surface exposed. In the past season I put a small piece of

[1] *Farming World Year-Book*, 1889.

hay into hand-ricks, as the weather was very broken. I thought it too green for tramp-ricks; and when put into stacks of four tons, long before the tramp-ricks were secured, there was much more lost hay in the bottoms, showing the advantage of the plan usually followed.

"Although many put up their hay in tramp-ricks without bosses, still a boss is a great advantage, as the hay is always in better order, and can be secured earlier. The boss prevents the rick from settling down so quickly, and there is consequently less risk of heating or mould."

General Notes.

Judgment in Making.—The process of "haymaking," as has already been more than once pointed out, cannot be so described in words as to reliably guide the uninitiated. Observation and practical experience are absolutely essential for the training of the man intrusted with haymaking. In modifying the practices in accordance with weather changes, and in deciding when the hay is in a fit state for advancing a stage in the process of harvesting, above all, perhaps, in determining when the final step of stacking can be taken, experience must ever be regarded as the most reliable guide.

Fitness for Stacking.—The indications of fitness of the crop for stacking or for putting into large cocks are well enough understood by practical men. The smell and feel are the main considerations. The smell of well-made hay is quite characteristic. If damp in the feel, the hay is unfit. If clover breaks readily on being twisted, it is regarded as ready for stacking; if it bends rather than breaks, and juice exudes from the stems, it is held to be insufficiently "made."

Over-making.—The importance of guarding against the over-making of hay is another point which demands careful attention. Mr James Howard remarked that whilst the skilful haymaker will be solicitous that his crop should be well made, he will on the other hand be anxious that it is not over-made: "In hot weather there is a great danger of this happening. It should be remembered that a crop may be as much damaged by scorching as by drenching. In hot, bright weather, therefore, too great care cannot be exercised in seeing that the crop is not left too long exposed to the rays of the sun before being put into cocks. On the other hand, it is proverbial that after fine, hot weather, more haystacks become heated than after unfavourable seasons. Caution, therefore, has to be exercised against both over-making and under-making."

Horse-rakes.—Since first introduced, horse-rakes have been vastly improved. The best patterns are now very capacious, efficient, and durable. In a wonderful manner they expedite the work of haymaking. In referring to the best types of horse-rakes for collecting hay, Mr James Howard stated that it was his own practice to use a horse-rake of the greatest capacity for this purpose. He did this for the reason that if a horse-rake with tines of small capacity is used, the hay is compressed to a very undesirable extent. From long observation he was satisfied that the most useful and efficient horse-rake for most purposes upon a farm, and especially for drawing grass into heaps for cocking, is one with very capacious tines. When horse-rakes were emptied of their load by hand, weight and size of tine were important considerations, but now that the power of the horse instead of the man is employed for relieving them of their load, there is not the same reason for restricting the size of the tines.

Advantage of Speedy Appliances.—The advantages of using expeditious labour-saving appliances in haymaking are strongly enforced by all experienced hay-farmers.

Mr Howard remarked: "The object of a good manager will be to get his hay into cocks as speedily as possible, especially upon the appearance of a storm; he should therefore be provided not only with the right kind of implements for the purpose, but with a sufficient number. . . . I have known many a crop ruined, not only from an insufficient number of hands being employed, but from dependence upon a single implement when two, at least, were necessary or desirable. . . .

"In the clearing of the ground and in loading, much economy of time may be effected. For instance, in the case of three full sets loading together with a pair of pitchers and one loader to each cart or waggon, nine rakers to follow, if hand-labour has to be resorted to, would be required to keep the work well up;

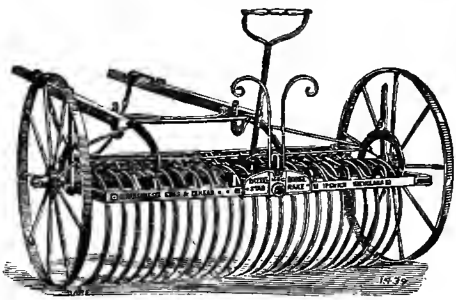


Fig. 476.—*The "Star" horse-rake.*

whereas if the horse-rake is employed, first to clear the space between the rows, and subsequently to follow the carts and waggons, the nine rakers are dispensed with, and their services available for the stacking or other work. The loading will also go on more expeditiously, as the pitchers will not have to wait for the rakers to unburden their drags."

Excellent types of improved horse-rakes are shown in figs. 476, 477, and 478, made respectively by Ransome, Sims, & Jeffries, Ipswich; Howard, Bedford; and Jeffrey & Blackstone, Stamford.

Hay-collectors.—Another very useful form of an appliance for collecting hay is represented in fig. 479. This improved collector is made by the East

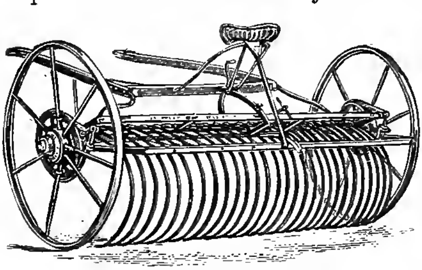


Fig. 477.—*Howard's horse-rake.*

Yorkshire Cart and Waggon Co., Beverley. The beam is of wood, and the teeth tubular wrought-iron with solid welded points.

Rick-cloths.—The use of rick-cloths when stacking hay in the open field or yard is to be commended, especially in unsettled seasons and wet districts. One form of erecting these cloths, long pursued, is shown in fig. 480. Modern ingenuity has devised various methods of erection, more or less convenient. These cloths are of great service in protecting a partially built stack from showers of rain.

When a rick-cloth has not been provided, large waterproof tarpaulins should be at hand, to be drawn over unfinished stacks to protect them from a sudden downpour of rain.

Salting and Spicing Hay.—It is a common practice—and in many cases a good one—to scatter a little common salt amongst hay while it is being stacked. When hay is in a damp or badly made condition, in consequence of

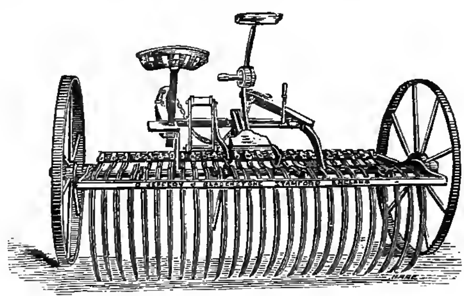


Fig. 478.—*The "Stamford" horse-rake.*

bad weather, salt is an excellent remedy against mouldiness. It is sown by hand by the builders upon every portion tramped down. The quantity used should correspond to the state of the hay, and must be left to discretion. Perhaps $\frac{1}{4}$ bushel to a ton is enough. Salt renders the ill-made hay more palatable to stock. "Hay spice," admirably suited for the sweetening of musty hay, is now offered by several firms. It is extensively used instead of salt, and is sown in stacking in the same way.

Threshing Hay.

The practice of taking seed from rye-grass hay is pursued to a considerable extent throughout the country. The portion to be threshed is left uncut until the seed is almost ripe. Rye-grass seed, however, is very easily dislodged from its stalk, and it is advisable on this account to cut just before the seed is quite ripe.

When mown, it is a common practice to tie the hay into sheaves, and set them in stooks for a few days to dry. After that, the sheaves are built in hand-cocks, and when these are sufficiently dry, they are either taken to be threshed

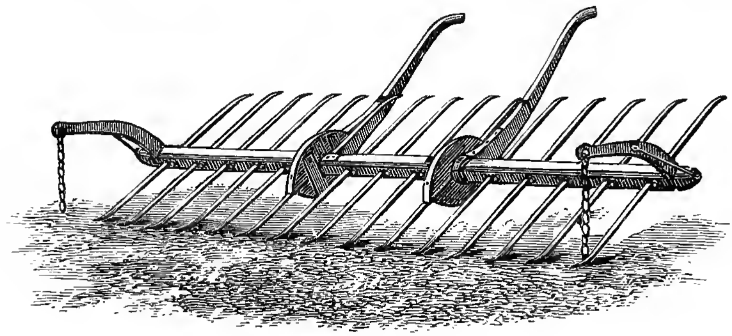


Fig. 479.—*Hay-collector.*

by the threshing-machine, or are threshed on the ground. In using the threshing-machine for this purpose, it is troublesome to clean it effectually. Some think it therefore a better plan to thresh the crop in the field by the flail. It could be done in the stack-yard, but the work is most quickly done in the field. Fig. 481 represents the particulars of this operation in a graphic but somewhat antiquated picture.

An outside door answers for the

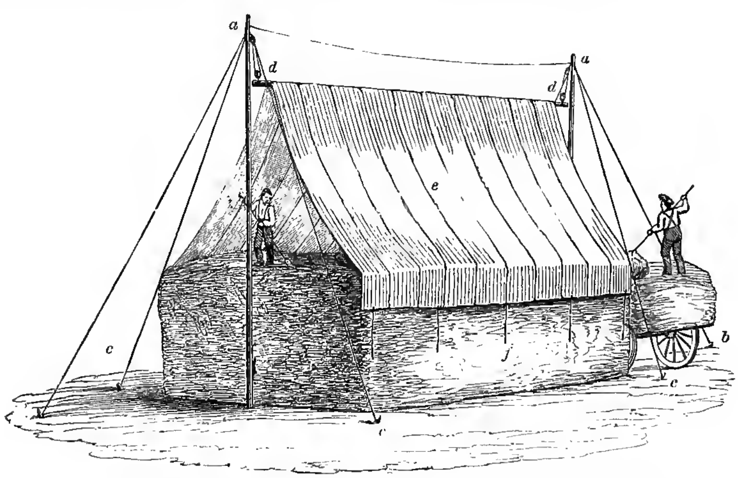


Fig. 480.—*Mode of erecting a rick-cloth over a hay-stack when being built.*

a a Wooden spars.
a to *a* Top-rope.
c c c Guy-ropes from side to side of a stack.
b b Guy-ropes from end to end of stack.
d d Blocks and tackle.
e Rick-cloth.
f Reef-points of cord.

threshing-floor, and at both ends is set upon a cushion of hay, which gives elasticity to the stroke of the flail. A field-gate is cushioned similarly in continuation of the door, and the large barn-sheet is spread under the gate to receive seed. The hand-cocks containing the sheaves are sometimes brought to the threshing-floor by one horse, which is yoked to them by the haims attached to a cart-rope passing ronnd the base of the cock. When the horse pulls, the cock slides upon the ground to its place of destination.

Others consider this an objectionable method, and would use a hay-cart, or sledge, or stack-lifter.

A field-worker loosens the sheaves and pitches them upon the door with a fork, with the seed end towards herself.

Two men, one on each side of the door, nse the flail. Another field-worker, at the junction of the door and field-gate, pulls the threshed hay with a long fork upon the field-gate, over which she shakes it, and another field-worker removes the shaken hay with a fork from the gate to the ground.

The threshers occasionally clear the door of seed with their flails upon the gate, through the spars of which it collects on the barn-sheet below. When the spars are filled, the seed is carried to a heap, and riddled by a field-worker upon a sheet preparatory to being put

Fig. 481.—*Threshing rye-grass seed in the field, either in sheaf or in bulk.*

a Horse bringing hand-cocks.
b Raker.
c Worker snpplying hay to threshers.
d e Threshers.
f Worker shaking threshed hay over the field-gate.
g Worker removing the threshed hay from the gate.
h Heap of threshed hay.
i Worker building coll as a man forks the hay.
k Barn-sheet on which a worker is riddling hay-seed.
l Heap of hay-seed.
m Sacked hay-seed.
n o Finished colls of threshed hay.
p Ladder.
r Spare rake.
s Provisions.

into sacks, to be carried to the corn-barn and winnowed.

The threshed hay is forked by a man to the field-worker npon the rick, which she builds in the form of a pike. A ladder is used to come down from the rick: a basket and bottles indicate that a drink of beer is acceptable to the workers in warm weather. Thus, if one part of this busy band of workers supplies the other with sufficient materials, the work goes on pleasantly and without collision.

The seed will more quickly part with its impurities in the winnowing, after it has lain for some days to dry and win on the barn-floor. After it is winnowed, it should be stored in the granary to dry. When sufficiently dry, it should be winnowed in the granary, measnred, and laid thicker together; and in spring it should again be winnowed, and freed from the many fresh impurities which have fonnd their way into it during the winter, such as cats' and vermin's dung, cobwebs from the roof, and dust. Whatever proportion of the seed is not required for the use of the farm may be disposed of to a seed-merchant or farmer. A fair crop of rye-grass, even when not too much ripened, should yield about 26 bushels of seed to an imperial acre when thus treated.

The Flail. — This antiquated and once most serviceable tool is now rarely seen in any part of the country. It consists of two parts, the hand-staff or helve, and the supple or beater, fig. 482. The hand-staff is a light rod of ash about 5 feet in length, slightly increased in breadth at the farther extremity, where it is perforated for the passage of the thongs that bind the beater to it. The beater is a rod of from 30 to 36 inches in length, made of ash, though a more compact wood, as thorn, is less likely to split; and to prevent this disintegration of the wood, the beater should be constructed to fall upon the *edge* of the segmental portions of the *reed* of the wood, which is easily accomplished in its formation. The usual form of the beater is cylindrical, the diameter being from 1¼ to 1½ inch. For the most part it is attached to the hand-staff by a thong of hide untanned: eel-skins make a strong durable thong.

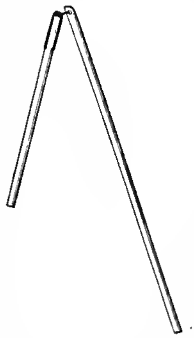


Fig. 482.—*Hand-flail.*

Artificial Hay-drying.

Soon after the disastrously wet, sunless summer of 1879, a considerable amount of attention was given to the devising and testing of appliances for the artificial drying of hay.

Hot Air and Neilson Systems.—Two systems attained wide notoriety. These were Gibbs's hot-air method and Neilson's exhaust-fan system. The former, the invention of Mr Gibbs, of Gillwell Park, Essex, involved the use of a huge, unhandy apparatus, costing about £350. For the Neilson system, the inventor of which was Mr Neilson of Halewood Farm, near Liverpool, fans of numerous patterns were brought out, costing in most cases about £14 or £15. As is often the case with new devices, great hopes were raised by these inventions. They excited much interest and attracted many enthusiastic advocates, who assured farmers that at last their trials and losses of harvest were at an end. Alas! it was little better than a dream. Both systems failed under the crucial test of practical work. They never came into general use, and it is rare now to hear of either the one or the other.

Ensilage preferred.—There are no doubt certain merits in these methods of artificial drying which are capable of being usefully developed and utilised. In public favour, however, they have been entirely displaced by the more reliable and more practical system of ensilage. Unlike the Gibbs and the Neilson system, ensilage has in the most handsome manner fulfilled the great things said of it by its pioneers. It has indeed done more. In the chapter specially devoted to "Ensilage" (Divisional volume ii., pp. 306-327), it has been shown that in the hands of British experimenters, ensilage has developed even greater merits than its earliest advocates in this country claimed for it.

It is more than probable, therefore, that the unequivocal success of ensilage is to some extent accountable for the speedy disappearance of the Gibbs and the Neilson systems from the arena of public attention.

Reading Trials.—It was at the Royal English Show at Reading in 1882, that the Gibbs and the Neilson systems were submitted to the fatal ordeal. With the view of having the practical utility of these systems put to the test, Mr Martin John Sutton, of the well-known firm of Messrs Sutton & Sons, seedsmen, Reading, offered for the acceptance of the Royal Agricultural Society a prize of 100 guineas for "the most efficient and economical method of drying hay or corn crops artificially, either before or after being stacked." The prize was accepted by the Society, and the outcome was the trial of Gibbs's Hot-air Dryer, and of eleven different fans designed to work the Neilson system, and of a system for ventilating the stack by the assistance of hot air.

Results.—The results were disappointing all round; so much so, indeed, that the judges reported that they did "not feel justified in awarding the prize."[1]

Conclusions as to Gibbs's system.—In reference to the trial of Gibbs's hot-air appliance, which was tried first on meadow-hay and afterwards on sewage-grass, the judges remark: "In the first trial, which was made under fairly favourable conditions, the exhibitor failed to make hay of as good quality as might have been made in similar weather without any artificial means. The result of the second trial, which was upon sewage rye-grass, was more satisfactory, and we are of opinion that on sewage-farms, where rye-grass has to be converted into hay, the machine might be a useful auxiliary; but that, even if the results obtained were more certainly and completely effectual than they have proved to be, the prime cost of the machine [about £350] would place it beyond the reach of ordinary farmers, while the difficulty of its removal would be a serious obstacle to its general use."

Conclusions as to the Neilson System.—In regard to this system, the judges concluded their report as follows: "The various adaptations of the Neilson system exhibited have been tried on meadow-hay in the stack, and three of the most powerful fans, exhibited by Mr Coultas, Messrs Lister & Co., and Mr Phillips, were afterwards tested upon barley stacks. The result, as regards hay, can in no case be considered satisfactory, taking into consideration all the circumstances under which the hay was put together. None of the exhibitors proved that they were able to make good hay in wet weather. In a few instances, where fairly good hay was obtained, equally good, if not better, hay might have been secured without the application of fans. The trials of the three selected fans upon corn were even less satisfactory than those upon hay, none of the machines having succeeded in effectually drying the corn in the stack."

As to Mr Kite's system of ventilation in the stack, the judges reported that it "was not successful in its application," and that they did not think it had "any practical value."

The practical failures of the Gibbs and Neilson systems render it unnecessary to devote space here to a description of their working. Nevertheless it may be interesting to notice very briefly their leading characteristics.

Gibbs's Hay Dryer.—The following description of Mr Gibbs's Hay Dryer is from the pen of Mr Anderson, consulting engineer of the Royal Agricultural Society of England:—

"This machine consists of a furnace for heating air, and a fan for propelling it into the haymaking-machine, which is an arrangement by which the damp hay is agitated, while a current of hot air is driven through it to dry it. The machine is driven by an eight-horse portable engine by means of a belt. On the fan-spindle is keyed a driving-pulley, 23 inches in diameter by 9 inches wide, and a fan 5 feet 4 inches in diameter by 21 inches wide, with four blades and inlets 24 inches in diameter. The fan is surrounded by a sheet-iron casing, and the inlets are enclosed with similar material, and formed on each side into a furnace about 8 feet long and 2 feet wide. On the grates of these furnaces coke is burned, and the products of combustion are forced by the fan through a sheet-iron trunk, 2 feet 2 inches by 2 feet, into the drying-machine, the supply being regulated by a throttle-valve, and the temperature ascertained by a pyrometer. The whole apparatus is carried on a pair of iron wheels, 48 inches in diameter by 7 inches wide, and provision is made for attaching a pair of shafts to the furnace end of the fan-case. A spark-guard, made of sheet-iron, rests on the ground, and encloses completely the lower portion of the fan-casing. On the side of the casing opposite to the driving-pulley a bevel-pinion is keyed on to the fan-spindle, and this gears into a bevel-wheel about three times its diameter, keyed on to a shaft at right angles to the fan-spindle, and connected to an inclined shaft by means of a universal joint; the

[1] An exhaustive and interesting report of these trials, written by Mr W. C. Little, the reporting judge, appears in vol. xviii., sec. ser., of the *Journal of the Royal Agricultural Society of England*, part ii. pp. 643-728.

other end of the shaft is connected by a similar joint to the driving-gear of the haymaking-machine.

"The haymaking-machine is about 27 feet long by 8 feet wide. It consists of a framing or skeleton trough, which, at about 6 feet from the gearing end, rests upon a pair of wooden wheels, 48 inches in diameter by 6 inches wide, while the other end is suspended from wrought-iron skeleton standards resting independently on the ground, and fitted at their upper ends with chain-pulleys, and at their lower with chain-drums actuated by tangent gear. By means of this arrangement any desired inclination may be given to the frame. The trough or frame carries a sheet-iron screen, made like the ridge of a roof, with a rise of about 1 foot 9 inches, and capable of having a reciprocating motion communicated to it, by means of a crank having a 9-inch throw. To facilitate this motion, the screen is carried on three pairs of 8-inch rollers keyed on to shafts which cross the trough, and revolving on bearings secured to its sides.

"To each side of the trough is fixed a framework consisting of seven uprights connected together at their tops. These carry, on each side of the machine, a crank-shaft of 18 throws, and each throw carries a prong 3 feet long, projecting down into the screen and close to its bottom. The prongs are projected 15 inches backwards, and these short ends are connected by chains to a bar which runs the whole length of each side of the machine and some 22 inches outside the uprights. The bars are carried on outrigger brackets, and are capable of being moved longitudinally about 12 inches by means of adjusting screws and handles at one of the ends, the object being to give the prongs, which are very loose on their cranks, a kind of double motion, which tends to make the hay travel longitudinally.

"To the framing over the screen is attached on each side a longitudinal bar, to which are hinged cross-bars, seventeen in number, from which project downwards short two-pronged forks, so arranged that each crank-prong has a fork coming over it. The office of the prong is to clear the hay off the crank-prongs as they revolve.

"Over the ridge of the screen is a sheet-iron flue, divided longitudinally down the centre, so as to make two parallel flues, and these are connected to the fan and fitted with regulators, so that the hot air may be distributed uniformly on both sides of the screen. The flue is supported on adjusting screws, so arranged that the distance of its edge from the screen may be varied at pleasure.

"The inclined shaft from the fan-case gives motion, by means of a pinion and wheel, to a crank-shaft which crosses under the trough of the machine at its extreme end, and actuates a connecting-rod which communicates a reciprocating motion to the screen. The crank-shaft also, at its further end, communicates its motion to an upright shaft placed at the extreme end and on one side of the trough; and this upright, by means of bevel-wheels, actuates the multiple crank-shaft which works the prongs. On the opposite side of the machine is a similar arrangement, deriving its motion more directly from the crank-shaft from the fan.

"The rate of traverse of the hay while it is being dried depends upon the inclination given to the screen and to the lateral set given to the prongs."

Neilson System.—The working of this system is exceedingly simple. "By means of a fan communicating by an air-tight passage with a central cavity in the stack, the hot air is withdrawn from the inside, in consequence of which the cooler and drier air of the outer atmosphere rushes through the interstices of the hay or corn, and in its passages cools and dries the stack." Many different kinds of fans have been designed—some being worked by hand, and others by horse or steam power. In all cases, however, the cooling is effected by creating a current of air out from and into the stack.

Utility of the Neilson Fan.—Although not capable of accomplishing the great feat claimed for it at the outset—that of making good hay in wet weather—the Neilson fan may nevertheless, in certain cases, be used with advantage. The late Mr James Howard stated in 1886 that from trials he had made during two seasons, he was satisfied a horse-power fan such as he possessed (made by

Mr Lister, Dursley) was a valuable appliance to have at command in case of need. "In a catching time," he added, "I should with a fan at command have no hesitation in carrying a crop before it was quite fit, knowing that if the temperature became dangerously high, it could at a trifling expense be quickly reduced. If there is any chance of the services of a fan being required, the stack must be built with the necessary air-chamber and lateral tubes—the particulars of which any maker of fans will supply."

Pressing Hay.

The bulky character of hay renders it desirable that means should be provided for compressing it tightly into convenient trusses or bundles. In these trusses it can be more easily and more cheaply carried alike by road, rail, and steamer, than in its natural bulk.

Much ingenuity and enterprise have therefore been exerted in the devising of hay-presses—additional impetus being given to these efforts by the railway companies offering a reduced rate for carriage when 50 cwt. or more are packed on to an ordinary railway waggon. For this purpose, such pressure as will pack nearly 8 lb. of hay or straw into a cubic foot is sufficient.

Trial of Hay-presses.—At the Nottingham Show of the Royal Agricultural Society in 1888, an important series of trials of appliances for pressing hay and straw were carried out. Prizes were offered for hay and straw presses — (1)

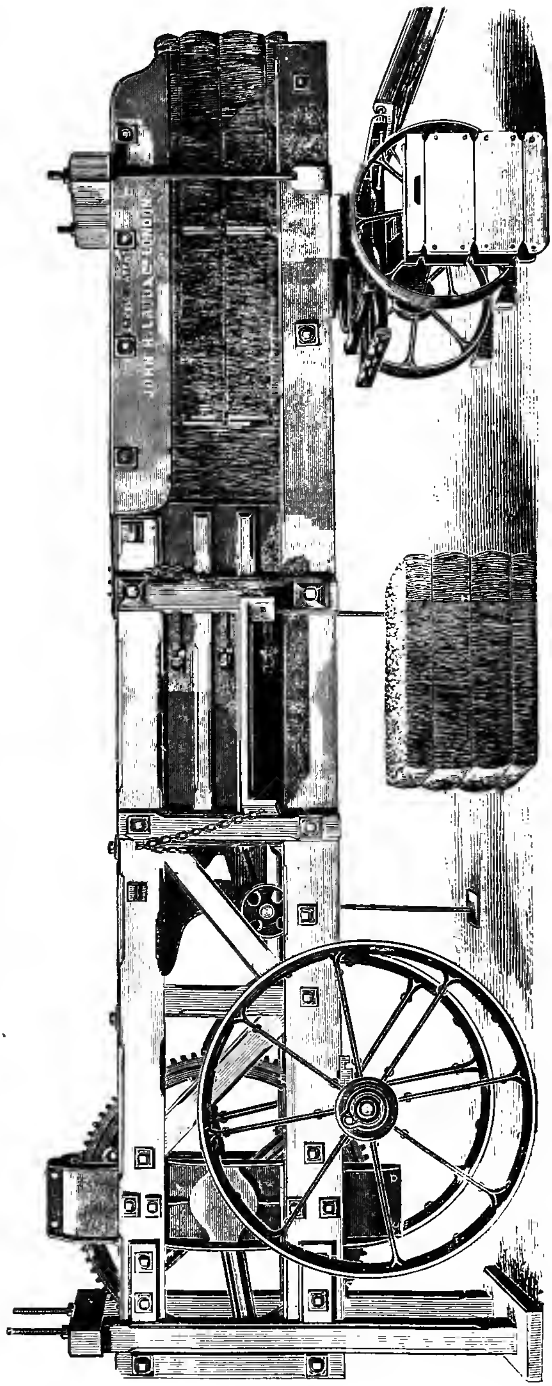


Fig. 483.—*Steam-power hay and straw press.*

worked by steam-power, (2) worked by horse-power, and (3) by hand-power—one prize being also offered for a press for old hay worked by hand-power.

Steam-power Presses.—Four steam-power presses competed. The first prize went to Messrs John H. Ladd & Co., 116 Queen Victoria Street, London, and the second to Messrs Samuelson & Co., Banbury. The first-prize machine, known as Ladd's Perpetual Press, is represented in fig. 483. It is a modification of the well-known American "Dederick Press," and is thus described in the *Journal of the Royal Agricultural Society of England*:[1]—

"Let the reader imagine a square pipe, partially filled with plastic material, to which a fresh portion of similar material is added at every stroke of a plunger, moving backwards and forwards in the unoccupied portion of the tube, and he will have a picture of the Ladd Press. If he further supposes that the occupied part of the pipe can be cramped at will upon its contents, he will understand how the density of Ladd's bales is determined. In such an apparatus every addition of unpressed material causes the extrusion from the end of the pipe of a similar quantity of compressed stuff, whose density depends upon the amount of friction induced by cramping between the pipe and its unextruded contents.

"The material to be baled is fed by a man, handling a fork, piecemeal into the body of the press. There, a platten, which has a to-and-fro motion communicated to it by a suitably geared crank and connecting rod, drives each mouthful of hay or straw introduced by the feeder back upon other already compressed material occupying the rear of the box. Six lateral latches, three on either side of the press-body, serve to retain each newly pressed mouthful of hay, and when enough for a bale has been compressed, the feeder introduces a square board, called a follower, loosely fitting the box, and provided with three cross grooves for the later admission of the binding wires. Binding is accomplished as each bale passes rearward, and after it has reached a portion of the press-body from which the sides have been removed for this purpose. After wiring, the bales, together with their followers, are successively extruded from the press, the former being removed, while the latter are returned to the feeder for repeated use."

The cost of baling with this machine, as found at the trial, was with straw 1s. 2½d. per ton, and hay from 6d. to 7d. per ton. It required four nominal horse-power to work it, and the mean density of its bales was 10.77 lb. per cubic foot with straw, and from 15.40 to 23.40 lb. per cubic foot with hay. Its cost price is £80.

The Messrs Samuelson's second-prize machine was the well-known "Pilter Press," an American invention improved upon in this country.

Horse-power Presses.—Four horse-power presses were tried. Mr George Stephenson, Newark-on-Trent, obtained the first prize, and Messrs Ladd & Co. the second. Mr Stephenson's press is shown in fig. 484. It employs what is known as the "toggle-joint," and "consists of a vertical box, or press-body, closed at the top by a sliding door, and laterally by a swinging door. A platform, placed at such a height that stuff can easily be received from the thresher and forked through the latter door, surrounds the press-body, and receives loose material. Two men were

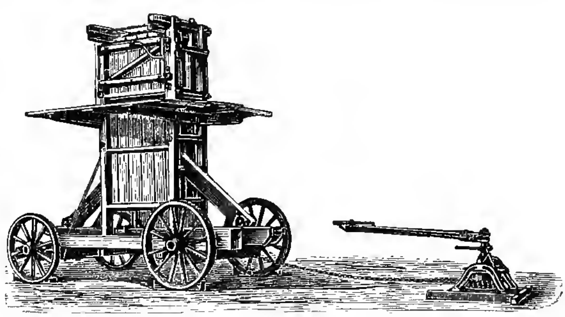


Fig. 484.—*Horse-power hay-press.*

[1] Vol. xxiv., sec. ser., 577.

employed upon this platform, either forking or trampling, and one man drove the horse.

"Within the box there is a moving platten which, during the charging operation, forms the bottom of the press-body.

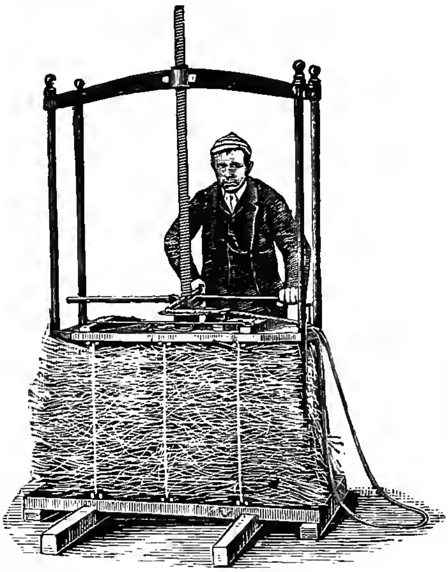


Fig. 485.—*Bamber's hay-press.*

The platten is supported by the two limbs of the toggle, and is low down in the box when members of the joint are widely open, high up in the box when these are closed.

"The toggle is operated by a chain, which, after passing around a guide-pulley to give it direction, is wound upon a windlass actuated by the horse. The platten rises, quickly at first, and slowly at last, through a considerable space—a movement well suited, as it appears, to the pressing of hay and straw, where a gradually increasing pressure, ending in a powerful final pinch, is the thing desired.

"When the toggle is open, and while there is little or no pressing to do, the horse's energy is used in bringing the widely separated limbs of the joint together, the leverage being at that moment greatly against him; but when the final pinch is given, and the work of compression is hardest, there is a hardly appreciable leverage against the horse, *quâ* the toggle, so that his work is equalised throughout the whole movement of the platten.

"After a bale has been completed, the windlass is released by means of a clutch, and the platten falls by its own weight, the rapidity of its descent being checked by a brake on the chain-barrel, under the control of the attendant. The bales are tied in the usual way, either with cord or wire, and afterwards tumbled from the platform to the ground.

"The ratio of movement between the horse and the platten at the point of maximum pressure is 301 to 1, so that, estimating the pull of the horse at 2 cwt., this would give 30 tons pressure upon the platten."

One horse worked this press with ease. It gave a density of 8.60 lb. per cubic foot in straw, and 13.50 in hay, the cost of baling in the former case being 1s. 9d., and in the latter 1s. 1d. per ton. The cost of this press is £70.

Messrs Ladd's second-prize press was the same machine as that illustrated in fig. 483, adapted for horse-power instead of steam.

Hand-presses.—At the Nottingham trials nine hand-presses competed. The first-prize machine, made by Mr J. Bamber, Saul Street, Preston, is represented in fig. 485. It is an exceedingly simple machine, in appearance similar to an ordinary cheese-press, provided with a

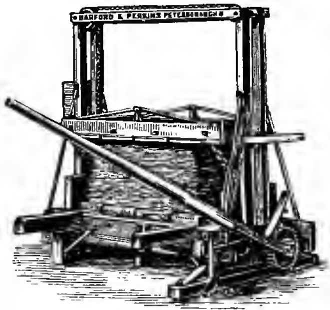


Fig. 486.—*Barford & Perkins's hay-press.*

pulley and endless cord for obtaining a quick return of the screw. Two men work this machine easily enough, compressing the materials by means of capstan levers which rotate the screw. After compression, the platten is returned quickly by means of the pulley and cord. One drawback is that, there being no compression-box, the bales have to be trimmed with a knife. The ratio of movement between the capstan lever and the platten in the trial was 120 to 1, which, assuming each man to exercise a force of 100 lb. on the levers, gives a pressure of 10.7 tons on the platten.

The Bamber hand-press weighs less than 3 cwt., and costs only £11. It gave a mean density of 4.20 lb. per cubic foot in its bales of straw, and 8.24 to 9.75 with loose hay, the cost of baling the straw being 1s. 5d. per ton and the hay 1s. 6d. per ton. It baled old hay, cut from the stack, at a cost of 8⅝d. per ton, giving a mean density of 9.10 lb. per cubic foot in the bales.

The second prize went to Mr W. Warnes, King's Lynn, Norfolk, for a heavy and powerful press costing £35.

Hand-presses for Old Hay.—Nine machines tried for the prize under this head, which went to Mr Bamber for his prize press in the other class, illustrated in fig. 485.

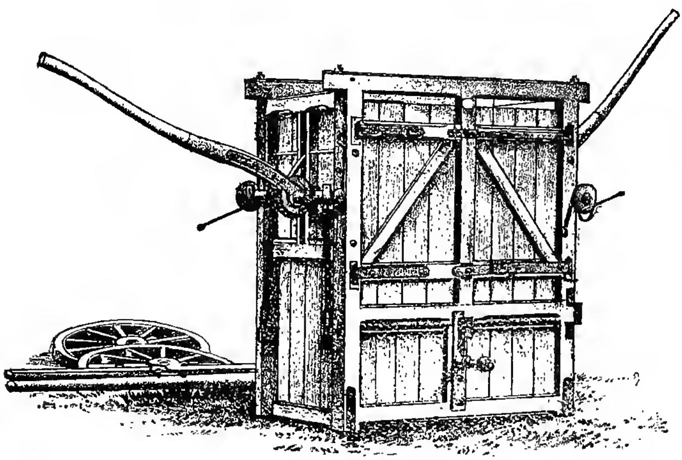


Fig. 487.—*Turnbull's hay-press.*

Although the judges in the Nottingham trials had in this class no second prize at their disposal, they highly commended a very useful machine which was shown by Messrs Barford & Perkins, Peterborough, and which has gained much favour amongst farmers throughout the country. This strong and effective press, which costs £25, is represented in fig. 486.

Highland Society Trials.—A trial of hand hay-presses took place at the Melrose show of the Highland and Agricultural Society in 1889. The first prize was taken there by J. Turnbull & Son, Carnock, Larbert, with the machine shown in fig. 487. The pressure is applied by a lever, as seen in the illustration. For transit it is easily mounted on wheels.

BARE FALLOW.

Three agencies, distinct, yet associated, have combined to curtail the time-honoured custom of bare-fallowing. The fall in the price of wheat, land drainage, and the application of science to the practice of agriculture, have so discredited bare fallow as to render it a thing of the past, except in the very stiffest of soils.

One crop of wheat, with the price at little more than 30s. per quarter, will not bear the rent and labour of two years. Where it could be avoided, therefore, bare fallow would of necessity have been discontinued. But by the advancement of agricultural education and the introduction of artificial manures, the farmer is enabled, in all except the very stiffest soils, to emulate, and indeed to surpass, the beneficial influence of bare fallow without leaving the land uncropped for a single season. Thus it has happened that the practice of bare-fallowing, once very common in the British Isles, has fallen into disrepute, and is now pursued only in exceptional instances, almost entirely on strong clays, which are so stiff and unpliable as to be unsuited for any of the standard root or fallow crops.

Fallowing and Loss of Nitrates.—Another influence which has operated against the practice of bare-fallowing is the discovery of the great loss which is liable to occur in uncropped land by the washing away of nitrates in drainage water. This occurrence is fully noticed in other parts of this work, notably in Divisional vol. iii. p. 156, and should be duly considered by every farmer who contemplates fallowing.

Objects of Bare Fallow.—The objects of bare fallow are to replenish exhausted soil by the natural agencies of rest and disintegration, and to afford an opportunity of eradicating weeds. By the growth of crops which are removed from it, the soil is robbed of its supply of available plant-food. To restore this lost fertility, our forefathers resorted to the device of allowing the land to "rest" for a year, and of tilling it so thoroughly during this time of leisure as not only to eradicate weeds, but also to so disintegrate the soil as to replenish the upper layers with available plant-food.

Production of Nitric Acid.—"The production of nitric acid," says Mr R. Warington, "is probably the most important result of a bare fallow. In ordinary soils at Rothamsted, left as bare fallow, there has been found at the end of the summer 34-55 lb. of nitrogen per acre in the form of nitric acid in the first 20 inches from the surface, the quantity depending on the richness of the soil in nitrogenous matter and the character of the season. The whole amount of nitrates produced during the fifteen months that the land remains without a crop has been estimated at not less than 80 lb. of nitrogen per acre for the arable fields under ordinary cultivation at Rothamsted. Supposing the season of fallow and the following winter are fairly dry, this increase in the available nitrogenous food will probably enable the soil to produce twice as much wheat as it could do without a fallow. If, however, the soil is exposed to heavy rain, the nitrates produced will be more or less washed out, and the benefit of the fallow greatly diminished. Bare fallow can be used systematically with advantage only on clay soils and in a tolerably dry climate; under other circumstances a continuance of the practice must result in a serious loss of soil nitrogen." [1]

Antiquity of Bare Fallow.—The practice of bare-fallowing is an ancient one. It was pursued by the Israelites, and was probably followed by the Teutonic races even prior to their association with the Romans. Anyhow the Romans bare-fallowed systematically, and brought the art with them into England. It was not until the eighteenth century that the benefits of thorough fallowing were made known, and extensively taken advantage of in Scotland. And curiously enough, Scotch farmers, while about the last to take kindly to bare-fallowing, were among

[1] *Chemistry of the Farm*, 58.

the first and readiest to displace the practice by manuring and root-growing.

Methods of Fallowing.—The principle of bare-fallowing has been employed in numerous ways to effect the desired objects of replenishing and cleaning the soil. In early times it is believed that more than one year's rest was given at a time. In the more distinctly historical ages one year has been the usual duration of the bare fallow. As to the interval between the bare-fallowings, practice has varied, and still varies greatly. Morier, in his Cobden Club Treatise (1870) on the "Systems of Land Tenure," refers to a three-field system of cropping, with "each field lying fallow once in three years," as having been practised in the first century.

This three-field system was at one time largely pursued in this country, and it was "last heard of" in the county of Durham. Under this system two-thirds of the land would always be producing grain or beans, the other third being bare fallow.

In the better classes of wheat soils, rich in inherent fertility, the fallow came at longer intervals, in every fourth, fifth, or sixth year, according to the character and condition of the land. The crops grown between the fallows would be wheat, beans, oats, and clover, alternated so as to give as many crops of wheat as possible in the rotation, yet without cropping with wheat in two successive years, or allowing wheat and oats to follow each other.

Where fallow exists, it takes the place of the root crop in the rotation.

Rotation and Bare-fallowing. — A discussion of all the "pros" and "cons" connected with the practice of bare-fallowing would of necessity involve the consideration of many points which fall more properly to be reviewed in the chapter on "Rotation of Crops." To save repetition, we therefore in this section avoid further remarks upon the general principles of bare-fallowing, and add a few notes as to the treatment of bare fallows.

Land to be Fallowed.—The portion of land to be fallowed will be the strongest clay on the farm, some piece of land which cannot be otherwise turned to good account. It may be so invested with weeds as to render it impossible to thoroughly clean it in time for an ordinary crop. Other conditions being equal, the portion of the shift to be fallowed will usually be that farthest from the steading, so that the green crops may be as near thereto as possible.

Wheat after Fallow.—Wheat is the crop which follows bare fallow. It is in some parts considered a good plan to have the wheat seed after fallow sown early, so that the young wheat may be through the ground in time to see the old wheat on its way to the stackyard.

Treatment of Fallows.—The treatment of bare fallows will perhaps extend over the greater part of eight or ten months. It begins in winter, finishes in the following August or September, and consists of several ploughings and grubbings, or draggings, with thorough harrowing, rolling, clod-crushing, and weed-gathering. It is impossible to determine beforehand how many times bare fallow should be ploughed, harrowed, grubbed, and clod-crushed, to make it clean; but it should be borne in mind that one of the main objects of bare-fallowing is to make the land thoroughly clean.

In many cases the bare fallow is ploughed or grubbed four or five times, at intervals of four to seven weeks; and the number of turns of the harrow must be left to the judgment of the farmer at the time.

Overworking Fallow.—It was at one time believed that the perfection of bare-fallowing was to work on till the land was reduced to a very fine tilth. Experience has proved it better for wheat to have a good-sized clod upon the surface in winter, however much the ground below may be pulverised. It is a decided mistake to reduce the surface of the fallow to a fine smooth condition in the autumn; and rolling in the autumn, after or just before the sowing, should never be practised.

Prevailing Methods.—Common methods of working fallow land are as follows: The fallow land is the last stubble to be ploughed in winter. The ploughing is done in the same manner as for potatoes and turnips. Then comes cross-ploughing in spring. If one furrow has been given after cross-ploughing, it will be as much as time will afford from working the potato and turnip lands; and as the bare fallow is not likely to be worked for some time, it is better to keep it in the rough state from the plough, because, should dry weather ensue, it will moulder down; and should wet weather set in, the rough land will be less tough to work.

When leisure at length permits attention to the bare fallow, its state should be particularly examined.

Weeds.—Should the weeds consist of fibrous and fusiform-rooted plants, they will be easily shaken out by the harrows in dry weather; but should their roots thread themselves through the hard clods, they cannot be detached by the harrows. Inattention to the state of the weeds at this stage may cause double work at a subsequent time. Clods containing portions of tenacious roots, knocked about in dry weather, will be broken into smaller pieces; but so will the roots in them, and the land be as far as ever from being cleaned. The best plan, then, is to allow the roots to grow, that the force of vegetation may break the clods, or render them easily so by a clod-crusher after a shower of rain has moistened them.

A precaution in the use of a roller should here be given. If the soil is in a mouldy state, rolling will only bury the hard clods with the roots in them, not break them. The harrows in 2 or 3 tines will break them better than rolling.

After a good clod-crushing, the land should be harrowed a double tine, first one way and then across.

Collecting Weeds.—The weeds will then be collected on the surface. It is not expedient to gather them immediately, as a good deal of fresh soil adheres to them. With an interval of one or two dry days, the soil will be easily shaken off.

The chain-harrow may be used to assist in collecting the weeds, and the work will be completed by graips or forks, or by the bare hand.

Disposing of Weeds.—In some cases the weeds are collected in heaps and carted off to be burned, destroyed, or converted into compost. In others they are wholly or partially burned on the land. It is not easy to so thoroughly burn weeds on the land as to prevent future growth; but this danger will be avoided if any roots found in the bottoms of the heaps are carefully removed when the ashes are being spread. Many farmers, however, prefer to make compost of the weeds, thus agreeing with Lord Kames, who exclaimed, "What better policy than to convert a foe into a friend?"

Kentish Practice.—In Kent, as in other parts of the country, only the stiffest soils are left in bare fallow, and even on these it is not now extensively practised. Mr Solomon, Dartford, Kent, writing in 1888, says: "A bare fallow is often taken after oats, or it may be after seeds. They plough even before Michaelmas if possible, then leave the ground till early in the year, and then plough again—it may be across or by turning back the furrow. The ground receives about four more ploughings and about a dozen or so harrowings and draggings, exposing couch and other weeds to the hot suns of July and August (which is all the weeding deemed necessary). Where we had some of our marshes here under plough the following was the rotation: Fallow, wheat, beans, wheat, and clover, but this was only a 'bastard fallow,' because they took one cut of clover and then ploughed up in June or beginning of July. The land was immediately cross-ploughed, so as to lay it up roughly, and it was left till September, when it was ploughed again for wheat, which was sown early in October."

Dung for Bare Fallow.—The manure for the bare fallow consists mostly of the part of the farm-dung which was left in the courts when the dung was taken away for the turnips, and that since made by the cattle and horses. Compost is now largely used for bare fallow. Every material convertible into manure should be used, and ash-courts, privies, cesspools, pigeon-house, poultry-houses, ponds, and ditches, cleared out at this time. These materials are compounded together with the farm-dung, straw, and compost, into a large dunghill in the compost-yard, ready for the bare fallow by the end of July. The dung is not much heated for bare fallow, as it has time partially to decompose in the soil before the wheat is sown; but should there be no time for that, it should be putrefied the more, that the wheat may not suffer in winter in ground hollowed by unrotted dung.

Preparing for Dung.—An ordinary preparation in bare fallow for the dung is to feer it into ridges. If the land has been drained, which it ought to have been at some time, the feering should be for casting the ridges together; and as the land will be seed-furrowed when the wheat is sown, this feering for casting should leave one single ridge on the side of the field at which the ploughing commences—so that in seed-furrowing the ridges may be cast together in pairs from side to side of the field. If the land has not been drained, it should be gathered up from the flat, leaving a half ridge on the side of the field, that the ridges might be completed in gathering up the seed-furrow.

Spreading Dung.—The dung is carted out to the feered field, hawked out of the cart by each ploughman in heaps upon each successive ridge, in such quantity per acre as may be determined on. The dung should be discriminatingly laid down, according to the wants of the soil in different parts of the field, the poorer soil on the heights of knolls having more and the deeper hollows less. Bare fallow is seldom so heavily manured as for green crops. Common dressings consist of from 8 to 12 tons per acre.

Field-workers should spread the dung evenly over the surface with common graips or forks, and the ploughs cover it in rapidly from the heat of the sun. If the heat is scorching, as many field-workers should be employed as to keep the plough going. It is too common a practice to spread the dung for bare fallow some time before it is ploughed in.

Drilling Fallow.—Some prefer ploughing in dung for bare fallow in drills. The drills are made in the single way, diagonally across the future ridges. The dung may be thrown in graipfuls from the cart as described for turnips or potatoes; but formerly the more general method was to drag the dung from the cart into heaps in the drills. The heaps are divided by a field-worker across three drills, and three workers spread the dung along the three drills with small graips, and the ploughs cover it in returning from making the drills, as is done in dunging for potatoes and turnips. The dung is thus quickly spread and covered in, and the land remains in drill until it is seed-furrowed for wheat. In this mode of manuring bare fallow, the dung, being in bulk in the drill, it putrefies readily; and after the drills are harrowed down, and the land seed-furrowed, the dung becomes intimately incorporated with the soil.

Folding on Fallows.—Bare fallow is manured in England by sheep folded within hurdles or nets, and fed on tares or other forage, and perhaps cake or grain, brought to them. As one break of land is sufficiently manured, a new one is enclosed. This practice is called folding, and is pursued with success.

"Bastard" Fallow.—In some cases rapid-growing crops—such as white mustard (*Sinapis alba*) or rye—are sown on the fallows early in summer, and folded by sheep when they are a few inches above ground. This is one form of "bastard" fallow,—other forms of "bastard" fallow occurring where a catch-crop of clover, vetches, or some other suitable plant is taken early in the season, and the land ploughed up early in summer, and then worked as fallow.

Green Manuring.—Another mode of manuring bare fallow is sowing some kind of rapidly growing plant upon it, and then ploughing it in. White mustard, *Sinapis alba*, is employed in this manner with advantage. About 12 lb. of the seed is sown on an acre, and after the plant has grown about four inches it is ploughed in. This operation is known as *green manuring*, and may be practised with many other plants. Rye is so employed.

In some cases two or three successive growths of mustard are thus ploughed into fallow land. As soon as the first crop is nearly at its full growth it is rolled flat, the land is ploughed, another seeding of mustard sown, the crop again ploughed in, and perhaps a third crop treated likewise. The first crop of mustard is sown in spring, after the fallow has received its second ploughing.

By this plan a great amount of vegetable matter is incorporated with the soil. By the decay of this matter the clays must not only be loosened in texture, but also enriched in the nitrogenous ingredients so essential for wheat. It is a cheap and effective system both of manuring and cleaning stiff land, unsuited for growing roots.

Objection to Green Manuring.—There is undoubtedly much to be said in favour of this system of green manuring for stiff soils. Yet it is perhaps better farming to combine the growing of these catch-crops with the folding of sheep. "Having succeeded in obtaining a crop, it is clearly better," says Professor Wrightson, "to feed it off with sheep than to partly waste it by ploughing it in."

COLLECTING TURNIP-SEED.

The saving of turnip-seed needs very careful attention. The plants should be cut down with the sickle before they are dead ripe, as the seed is very apt to shake out.

Drying the Seed.—The best mode of winning the seed is to place the stems against frames of wood. Suitable frames are formed by setting hurdles on the ground, wide below, and placing their tops against each other in the form of an isosceles triangle, thus leaving an opening between them to let the air pass through. The stems of the first plants are placed upright on their butt-ends upon the ground against both sides of the hurdles, and the others are put upon them upwards till they reach the tops of the hurdles, when the mass appears as a thatched roof. The plants are then covered with straw, for protection from rain and birds, and bound down with straw or other ropes.

Threshing.—The seed is threshed out by the flail in the same way as rye-grass seed.

Produce.—Swede seed, when a good crop, yields 28 bushels per acre; yellow turnips, 20 bushels; and globes, 24 bushels.

AUTUMN.

AUTUMN WEATHER AND FIELD OPERATIONS.

In the seasons passed through, we have seen Winter the season of *dormancy*, in which all nature desires to be in a state of repose; Spring, the season of *revival*, in which the vivifying powers of nature inspire every created being with new vigour; and Summer, the season of *progress*, in which nature puts forth all her energies, to increase and multiply varieties of productions. Now we contemplate Autumn, the season of *fruition*, in which nature, bringing every plant to perfection, provides for the ensuing year sustenance for man and beast.

Study of the Seasons.—While the natural action of spring and summer is single, that of autumn has a compound character. "Thus, if we follow out the study of the autumn in a proper manner, it leads us to all the revolutions that have taken place in the surface of our planet; and in this way a plant of which we can, in a few months, see the beginning, the perfection, and the decay, becomes to us an epitome of the system of growing nature in its widest extent and through its most prolonged duration. This is the grand advantage which studying the productions of nature in their connection, and the events and occurrences of nature in their succession, has over the mere observations of the individual substance and the passing moment; and it is this which gives to the law of the seasons so high a value above all the beauties of the seasons taken in their individual character."

Rewards of Labour.—Autumn maturing its products, the toiling labours of the husbandman during the period of a year find their reward. In it, hope enjoys the possession of the thing hoped for; and the yield being plentiful, the husbandman is full of thankfulness. "It is this feeling which makes the principles of seasonal action thicken upon us as the year advances, and the autumn to become the harvest of knowledge, as well as the fruits of the earth. Nor can one help admiring that bountiful and beautiful wisdom which has laid the elements of instruction most abundantly in the grand season of plenty and gratitude."

Barometer Oscillations.—The phenomena accompanying the oscillations of the barometer of a general character, applicable to all seasons, are these: A fall of the mercury with a S. wind is invariably followed by rain in greater or less quantities. Great depressions are followed by change of wind, which becomes strong, and is followed by much rain. If the mercury rise with the wind at S.W., S., or even S.E., the temperature is high. A rising barometer with a S. wind is followed by fair weather; such a rise is of rare occurrence. Storms of wind, especially when accompanied with much rain, produce the greatest depression of the mercury. No great storm ever sets in with a steady rising barometer. If, after a storm of wind and rain, the mercury remain steady at the point to which it had fallen, serene weather may follow without a change of wind; but, on the rising of the mercury, rain may be expected on a change of wind. If the weather during harvest has been fine, and a fall of the mercury, with a shower, occur—if the wind turn a few points to the N., and the barometer rises above 30 inches—the weather may be expected to be fair for some days.

Wind.—In England the winds which blow for the greatest number of days together, without intermission, are the W. and W.S.W. The E. and E.N.E. are the winds next most prevalent. The W. winds surge mostly by night, and their average force is twice that of the E. winds. The E. winds are generally calm at night, but blow with some power during the day. On an average, sunrise and sunset are the periods of the 24 hours in which there is the least wind. An hour or two after noon is the period when the wind is the highest. As a general rule, when the wind turns against the sun, from W. to S., it is attended with a falling mercury; when it goes in the same direction as the sun, or turns direct from W. to N., the mercury rises, and there is a probability of fine weather. In high pressures the *upper* current usually sets from the N.; in low pressures it sets from the S. and S.W.

Rain.—The greatest average quantity of rain falls in October. The heaviest rains come down in summer and early autumn months. In summer, 1½ inch will sometimes fall in less than one hour in short and tempestuous torrents. In autumn the same quantity will occupy many hours in falling.

Clouds.—The *cirrus*-cloud is seen at all seasons of the year, and at all heights of the barometer. If the mercury be falling, its changes are rapid, and, on the approach of rain, its delicate texture becomes confused, and is ultimately lost in one dusky mass, resembling *ground glass.* The *cirro-stratus* is also seen at all seasons, and is the immediate precursor of rain or wind, and of a falling barometer. It is in this cloud that *halos, parhelia,* &c., are seen. The *cirro-cumulus* attends a rising barometer. *Coloured coronæ* have their origin in this cloud. The *cumulus* frequently attends a rising barometer. If on a fine morning this cloud suddenly disappear, and it be followed by a *cirro-stratus* cloud, with the wind tacking to the S., the mercury falls and rain soon follows. When the cumulus increases *after* sunset, with a ruddy copper-coloured hue, it denotes a thunderstorm. The effect of the *cumulo-stratus* cloud on the mercury gives it a tendency to rise. It indicates thunder-gusts, showers of hail, and sudden changes of the wind. It is the densest modification of cloud, and, in passing overhead, causes a reduction of temperature.

The *rain-cloud* is never seen with the barometer at great elevations. The rainbow is the lovely attendant of the nimbus *only.*

The *stratus* is the cloud nearest the ground. Calm weather is essential to its formation. It is frequent in fine autumnal nights and mornings, sometimes resting on the ground, sometimes hovering some hundred feet above it. It obscures the sun until his rays have raised the temperature of the air sufficiently to evaporate it, when it gradually disappears, and leaves a clear blue sky. The stratus deposits moisture. It is called the night-cloud, and is most frequent from September till January. It has no sensible effect on the barometer.

If the clouds are without any progressive motion, and increase rapidly, a storm in all probability will be in the vicinity; but if they move hurriedly towards any particular quarter of the heavens, the storm will be in the direction whither the clouds are seen to hasten: these signs of thunder are seen though the storm may be 150 miles distant. In certain states of the atmosphere, when the clouds rise confusedly, and change their forms abruptly, it is difficult for the inexperienced to classify them.

Autumn Flora.—The autumnal *flora* consists of Michaelmas daisies, starworts, and other late-blowing plants, with their companions the fungi and mushrooms, which are a remarkable class of vegetable productions.

Autumn Folk-lore.—The following is folk-lore connected with the months of autumn :—

Dry August and warm, doth harvest no harm.

If the twenty-fourth of August be fair and clear,
Then hope for a prosperous autumn that year.

September, blow soft, till the fruit's in the loft.

A good October, and a good blast,
To blow the hog acorn and mast.

In October dung your field,
And your land its wealth shall yield.

Many haws, many snaws.
Many sloes, many cold toes.

Autumn Work.

Harvest.—The great work of autumn is the harvesting of the corn crops. This necessarily engrosses the entire time and attention of the farmer and his assistants until these perishable crops are secured beyond danger in the stack-yard.

Weather and Harvest.—During this eventful period of a month at least, the farmer looks night and day at "the face of the sky," consults his glass, and fear or hope inspires him according to its indications. And no wonder, for the results of a whole year of labour are at stake on the exigency of the weather, and he feels that unless he exercise his best skill and judgment, he will not be satisfied with himself. Still none does more hopefully go to his great task than the farmer :—

"The wind, the rain, the sun,
Their genial task have done.
Wouldst thou be fed?
Man, to thy labour bow,
Thrust in thy sickle now,
Reap where thou once didst plough,
God sends thee bread."
—*James Montgomery.*

When every straw is safe in the stack-yard, and he has closed its gate for the season, the farmer is satisfied that his task is finished, and he may now enjoy repose.

Magnitude of Harvest-work.—The labour of harvesting a crop is almost incredible. Only conceive the entire cereal crop of such a nation as this reaped, carried, and stored in minute sheaves, in the course of one single month! Then, besides the harvest of the cereal plants, the leguminous, as well as the root crops, are stored in autumn; for although the turnips are not wholly removed from the ground at once, like other crops, they are stripped and prepared for winter use.

Autumn Anomalies.—Some curious anomalies in farm labour occur in autumn. One is sowing a new crop of wheat, while the matured one of the same grain is being reaped; another, that while spring is the natural season for the reproduction of animals, autumn is that for the reproduction of sheep.

Field-sports.—The sports of the field commence in August. The gatherings on the hills in thousands on the historic "Twelfth" of August, in quest of the unique-flavoured red grouse, *Lagopus scoticus*—of which Scotland should be proud as its only *indigène*—find a welcome home in shielings, which, at other seasons, would be contemned by their luxurious urban occupiers. Partridge-shooting comes in September, at times before the corn is cut down. Hare-hunting finds ample room by October. Last of all, the attractive "music" of the pack gathers around it, from hill and dale, all the active Nimrods of the country. At this season, however, the farmer is too much occupied in his precious work to bestow time on field-sports.

Autumn Crops.—Several crops sown in autumn succeed in England, but few can be sown in Scotland at that season with safety. Most of the forage plants sown in autumn in England, for affording early food in spring—as crimson clover, winter tares, &c.—would not withstand a Scottish winter; and some plants sown in England, on stubble-ground—as the stone turnip and rape—could not be sown so late in Scotland.

The harvest in England is from two to three weeks earlier, the stubble is bare so much earlier, and the land is in a comparatively drier state, and may be worked to advantage before the wet weather sets in at the latter part of autumn. The later harvest in Scotland, and the earlier winter, would not as a rule permit working stubble after a grain crop; and there is but little done in Scotland in the way of growing winter forage crops.[1]

SOWING CRIMSON CLOVER.

The crimson clover, *Trifolium incarnatum*, is one of the most beautiful plants cultivated in the field. Its stem rises to 18 inches or two feet in height, with spikes of tapering, nodding, brilliant scarlet-coloured flowers. It was long cultivated in the garden as a border annual. It is an excellent forage plant, and when sown in autumn, so quick is its growth, that it affords the earliest cutting in spring of any plant of its age. In Scotland it is useless to attempt its cultivation except as a garden plant, damp autumns and winter frosts never permitting it to come to a good result. It is successfully grown in some parts of Ireland.

Culture in England.—Trifolium is grown largely in the south of England. It produces the best results on soils of a loamy nature; but on thin, poor, high-lying land the plant appears quite out of place.

Of all known plants it is best suited for the stubble of a cereal crop in England. "There," observes Lawson, "it has been found to succeed best, either drilled in summer in rows of from 8 inches to one foot distant, or sown in autumn in broadcast on stubble, after the corn crop has been removed, and with no previous preparation save one harrowing or two, so that the seed may be the more easily covered. In very tenacious soils a very shallow ploughing is given, but in general it is found better to dispense with the ploughing altogether; for the many failures which occurred previous to its culture being properly understood, are now attributed entirely to the ground having been too much loosened and pulverised by repeated ploughings."[2] It is better, therefore, to dispense with ploughing altogether, as the plant takes best in a firm bed.

Seed.—In England, from 20 lb. to 28 lb. of seed are sown per acre broadcast; and the quantity is increased or lessened according to the nature of the climate and soil.

From the beginning of August till the first week of September is the best time to sow.

Crimson clover ripens its seed easily in England; and English seed of the first year after importation is the best, being heavier and more free of the seeds of weeds than the foreign seed.

As a Forage Crop.—When sown in autumn, the entire crop may be grown, cut down, and cleared off by June following, allowing the ground to be worked up for late turnips, to be consumed in autumn. When cut in full flower, it makes hay much relished by horses, and its entire yield is said to be more than the common clovers. It is better suited to sow on stubbles than even the stone turnip. It is more rapid in its growth than winter tares. On light land a crop of buckwheat may be readily obtained after it. Italian rye-grass may be sown with it, and will grow as rapidly. After the crimson clover has been cut, the rye-grass will continue to grow and afford an excellent second crop.

The crimson clover, having the property of smothering early weeds, is not well suited for sowing among a corn crop.[3]

Late Variety.—A variety of crimson clover named by the French *tardif*, or late-flowering, was introduced to notice in France about 1836. If sown at the same time as the common variety in autumn, it will flower next season after that has yielded its crop, and thus form a valuable successor. Its characteristics are lateness of flowering and tallness, with vigour of growth.

[1] See Divisional vol. iii. pp. 253-260.

[2] Lawson's *Agric. Man.*, 154.

[3] Rham's *Dict. of the Farm*—art. "Clover."

Extra late Variety.—A few years ago Messrs Sutton & Sons, of Reading, introduced another variety, called Extra Late Red (*Trifolium incarnatum tardissimum*), which usually comes in from ten days to a fortnight after *T. tardif*, thus prolonging the supply of this valuable forage crop up to midsummer. The Extra Late Red has a special value on account of its suitability for filling up deficient clover leys, as if sown after the corn is off it is ready for cutting with the clover sown in the previous spring.

White Variety.—A fourth variety, with white flowers) Late White Trifolium), which comes in about the same time as *T. tardif*, is also spoken of favourably by some growers.

HARVESTING RED-CLOVER SEED.

Red-clover seed, *Trifolium pratense*, not being sown alone among the corn crops in Scotland, cannot there be reserved for growing seed, though the climate in some seasons would ripen it. We have gathered its seeds in Scotland as fine as any grown in England. In England the rye-grass, *Lolium perenne*, is not so great in favour as a forage plant, as in Scotland; so that red clover without rye-grass is common, although not intended to bear seed.

Where red clover is raised for seed, the seed is sown alone. Were it to stand for seed at the first cutting, when the blossoms do not appear simultaneously, the seed of one plant would be matured, while that of another would be scarcely formed. At the second cutting the flowers blossom at one time, and the plants attain the same height, the crop appearing one of the richest description in our fields. The first cutting in ordinary practice is delayed until the plant is in full bloom, and sometimes till the bloom has begun to decay; so no surprise need be felt when a full second cutting is not obtained after such treatment.

When the seed is imported from Holland or France, a full crop is obtained only in the first cutting, for a good second cutting from such seed never occurs. The want of a second cutting may thus be accounted for in cases where foreign seed has been sown unknowingly by the farmer.

To secure a good second cutting, no foreign seed should be sown, and the first crop should be cut before the plant comes into bloom; or sheep might eat down the crop by the end of May or beginning of June, when the second growth will come away thick and vigorously.

The red clover is injured by insects when in bloom.

Cutting and Drying.—When the blooms of the plants become withered, the crop should be cut down with the sickle or scythe, likely at the end of August or beginning of September. If put together in heaps, a slight degree of heating will cause the seed to leave the husk more readily on being threshed; and on the heated heaps being spread out to the sun, the crop will soon be dry enough to lead home to the steading, to be threshed with the flail or threshing-machine.

When the weather is good this plan may be adopted, but should it prove damp the crop should be sheafed, and set into stooks to dry, and afterwards carried to the stackyard and built into stacks, to be threshed at a convenient time. There is little danger of the seed falling from its husk, as it is difficult to thresh out; but the heating recommended renders the husk brittle, and easily broken by threshing.

Threshing.—Where a large quantity is cultivated for seed, the threshing-machine should take out the seed; but of a small quantity a considerable proportion of the seed might be lost in the mill, so the flails should be used. In the threshing-machine the fanners blow away the husky light matter, while the heavy seed falls down the corn-spout, from which it is sifted through a sieve, to free it of dust and sand and blind husks. It is then measured by the bushel.

SOWING ITALIAN RYE-GRASS.

Italian rye-grass, *Lolium italicum*, growing rank and quick, is not so well suited for sowing among a corn crop as by itself when used as a forage crop. Its nature certainly indicates that it is better adapted for a forage than a pasture plant.

Sowing for Forage.—As a forage crop it should be sown by itself in a portion of the dunged fallow land in August, or the middle of September at latest, that it may acquire sufficient strength to stand the winter. It may be sown broadcast, there being no use of drilling it, since it will grow as early in spring as any weed, and will outstrip it in growth.

Seed.—From its natural tendency to produce many stalks from the same root, and its upright habit of growth, not forming a close turf, it should be sown thick, especially in autumn, to stand the winter —3 to 4 bushels per acre, to have plants enough in spring for an early cutting.

If the ground and weather are dry in spring, the roller should smoothen the surface.

Produce.—The crop will be ready for cutting in May, and yield from 3 to 5 tons of forage per acre.

A new selection, Sutton's Evergreen Italian, has the advantage of producing a quicker and more luxuriant bottom growth than the ordinary variety, on which account it is rapidly superseding the latter, especially for early sheep feed in the spring.

Irrigation Crop.—Italian rye-grass is an extremely valuable crop for irrigated land. It is in general use on sewage farms throughout the country.

GRAIN HARVEST.

The joy of the harvest has been extolled by emotional writers in all ages. The merry whir of the modern reaper has drowned the dull hum of the primitive "shearing" of ancient times. By the genius of the inventor and the enterprise of the farmer the entire process of harvesting has been revolutionised. Yet with all those changes the glory of the harvest survives. And who would have it otherwise!

Beginning of Harvest.—The nature of the weather during the season has of course much to do with the date of the harvest, as well as with the character of the crop. As a rule, reaping begins with the winter wheat in England in the third or fourth week of July, and about the middle of August in Scotland. Between a late and an early season there may be a difference of three, or even four weeks. The pulse crops follow the cereal crops in ripening.

Stage for Cutting.

The propriety of cutting wheat and oats before they are dead ripe has been well established.

Experiments with Wheat.—Experiments conducted by John Hannam, North Deighton, Yorkshire, gave the following results with wheat:—

No. 1, reaped *quite green* on 12th August, and stacked 26th August, gave a return of £11, 17s. per acre.

No. 2, reaped *green* on 19th August, and stacked 31st August, returned £13, 6s.

No. 3, reaped *raw* on 26th August, and stacked 5th September, returned £14s. 18s.

No. 4, reaped *not quite so raw* on 30th August, and stacked 9th September, returned £14, 17s. 4d.

No. 5, reaped *ripe* on 9th September, and stacked 16th September, returned £13, 11s. 8d. per acre. Hence—

	Per acre.					
A *loss* of	£1	14	8	on No. 1	compared with	No. 5.
"	0	5	8	on No. 2	"	No. 5.
A *gain* of	1	6	4	on No. 3	"	No. 5.
"	1	5	8	on No. 4	"	No. 5.
"	3	1	0	on No. 3	"	No. 1.

Advantage of Early Cutting.—In this case wheat reaped two weeks before it was quite ripe gave an advantage in every point, namely:—

	Per cent.
In weight of gross produce, of . .	$13\frac{1}{5}$
" equal measures, nearly	½
" equal number of grains, nearly . .	2½
In quality and value, above .	3¼
In weight of straw, above .	5

Moreover, the straw was of better quality, while there was a better chance of securing the crop, as well as a saving in securing it.

Loss by too Early Cutting.—On the other hand, wheat, reaped one month before it was ripe, gave an advantage of 22 per cent in weight of straw compared with the ripe, but suffered disadvantage in every other point, namely :—

	Per cent.
In weight of gross produce, . .	$11\frac{5}{13}$
" equal measures, above	$\frac{1}{3}$
" equal number of grains, above, . . .	$13\frac{1}{6}$
In quality and quantity, above .	$\frac{4}{5}$

Potato-oats.—Upon one occasion we cut down a few stooks of potato-oats when quite green, though full in the ear, to allow carts to pass to a place destined for the site of a hay-stack, and after standing till the rest of the field was brought in, they were threshed with the flail by themselves, and the sample was the most beautiful grain we ever saw.

Ripening in the Sheaf.—If there is not too much of the ripening process to be accomplished when the cutting takes place, it will be successfully completed in the sheaf. It is a nice point to decide how much of the ripening may be left till after the grain is severed from the roots. Experience alone can be relied upon as the guide. There seems little doubt that the cut grain can do more in the way of ripening itself in the sheaf than is generally believed.

Seed Grain.—Grain intended for seed should not be cut until it is very nearly, if not quite, ripe. The riper it is the greater the vitality of the seed. If the weather is favourable, therefore, the portion of the crop intended for the production of seed should be left a little longer uncut.

Shedding or "Shaking."—One of the greatest risks of loss by allowing grain to become dead ripe before being cut is that of shedding or "shaking." Oats are particularly liable to loss in this way, both by wind and hail storms, before being cut, and by the shedding in the process of harvesting. From 10 to 30 per cent of the corn is often left on the ground in this manner, and the injury is all the greater since it happens that the plumpest and best matured grains are the most easily dislodged from the straw. With oats, therefore, it is especially desirable that early rather than late cutting should be the rule.

The greatest losses by shedding in oats usually take place when high wind follows rain and bright sunshine. After being swollen by the rain the chaff is thrown wide open by the sun, exposing the grain to the play of the wind.

Barley.—The stage at which barley should be cut has to be regulated mainly by the particular purpose for which the grain is intended. If it is to be used for feeding stock, or in the manufacturing of whisky, the crop should be cut just before it is fully ripe. If it is to be employed for brewing, especially for the production of the lighter coloured ales, the crop should be left uncut until it is dead ripe. For brewing, the value of barley depends greatly upon its colour, which, for this purpose, should be as bright as possible, not "steely-white" or gritty-looking, but a pure soft white, with a very slight golden tinge. The deep golden colour so common in barley grown in Scotland and the north of England, renders it unfit for the manufacture of light-coloured ales.

To secure this bright colour the barley in the south of England is left uncut until it is dead ripe, when very little drying is sufficient to prepare it for stacking or threshing.

The main object of the farmer who grows brewing barley is to shorten the drying period. While on the root, barley, although drenched with rain, will regain its bright colour to a wonderful extent; but after being cut it is liable to be permanently damaged in colour, even by one heavy shower of rain. The farmer, therefore, not only allows the grain to become dead ripe, but also lets the drying of the straw go on to a considerable extent before cutting the crop.

Happy Medium.—There is a happy medium in the time to begin cutting grain as in most things else. Much will depend upon the district, whether the season be late or early, and the weather good or bad. In late districts, in a backward season, it may be better to cut "on the green side," that is, to begin early, than to delay till the crop is more nearly ripe. In these cases there may be great danger of injury to the crop by inclement weather, perhaps by premature frost and snow, so that the prudent farmer will prefer to have a moderately ripened crop well preserved, than a well-ripened crop injured in the stook.

The exact time when cutting should begin is a matter which each individual farmer must, after careful contemplation, determine for himself every harvest as it comes round.

Ripening Process.—As a general rule, corn in a healthy state comes to maturity first in the ear, and then in the upper part of the straw downwards. When the straw becomes matured first at the root, the grain suffers premature decay; and when this is observed, the crop should be reaped, as it can derive no further benefit from the ground, and its grain will dry more speedily in the stook than on the root.

Judging Ripeness.—The most ready way of judging when the ear is ripe in wheat and oats is to note the state of the chaff in the ear, and two or three inches of the straw under the ear. If these parts are of a uniform straw-yellow colour, and feel hard in the ear of the oat, and prickly in the wheat, on being grasped, they are ripe. On examining the grain itself, it should feel firm under pressure between the finger and thumb, and the neck of the straw should yield no juice on being twisted with the fingers and thumbs.

Barley should be of a uniformly yellow colour in the grain and awns, and the rachis somewhat rigid; and as long as the head moves freely by a shake of the hand, neither the grain nor the straw is sufficiently ripe.

When very ripe, wheat bends its ear down, opening the chaff, becomes stiff in the neck of the straw, all clearly indicating that nature intends that the grain shall fall out. Red wheat is less liable to be shaken than white; but any kind will shake out when too ripe, provided the plant is in good health and the grain of good quality—for it is difficult to make immature grain leave the chaff even when hardened.

Degrees of Ripeness.—It might be supposed that when the ear and the entire straw are of uniformly yellow colour, the plant is no more than ripe; but by that time the straw has ripened to the root, and the ear become rigidly bent and ready to cast its seeds with the slightest wind. When the neck of the straw of barley is ripe, it is, as a rule, time to cut; and when too ripe the ear bends down, the awns, diverging, stand nearly at right angles with the rachis, and the whole head is easily snapped off by the wind. In oats, when over-ripe the chaff stands apart from the grain, which is easily shaken out by the wind.

It is not equally prudent to reap all sorts of grain at the same degree of maturity. When wheat is reaped too soon, it is apt to shrink, and have a bluish tint in the sample; and when too ripe, the chaff opens from the grain, which is apt to fall out on the least wind; and some sorts of white wheat are thus very subject to fall out, even before reaching the point of maturity. Barley, when reaped too soon, also shrinks, and assumes a bleached colour. Much less loss attends the reaping of oats too soon than the other grains.

Progress of Ripening.—In regard to the ripening of oats, Alexander Murray Nether Mill of Cruden, in Aberdeenshire, made experiments to ascertain not merely the natural progress towards ripeness, but the state of the grain at the different stages of ripening. He could distinguish 6 stages. The 1st stage was the lowest leaf, fig. 488, becoming yellow; the 2d, when the next leaf became yellow; the 3d, when the third leaf turned yellow; the 4th, when the uppermost leaf was yellow; the 5th stage was when the parts of the stem where the panicles are attached were still green; and the 6th was when the stem of the panicles became also yellow.

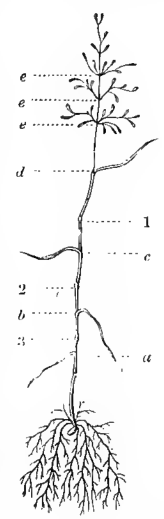


Fig. 488. — *Progress of ripening in a stalk of oats.*
a Lowest leaf.
b Next leaf.
c Third leaf.
d Uppermost leaf.
e e e Panicles where they join the stem.
1, 2, 3, The 3 uppermost joints of the stem.

The condition of the grain at each of these stages of ripeness was easily distinguished from each other, and then ripeness followed in consecutive order. Such was the rapid change effected in the condition of the grain between the 5th and 6th stages, that it acquired the additional weight of from 1½ lb. to 2 lb. in one bushel.[1]

Harvest Labour.

As harvest-work requires more labourers than live on the farm, a sufficient number have to be engaged to assist them. Farms near a large town may obtain the requisite number daily, and in these cases the labourers usually return to their own homes at night. These extra day-labourers are paid daily or weekly, according to arrangement. On farms at a distance from towns, no reliance can be placed for obtaining labourers at harvest. For them labourers are hired to remain all the harvest on or near the farm. Such labourers receive food daily, and their money wages are paid at the termination of the engagement. To obtain additional hands for a few days, when a large breadth of corn becomes suddenly ripe, from the peculiar state of the weather, and to enable hands to obtain harvest-work whose engagements are finished, or not yet begun, hiring-markets are held at numerous convenient centres early on Monday morning.

REAPING APPLIANCES.

Of the many appliances designed for the reaping of the corn crops three alone —the sickle (or hook), the scythe, and the reaping-machine—have been extensively employed. These three came into use in the order named, the first having as yet had the longest lease of life. Except on very small holdings and for odd purposes, the reaping-machine has entirely superseded both the sickle and the scythe, and in its many forms and developments is performing the work in an expeditious, satisfactory, and economical manner.

Sickle or "Hook."

As late as 1868, when the third edition of this work was being prepared for the press, the sickle was considered to be still employed so extensively as to warrant the retention of the detailed account given in former editions of the manner of reaping with the sickle. Since that time, however, the work of the harvest has been completely revolutionised. In most parts the scythe supplanted the sickle, and now the reaping-machine has driven both into disuse.

[1] *Trans. High. Agric. Soc.*, Jan. 1847, 624.

It is interesting to note that, in several parts of the country, the sickle survived until the reaping-machine was ready to take its place. In these parts the scythe never succeeded in obtaining a footing.

Form of Sickle.—Although the sickle has lost its position as an important farm tool, it will be of interest to reproduce the following notes and illustrations of the two forms, the toothed and the smooth-edged sickles, which were employed.

Toothed Sickle.—The toothed sickle is represented in fig. 489. It has a blade of iron, with an edging of steel. The teeth are formed by striking with a chisel and hammer, in the manner of file-cutting,

Fig. 489.—*Toothed sickle.*

the cutting being only on the lower side; but when the blade has been bent to the proper form, tempered, and ground on the smooth side, the serratures are brought prominently out on the edge of the blade; and as the striking of the teeth is performed in a position oblique to the edge of the blade, at an angle of about 70°, the serratures on the edge acquire what is called a *hook* towards the helve, thus causing the instrument to cut keenly in that direction when drawn through the standing corn. When the blade has been thus finished, a wooden helve of the simplest form is fitted upon the pointed tine at its root.

Smooth-edged Sickle.—The large, smooth-edged sickle, is represented in fig. 490. It has a curvature approaching very near to that which, in this implement, may be termed the *curve of least exertion;* and throughout that portion of the sickle which performs the cutting process, it possesses this peculiar property from the following circumstance, that lines diverging from the centre of the handle of the sickle, and intersecting the curve of the cutting edge, all the diverging lines will form equal angles with the tangents to the curve at the points of

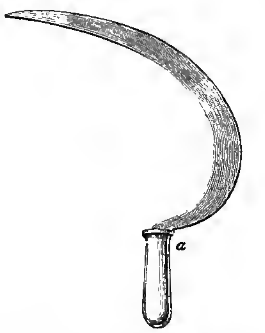


Fig. 490.—*Large smooth-edged sickle.*
a Centre of the handle of the sickle.

intersection. This property gives to the cutting edge a uniform tendency to cut at every point in its length without any other exertion than a direct *pull* upon the helve.

From these circumstances, it may be supposed that this is a much easier implement to cut with than the toothed sickle; and so it really is, but the dexterous use of either implement depends altogether on habit and practice.

Sickle still used.—Upon very small holdings the sickle is still in use in many parts of the country. It has this advantage, that women can work it as well as men, while, for the former, the scythe is not a suitable implement. Upon large farms, too, the sickle is sometimes employed in reaping portions of the crop which have been laid and twisted by stormy weather. As late as 1889 large fields in the Lothians of Scotland were on this account reaped by the sickle. It is a tedious and costly process, however, and should be resorted to only where it is impossible to work the reaping-machine or scythe with satisfaction.

Reaping by the sickle requires of course a larger supply of hand-labour than either scythe or machine reaping, the latter requiring least of all.

Thraving.—Reapers with the sickle were in most cases paid by piece-work—by so much per *thrave* cut. A thrave consists of two full stooks of corn, each stook of oats and barley consisting of 12 sheaves, and of wheat 14 sheaves, and each sheaf measuring 3 feet in circumference or 12 inches in diameter at the band. The proper size of sheaf was ascertained by a sheaf-gauge.

Sheaf-gauge.—This tool, as an object of curiosity, is shown in fig. 491. When used, the prong of the gauge embraces the sheaf when lying on the ground, along the band, and if the sides and top of the gauge slip easily down and touch the band, the sheaf is of the required size, the prongs being one foot long and one foot asunder inside.

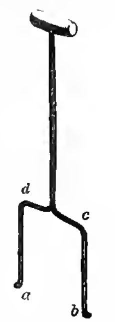


Fig. 491.—*Sheaf-gauge.*
a b c d Prong of gauge. *a b* Points of prong. *c d* Upper part of prong.

Scythe.

The scythe is a more expeditious tool than the sickle. With a given number of men and women, it enabled the farmer to cut down his crop much more speedily than was possible with the sickle. The introduction of the scythe therefore led to the general abandonment of the sickle. In certain parts, where there was an abundant supply of cheap labour, the sickle maintained its hold until the overwhelming superiority of the reaping-machine drove it into the limbo of forgotten things.

It is therefore true, though it may seem strange, that in certain districts the scythe was first used to cut "roads" for the reaping-machine.

Hainault Scythe.—Many different forms of the scythe have been employed. The Hainault or Flemish scythe may be regarded as an intermediate implement between the sickle and the cradle-scythe. It is held in the right hand by a handle 14 inches long, supported by the fore-finger, in a leather loop. The blade, 2 feet 3 inches in length, is kept steady in a horizontal position by a flat and projecting part of the handle, 4½ inches long, acting as a shield against the lower part of the wrist. The point of the blade is a little raised, and the entire edge

Fig. 492.—*Reaping with the Hainault scythe.*

bevelled upwards to avoid striking the surface of the ground. By fig. 492 an idea of the form of the Hainault scythe and its hook, and of the mode of using them in reaping corn as described, may be formed.

In 1825, the author of this work accompanied the Flemish reapers, Jean B. Dupré and Louis Catteau, through Forfarshire, and drew up a report of their proceedings in that county for the Highland and Agricultural Society. The impression on the farmers present was, that a saving of about one-fourth might be effected by the Hainault scythe in comparison with the common sickle; but it was not equal in its work to our cradle-scythe, and therefore never came into general use in this country.

Common Scythe.—The scythes used in this country still exhibit different forms. The helve or sned is usually made of wood, in two short branching arms, as shown in fig. 493, or in one long piece, as in fig. 494.

Cradle.—The cradle-scythe, once very common in the north-east of Scotland, is represented in fig. 493. In this form the scythe-blade is 3 feet 4 inches to 3 feet 6 inches long. The principal helve is 4 feet in length, to which the blade is attached in the usual way, the hook of the tine being sunk into the wood, and an iron ferrule brought down over the tine, binding it firmly to the wood, the blade being further supported by the addition of the light stay, the *grass-nail.* The minor helve, 3 feet in length, often much shorter, is tenoned into the principal, and the two handles are adjusted by wedges in the usual way to the height and mode of working of the mower, the distance between the helves at the handles being about 24 inches.

The *cradle* or rake consists of a little wooden standard, about 8 inches high, jointed to the heel of the blade, so as to fold a little up or down across the blade. Into this are inserted three or four slender teeth, following the direction of the blade, and from 6 to 15 inches long: the head of the standard is supported by a slender rod of iron, which stretches about 18 inches up the handle, where it is secured by a small screw-nut capable of being shifted up or down to alter the position of the standard and its teeth to suit the lay of the corn.

The function of the cradle was to carry the cut corn round with the sweep of the scythe. Except for a very short crop, however, the cradle is really not neces-

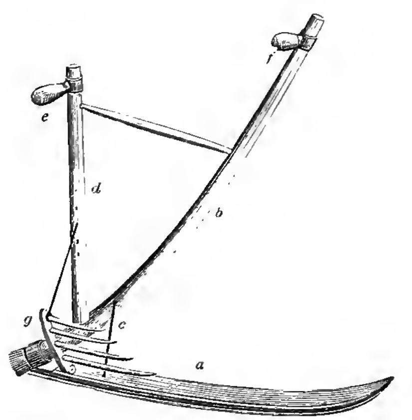


Fig. 493.—*Cradle-scythe for reaping.*

a Scythe-blade.
b Principal or left helve.
d Minor or right helve.
c Grass-nail.
e Right-hand handle.
f Left-hand handle.
g Cradle or rake with its stay.

sary, and was latterly to a large extent dispensed with.

Setting a Scythe.—In setting the blade, the following rule is observed: When the framed helves are laid flat on a level surface, the point of the blade should be from 18 to 20 inches above that surface, and measuring from a point on the left helve, 3 feet distant from the heel of the blade, in a straight line; the extremity of the blade should be also 3 feet distant from that point.

Iron Scythes.—Iron has, in many cases, been substituted for wood in the construction of the helves; but it is not by any means so well adapted to the purpose as the wooden helves. If iron helves are made sufficiently light there is too much elasticity in the fabric, which is fatiguing to the workman, by reason of the tremor produced at every stroke of the scythe; and if they are made sufficiently rigid, the scythe is too heavy for the workman.

Straight Sned.—The blade of the common scythe with the straight sned, fig. 494, is mounted on the same principle

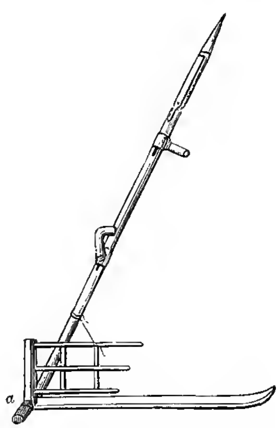


Fig. 494.—*Common reaping-scythe.*
a Cradle.

and the same manner as the blade of the bent sned, fig. 495. This scythe with the straight sned may also be mounted with a cradle, fixed on the head of the sned, and held in its position with a light stay between the cradle and the sned.

Sharpening Scythes.—When any of the scythes are used in reaping, the strickle and the scythe-stone are much in requisition. They should be used only as often as to keep a keen edge on the blade. Experienced reapers keep a "long" rather than a "short" edge on their scythes, and thus require less of the sharpening tools. An edge put on at a short angle is easily and speedily blunted.

Method of Scythe-reaping.—Although reaping with the scythe is now the exception, it may be useful to reproduce the following details as to the method of scythe-reaping.

Reaping with the scythe is best executed by the mowers being placed in *heads*—namely, one head of three scythemen, three gatherers, three bandsters, and one raker; or, as some would prefer, one head of two scythemen, two gatherers, two bandsters, and one raker.

A number of heads on the second arrangement may be employed on a large farm, while a small farm may employ one head on the first arrangement.

The best beginning of scythe-reaping a field is to mow the ridges parallel with the fences from the top to the bottom, or from the bottom to the top, as the corn happens to be laid; and if not laid, with the inclination of the corn by the wind. After this, both the head-ridges should be mown in the direction of the wind. Both acts can be done at once with two heads of mowers. Thus the four sides of the field are opened up, leaving angles of the standing corn to commence future operations across the ridges. Every head should be led by an experienced and steady mower.

Fig. 495 gives the arrangement of one head of work-people engaged in scythe-reaping, three scythemen being introduced to show the three different forms of scythes. The foremost mower has a scythe with a bent sned, the middle mower with a straight sned, and the hindmost with a cradle scythe. These all lay over the corn in equally beautiful swathes.

The women-gatherers follow each mower, making a band from the swathe, and laying as much of the swathe upon it as will make a sizable sheaf, and so carefully as to leave the ends of the bands free for the bandster to take hold of easily and quickly. The gatherer should be an active methodical person, otherwise she will make rough work.

The bandster follows her, and binds the sheaves, any two of the three bandsters setting the stook together; and in taking the sheaves across the ridges, the stooks should be set upon the same ridge, in order to their removal by the cart with the least trouble.

Last comes the raker, to clear the ground between the stooks with his large hand stubble-rake of all loose straws, and brings them to a bandster, who bundles them by themselves, and sets them at the side of a stook, and not at its end, to obstruct the ventilation of the air through it. When the mowing and gathering are properly executed, the rakings should not exceed from 4 to 5 per cent of the crop.

Speed with the Scythe.—The speed of the scythe is considerable. A good mower will cut an acre of wheat, or perhaps rather more, in one day; and from one and a half to two acres of oats and barley.

Another Method.—In some parts of the country it was the custom in cutting with the scythe to lay the swathe up against the standing corn, and to gather it while in that position. Why this mode of disposing of the swathe should be preferred to laying it flat on the ground, it is difficult to conjecture, unless to conceal the awkwardness of the mower, for not one single advantage does the method possess; while the disordered condition in which the corn is taken away by the gatherer from the standing corn, compared with lifting it clean from the flat ground, is of itself a sufficient objection to the practice.

Fig. 495.—*Mowing corn with the scythe.*

a a a Swathes of corn.
b b b 3 mowers.
c c c 3 gatherers.
d d Open sheaves.
e Bandster binding a sheaf.
f f Bandsters setting a stook.
g Stook.
h Man raker.
i Hand stubble-rake.
k Bound sheaf.

But the almost universal adoption of the reaping-machines has rendered it unnecessary for the present race of farmers to acquaint themselves with the working of either the sickle or the scythe, useful as these appliances have been in their day.

THE REAPING-MACHINE.

In all parts of the United Kingdom, and on almost all farms of any considerable size, the reaping-machine has superseded the slower and older appliances for cutting down the corn crops.

Historical.

Although it did not come into extensive use until near the middle of the nineteenth century, the reaping-machine is by no means a modern invention. It is indeed much older than is generally believed.

Ancient Machine.—Both Pliny and Palladius describe a reaping-machine worked by oxen, which was much used in the extensive, level plains of the Gauls.[1]

[1] *Dic. Gr. and Rom. Anti.*—art. "Agric."

Pliny's words are: "In the extensive plains of Gaul large hollow machines are employed, with teeth fixed to the fore-part, and they are pushed forward on two wheels through the standing corn by an ox yoked to the hind-part; the corn cut off by the teeth falls into the hollow part of the machine."

Nineteenth Century Machines.—It is known that before the advent of the nineteenth century several attempts had been made to devise a workable reaping-machine. No authentic information has come down to us as to the actual structure of these abortive machines.

But soon after the commencement of the nineteenth century, when agricultural improvements were making progress in every direction, and in particular by the extension of the use of improved machinery to the various branches of farming, active attention was successfully devoted to the invention of a reaping-machine. With the object of stimulating inventors, agricultural societies offered premiums, and we know that within the first twenty-five years of the century nearly a score of reaping-machines, less or more distinct in pattern, and invented by different men, were introduced into public notice in England and Scotland.

Boyce's Reaping-machine.—Very early in the century we learn of Boyce's reaping-machine, for which he secured a patent. This was based on the revolving-cutter principle; but the revolver was armed with a series of short scythes, which cut the corn as the machine moved along. It was destitute, however, of a proper apparatus for gathering and depositing the corn after being cut, and hence it never reached any degree of success.

Plunket's Reaping-machine.—About the same period, Plunket, a London implement-maker, made a similar attempt, also on the revolving principle; but in place of the scythe of Boyce, he adopted a circular cutter, toothed like a fine saw or sickle. Being also destitute of a proper gathering apparatus, this machine acquired no reputation, and speedily was laid aside.

Gladstone's Reaping-machine.—About the same time, 1806, Gladstone, a millwright, of Castle-Douglas, Kirkcudbrightshire, brought out a reaping-machine that excited much interest, and possessed considerable promise. Its principle was the revolving circular smooth-edged cutter, supported in a carriage-frame, with two main-wheels only. A pair of long horse-shafts projected forward at one side, so that the horse walked alongside the standing corn—thus *drawing* the machine. The circular cutter was ingeniously overlapped by a sort of shield, armed with pointed prongs, projecting in front of the cutter, which served to collect and to hold the straw until the cutter had done its work. A complicated and peculiar apparatus was applied as a gatherer, to collect and deliver the cut corn in small parcels like handfuls. This machine, as given in the *Farmer's Magazine*, vol. vii., appears to have possessed great ingenuity of contrivance as a whole. Its cutter also appears to have been formed on a sound principle; and it was, besides, provided with an apparatus by which the cutting edge could be whetted as often as necessary without stopping the action of the machine. Its gathering apparatus, however, carries too conclusive evidence that upon that member of the construction the whole design had failed, and the machine sank into oblivion like its predecessors.

Salmon's Reaping-machine.—At a still later period Mr Salmon of Woburn brought out a reaping-machine, under promising circumstances. In this there appears the first indications of a cutter on the clipping principle, combined with an apparatus for collecting and delivering, that promised to lay the cut corn in parcels like sheaves ready for binding. Although this invention seems to have been brought out under the most flattering hopes of success, it does not appear to have ever obtained the approbation of the class for whose use it was intended, and has been, like its precursors, almost forgotten.

Scott's Reaping-machine.—Soon after 1815 Mr Scott of Ormiston, East Lothian, factor to the Earl of Hopetoun, invented a machine which had a cutter acting on the revolving principle, though not a circular cutter, but a wheel carrying sixteen small-toothed sickles, and had projecting prongs in front of them, like Gladstone's. This machine was supplied with other contrivances, such as a brush to keep the cutters free of stubble or weeds, which might otherwise have stopped their proper action; but with all these precautions and auxiliary appendages, it never performed beyond a mere trial.

Ogle and Brown's Reaping-machine.—About 1822, Mr Ogle, at Renington, near Alnwick, invented a machine, by which he and a Mr Brown of Alnwick engaged to combine every act of reaping, except binding and placing the sheaves in stook. This machine is reported to have performed very satisfactorily in the field upon wheat and barley; but in consequence of no encouragement being given to the makers, the manufacture of the machine was dropped after the first complete specimen was made. The inventor, in 1826, published a drawing and description of the machine in the *Mechanics' Magazine*, vol. v., from which the following abstract is taken. The framework or body of the machine closely resembled a skeleton of a common cart, with its wheels and shafts, to the latter of which the horses were yoked to *draw* the machine, walking by the side of the standing corn. To the right of the carriage was projected the cutting apparatus —a light frame, whose front bar was of iron, and armed with a row of teeth 3 inches long, projecting forward; immediately upon these teeth lay the cutter, a straight-edged steel knife, equal in length to, and a little more than the breadth of, the corn to be cut at one passage. By a motion from the carriage-wheels, this knife was made to vibrate rapidly from right and left, as the machine travelled. Above, and a little before the cutter, a fan or vane was, from the same source, made to revolve, which thus collected and held the corn to be cut by the knife; and, on being cut, was by the vane carried backward, and laid upon a deal platform immediately behind the cutter: here, by the assistance of a man with a rake, it was collected to the extent of a sheaf, and then discharged.

There is here observable a very curious coincidence in the almost perfect sameness, in every point, between Ogle and Brown's machine and M'Cormick's American reapers, to be afterwards noticed. The similarity is so perfect, that the description of either would suit equally well for the other. But the curiosity of it is lessened from the consideration that similar coincidences are not uncommon amongst mechanists.

Kerr's Model of a Reaping-machine.—A case of this kind actually occurred at the period of Mr Smith's invention of his reaping-machine, in Mr A. Kerr, of Edinburgh, having produced a small model proposed as a reaper, in which the *cutter* and *gatherer* were exactly on the same principle as those of Mr Smith, and were admitted to be so by that gentleman.

Deanston Reaper.—Mr Smith of Deanston, afterwards so well known as an agriculturist, came on the field with his reaping-machine in the year 1812, with very considerable promise of success. He adopted the continuous rotatory action, and although his first trials were not altogether successful, they were such as led to a series of improvements that brought the machine to a degree of efficiency which promised ultimate success. The Dalkeith Farming Society had previously offered a handsome premium for the invention of an effective reaping-machine, and Mr Smith became the only competitor in 1812. In the following year the machine, in its improved state, was again exhibited in operation before a committee of the Dalkeith Club, when they, although not considering it entitled to the full premium, voted to Mr Smith a piece of plate, valne fifty guineas; and shortly after, the Highland and Agricultural Society having appointed a committee to examine and report on its efficiency, found that report so satisfactory that a piece of plate of fifty guineas' value was in like manner voted to the inventor, and at the same time a complete model of the machine was lodged by Mr Smith in the Society's Museum, and afterwards transferred to the Technological Museum.

Mr Smith introduced many improvements in his machine between 1812 and 1835. In the latter year, in its improved form, it was brought out with renewed hopes of success at the Highland and Agricultural Society's Show at Ayr, where it was exhibited in operation with remarkable *éclat*. The experiment was made on a field of wheat in a fair condition for being cut by a machine. The operation began, not on the outside, as was usual, but right in the middle of the field. The passage of the machine through the field left behind it an open lane, where nothing was at first observable but a bare stubble, the cut corn being all laid down at one side against the standing. Never, perhaps, did an experiment come off with better effect or greater success; the general impression was that the problem had at last been solved—that Smith's machine was complete. Not so was it, however, in fact; for, notwithstanding the striking effects produced by that day's trial, the machine remained, and to this day remains, without making further progress.

It is more than probable that the failure of this machine rested mainly on the following defective points: 1st, from its great length and weight it was unwieldy in all its movements; 2d, from its great length, also, and from the mode of attachment of the horses, together with the want of a swivel-carriage either before or behind, it was defective in turning at a landing; 3d, from the small diameter of the bearing front wheels, and especially from these being placed nearly directly under the centre of the revolving cutter, this important member, when these wheels fell into a furrow, ran right into the brow of the adjacent ridge, and thus destroyed for the time its whole edge, its projection before the wheels being nearly 2½ feet; and 4th, it may be stated as an objection, that the price could not be much under £50.

Mann's Reaping - machine. — Mr Joseph Mann, Raby, Cumberland, brought out a reaping-machine in 1820, in the state of a working model, before the Abbey Holme Agricultural Society, who expressed their approbation of the design, and advised a horse-power machine to be constructed with some proposed alterations, one of which was that the horses should *push* instead of *draw* the machine, the model having been upon the drawing principle. These alterations seemed to have turned out rather unsuccessful, for in 1822 a full-size machine was exhibited to the same society. But the mechanist having endeavoured to satisfy too many opinions, his machine became so complicated that its success was doubtful, and it fell aside till 1826, when Mr Mann returned to his favourite method of *drawing* instead of pushing. From this period to 1830 he was, from time to time, engaged in completing his improved design, and his improved machine was exhibited at the Highland and Agricultural Society's Show held at Kelso in 1832. On this occasion we had ample opportunity of studying its construction, and also witnessed its trial on a small portion of a field of oats, performed under very unfavourable circumstances. On the whole, although the trial called forth much approbation, the judges could not take upon them to recommend a premium. Yet it is our opinion that the principles of that machine, in the hands of an able mechanician possessed of capital (for of that commodity, like many others of his kind, the inventor was deficient), might have placed it foremost in the competition for the solution of the problem.[1]

First Effective Reaping-machine.

Of all the reapers hitherto taken notice of in this work, it is believed that not one of them was ever worked throughout a harvest. Even Smith's and Mann's machines, which were the most perfect, do not appear to have been worked beyond a few hours consecutively. Their actual capabilities, therefore, seem never to have been properly tested.

Bell's Reaping-machine.—The year 1826 may be held as an era in the history of this machine, by the invention, and the perfecting as well, of the first really effective mechanical reaper. This invention is due to the Rev. Patrick Bell, minister of the parish of Carmylie in Forfarshire.

The principle on which its cutting operation acts is that of a series of clipping shears. When the machine had been completed, Mr Bell brought it before the Highland and Agricultural Society, who appointed a committee of its members to inspect its operation in the field, and to report. The trials and the report being favourable, the Society awarded the sum of £50 to Mr Bell for his invention, and a correct working-model of the machine was subsequently placed in the Society's Museum. The invention shortly worked its way to a

[1] *Jour. Agric.*, i. 250.

considerable extent in Forfarshire; and in the harvest of 1834, we, in a short tour through that county, saw several of these machines in operation, which did

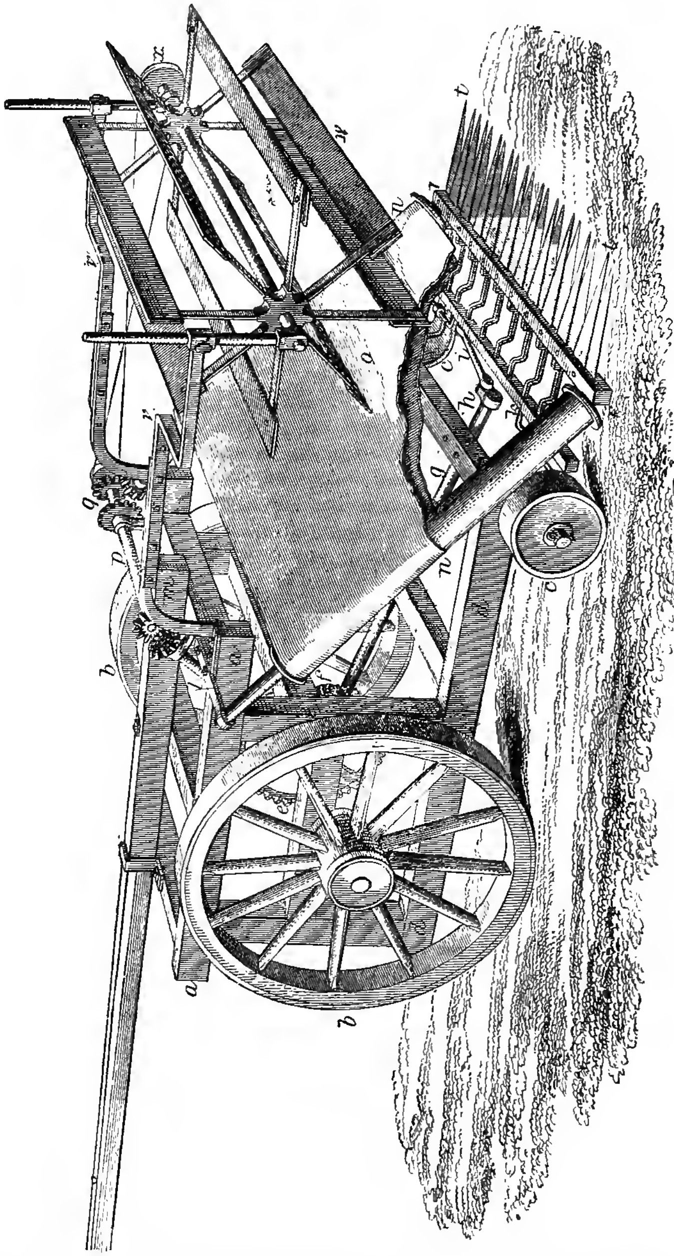


Fig. 496.—*Bell's reaping-machine.*

their work in a very satisfactory manner. Dundee appears to have been the principal seat of their manufacture, and from thence they were sent to various parts of the country. It is known, also, that *four* of the machines were sent to the United States of America; and this circumstance renders it highly probable that they became the models from which the numerous so-called inventions of the American reapers have since sprung. At the great fair or exhibition held at New York in 1851, not fewer than six reapers were exhibited, all by different hands, and each claiming to be a special invention; yet, in all of them, the principal feature—the *cutting* apparatus—bears the strongest evidence of having been copied from Bell's machine.

Construction.—To enable readers to form a just conception of the construction and principles of Bell's machine, and to compare it with other early attempts, a plate is given, showing a full view, in perspective, of Bell's reaper in its most genuine form. The machine consists, first, of an open carriage-framework of carpentry about 4 feet wide, the same in length, and about 3 feet high, marked *a a* in fig. 496. This is supported on two principal wheels, *b b*, about 4 feet in diameter, and two minor wheels, *c c*, 18 inches in diameter, supporting the forepart of the carriage, to the front bar of which the cutting apparatus is attached. The axle of the main wheels, *b b*, passes quite through the carriage-frame, and supports it by turning in bearings fixed to the middle horizontal bars on either side. On this axle is fixed a bevel-wheel, *e*, 20 inches in diameter, turning with the main wheels and axle and gearing into the bevel-pinion, *f*, fixed upon the sloping shaft, *g*, which, at its lower end, carries a short crank, *h*. This last, by means of the connecting-rod, *i*, gives the vibrating motion to the cutter-tail bar, *k*, to which bar the tails of the movable blades of the series of shears are loosely jointed.

The bevel-wheel, *e*, gives motion also to the small sloping shaft, *l*, through a pinion not seen in the figure; and at the upper end of this shaft, by means of the two small mitre-wheels, *m*, motion is given to a small horizontal shaft, *p*, on the end of which a combination of three bevel-wheels and clutch at *q* gives motion to the first web-roller, making the web, *o* (which is here represented as torn off to expose the parts below), revolve to right or left, as desired. The web, *o*, when in action, is stretched over the two rollers, *n n*. The light iron bars, *v v*, serve to carry the revolving fly, *w*, or vane to collect and carry the cut corn to the web. The vane, *w*, derives its motion from a pulley fixed on the extreme end of the small shaft, *p*, another, *x*, being fixed on the extremity of the axle of the vane, *w*; and a small band passing round these pulleys completes the motion. The vane, *w*, is readily adjustable upon the light arms, *v v*, to suit any height of grain, and also in distance horizontally, to suit the delivery of the cut grain upon the web, *o*.

This machine was worked by two horses, pushing it before them by means of the pole, *s*, to which they were yoked by the common draught-bars.

The cutter consists of a fixed bar of iron, *r r*, 6 feet in length, so that it projects over and clears a passage for all the bearing-wheels and other projecting points in the machine. The bar is strongly attached to the fore-part of the framework by two iron brackets, and to the bar are firmly bolted the thirteen fixed blades of the shears. The twelve movable blades are likewise attached to the same bar, each upon a joint-bolt. Each of these last blades is prolonged backward in a tail-piece, till they rest in the vibrating bar, *k*, where the extremity of each tail rests between two pegs, which serve as a secure but simple and loose joint for it.

The revolving vane, *w*, in front serves to catch hold of and retain the corn against the onward pressure of the cutter; but their chief duty is to assist in laying the cut corn upon the endless web, *o*. The duties of the web are very simple, being merely to convey the cut corn to right or left, and to deliver it upon the ground, which it does with a regularity perfectly sufficient for the purpose of being gathered into sheaves.

Work done.—In the process of working this machine, Mr Bell's practice was to employ one man driving and conducting the machine; eight women are required to collect the cut corn into sheaves, and to make bands for these sheaves; four men to bind the sheaves, and two men to set the sheaves up in stooks—being in all fourteen labourers, besides the driver of the horses, whose time reckons along with them; and the work performed averaged 12 imperial acres per day. These data were obtained from fourteen years' experience of the machine, and are therefore reliable.

Cost of Reaping.—The expense in money for reaping by this machine about 1835 averaged 3s. 6d. an acre, including the expense of food to the workers. This, in round numbers, was a saving of one-half the usual expense of reaping by hand, at the lowest calculation; and the saving on a farm where there might be 100 acres of cereal and leguminous crop would do more than cover the price of a machine of the best quality in two years.

Slow Progress of Bell's Reaper.—It is difficult to account for the fact that Bell's machine was not more extensively adopted. For a period of nearly twenty years it was successfully used; and yet, with practical agriculturists, it did not seem to gain so high a reputation as its American rivals—the machines of Hussey and M'Cormick—yet to be described.

Merits and Faults of Bell's Reaper.—"There have always," says the Report of the Royal Agricultural Society on the exhibition and trial of implements at Chelmsford (1856), "been some points of excellence in Bell's machine not shared by any other. The power of cutting in any direction, of delivering the corn on either side, right or left, and of requiring no scytheman to prepare its way, are advantages peculiar to this machine. These have hitherto been considered as counterbalanced by the excessive draught of the machine, by the liability of the delivery-web to become disordered, and by the

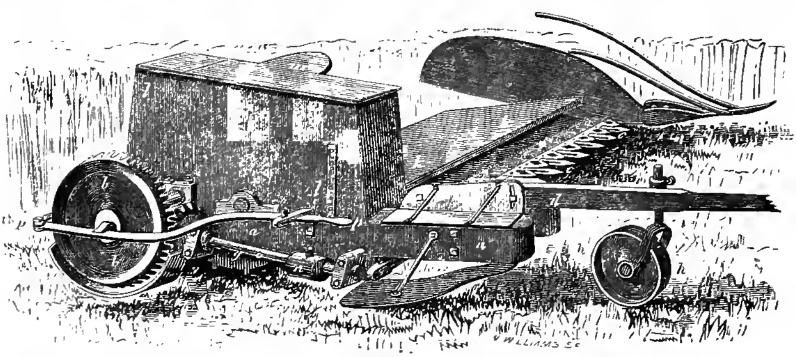


Fig. 497.—*Dray's Hussey reaping-machine in perspective.*

labour and difficulty of steerage. These drawbacks have, since last year, been in a considerable degree removed. The delivery-web has been superseded by three gutta-percha bands, which, without deducting from its former efficient delivery, has reduced friction and greatly diminished draught. Other minor alterations have been made, still further diminishing draught."

Subsequent makers improved on Bell's machine, and now it exists only as the groundwork of the modern reaper.

American Machines.

The two machines which, perhaps, did most to popularise the reaping-machine in this country were both introduced from America. They were known as Hussey's and M'Cormick's machines—Hussey's being manufactured by Messrs Dray & Co., engineers, of Swan Lane, London Bridge, London; M'Cormick's by Messrs Burgess & Key, Newgate Street, London. These firms introduced great improvements in the machines which they respectively manufactured, so much so, that there would be some difficulty in recognising in them the same machines, the appearance of which, at the Great Exhibition of 1851, created such an interest in the agricultural world.

Dray's Hussey Machine.—In fig. 497 we give a perspective view of Hussey's reaper, improved by Messrs Dray. The cost of this machine was £25.

M'Cormick's Reaping-machine.—In M'Cormick's reaper, with the improvements introduced by Messrs Burgess &

Key, Newgate Street, London, the cutting apparatus and driving-gear presented features somewhat similar to those of Hussey's machine. But while in Dray's machine the grain, after being cut, was delivered to a platform, the working of which required a special attendant, and the grain delivered to the ground in quantities sufficient to make a sheaf, was required to be immediately bound up in order to clear the path for the return journey of the machine—in Burgess & Key's the cut grain was at once delivered to a screw platform, and passed to the ground at the side of the machine. A special attendant was therefore not required, and the grain, moreover, being delivered at the side, could be left till the whole could be conveniently bound up.

In fig. 498 we give a perspective view of M'Cormick's machine, the cost of which was £42, 10s.

Modern Reaping-machines.

From these small beginnings in the invention and manufacture of reaping-machines a great industry has sprung

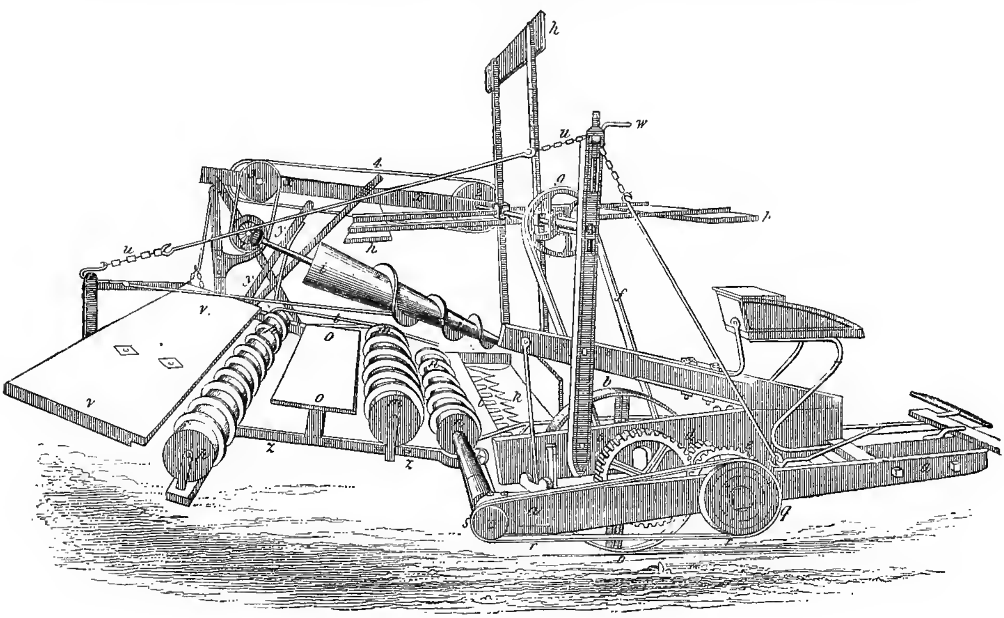


Fig. 498.—*M'Cormick's reaping-machine.*

up, from which the agriculture of this country has derived benefits of inestimable value. The firms in the United Kingdom who manufacture reaping-machines are now numbered by the hundred, and the larger firms send out several thousand machines every year.

Many improvements have been introduced with the view of simplifying the construction, reducing the draught, lessening the cost, and increasing the efficiency and general usefulness of the machines.

Varieties of Machines.—The reaping-machine is now produced in many forms, less or more distinct, suited for different purposes and different conditions of soil and climate. There are the simple mower, adapted merely for mowing hay and leaving it lying as it is cut; the combined mower and reaper, which may be arranged not only to cut the crop, but also to gather it into sheaves or swathes; the back-delivery, the side-delivery, the self-delivery, and the reaper in which the sheaves are turned off by the hand-rake. And last, and greatest of all, comes the combined reaper and binder, which is now an established success, performing its intricate and difficult work in a most admirable manner.

Draught.—Most reaping-machines are arranged for the draught of two horses. Some may be worked by one horse, and others occasionally require three horses.

Price.—The prices of the different reaping and mowing machines vary greatly, from £14 to £25, according to strength and other features. In recent years there has been a marked reduction in price, and this, accompanied by increased efficiency, has given a great impetus to the employment of machines in cutting the hay and corn crops. The combined reaper and binder costs from £38 to £45.

Perfect Workmanship.—The work accomplished by the leading reapers and mowers is now as nearly perfect as might be. Unless the crop is very seriously laid and twisted, the improved machine will pick it up and cut it from the ground in the most regular and tidy manner, leaving a short even stubble. Now and again a corn crop is laid and twisted by a storm so as to defeat the reaping-machine; but the possibilities of the modern machine are indeed wonderful.

Speed.—The speed of the reaping-machines varies considerably, according to the width and general make of the machine, the character of the ground and the crop, and the horses employed. The extent reaped in a day of ten to twelve hours would perhaps run from 8 to 14 acres, the greatest breadth of course being cut where the machine can work continuously along all sides of the field. This, however, is possible only when the crop stands tolerably erect. If a strong wind is blowing, or if the crop is bent to a considerable extent, it is advisable, to ensure good work, to cut only in one direction—against the "lie" of the crop. The machine in this case returns "empty" and out of gear; and it is not all lost time that is employed in the return journey—for the relaxation is appreciated by and is beneficial to the horses, which can thus go at a smarter pace when reaping and work longer without being fatigued.

Force employed.—The force of labourers required to keep a reaping-machine going varies chiefly with the rate of the reaping and weight of the crop, but partly also with the form of the machine, whether for self or manual delivery. With the self-delivery reaper one man to drive the horses is sufficient on or at the machine. The manual-delivery reaper requires an experienced and careful person to deliver the sheaves, and a man or lad to drive the horses.

To "lift" the sheaves, bind, and stook them, from six to ten persons will be required, according to the rate of reaping and the weight and bulk of the crop. It is the custom in some parts to have boys making bands, women lifting the sheaves on to the bands, and men to bind and stook. In other cases women make bands, lift and bind, the stooking being done by men. In many parts, chiefly in the south of England, men do all the manual harvest-work.

In many cases the raking is now accomplished by a rake attached to the rear of the reaper. When this is not provided the work has to be done by a horse-rake, or by a rake drawn by a man or lad.

Cost of Reaping.—The cost of reaping grain by the reaping-machine, including cutting, binding, stooking (or shock-

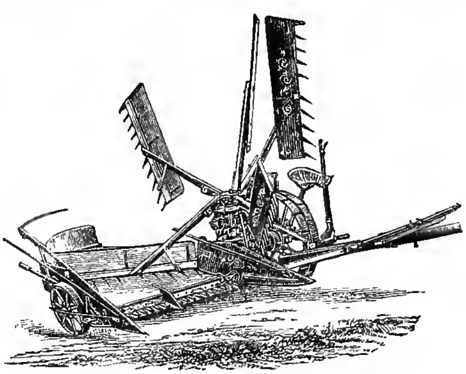


Fig. 499.—*Harrison and M'Gregor's self-raking reaper.*

ing), and raking, will vary with the rate of wages, the nature of the ground and the crop, the rate of reaping, and the character of the machine, from about 8s. to 12s. per acre. Much depends upon the season—for it is obvious that when the crop is standing erect, so that it can be cut continuously around the field, the speed must be greater and the cost less. Then a heavy crop may require one couple

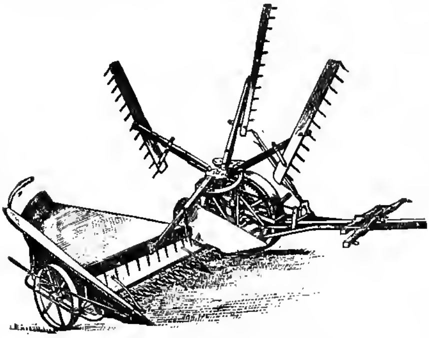


Fig. 500.—*Howard's self-delivery reaper.*

more to lift and bind and stook than would suffice for a light crop. See cost of working the binder and reaper, pp. 84, 85.

It is well established that, by the introduction of the improved reaping-machine, the work of cutting the grain crops has been not only much accelerated, but also in most cases to some extent lessened in cost.

Illustrations of Modern Machines.—It is not necessary to describe in detail the mechanism of improved reaping-machines. They are now so simple and efficient that any man of average intelligence and care can work them perfectly. It may be interesting, however, to glance at the illustrations of reaping and mowing machines presented in this section, and in that relating to "Haymaking," with the object of exhibiting some of the leading types of these admirable appliances now in use.

Fig. 458, p. 5, represents Howard's mower; fig. 459, p. 5, the "Munster" mower, made by R. & F. Keane, Cappoquin, County Waterford; fig. 460, p. 6, the "Victor" mower, made by Pierce & Co., Wexford; fig. 462, p. 7, the "Caledonian Buckeye" mower and

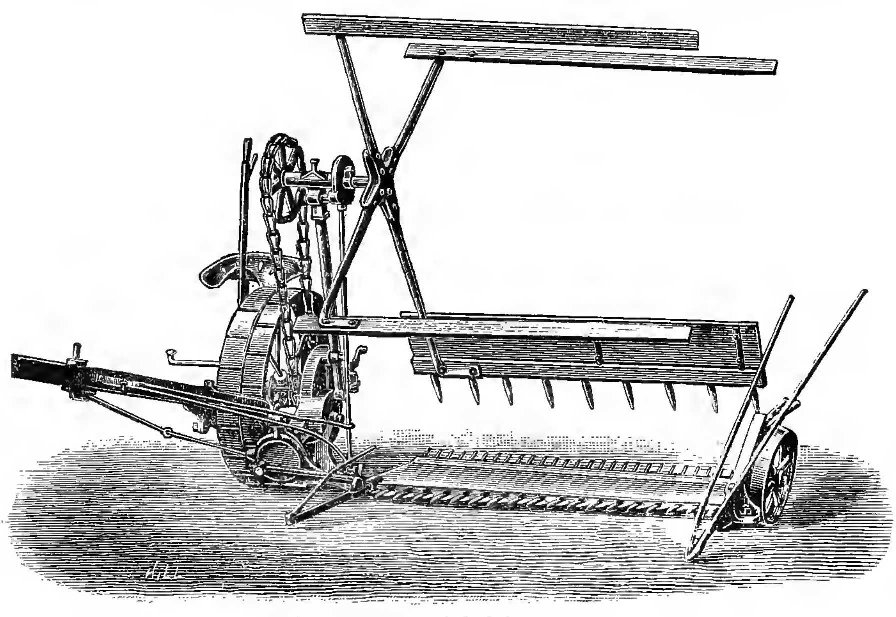


Fig. 501.—*Samuelson's back-delivery reaper.*

reaper, made by Alexander Jack & Sons, Maybole, Ayrshire; fig. 461, p. 7, the "Albion" mower, made by Harrison, M'Gregor, & Co., Leigh, Lancashire; fig. 499, the self-raking, side-delivery reaper, made by the same firm; fig. 500, the "Reliance" reaper, made by J. & F. Howard, Bedford; fig. 502, Walter A. Wood's self-delivery reaper; and fig. 501, back-delivery reaper, made by Samuelson & Co., Banbury.

PROCESS OF REAPING.

The detail-work of reaping corn with the machine varies considerably throughout the country. The process is not quite the same for the different varieties of grain even in any one district, and the climate and labour-customs are also responsible for differences in the methods of working.

Reaping Oats.

The main principles which should guide the farmer in arranging the practical work of reaping are applicable alike to wheat, barley, and oats; yet it will be convenient, in the first place, to describe the reaping of oats, and afterwards point out the distinctions relating to wheat and barley.

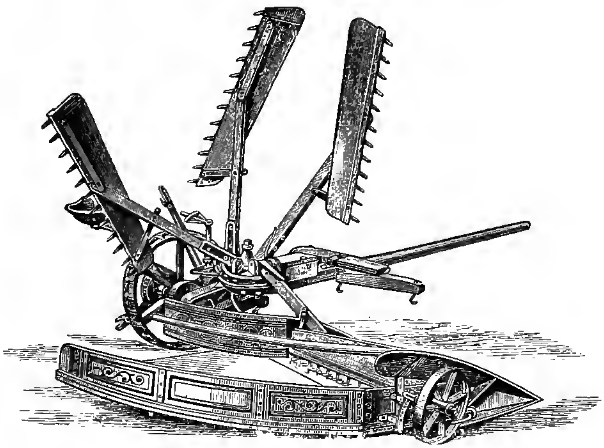


Fig. 502.—*Wood's self-delivery reaper.*

Preparing for Reaping.—A day or two before reaping is to be begun, "roads" for the reaping-machine should be cut with the scythe all round the field or section about to be cut. One cut of the scythe is usually considered sufficiently wide, but at the ends where the machine is to be turned it is more convenient to have the "road" two cuts wide. The corn cut out of the "roads" is tied into sheaves, which are laid against the fence and stooked with the main crop when it is being cut.

The scythe is the most convenient appliance with which to form "roads" for the reaping-machine, but in some parts the hook is still employed for this purpose.

In reference to the preparation and sharpening of reaping-machines, see p. 4 of this volume.

Manual and Self-delivery Machines.—Of the two main classes of reaping-machines, manual and self-delivery reapers, the former makes better work with heavy or tangled crops, but requires an extra man in working. In crops which are moderate in length and not much twisted, the self-delivery reaper, with the saving of one man's labour, is quite as efficient as the manual delivery.

Self-delivery Reapers.

Side-delivery Reapers.—Self-delivery reapers are of two classes, back and side delivery. In the former the sheaves are dropped behind the reaper in the same position as those left by the manual delivery, while in the latter they are deposited far enough to the side to permit of the machine passing, whether the sheaves are tied before it comes back again or not. With the side delivery a whole field may be cut without binding any sheaves, while they must be bound as the cutting proceeds if the back delivery or manual machine is used.

In the dry climate of the south and east of England it is often an advantage to cut a crop and let it lie a day or so before binding, hence side-delivery machines are those most in use there.

In Scotland, however, the climate is so uncertain, that a crop cannot advantageously be left unbound even for one day, because should it once get wet when lying loose, the difficulty of drying it again is so great, that it more than counterbalances any gain which might result from the method. In Scotland, therefore, the self-delivery reapers are nearly all of the back-delivery pattern, side-delivery ones being exceptionally rare.

Another point in favour of the system of binding immediately behind the machine is that in this way the labourers work more expeditiously than when they are not pressed by the reaper.

Manual *v.* Self-delivery Reapers.—In districts of Scotland having a moderate rainfall, and where, consequently, the grain crops are moderate or short in the straw, or where labour is comparatively scarce in harvest-time, the back-delivery reaper is the kind most largely used. Indeed, in the eastern counties the back-delivery machine is found everywhere. In the western and south-western counties, however, a self-delivery reaper is seldom seen, and very seldom do they work well; because in these districts the rainfall is heavy, the straw long and soft, while the whole country is more exposed to wind than on the eastern side of the watershed. The consequence is, that grain crops are usually laid and often much twisted, and in reaping much better work can be done with the manual than the self-delivery reaper.

Cutting.—In working with either the manual or self-delivery reaper, cutting may be done in two ways—either along one side of a field or round about. If the crop is not laid in one direction, the weather is moderately calm, and the crop mostly standing, the roundabout method is the best, as no time is lost returning.

Force of Labour.—If the crop is moderately ripe, and the straw dry and free from grass, so that fairly large sheaves may be made, each man binding may do from 3 to 5 roods per day, the extent depending very much on the size of the sheaves, the thickness of the crop, and the tidiness with which the work is done. In many districts of Scotland women do the bulk of the binding; and if the crop is light or the sheaves small, most women who know their work can do as much as the average of men. For heavy crops, however, where large sheaves are made, they are not so well suited, in which cases three women will be required for every two men, or it may even be two women for each man.

In reaping round about, the binders may be distributed in two ways: each may have a certain distance to do, or a certain number of sheaves to tie. If the crop is moderately regular, no better plan need be adopted than that of dividing the circumference of the field into equal divisions for each binder, and sticking a piece of wood into the ground where the one division ends and the other begins. When a binder has finished his or her number of sheaves in a swathe, a stoppage is made until the reaper again comes past, when the work is resumed.

By so doing, all unnecessary travelling backward and forward is done away with, and each binder gets a regular share of the good and bad parts of the crop in the field. In this system of working every one gets an equal share to do, and cannot avoid doing it; yet good as the system is where the binders are all on an equality, it is not a suitable one to adopt where there are inefficient persons or learners, as one slow person in the lot keeps back the whole squad.

The same system can, of course, be pursued where two or three reapers follow each other, if a corresponding number of binders can be obtained. If two machines are working, the driver of the second should start as soon as the first is half-way round, and the drivers should endeavour to keep as near as possible the half circumference of the field apart. In this system of harvesting each binder should properly clean up the ground where each sheaf has been made, before leaving the spot.

Raking.—A drag-rake similar to a hay-rake, but smaller, is often attached to each machine, which rakes the ground that was cut the swathe previous. In order to allow the rake to work, the sheaves as tied must be conveyed back from the standing grain fully two breadths of the reaper.

After every half-dozen swathes or so of the reaper, the marking-posts may be moved nearer to the side of the uncut grain, so that disputes may be prevented from arising among the binders as to who should or should not tie certain sheaves.

Another Method.—By the other system, where each binder has an equal number of sheaves, each begins near or where they ended the time previously, the number of sheaves, not the distance, regulating the place. This system is very well suited for comparatively small fields where the number of sheaves allotted to each binder is not very large, no larger than each binder can easily count his or her own share without moving backward to do so.

Occasionally the system of each binder having a certain number of sheaves is worked on the plan of allowing each to begin always at the same place—the counting of the sheaves being always begun at a certain point, usually a corner. By this method the last two binders should invariably be two of the best, and they should work together, so that if more than the regular number of sheaves are left to them, they can divide them between them. In this way two can easily work up an excess which would be too much for one; and if the driver takes careful note each time he passes of the quantity left for the last two, he can in the round following give them a little more or less by driving the next turn a little wider or narrower.

Of course, as the circumference of the uncut portion of the field becomes less, the number of sheaves to each binder must be reduced. If there is difficulty in making up the full complement of sheaves, the reaper should be driven to its full width; and if too many sheaves are left to the last two binders, a narrower swathe should be taken. By attending to these few details, there is very little difficulty in giving the exact number of sheaves to each binder; and as each travels back and begins at or near the same spot, any learners or less efficient workers may, without causing any derangement of the rest of the work, get a less number of sheaves than the others.

Detecting Bad Work.—Another advantage is that by this method each binder's sheaves are all together, so that the farmer can at once see if any one has been doing the work in a careless or slovenly manner; whereas by any of the other methods, it is impossible to say by whom the sheaves were bound and stooked after the first or second swathe.

Manual-delivery Reapers.

The manual-delivery reaper, however, is still strongly in favour. Its main advantage is that the man who puts off the sheaves can more readily accommodate himself to the different circumstances of the crop than any automatic apparatus yet devised can do.

Arranging the Force.—Where the cutting is round about, binding behind the manual-delivery reaper is of course exactly the same as if a side or back delivery machine were used. Most of the cutting with the manual-delivery machine is, however, done only along one side or end of a field. In this case the binders may have an equal or any number of sheaves each, or a certain distance.

Where the men putting off the sheaves know their work and attend to it, there is no difficulty in getting them to put off their sheaves to within one or two per cent of the same number every time, and under such circumstances a regular number of sheaves for each is the better plan.

If from inability of the men who put off the sheaves, or inequality of the crop, such cannot be done with moderate regularity, then the better plan is to measure off a certain distance for each binder. Even with measured distauces (a certain number of steps of the person in charge), annoyance occasionally arises between binders who are too exacting in what they should or should not do. A sheaf is probably dropped just on the division line, or it may be a little to the one side or the other, yet neither of the binders will own it. The farmer or person in charge must of course come along and say to whom it belongs; but in the interval the reaper has been stopped, and with it the work of ten, twenty, or more persons.

If two manual-delivery machines are

working together, the one should be just entering the swathe while the other is going out at the other end, so as to allow the binders an equal time to tie the sheaves behind each machine.

It will be the duty of whoever is in charge, be he farmer or overseer, to make sure that each binder gets an equal number of sheaves, and that they are efficiently bound.

The binders should waste no unnecessary time in gathering heads or straws, because if the lifting and binding are properly done, there should be few to gather.

In some cases it has been the custom to have the band-making and lifting done by women and lads, and with men following to bind and stook. It is more expeditious, however, for each labourer to combine the lifting and binding, and leave the stooking or shocking to another.

Bands and Binding.

The corn-band, fig. 503, is made by taking a handful of corn, dividing it into two parts, laying the corn-ends of the straw across each other, and twisting

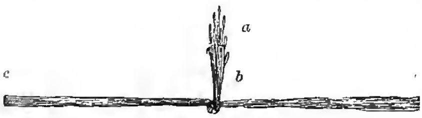


Fig. 503.—*Corn-band ready to receive the sheaf.*
a Corn-end of straw. *b* Twisted knot.
c c Band stretched out.

them round so that the ears shall lie above the twist—the twist acting as a knot, making the band firm. The reaper then lays the band stretched at length upon the ground, to receive the corn with the ears of the band and of the sheaf away from him.

When the band has been laid on the ground, the stubble-ends of the straw in the sheaf should be quickly squared by pushing up any straws that are too far down. The sheaf should then be rolled together from the side next the standing grain, caught firmly in the arms, laid in the band and bound, any loose straws at the cut end being pulled off as the sheaf is thrown to one side.

The bands should always be made of two lengths of straw, as under no circumstances can a single length be used advantageously. If the band is made of a single length of short straw, the ears are sure to be inside the knot, and if they once get wet, they are liable to grow before they are again dry. If the straw is very long, less can be said against the practice; but even then a few grains will come off the ears of the band into the hand every time a sheaf is tied. For one sheaf this does not look much, but for a whole day it amounts to a considerable quantity. If single lengths are used as bands, the roots of the straw, not the ears, should always be twisted in under the band, otherwise the loss from both sprouting and shedding will be even greater than by the other method, which is quite bad enough.

Method of Binding.—Going to the stubble-end of the sheaf, with his face to the corn-end, the binder gathers the spread corn on either side into the middle of the band with both hands, and, taking a hold of the band in each hand near the ends, he turns the sheaf as much round as to place the corn-ends beyond his left elbow; then, crossing the ends of the band, pulls forcibly with the right hand close to the sheaf, and keeps the purchase thus obtained with the under side of the left hand, while he carries the end in the right hand, below and behind his left hand; and then, taking both ends in both hands, twists them firmly and thrusts the twist under the band with the right hand, as far as to keep a firm hold. In a bound sheaf, the corn-knot in the middle of the band is held firm by the pressure of the sheaf against the ears of corn and the twisted part of the band.

Position of the Band.—The band should always be put on as near the middle of the sheaf as possible, never below the middle, but if anything above it. If put on much below the middle the top of the sheaf spreads out, instead of keeping close together, and if rain comes on the water runs down the centre of the sheaf instead of the outside of it; and a sheaf which has been once wetted at the centre, particularly a large one, rarely dries without being opened and spread, unless the circumstances are all the more favourable.

Size of Sheaves.

Although large sheaves add considerably to the speed with which a crop can be tied, they hinder materially the after-drying of the crop. In the end it will therefore be found the most profitable way to make the sheaves as small as possible, consistent with the length of the crop. In a short crop with grass among the straw, they should not be over 6 inches in diameter at the band, and in the longest and cleanest straw 10 inches will be quite sufficient.

Lifting broken Stalks.—If the crop is much twisted or tangled, each binder should carefully fold up the heads of the standing grain, if these are inclined to be broken down by the passage of the reaper. On some occasions this takes up considerable time, but it is advisable to have it done, because if the ears are not lifted up they are liable to be cut off by the next passage of the machine, and left on the ground instead of being secured in the sheaf. A young girl or lad is sometimes employed entirely at this work.

Raking.

Rakings from a grain field rarely leave much to the grower after all expenses of gathering are paid, because to begin with they are often dirty and full of stones, and, if once wetted, can rarely be thoroughly dried again. It is a good plan to let ewes or lambs have a run of the stubble ground after the crop has been removed.

A light drag-rake, hauled by a boy, is perhaps the best way of gathering the rakings, as a boy at a wage of from one to two shillings a-day can easily rake from 5 to 7 acres, whereas a man with a horse-rake will do little more than the double of that. If the boy rakes the ground between each row of stooks before the stubbles and straws are in any way trampled on by the horses' feet, few will be missed, and all will be clean.

A hand-rake, simple of construction, is shown in fig. 504. The head is 5 feet long, and should be made of good tough ash, 2½ by 2 inches; the helve 6 feet in height, of the same material, and furnished with a handle that can be fixed in any desired position by means of a ferule and wedge. The helve is tenoned into the head and strengthened by iron braces. The teeth are of steel or iron, 7 inches in length, and set at 4 inches apart, but formed in the lower part so that the bend rests on the ground, preventing their points penetrating and mixing the earth with the gleanings.

The best method of fixing the teeth is by a screw-nut, as in the horse-rake, as they are easily removed on being broken. It is advisable to have the ends of the head hooped with iron, to prevent splitting.

Although this is commonly called a hand-rake, it is really pulled by a leather strap, attached to the shaft and passed over the shoulder of the raker.

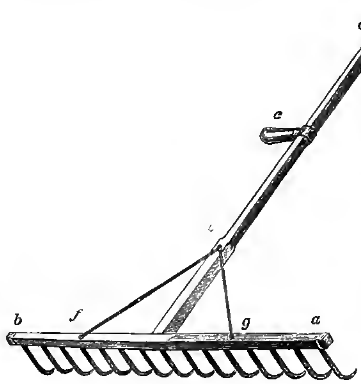


Fig. 504.—*Hand stubble-rake.*

a b Head of rake. *e* Handle.
c d Helve. *f c g* Iron braces.

If the machines are cutting only one way, in returning they must pass behind the second row of stooks, in order to give the raker time to rake the space between the first and second rows.

Drying Rakings.—The disposal of rakings during harvest operations has been a difficulty with many people. If put into sheaves or coils, they are liable to get wet and be more or less spoiled —in fact often wasted. Some farmers maintain that the best, least costly, and easiest way is for the raker to thrust each lot as gathered into the very centre of a stook. They must not be carelessly shoved in under the two end sheaves, because there the wind will blow the rain in on them, and they will be little more secure than if left outside; but they should be thrust as far in as to be clear of the end pair of sheaves. In this position they will be free from rain; and owing to the current of air through the stook they dry quickly, and at stacking time they can either be brought in along with the sheaves or by themselves.

Others, however, object to this plan, on the ground that the rakings placed in the centre of the stook interfere with the drying of the crop.

Shocking or Stooking.

Where the reaper is cutting one way only, two stookers or shockers will be required. If two machines are working together, three will be sufficient in a short-strawed crop, while four may be hard enough worked in a long crop. Shocking or stooking should always begin at the end of the swathe which is first cut, the second stooker beginning a new row as soon as he sees the first one started, and the others as soon as possible afterwards, each beginning as near as possible about the same distance from the standing grain. An easy guide is for all to follow some particular wheel-track of the reaper, as these in most circumstances are easily seen.

Forming Stooks.— In building a stook, the centre pair of sheaves should always be set up first. Each sheaf should get a good solid dump on its butt end, so as to give it a firm foundation; and the two sheaves should be firmly pressed together at the top, by putting a hand on the outside of each a little above the bands, and exerting considerable pressure on these parts. Each following pair of sheaves should be put at opposite ends of the stook, in such a position that they only very slightly incline their heads towards the centre of the stook.

Theoretical Error.—In most publications on farming, wherein stooking is described, it is generally said that each pair of sheaves should stand perpendicularly or independently of the rest of the stook. Such instructions are decidedly wrong, and should not be followed in practice. If the last pair of sheaves at either end in a stook are set up perpendicularly, or so as to stand if the rest of the stook were taken away, it will almost to a certainty be found that in stormy weather the last pair at the lea end would at once be blown down; and if they were not blown over, it would only be because they were entirely in the shelter of the other sheaves. If the sheaves are set up perpendicularly, and the pair at the lea end are blown down, then the next pair are similarly exposed; they soon go also, and ultimately the whole stook. If, however, the first pair are perpendicular, and all the other pairs have a very slight lean towards the centre pair, a much more substantial stook is built than if all are set perpendicularly.

Placing the Band-knots.—Were the corn-knots in the bands set outwards in the stook, the rain in a wet season might injure them; and as they bear a sensible proportion to the corn of the whole stook, the sample might thus be materially injured. By simply turning the corn-knots inwards, and the root-knots outwards, the injury is prevented. In a fine season the corn-knots may be placed outside.

But in the hood-sheaves the corn-knots were generally placed uppermost, and exposed to the rain; because, were the other *side* of the sheaf exposed *upwards*, where a groove runs down the length of the sheaf, by the straw being gathered into that form while making the root-knot of the band, the rain might penetrate by the groove through the body of the sheaf, lying in its horizontal position, to the corn in the standing sheaves below, and thereby inflict a much greater injury than merely spoiling the corn-knots.

Size of Stooks.—In no variety of harvesting work is there greater variation than in that of shocking or stooking, simple and plain as it may appear to be. In some districts the sheaves are entirely set up in stooks of four or six sheaves, while in others they will be found of all sizes, up to fourteen or sixteen pairs of sheaves. By making extremely long stooks, the risk of their being blown down by the wind is undoubtedly lessened, but at the same time so is the speed with which they are dried. In a large stook the end pair of sheaves will usually be found ready to stack several days before any of the centre pairs; and if any of the centre pairs get soaked with rain, they will scarcely dry at all, unless taken from the centre.

A wheat stook of 8 sheaves is shown in fig. 505.

If the grain is not very tall, fine in the straw, and contains any rye-grass or other

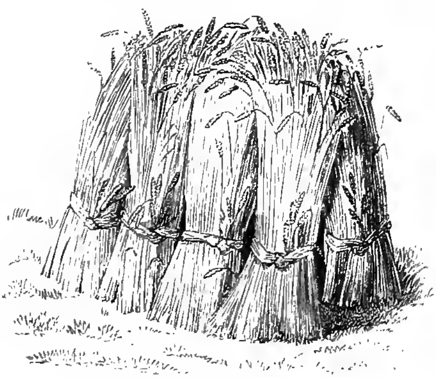


Fig. 505.—*Ordinary stook of wheat.*

grass, the stooks should not as a rule be larger than eight sheaves, four on each side, and in sheltered situations the number may be advantageously reduced to six sheaves. Very short-strawed crops should also be set up in stooks of four or six sheaves, or in exposed situations eight sheaves may be used. Where the straw is full length, eight sheaves are most generally used, and if the crop is very long, the stooks may contain ten or twelve sheaves.

"Pirling."—A very common and effective plan of stooking pursued in certain exposed districts of the west and south-west, is to set up two pairs of sheaves, the one pair at right angles to the other instead of side by side, as in an ordinary stook. The butts of the sheaves are if anything kept a little wider apart than in ordinary stooking, and when set up, the tops of the four sheaves are tied together about 9 inches under the apex, by a few straws pulled out of the top. This system is called "pirling," and, unless in particular districts, was probably more common half a century ago than now.

Stooks of this class dry much quicker than those of any other, and withstand a gale which levels almost every other stooks. The time required to do the extra tying, although a little, is not great, and need not deter any one from adopting it, where the circumstances call for such protection from wind and rain.

Hooding.—Hood-sheaves for oats, although at one time almost universally adopted, is now seldom practised. Owing to the earlier and shorter harvest of the present as compared with bygone times, some of the precautions once adopted are not now necessary.

A once common form of "hooding" is shown in fig. 506.

"Gaiting."—Another ancient method of setting up sheaves, which has now almost entirely been discarded, is "gaiting"—viz., setting up each sheaf singly, where the grain was wet when cut. The band of the sheaf is tied loosely round the straw, just under the corn, fig. 507, and the lower part of the sheaf is made to stand by spreading out the straw's end in a circular form. Gaitins are set by the bandster upon every ridge; the wind whistles and the rain passes through them. Gaiting is practised only in wet weather, and even then only when a ripe crop is endangered in standing by a

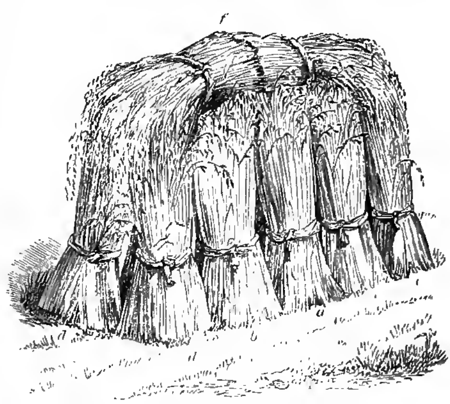


Fig. 506.—*Barley or oat stook hooded.*

a First 2 sheaves set. *b* Second 2 sheaves set. *c* Third 2 sheaves set. *d d* Fourth 2 sheaves set. *e* Fifth 2 sheaves set. *f* Hood-sheaves set.

shaking wind. It is used for oats and barley, wheat never being gaited, because when wheat gets dry, after being cut in a wet state, it is apt to shake out in binding the gaitins. Gaitins are apt to be upset by a high wind, but after having got a set, it is surprising what a breeze they will withstand. After being blown down they are not easily made to stand again, and then three at least are set against each other; but whatever trouble the resetting should create, they should not be allowed to lie on the ground, and it will be found that a windy day wins them quickly.

Direction of Stooks.—The direction to which the ends of stooks point is a very important one, to which, in many

Fig. 507.—*Gaitin of oats.*
a Band loosely tied. *b* to *c* Base of sheaf spread out.

cases, too little attention is often paid. When finished, the stooks should always point as nearly as possible between south and south-west—to the one o'clock sun—as the prevailing winds then strike them on the end, and blow right through the stook. In this direction the sun dries each side of the stook about equally, which, in a wet or late harvest, is a matter of considerable importance.

Barley.

In nearly all respects the harvesting of barley is much the same as that of oats. Barley, however, as has already been indicated, is rarely cut with a green tint like oats, but is allowed to stand till it is fully ripe, more particularly if it is intended for malting purposes. For malting it must all germinate at or near the one time, and if a portion of the grain is not fully ripe when cut, these grains will be more tardy in germinating.

Quick Drying.—As bright clear samples are of most value for malting purposes, those samples giving a price very much in excess of darkened ones, it is of great importance to a farmer to be able to shorten the period during which his barley crop runs risk of damage from the weather.

Small Sheaves.—Small sheaves, owing to their being quickly dried to the very centre, and a much larger proportion of the grain being exposed to the influence of the sun and air, are much to be preferred to large ones, as the latter are apt to darken the grain in the centre of the sheaf. In an unsettled harvest large sheaves can scarcely be got dried through, whereas had they been small, they might have been at least so far dried as to be rickled, where the drying can be completed without much further risk.

A larger proportion of barley than any other grain is threshed from the stook, and small sheaves and stooks are as great an advantage for such in good bright weather as in times when it is dull and close.

Wheat.

Scythe unsuitable.—In the cutting of wheat the scythe has never been extensively used. The straw of wheat is so hard that the scythe does not readily cut it, and when cut by the scythe it is almost impossible to make a respectable sheaf of it. Scythe-cut sheaves of wheat are generally very long, a great many ears are in the butt of the sheaf, and the stooks rarely ever stand well, even when carefully put up. As a means of harvesting wheat the scythe may, therefore, be considered unsuitable.

Hook.—The reaping-hook makes good work in wheat, and for opening headlands is likely to be continued for many a long day.

Reaping-machines.—The ordinary self and manual delivery reapers all make excellent work in a wheat crop, and were suitable for harvesting wheat before they could be generally used for the softer-strawed grains.

Self-binders.—In a regular up-standing crop of wheat no class of machine can do work equal to the binder, and at so small a cost. In wheat of the proper class the binder's highest degree of perfection is attained, and harvesting is done by it with an ease, speed, and accuracy of which, before the days of binders, farmers could have formed no conception.

Time to Cut Wheat.—Wheat should not be so ripe as barley when cut, but riper than was suggested for oats. Whenever wheat becomes white or yellowish-white under the ear, it may be cut any time, as no more sap can then pass from the lower portions of the straw, much less from the roots, to the ear. If cut rather on the early side, the outer skin or brawn is generally thinner and clearer; while if the crop is allowed to become dead ripe, the colour is deadened or dulled, while the outer skin is much thickened. This thickening of the outer skin apparently is a provision of nature to prevent premature decay of the grain. Extra ripe wheat also germinates freely if subjected to rough weather; and although early and strong germination is a good point in a seed sample, it is rather a bad one when it occurs in the stook.

Sheaves for Wheat.—Owing to the dryness, stiffness, and length of the straw of wheat, it is usually advisable to bind it in larger sheaves than any of the other classes of grain. A large sheaf of wheat dries about as easy as a small one of oats or barley; and whereas oats or barley are easily stooked if small sheaves are made, it is difficult to satisfactorily put up stooks of small sheaves of wheat. The straw of wheat is so hard and slippery that small sheaves easily slide past one another, and even in calm weather they are difficult to keep on end, and in stormy weather they are almost sure to go down entirely.

Wheat Stooks.—Stooks of wheat are seldom built of less than ten or twelve sheaves, and occasionally more—in fact, small stooks of wheat, such as have been recommended for oats, can scarcely be made to stand at all.

Hooding.—Before the advent of the reaping-machine, it was customary to cover each stook of wheat with two hood-sheaves, as shown in fig. 506. For wheat these were tied as near as possible to the butt-end, and were laid along the top of the stook, the two butts meeting above the centre. Both hood-sheaves were laid on at a considerable angle, generally about half the slope of an ordinary roof. When about to put on a hood-sheaf, the man catches it with both hands and raises it against his breast, with the butt-end uppermost. When in this position, he places his hands together, on the side of the sheaf farthest from him, and taking hold of a portion of the straw in each hand, he pulls the upper three-fourths of the sheaf partially asunder, making a rough gutter in the under side of the sheaf. He then places it on the top of the stook, carefully guiding the heads of the sheaves into the gutter, and mildly yet firmly pressing it down on them, in such a position that, below the ears of the hood-sheaf, about a quarter of the straw is on each side, and one-half right along the top.

The hood-sheaf should not be so much split that the ears of the under sheaves protrude, nor should it be tied so near the middle that a gutter can scarcely be made in it, nor yet so near to the butt that a portion of the straws drop down almost perpendicularly.

When put on, the first hood-sheaf should cover fully one-half the stook, and when the other one is put on, the butt-end of the first one should be slightly pushed up. After fixing the second one similarly to the first, the workman steps to the side of the stook, and carefully presses the two butts into each other.

The hood-sheaf on the east side should always be put on first, as the butt of the west one shelters it from the west wind, and prevents it from being thrown off.

"Pros" and "Cons" of Hooding.—Hooded in this manner, wheat stooks stand a considerable amount of either wind or rain; but if carelessly done it is worse than useless, as the first gust of wind knocks a large proportion of the hoods off, and if rain falls, both hood-sheaves and stooks are worse wetted than if they had not been hooded at all. Hooding, if well done, is undoubtedly an advantage, if calm damp weather follow. In ordinary harvest weather, however, the advantage is questionable, while in stormy weather it is of no use, and in bright sunshine the hoods are positively harmful, as the ears are prevented from being hardened by the rays of the sun.

After the close, foggy, and warm harvest of 1872, when an enormous quantity of wheat was sprouted in the sheaf and before being reaped, hooding was practised by many farmers to a greater or less extent for a few years; but, as the scare of that year wore off, the custom became less common, and now it is rarely ever seen.

Hooding Oats and Barley.—Both oats and barley are also, as already stated, occasionally hooded. With them the hood-sheaves are generally set with the ears up. Instead of being bound very near the butt-end, as is done with the hood-sheaves of wheat, oats and barley are tied if anything nearer the ears than usual, and the sheaves are set at a much greater angle. Oats are almost always done in this way, but barley is occasionally done both ways. Where hood-sheaves are used, the length of the stook must be proportionate to the length of the crop. The stook must not be longer than can be easily covered by the two hood-sheaves, with a small part to spare, so as to drop the water clear over the ears of the end sheaves.

SELF-BINDER.

The most modern and most expeditious method of harvesting grain is by the automatic combined reaper and binder—one of the most useful agricultural inventions of the nineteenth century.

General Construction.—In the binder the cutting apparatus differs only in details from the ordinary one-wheeled self-delivery reaper. The grain as cut falls across an endless web, which conveys it over the top of the driving-wheel to the knotter, where the straw falls into two arms called compressor jaws, which keep it on the knotter-table until a sheaf of any specified size has accumulated. Whenever a sheaf of the desired size has been delivered to the compressors, these relieve the tripper, which sets in motion the needle (carrying the binding twine) and the knotting apparatus. The needle is circular, and in its course it passes the band (twine) round the sheaf, when the band is caught by the knotter, and almost instantaneously a firm and secure knot is tied, while the needle is drawn back ready to operate on a new sheaf. As soon as the knot is tied and the string cut, the sheaf is ejected from the machine in a horizontal position, dropping on the ground on its side, quite clear of the machine.

Efficiency of the Binder.—The binder, even as now constructed, is admirably suited for cutting standing grain of any kind, more particularly where the straw is not very long. The land should be laid down with as flat a surface as circumstances will permit, otherwise a longer stubble will be left. Granted a moderate crop of standing grain and good weather, these machines do their work in a way which cannot be equalled in any other manner.

When the binder was first introduced, wire was used in tying. As would be expected, there were strong objections to the wire, and the substitution of twine was a step of the greatest importance.

One drawback to twine is that it is easily cut by mice, and when these vermin get into stacks of twine-bound sheaves, much trouble may be caused by loose sheaves. The best method of prevention is of course to keep mice from getting into the stacks.

THE HORNSBY BINDER.

The binder made by Messrs R. Hornsby & Sons, Limited, Grantham, is selected for detailed description and illustration, because of its having won the first prize at the great trial of binders held by the Royal Agricultural Society of England at Shrewsbury in 1884. Since that time numerous important improvements have been introduced into this as well as other well-known binders.

A sheaf-binding harvester has four separate operations to perform—viz., cutting, elevating, binding, and delivering the grain.

Cutting the Crop.

The cutting apparatus is, as already indicated, similar to that employed in the simple reapers, and need not be particularly described.

The illustration, fig. 508, shows Messrs Hornsby's arrangement of finger and its method of attachment to the framing of the machine, by which they obtain the lowest cut without the platform rubbing on the ground. This great advantage is gained by the new plan of bevelling the platform boards and riveting to them an under-plate of iron, so that the fingers may be close to the ground whilst the platform is quite clear of it.

The platform canvas for carrying the cut crop to the foot of the elevator is kept as low as possible, so that even

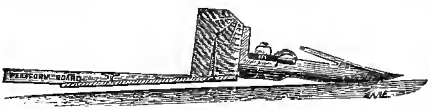


Fig. 508.—*Finger arrangement*

short crops fall readily upon it without any liability to choke the knife.

The new pattern reel and reel-support can be instantaneously adjusted, up or down, backwards or forwards, for dealing with laid, twisted, or heavy crops.

The reel has different speeds, so as to adapt it for every contingency of wind and crop, and for the varying speeds of horses and bullocks.

Both inside and outside dividers are adjustable to suit all crops, making perfect division on the one side, and lifting up hanging ears and cutting every straggling straw on the other.

Elevating.

The cut grain is carried up to the knotter between canvas elevators, entirely out of reach of wind—in fact,

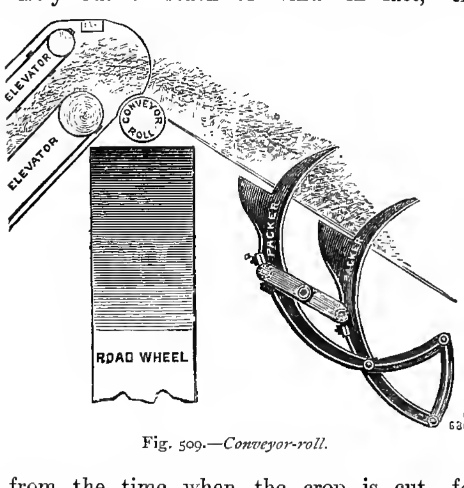


Fig. 509.—*Conveyor-roll.*

from the time when the crop is cut until it lies on the ground in bound sheaves, no wind can reach it.

The elevating canvases are brought down below the level of the platform canvas, so that the one feeds the other evenly and regularly. This is done by means of a novel arrangement of strengthening plate enabling the canvas rollers to work lower than in any other. The canvases are also shorter, owing to the reduced height of the machine, which, with the increased diameter of the rolls, reduces draught and makes the canvases run perfectly with less frequent tightening and adjusting.

The laths are *riveted to the canvas*, and are of an improved shape, securing easy running over the rollers, and preventing any straws from sticking between them and the canvas.

The canvas rollers run in metallic bearings.

Elevator and Platform Rolls.—By a newly patented arrangement, the rolls for the platform and elevator are made the full width of the machine, making the canvases more certain than ever in their action, the roll ends being recessed into the framing, so that loose straws cannot possibly wind round them. The butter-roll is also of full width.

Conveyor-roll.—The height of the machine is considerably reduced by the use of a conveyor-roll, to pass the cut crop from the top of the elevators close over the top of the main road-wheel to the binder-table. See fig. 509.

Binding.

The "Hornsby" binding mechanism is exceedingly simple, perfectly automatic in its action, and perfectly reliable in operation.

To avoid wear and save power, the binding apparatus remains at rest whilst the cut crop in a steady stream passes down from the elevator, and is pressed forward by the packers; but the moment enough has been accumulated to form a sheaf (of one of the five sizes before determined on, according to the crop), the binding mechanism is automatically started, the needle carries the string round the sheaf, the knot is tied, the string cut, the loose end retained for the following sheaf, and the operation is complete.

Needle.—A new patent needle, illustrated in fig. 510, is now used, which works with much less friction on the twine. It is also much easier to thread.

The Knotter.—The improved Hornsby knotter is shown in fig. 511, whilst figs. 512, 513, 514, 515, 516, and 517 show the manner in which the knot is tied. Fig. 518 represents the tied knot.

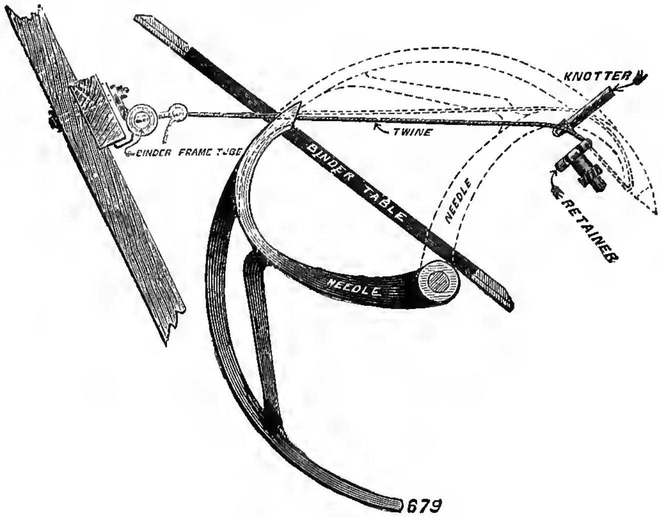


Fig. 510.—*Needle.*

Delivery of Sheaf.—It is important that the sheaves should be delivered gently, for if they were subjected to rough usage a considerable quantity of grain might be knocked out, especially if the crop were over-ripe.

In the "Hornsby" binder the sheaf is firmly held whilst the knot is being tied; the ejectors then coming into action press it forward, whilst the retaining boards fall, so as to slide it gently to the ground without liability to shedding. It delivers the sheaf near to the ground, and thus avoids shaking.

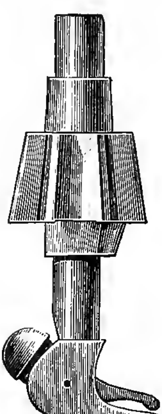


Fig. 511.—*Knotter.*

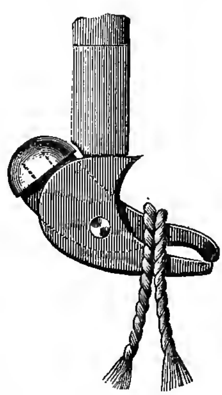


Fig. 512.—*String laid across knotter.*

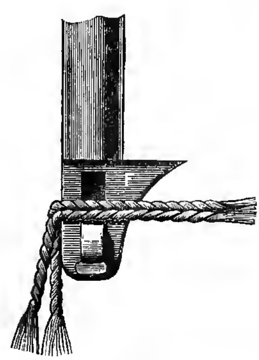


Fig. 513.—*Quarter turn, showing position of string on top of jaw.*

At Work.—The Hornsby binder may be worked by two strong horses, but many prefer to use three. The horses will perhaps travel about three miles per hour.

Speed.—At this speed and cutting around the field the binder may cut about an acre and a half per hour. Its daily work is therefore a simple question of how many hours it is kept in action.

The Hornsby binder is shown at work in fig. 519, the sheaves being laid in rows

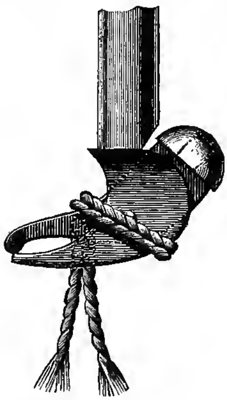


Fig. 514.—*Half turn.*

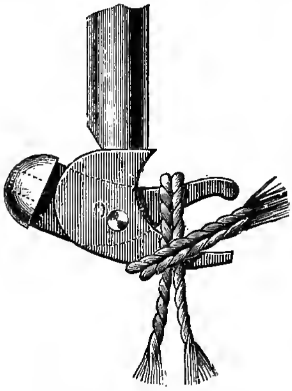


Fig. 515.—*Whole turn, jaws open and string entering.*

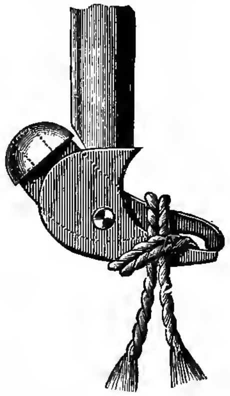


Fig. 516.—*Jaws closed on string: the string-knife then cuts the ends, and the lever draws the string off, completing the knot.*

by the sheaf-carrier, which lessens the labour in stooking.

Other Binders.

The manufacture of combined reapers and binders is now carried on extensively by several eminent firms. Each machine has its own peculiar merits and special admirers, but, as with ordinary reapers, they are now all wonderfully efficient. The other binders best known in this country are the Howard, the Samuelson, the Bisset, the Wood, the M'Cormick, the Massey, and the Brantford binders. The two last named are made in Canada, and the Wood and M'Cormick machines in the United States of America. The Howard binder, made by J. & F. Howard, Bedford, is represented in fig. 520; the Bisset binder (the first brought out in Scotland), made by Bisset & Sons, Blairgowrie, in fig. 521.

Progress of the Binder.

On farms of average size the binder is making much more rapid progress, and is a far more serviceable machine, than the manual reaper was at its introduction. The experience gained in the manufacture of the ordinary reaper has been fully

Fig. 517.—*Completed knot.*

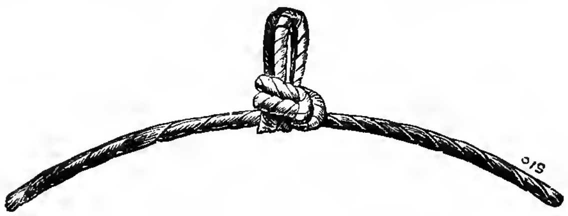


Fig. 518.—*Knot tied by the Hornsby binder.*

taken advantage of in the manufacture of the binder; and whereas the first reapers often failed, through the breakage of some more or less important part, the binder rarely does so. If it fail to do its work, it will, as a rule, be found that the crop is too heavy or too much laid and twisted, or the land unsuitable.

Judging from present appearances the day is not far distant when the binder will be as common a machine on the average farm as was the mower or reaper about 1880. With a light and serviceable binder, which could be depended on for cutting all average crops, there need be little extra hurry or press of work at harvest more than at any other time of the year, while the whole might be accomplished without an extra hand being engaged.

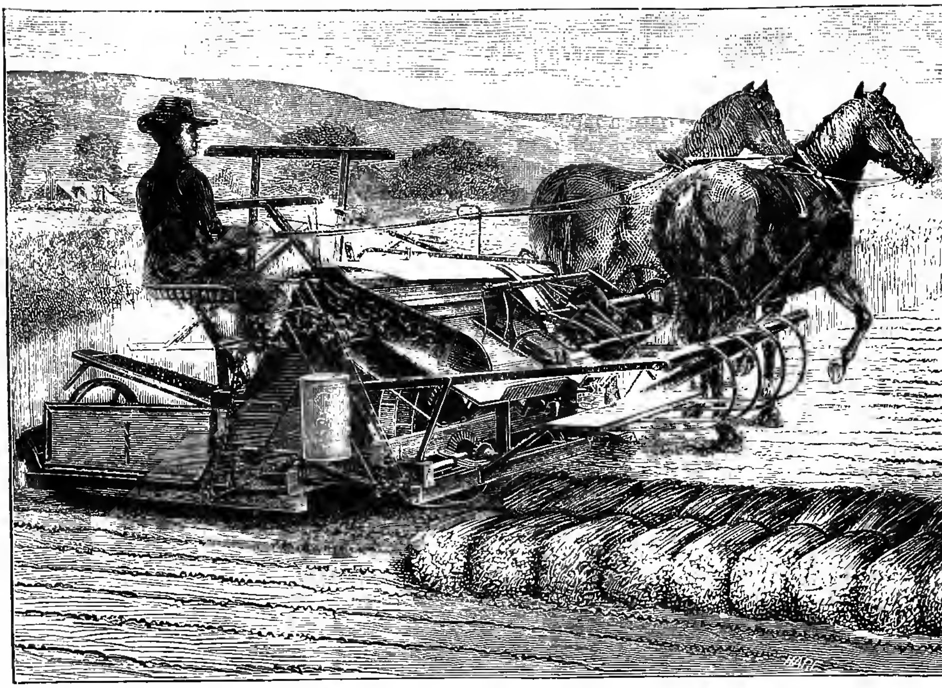


Fig. 519.—*Hornsby binder at work.*

Working the Binder.

Before beginning with a binder, a couple of swathes should be cut with the scythe round the whole field, or if more convenient, one swathe with a scythe and one with an ordinary manual or self-delivery machine. Two swathes are necessary, not entirely on account of the width of the machine, but to provide walking space for the three horses, often required to work the binder.

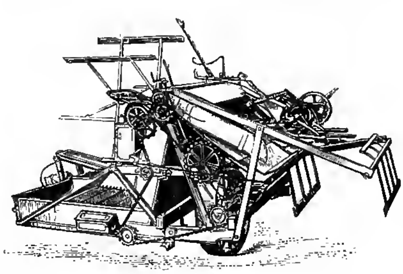


Fig. 520.—*Howard's binder.*

Where the circumstances permit, the easiest cut is round the field, but if the crop is bent in any particular direction it must be cut one way only.

Speed.—Cutting round about, an acre an hour is easily accomplished, and if the horses travel freely an acre and a half may be done.

Hands required.—According to the weight and closeness of the crop, from two to four men will be required to stook, if going round about, while only half the number will be required if cutting is done one way only. Behind a binder going round the field, a man can stook more grain of an equal weight than he will do after any other method of cutting.

With good string, the knotting apparatus rarely gives trouble, and the whole machine is easily under the control of one man.

Raking.—Where the binder can work anything like satisfactorily, no raking is required, as very few straws are left.

Size of Sheaves.—With a moderately regular crop, the sheaves can be made much smaller than where the crop has to be tied by hand, without adding materially to the cost, the only increase being what extra will be required for binding-twine, and the little additional labour required in stooking a crop of small or moderately sized sheaves instead of large ones.

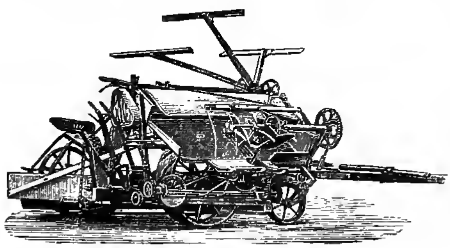


Fig. 521.—*Bisset's binder.*

The small number of hands required in the harvest-field, where a binder is in use, would thus, on a moderate-sized farm, allow of reaping and stacking going on simultaneously—that is, if the varieties of crops were so regulated as to allow them to come forward in regular succession.

Cost of Cutting with Binder and Reaper.

The exact cost of cutting a certain area of corn will of course, as already pointed out, vary considerably in accordance with the kind, condition, and weight of the crop, the configuration of the ground, the rate of wages and skill in management.

Saving in Labour.—It is now generally conceded that where circumstances are favourable—the fields moderately large and level, and the area under grain crops sufficiently large to warrant the somewhat heavy initial outlay in purchasing a binder—the cutting can be accomplished at from 1s. to 3s. per acre cheaper by the self-binder than by the ordinary reaping-machine. Common estimates indicate a saving of about 1s. 6d. or 2s. per acre—the saving of course arising in manual labour.

Saving in Crop.—Another point in favour of the binder is that it gathers up the crop more cleanly than the reaper. It leaves fewer stray stalks of grain on the ground, and thus saves both straw and grain. The saving on this head alone has been variously estimated at from 1s. to 5s. per acre. In average circumstances from 1s. to 2s. would perhaps be tolerably near the mark.

Examples of Cost.—Writing in 1886, Mr John Prout, Sawbridgeworth, Essex, states that in the harvest of the previous year he cut 100 acres with the binder with hardly a mishap, his men being able to work the binder satisfactorily after the guidance of an expert for one day. He gives the following information as to cost:—

Binder.—"On an average 10 acres per day were cut and bound at the following cost:—

Six horses .	£1	10	0
Two men . .	0	14	0
Two boys . .	0	7	0
String, 2s. per acre .	1	0	0
Oil . . .	0	2	0
Total for 10 acres	£3	13	0
Per acre, 7s. 3d.			

Ordinary Reaper.—"I calculate for an ordinary reaper, 12 acres per day:—

Four horses . . .	£1	0	0
Tying by hand, 6s. per acre	3	12	0
Two men .	0	14	0
One boy .	0	3	6
Oil . .	0	2	0
Total for 12 acres . .	£5	11	6
Per acre, 9s. 3d.			

Showing 2s. per acre in favour of the binder. I have taken the string at 2s. per acre, as my crops are generally heavy, hence also the charge of 6s. per acre for tying."[1]

An Oxford Example.—Mr A. Parsons-Guy, Begbroke Hill, Kidlington, Oxford, gives the following statement of the cost in harvesting with the binder in 1885:—"We cut 244 acres, an average of 14 acres per day, working six horses, with two men and two boys; 124 were

[1] *Agric. Gaz.*, 1886, 39.

cut on our farm, and 120 for neighbours.

Binder.—"I append statement of 124 acres cut on own farm:—

248 lb. of string at 7d. per lb. .	£7	4	8
Six horses, nine days, at 3s. per day	8	2	0
Two men, nine days, 6s. each .	5	8	0
Two boys, nine days, 1s.	0	18	0
Shocking, 1s. per acre .	6	4	0
Oil, repairs, sundries . .	1	5	0
Depreciation on £60 at 10 per cent	6	0	0
Total for 124 acres . .	£35	1	8
Per acre (say) 5s. 8d.			

Ordinary Reaper.—"The following is what I should have had to pay [with the ordinary reaper]:—

Cutting by hand 124 acres .	£74	8	0
Per acre, 12s.			

Saving by Binder.—"On the other hand I have saved:—

Balance in favour of binder on 124 acres	£39	6	4
String from 124 acres for sack-tying, &c.	1	0	0
Corn saved by using binder, 2s. per acre .	12	8	0
Total on 124 acres .	£52	14	4
Per acre, 8s. 6d."			

Explanations.—Mr Parsons-Guy gives the following explanations of some of the above items:—

String.—"We soon found we could get string at 7d. per lb., which did equally as well as the more expensive string sent out with the machine, and being much lighter, 2 lb. would readily tie an acre."

Horses.—"We worked from seven in the morning till as long as we could see, say eight o'clock, making a day of thirteen hours, as we made no stoppage for meals, one man shutting his horses off and the other putting his on immediately, putting in a fresh knife and well oiling before starting; thus a horse only had six and a half hours per day, and I think 3s. is a fair allowance for that time. We did not find the binder require more horse-power than the ordinary self-raking reaper. Two strong horses would work it comfortably, but I generally put on three, for I found the front horse, which was ridden by a boy, kept the others along, and also assisted in guiding the machine, which left the man in charge most of his time to see to the proper working of the machine."

Shocking.—"One shilling per acre was paid, but I find that plenty would be glad to do it for 9d. another season. My arrangement was that it should be left tidy—any loose sheaf tied, and any loose grain picked up."

Depreciation.—"Depreciation I cannot put at more than 10 per cent, as after our own we cut 120 acres, and I could make £40 off my machine at the present time [second year], but I do not see its value lessened more than £5."[1]

Management and Work.—Mr Parsons-Guy states that neither of the two men first put to manage his binder had ever seen one before, and they found no difficulty in working it. It made splendid work, and as to the certainty of tying he adds—"I do not think through the whole of the harvest we had half-a-dozen sheaves leave the machine untied from the fault of the binder."

STACKING CEREALS.

It is necessary that reaped corn remain some time in the shock or stook in the field before it will keep in the large quantity composing a stack or in a barn.

Time for Drying.—The length of time required for drying depends largely on the weather, but partly also on the ripeness of the corn when reaped. If the air is dry, sharp, and windy, the corn will be ready in the shortest, while in close, misty, damp air, it will require the longest time. As an extreme, one week for wheat, and 10 days for barley and oats, will usually be sufficient. Small sheaves of course dry more quickly than large sheaves. Corn having an admixture of grass in the ends of the sheaves is the most difficult to dry. In reaping with the machine the corn is more closely packed in the sheaf than when reaped with the scythe, and thus in the former case a day or two's longer drying may be required.

Judging of Dryness.—Mere dryness of straw in feeling does not constitute every requisite for making newly cut corn keep in the stack. The natural sap

[1] *Agric. Gaz.*, 1886, 59.

of the plant must not only be evaporated from the outside, but from the inside also. The outside may feel quite dry, whilst the interior may be moist with sap. The state of the internal condition, therefore, constitutes the whole difficulty of judging whether or not corn will keep in the stack.

Several criteria exist by which certainty is arrived at—namely, by the straws being loose in the sheaf; by easily yielding to the pressure of the fingers; by the entire sheaf feeling light when lifted off the ground, and dry when the hand is thrust in beyond the band; or by twisting a straw, and observing if any sap remains in it.

In winning, the sap of the straw of the cereals is, no doubt, converted into woody fibre, as that of the grasses is on being converted into hay.

Weather and Drying.—Winning is effectual when the weather is dry. Wind is also winning, but the stooks are apt to be blown down, and incur the trouble of setting them again, which cannot be so well done as at first. Rain immediately following or accompanying wind injures stooks materially. When much rain falls, accompanied with cold, the corn becomes sooner ready than the straw for the stack; and, to win the straw, the bands may have to be loosened, and the sheaf spread out to dry in the wind and sun. In like manner, the sheaf may be spread out in dry weather, when a large proportion of young grass is mixed with the straw.

Corn wins in no way so quickly as when "gaitined." See p. 76.

Sprouting.—When the air is calm, dull, damp, and warm, every species of corn is apt to sprout in the stook before it is ready for the stack. In this way the quality of the grain is often much injured.

Process of Stacking.

Temporary Stacking or "Rickling."—Oats which have had rye-grass, clovers, or other grasses sown with them are usually difficult to dry, and more particularly in a damp climate or a late season. With such crops "rickling," "coling," or "hooacking" is sometimes resorted to before the crop is dry enough for stacking. A "rickle," "cole," or "hooack" may contain from 6 to 8 or more stooks, according to the size of the stooks and length of the crop.

The centre of the "rickle" is composed of 4 or 6 sheaves, all set up together, with the bottoms slightly out and the heads close together. Around these are built another circle, the butts of which also resting on the ground, the next row being kept far enough up to just cover the straps or bands of the sheaves of the preceding one. The sheaves of each row are, as far as possible, laid on over the space between the two sheaves under it, as in slating, and the butt-end slightly spread. All sheaves are built in the "rickle" with the side downward which was outside in the stook; and as there is always more or less of a slope on the butt-end of each sheaf, placing them in this manner makes a much neater "rickle," and throws the water much better off. The sheaves in the "rickle" are kept lying at a pretty steep angle, the number in each course being considerably reduced, until at the height at which a man can just reach, it can be finished by two sheaves, which are tied together by a rope of straw passed round both. This band should be low enough to take hold of the tops of the course of sheaves under the topmost two, and should be drawn as tightly as possible. If the band is put on too high up, or too slack, the top sheaves are very easily blown off; whereas if the whole has been properly built, and afterwards secured by a rope, the crop is proof against a great amount of very wet or stormy weather.

A common method of field-stacking is as follows: The hands are divided into parties of four, and each party take three rows of stooks. One man lays a foundation about 6 feet in diameter on the line of the middle row, and proceeds as in ordinary stacking. Another man forks the sheaves, and the remaining two drag in the corn from the adjacent stooks. By grasping the tops of the sheaves eight sheaves can be hauled in at one time. The small rick is gradually drawn to a narrow point, and the top sheaves are tied down with a couple of straw or coir ropes.

Advantages of "Rickling."—This

manner of securing a crop allows of the butts of the sheaves being dried in a way attained by no other system.

Sheaves with grass in the butts very speedily kill off the young grasses under them, particularly in wet weather. "Rickling" allows of the crop being placed in a new position, and damage to the grasses avoided, while at the same time almost securing the crop, and putting it into such a position that it readily dries afterwards, and is never difficult to get dry enough for carting to the stack.

Preparing for Stacking.—While the first-reaped corn is winning in the field, the stackyard should be put in order to receive the new crop by removing everything that ought not to be in it—such as old decayed straw, which should have been used in time for litter; and weeds, such as strong burdocks, thick common docks, tall nettles, rank grass, yellow weed; which in too many instances are allowed to grow and shed their seeds, and accumulate to a shameful degree during summer. The larger classes of implements are often accommodated in the stackyard for want of sheds to keep them in, and these must now be removed.

Where stathels are used, they should be put in repair. Loose clean straw should be built in a small stack on one of the stathels, or other place, to be ready to make the bottomings of stacks as wanted. Drawn straw or other thatch material should be ready for thatching the stacks of barley as they are built, in case of wet weather occurring—a little time being given for the stack to settle, else the ropes by which the thatch is held become loose, and require to be tightened.

Straw-ropes or coir yarn should be stored in the hay-house or elsewhere, ready to be used in thatching. The tops or frames should be put on the tilt-carts: the corn-carts should be put on their wheels and the axles greased; and the ropes should be attached to the carts. The forks for pitching the corn in the field, and from the carts to the stacks, should be ready for use. Neglect and want of foresight in these particulars, small as they may appear, indicate mismanagement on the part of the farmer.

Cart Frames.—The tops or frames for placing upon tilt-carts are a light rectangular piece of framework, as shown in fig. 522. Two main bearers are fitted to lie across the shelvements of the cart; the foremost is slightly notched, and the hindmost rests against the backboard of

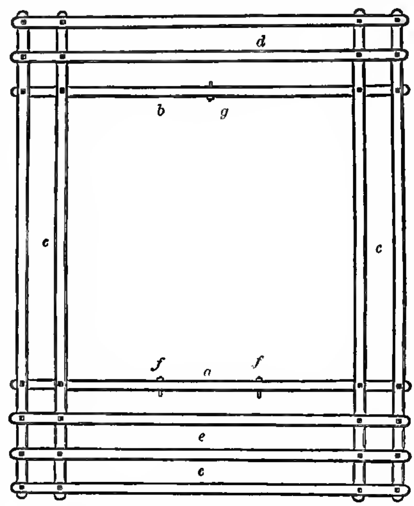


Fig. 522.—*Corn and hay cart tops or frame.*

a Foremost main bearer.
b Hindmost main bearer.
c c Pairs of slight side-rails.
d 2 hind cross-rails.
e e 3 arched fore cross-rails.
f f Bolts through rail in front of cart.
g Bolt through rail on backboard of cart.

the cart, the top sides of which being first taken off. One pair of slight side-rails is applied on each side, crossing the bearers, and notched upon and bolted to them with screw-bolts, these being crossed by two rails behind, and by three more in front; and as these last project over the back of the horse, they are made in

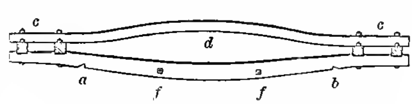


Fig. 523.—*Transverse section of the tops or frame.*

a b Notches in foremost main bearer.
c d c Arched rails over back of horse.
f f Bolt-holes in frame.

arch form, fig. 523, to give freedom to the animal.

The extreme length, from outside to outside of the front and back rails, is usually about 10½ feet, and the breadth in the same manner is about 7¼ feet, affording a superficial area for the support of the sheaves of corn of 76 square feet.

A simple and effective method of securing the frame to the cart is by means of the bolts in the bearers, the front ones passing through the head-rail of the front of the cart, and the hind one through the top-rail of the tail-board.

Harvest Cart.—But the common corn or hay cart is a more convenient and efficient vehicle for carrying the corn crops into the stackyard than the tilt-cart with the frame, inasmuch as the load is more on a level with the horse-draught, and the body being dormant, the load is not liable to shake with the motion of the horse. Fig. 524 gives a perspective view of such a cart. Lightness is a special object in its construction, so that it is made of light strong wood. The shafts are usually about 17 feet in length, of which 6½ feet go for the horse-yoke and 10½ feet for the body, measuring over the cross-heads. These are secured to the shafts by iron standards passing through them and the shafts. Their sides are supported by oak standards; and these in their turn, along with the iron standards, support the inner top-rails, 12 feet in length, and the broad load-tree. The outer rails, also 12 feet long, are supported by iron standards resting on the extremities of the cross-heads, and also by those of the broad load-tree. The extreme breadth of the outer rails is 7 feet, and as the outer

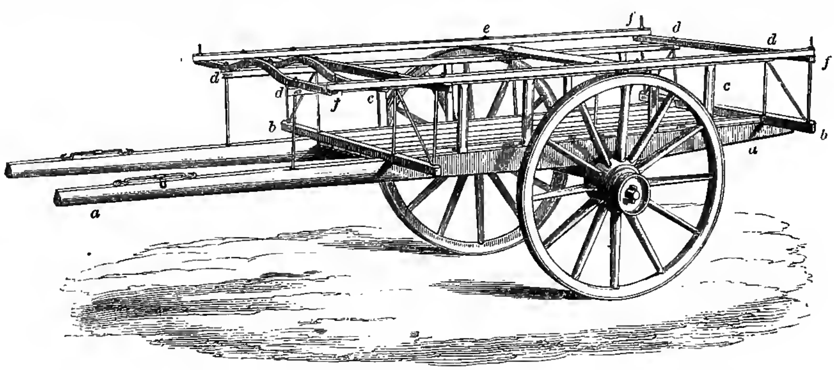


Fig. 524.—*Common corn and hay cart.*

a a Shafts of Baltic fir. *c c* Oak standards. *e* Broad load-tree.
b b Cross-heads. *d d*, *d d* Inner top-rails. *f f*, *f f* Outer rails, front and rear.

rails support the sheaves of corn over the wheels, and are 12 feet in length, the superficial area of the cart for the load is 84 square feet, which is greater than that of the top-frame of the tilt-cart.

The two front cross-rails over the horse's rump are arched, to give him freedom. The body is usually close-floored, besides having a low ledge-board running inside the standards to keep in the corn that may have shaken out of the sheaves.

Corn-carts are not in all cases furnished with wheels of their own. The body may be set upon those belonging to the tilt-carts. The broad load-tree, 9 inches broad, is convenient to sit upon in driving, and to stand upon when forking the sheaves in unloading. The cart weighs about 8 cwt.

It is easily converted into a *dray-cart* by simply removing the framework, which should then have the standards based upon two longitudinal rails, instead of being mortised into the shafts. In such a form it is eminently useful in carrying large timber.

Improved Harvest Cart.—An improved form of harvest cart is shown in fig. 468, p. 23, with hay and straw ladders at both ends.

Farm Waggon.—The English farm waggon is also used in carting corn, but is not so expeditious as the cart except where the distance from the field to the stackyard is considerable. The improved waggon made by Crosskill & Sons, Beverley, is shown in fig. 525.

Harvest Forks.—Forks used in the loading of corn require to have long shafts, not less than 6 feet, and small prongs. Such a length of shaft is required to lift the sheaf from the ground to the top of a loaded cart, or from the cart to the top of a stack. The fork used in the field should have a strong stiff shaft, as the load on the cart is at no great elevation. That for unloading the cart to the stack should be slender and elastic, as many of the sheaves have to be thrown a considerable height above the head.

The prongs, being small (about half the length of the prongs of the hay-fork), just retain hold of the sheaf, without being so deeply pierced into the band as to be withdrawn from it with difficulty. A deep and firm hold with long prongs renders the pitching of a sheaf a difficult matter; and if one of the prongs happen to be bent, or a little turned up at the point, the difficulty is much increased.

The prongs of the forks are now made of steel, and are therefore much lighter, more durable, and far superior in every way to the old-fashioned iron fork.

The best fork for the person on the top of the stack to use, in assisting the builder, is the short stable-fork.

Cart-ropes.—The loads of corn and hay on the carts are fastened with ropes, which should be made of the best hemp,

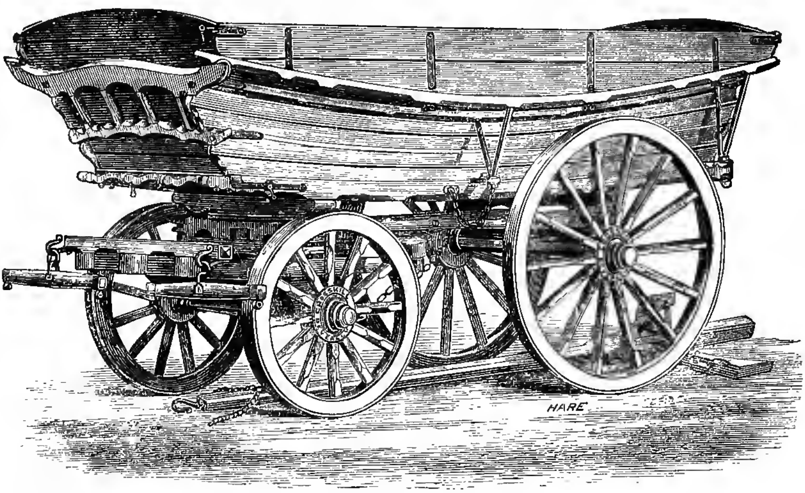


Fig. 525.—*Farm waggon.*

soft and pliable. Ropes are either single or double, and both are required on the farm. Double cart-ropes are from 20 to 24 yards long, and single ones half those lengths.

The single ones are used on ordinary occasions, when a small load of straw or other bulky article is carted to short distances on the farm; but in harvest and hay time double ropes are always used for security to the load. The double rope is made fast to the hind part of the corn-cart by first doubling it, and then measuring its middle from the centre of the cross-head to its extremity on both sides, where one turn or two are taken round the iron standards and the cross-head by each division of the rope, the ends of which are then passed in the inside of the upper cross-heads, and brought over them to the outside. Each division is coiled up by holding the rope in the left hand at about two yards from the cart, and bending the remainder in coils with the right hand until the end of the rope is gained, when the coil is made to take a turn along the loose part of the rope in its middle, and then the loose part still remaining is slipped through one loop of the coil and passed over it so as to make a loop-knot, which holds the coil suspended from the cart about 3 feet from the ground.

Fig. 526 shows the rope coiled and suspended when not in use. When a ring is fastened in the cross-head of the cart, the middle of the rope is passed through the ring, and a turn taken round the extremity of the cross-head on each side of the cart, as above.

Care of Ropes.—Cart-ropes last according to the care bestowed on them. When used with the corn-cart, they should never be allowed to touch the ground, as earthy matter, of whatever kind, soon causes them to rot. When wetted by rain they should be hung out

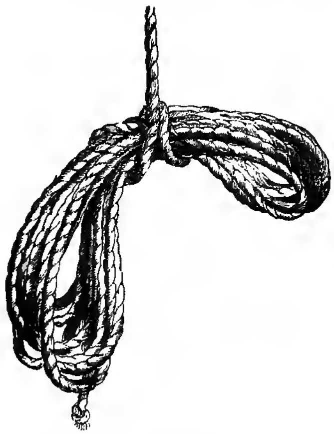


Fig. 526.—*Coiled-up cart-rope.*

in the air to dry. On being loosened when the load of corn is to be delivered to the stacker, they should be coiled up before the load is disposed of, and not allowed to lie on the ground till the cart is unloaded.

A soft rope holds more firmly, is more easily handled, and far less apt to crack, than a hard one.

Stack-ropes.—For tying down thatch or holding firm the tops of stacks, straw-ropes, once universally used, are now being supplanted by coir-ropes or yarn. This latter material is cheap, durable, and convenient to use. If well cared for, it should last three or more years; and many farmers contend that, especially on large farms, or where straw and labour are both scarce and dear, the coir-rope is cheaper than the straw-ropes.

Straw-rope making.—Nevertheless, straw-ropes are still largely employed, and where they can be made without any appreciable addition to the labour bill, they will likely continue to be used. It will thus be useful to repeat here the information in former editions of this work as to the making of straw-ropes.

Straw-ropes are made by means of the implement named the *throw-crook.* Various forms of this instrument are in use, and one of the simplest is fig. 527, which is made of a piece of tough ash, about 3½ feet long, the round part of which is thinned off until it is capable of being bent to a curve, and is there retained by an iron stay, part being left projecting beyond the stay for the attachment of the end of the rope to be made. The straight end is furnished with a ferule and swivel-ring, by which it is either attached to the person by a cord passed round the waist, or held in the hand.

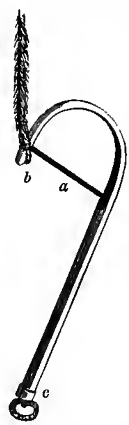


Fig. 527.—*Old throw-crook.*

a Iron stay.
b Projection for end of rope.
c Ferule and swivel ring.
c b Line of direction of rope.

In using this implement the rope-maker is stationary, usually sitting beside the straw; and the spinner with the throw-crook moves backwards as the rope extends. In its action this form of throw-crook is attended with a jerking motion, when the left hand holds the swivel, and the right one revolves the instrument round the shank. The twist given to the rope is effected by the revolution of the implement round the line of direction, in generating which a jerk is given to the rope at two opposite points in the circle of revolution, which may be greatly neutralised by the spinner causing both hands to revolve in opposite circles.

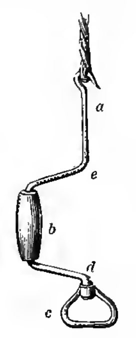


Fig. 528.—*Best throw-crook.*

a Hook, and
a e d Curved spindle of iron.
b Perforated cylindrical handle of wood.
c Swivel-ring.
e b d Curved part of iron spindle.

A better form of throw-crook is fig. 528, where the strain of the straw-rope is in a straight line from the hook, along the spindle to the handle. The left hand holds a swivel-ring, and the right hand causes the curved part to revolve by means of a perforated cylindrical handle of wood;

the rest of the instrument beiug made of iron.

An improved form of spinner consists of a simple contrivance by which one person is enabled to spin two or three ropes at one time. The contrivance hangs from the shoulders of the spinner, who, by turning one handle, gives motion to two or three spindles, to each of which a rope is attached, the spinner moving backwards as the ropes increase in length.

A stationary spinner at one time much used has lost favour.

The once common method of twisting straw-ropes by a throw-crook is shown in fig. 529. The left hand of the twister,

Fig. 529.—*Making a straw-rope with a throw-crook.*

a field-worker, holds by the swivel-ring, fig. 528. Her right hand grasps the hollow cylinder of wood. A man, sitting on a stool or a bnndle of straw, places a little drawn straw in the hook, and the twister causes the hook to revolve round an axis, while walking backwards along a path swept clean, in a shed or the stable. The man, nearly closing the left hand, lets ont the straw gradually between the thumb and the fingers, retaining it till sufficiently twisted, while the right hand is engaged snpplying small portions of straw in eqnal and sufficient quantities to make the rope uniform in thickness throughout and strong enough, the twister drawing away the rope as fast as the spinner lets it out.

This work has to be skilfnlly and carefully done—for where the rope is let ont unequally, it breaks at the small part; when twisted too much, it snaps asunder; when not twisted enough, it comes asunder at any place by the least pull; and when the twister does not keep the rope straight as fast as it is let out, it twists into loops, which are not easily made straight again. All loose straws and other materials should be swept away from the walk in which straw-ropes are made, otherwise they will be picked up and appropriated by the twisting rope.

In some parts the man works the straw into form with both hands while stooping, and his back turned to the twister; but the rope thns made is thick and rough compared to the mode described above. Thistles negligently left in the straw the spinner should throw out, or he will suffer severely by their stings.

Straw for Ropes.—The best sort of straw for making into ropes is that of the common or Angns oat, which, being soft and pliable, makes a firm, smooth, small, tough rope.

The ordinary length of a straw-rope for a large stack is about 30 feet. Counting every interruption, a straw-rope of this length may take five minutes in the making—that is, 120 ropes in ten hours.

Winding Straw-ropes.—After the rope has been let out to the desired length, the man winds it firmly in oblique strands on his left hand and arm into an oval ball, the twister advancing towards him as fast as he coils the rope, which is finished and made firm by passing the end of it below one of the strands.

Fig. 530 represents a straw-rope *coiled* up in this form. With the ends smaller than the middle, the rope can be easily taken hold of and carried; and in the oval form instead of the spherical the coil can be more easily thrown upwards to the top of a stack. Still many prefer large circular coils, except for use in

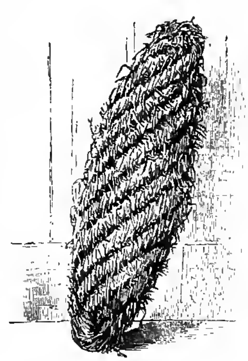


Fig. 530.—*Coil of straw-rope.*

forming a network of ropes over a stack, for which small oval bundles are most convenient. Straw-ropes should be spun of such lengths as are suitable to the size of the tops of the stacks.

Thatching.—The material to be used in thatching the stacks must also be in a state of readiness before the crop is brought into the stackyard.

Material for Thatch.—The material most largely used in thatching stacks is straw, which has been previously drawn parallel by the hand and tied into sheaves. The roughest and rankest straw is generally used for thatch. In some cases rushes or other coarse herbage is employed instead of straw.

Drawn Straw.—A common method of drawing straw for thatch is as follows: In commencing to draw straw in the straw-barn, the man takes a wisp from the mow, and, placing it across his body, takes hold of each end of the wisp, and spreading out his arms, separates the wisp into two portions. Holding the ends of both portions in one hand, he takes hold of the other ends with the other hand, and spreading out his arms, draws the straws parallel and straight; and he does this until he finds the straws parallel and straight, when he lays down the drawn wisp carefully upon the floor of the barn.

The state of the straw, and the kind, render the drawing more or less easy and expeditious. When straw is much broken in thrashing, it requires the more drawing to make it straight; and of all the kinds wheat-straw, being long and strong, is most easily and quickly drawn, barley-straw being shortest and most difficult to draw. Oat-straw is the most pleasant of any to draw.

After as much has been drawn and laid down as to make a bunch of about 15 inches in diameter, the man makes a *thumb-rope* by twisting a little of undrawn straw round the thumb of his right hand, drawing it out with his left and twisting it with his right alternately, until a short coil is made, one end of which he places on the floor by the side of the drawn straw, and puts his foot upon it; and, keeping hold of the other end in his left hand, puts the drawn straw into the rope with his right; and then, holding both ends of the rope, binds the straw into a bunch as firmly, and in the same manner, as a bandster does a sheaf of corn. A bunch of drawn straw is represented in fig. 531.

Thatch-making Machine. — The genius of the inventor has now come to the aid of the farmer in the making

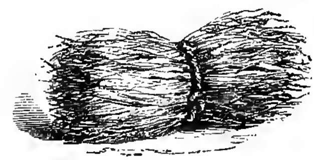


Fig. 531.—*Bunch of drawn straw.*

of thatch, as in most other of his operations. In fig. 532 is found a representation of a thatch-making machine which is now used with excellent results. It is made by Messrs Barnard & Lake, Braintree, Essex, and won the prize of £25 offered by the Royal Agricultural Society of England in 1886 for the best thatch-making machine. The drawn straw is fed into the machine by hand, and the form of the thatch when completed is well shown in the figure. It is found that this machine economises straw, and saves time in thatching.

This machine is also employed in making straw matting to protect pits or clamps of roots, as well as race-courses from frost. It likewise produces excellent material for providing shelter in sheepfolds.

Forking.—The carts, forks, straw, and ropes being in readiness at the steading, and the corn fit for carrying to the stackyard, the first thing is to provide an efficient person to fork the corn in the field to the carts. That man is the best for this work who is able to wield the sheaves from each stook with ease, and has dexterity to place them in positions most convenient for the carter to build them on the cart. Throwing the sheaves in an indiscriminate manner, or too quickly upon the cart, makes the work less easy for the carter; for he has the trouble of turning the sheaves to arrange them aright, while his footing upon the load is insecure. A delay of two or three minutes thus occasioned in loading each cart makes a considerable loss of time upon the day's work.

Injury to Young Grass.—In carrying the crop off the ground, care should be taken to do as little injury as possible to the land with the cart-wheels, particularly to young grass. To avoid this, and give an unerring guide, the horses should walk in the open furrow between the ridges, while the wheels pass along their furrow-brows. But this, of course, can be done only when the stooks are in rows sufficiently near to the furrow. If the loads are light and the track frequently changed, little damage will be done.

Order in Forking Sheaves.—In forking a hooded stook from the ground, the hood-sheaves are first taken, then the sheaves from the body of the stook, from one end, sheaf by sheaf, in pairs, to the other end. More loss of time is involved

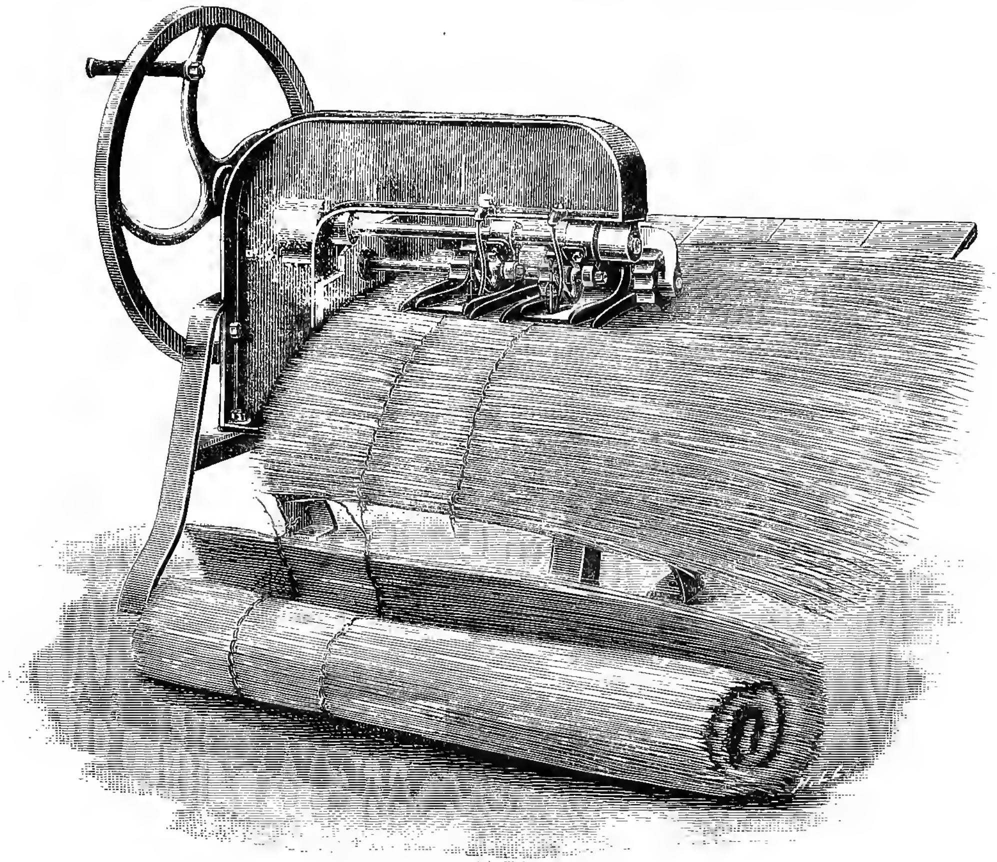


Fig. 532.—*Thatch-making machine.*

in disregarding this order of removal of the sheaves than might appear, for if the centre sheaves are first taken away, more force is required to do it, and the end ones will likely fall down; and if one side of a stook is taken away before the other, the other side will fall. In any way but the first, the sheaves will be caught by the fork inconveniently.

When stooks have stood long upon the ground, they may require considerable force to remove them.

Carting "Gaitins."—On removing gaitins from the field, they must first be bound into sheaves, which is done by loosening the slack band from its tying and slipping it down the body of the gaitin to the proper place, and binding it in the manner of a sheaf when reaped. They are not stooked when bound, nor left scattered on the ridges as they stood before, but laid in heaps on alternate ridges with the corn-ends away from the cart, as near the furrow-brow as most convenient for the forker and the carter. A number of hands are required to bind gaitins as fast as they are carted off.

Loading a Cart.—A corn-cart is loaded with sheaves in this way: The body is first filled with sheaves, their butt-ends to the shaft-horse, and to the back-end of the cart. When these come to the level of the frame, other sheaves are placed across them in a row along both sides and both ends of the frame, with the butt-ends projecting as far beyond the outer rail as the band, the sheaf at each *corner of the frame* being held in its place by transfixion upon a spike of the elongated bolt which secures the corner of the outer-rail frame. Another row of sheaves is placed upon these. Sheaves are then placed along the middle of the cart with the butt-ends like those in the body upon the corn-ends of the side sheaves to fill up the hollow of the load.

Thus row after row of sheaves is placed, and the hollow in the middle filled well up at last, 12 full stooks making a good load upon an ordinary cart.

Before finishing, it should be seen that the load is neither too light nor too heavy upon the horse's back.

A load thus built will have all the butt-ends of the sheaves on the outside, and the corn-ends in the inside.

Roping Loaded Carts. — The ropes keep the load from jolting off the cart upon the field and the road. They are thrown across the load diagonally from the hind part of the cart to the opposite shaft at the front, and one end is made fast to each shaft,—the forker holding on the slack, while the carter on the load tightens the rope by pulling from behind, and trampling on the sheaves to make them firm. The crossing of the ropes at the centre prevents the load splitting asunder over each side of the cart.

Some carters wish to show their dexterity in building loads of corn by bringing them to the stackyard without the assistance of ropes. This practice, however, is not to be commended, except where the roads are good and the land level.

Hours of Carting.—Carrying often is continued from break of day to twilight. From a little after sunrise to a little after sunset, corn may be taken in with safety. Morning and evening dew may occasionally interrupt the carrying.

It is customary in some parts of the country to keep the horses in the yoke all day, and to feed them with corn in nose-bags while the carter is dining, as also to give them green food—tares—while the cart is unloading at the stack. In other parts the horses are taken out of the yoke, watered, and put into the stable, where they receive their corn while the men are at dinner. This latter is the best plan for the horses, in which they will work the longest day's work with less fatigue; yet it usually occupies one hour of the best part of the day before they are again on the road, whereas a half hour, in the other case, is sufficient for the men to dine, and the horses to feed on corn.

Feeding Horses in the Field.—Some horses are apt to take fright when the bridles are slipped off their head while in their yoke, to allow them to eat the tares with freedom. Such a mishap is doubtless the effect of bad breaking-in. To avoid it in any case, the bit should be fastened with a small strap and buckle to the near side of the bridle, and it will slip out easily when the strap is unbuckled.

A load of tares is brought to the steading fresh in the morning for the horses employed at leading. Tares are not suitable for horses until the pods are pretty well filled with grain, as prior to that state they are apt to purge and weaken them.

Commencing Stack - building. — While the first cart has gone to the field, the builder of the stacks, or stacker, collects his forks, ladders, and trimmer; and his assistant, who pitches the sheaves conveniently for him on the stack, fetches a few straw-ropes and a hand-rake into the stackyard.

The first stacks are built on the stathels, which are arranged along the fence of the stackyard, and which require no preparation for the reception of the stacks.

When more than one stacker is required, each should have one head of carts leading to him; and the number of carts in one head depends on the distance the corn has to be brought. There cannot be fewer than two carts to one head, to come and go. The same forker and carts should serve the same stacker, because the same workers together understand each other better in their work.

Arranging a Stackyard.—In filling a stackyard, the barley being the first crop threshed—being the first in demand in the market—their stacks should be placed nearest the barn; and wheat being last threshed, their stacks are placed upon the stathels. Oats being required at all seasons, their stacks may be placed anywhere.

Stacks of peas and beans fill up the heart of the stackyard when there is room, or are placed on the outside.

Foundation for Stacks.—When stacks are built upon the ground, stools of loose straw are made, to prevent the sheaves at the bottom receiving injury from the dampness of the ground. A stool for a stack is made in this manner: Stick a fork in the ground, on the spot where the centre of the stack is desired to stand. Put a quantity of dry straw round the fork, shake it up with a fork, and spread it equally thick over the area the stack shall occupy. Then take a long fork, with the radius of the stack notched upon its shaft, 7½ feet; embrace the shaft of

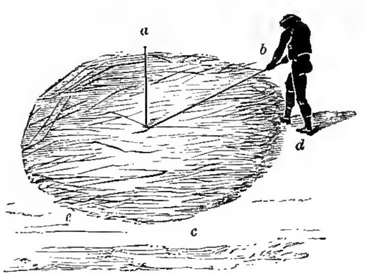


Fig. 533.—*Making a stool for a corn-stack.*

a Fork stuck into the ground.
b Fork 7½ feet long.
d Man making the circle of stool with his feet.
e c d Circle of stool 15 feet in diameter.

the upright fork between its prongs, and push in and pull out with a foot the straw, so as in walking round the circumference of the stool to make a circle, having a diameter twice the radius notched upon the shaft of the fork (fig. 533).

Process of Stack-building.— In setting a loaded cart to a stack, the

Fig. 534.—*Building a stack of corn.*

e Loaded cart of corn alongside a stack.
f g Sheaves of corn with their butt-ends outwards.
m Carter forking up a sheaf.
k Field-worker receiving the sheaf with a fork.
h Stacker kneeling on the outside row of sheaves.
i Sheaves of the inside row.
l Sheaf placed most conveniently by the field-worker for the stacker.

carter should take advantage of the wind in forking the sheaves from the cart. The stack should be built in this way: Set up a couple of sheaves leaning on each other in the centre of the stathel, and another couple against their sides. Place other sheaves against these in rows round the centre, with a slope towards the circumference of the stathel, each row being placed half the length of the sheaf beyond the inner one, till the circumference is completed, when it should be examined; and where any sheaf presses too hard upon another, it should be relieved, and where a slackness is found, a sheaf should be introduced. Keeping the circumference of the stack on the left hand, the stacker lays the sheaves upon the outside row round the stack, placing each sheaf with his hands upon the hollow or intermediate space between two of the sheaves laid in the preceding row, close to the last one, and pressing it with both his knees, fig. 534.

When the outside row is thus laid, an inside row is made with sheaves whose butt-ends rest on the bands of the outside row, thereby securing the outside sheaves in their places, and at the same time filling up the body of the stack firmly with sheaves. A few more sheaves may be required as an inmost row, to raise the heart of the stack at its highest part.

It is of immense benefit to a stack to have its centre hardened with sheaves, as it is the heart sheaves which retain the outside ones in their places in the circle, with an inclination from the centre to the circumference; and it is this incline of the outside sheaves that prevents the rain passing along the straw into the heart of the stack, and where it would soon spoil the corn.

Size of Stack.—The number of rows of sheaves required to fill the body of a stack depends on the length of the straw and the diameter of the stack. For crops of ordinary length of straw, such as from 4½ to 5 feet, a stack of 15 feet diameter is well adapted; and in which one inside row, along the bands of the outside one, with a few sheaves crossing one another in the centre, make such a stack sufficiently hearted. Where long wheat grows, from 5 to 6 feet, the stack should be 18 feet in diameter, to give room to a few sheaves for the hearting. A stack of 15 feet in breadth is rather too much for the carter to fork heavy sheaves across to the stacker, when the stack has attained the height of his head, and when the load in the cart becomes as low as the load-tree.

Second Forker.—The stacker should receive the sheaves within easy reach, as he cannot reach far on his knees to take them without loss of time, and risk of making bad work. To facilitate the building, a field-worker may be employed to receive the sheaves on a short fork from the carter, and to throw them to the stacker in the position he wants them, to save him the trouble of turning them. By a little dexterity, the field-worker might catch every sheaf as the carter pitches it from his fork upon his or her fork at the band, where the sheaf is balanced, and when it may easily be thrown with its butt-end to the right hand of the stacker.

For regularity of work, the carter should pitch the sheaves just as fast as the builder can place them, and no faster, having only one sheaf in reserve on the stack in advance of the builder—any more can be of no service to him, and may be a hindrance.

It is necessary for the field-worker to use the fork equally with the right hand and the left, otherwise she will be obliged to swing the sheaves across herself for half the round of the building of the stack, thereby incurring much unnecessary fatigue. The field-worker remains on the stack as long as she has a footing, to hand the topmost sheaves to the builder.

By another plan which many prefer, the second forker becomes unnecessary. When a stack gets near completion, and the cart at the stack nearly empty, another stack is begun until a cart arrives with a full load, when from the top of it one forker is easily able to send up sheaves for the completion of the former stack.

Trimming Stacks.—As each cart is unloaded, the stacker descends to the ground by means of a ladder, and trims the stack by pushing in with a fork the end of any sheaf that projects further than the rest, and by pulling out any that may have been placed too far in. As the stack rises above the stacker he cannot trim it with a fork. He uses a *trimmer*, consisting of quarter-inch thick flat board about 20 inches in length and 10 inches broad, nailed firmly to a long shaft, fig. 535, with which he beats in the projecting ends of sheaves, giving the body of the stack a uniform roundness. An improved trimmer has its edges formed into thick strong teeth.

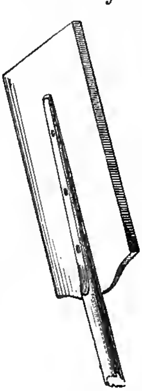


Fig. 535.—*Stack-trimmer.*

Form of Stack. — Many stackers make the stack swell out as it proceeds in height, but this is not necessary for throwing off the drops of rain from the eave, as the eave itself, on the stack subsiding after being built a few days, or the thatching, projects sufficiently to throw off the drops. The body of the stack should be carried up perpendicularly.

Height of Stack.—As a stack of 15 feet in diameter should ultimately stand 12 feet high in the body to maintain a due proportion, an allowance of about one foot for subsidence, before making the top, is generally given. The height is measured with the ladder, and allowing two feet for the height of the stathel, a 15-feet ladder will just give the desired height of the body before the top is built up. Fig. 536 is a stack built upon a stathel.

Eave.—The eave of a stack is formed according to the mode in which it is to be thatched. If the ropes be placed lozenge-shaped, the eave-row of sheaves is placed just within the topmost row of the body. If the ropes are to run from the crown of the stack to the eave, the eave sheaves project two or three inches beyond the topmost row of sheaves.

Topping Stacks.—In building the top of a stack, every successive row of sheaves is taken as much in as to give the slope the same angle as a common roof—one foot below the square. The bevelled bottom of the sheaves, acquired by standing in the stook, answers the slope of the top pretty nearly. The hearting of the top of a stack should be particularly attended to, as on rain obtaining admission at the top it cannot be prevented descending to the heart. After the area of the top has contracted to a space on which 4 sheaves only can stand upright, they are placed with their butt-ends spread a little out, and the tops pressed together, so as to complete the apex of a cone. The top sheaves are held in their position against the wind by means of a straw-rope wound round them and fastened to the stack.

Process of Thatching.

Seldom is leisure found to thatch stacks as long as there is corn to carry in. The finer the weather less the leisure. A damp day, however, which prevents carrying, answers well for thatching, as thatch-straw is none the worse of being a little damp; but in heavy rain it is improper to thatch and cover up the wet ends of sheaves. The materials for thatching should all be at hand before commencing—drawn bunches of straw, coils of straw-ropes or coir-yarn, ladders, forks, hand-rakes, and graips. To get on with the business quickly, one man and two assistants are required for each stack—the most thrifty assistants being field-workers, to supply the thatcher with straw and ropes, and tie the ends of the ropes.

Method.—The thatching of a stack with drawn straw is done in this manner—the lozenge-shaped being the most common: On the thatcher ascending to the top of the stack by means of a ladder, which is immediately taken away by an assistant, one bundle or two of drawn straw are forked up to him by the other assistant, and kept beside him behind a graip stuck into the top of the stack. The straw is first laid and spread upon the eave, beyond which it projects a few inches, and then handful after handful is laid in an overlapping manner to the top. Where a butt-end of a sheaf projects, it should be beaten in; and where a hollow occurs, a sheaf should be drawn out a little, or the hollow should be filled up with additional straw. In this manner the straw is evenly laid all round the top of the stack, to the spot where the thatcher began.

Forming the Apex.—After putting the covering on the top of the stack, fig. 536, he makes up the apex with a small bundle of well-drawn long straw, tied firmly near one end with a piece of cord, and the tied end is cut square with a knife; the loose end being spread upon the covering, and giving the finish to the thatching. To secure the apex in its place, a straw-rope is thrown down by the thatcher, the end of which his assistant on the ground fastens to the side of the stack. After passing the rope round the apex, he throws it down in the same direction, where it is also fastened to the stack. In like manner he throws down a rope round the opposite side of the apex, and their ends are also fastened by the assistant.

Roping Stacks.—Having thus secured the ornamental *top*, the thatcher comes down the thatching, closing up the covering in the descent of his track, and descending by the ladder placed to let him down. Taking a longer ladder, he inclines its upper part nearly parallel to the covering of the stack, and secures its lower end from slipping by a graip thrust against it into the ground. He then stands upon the ladder at a requisite height above the eave, where he receives

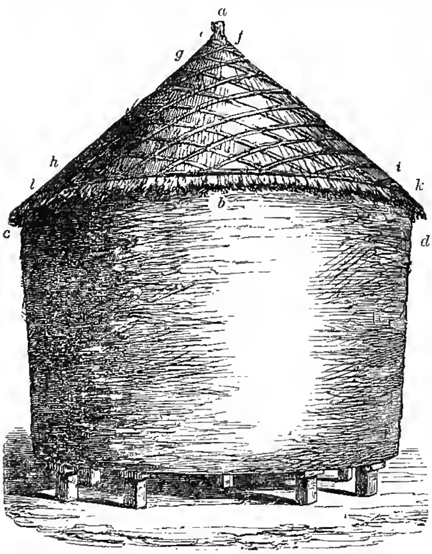


Fig. 536.—*Lozenge mode of roping the covering of a corn-stack.*

a Apex or ornamental top.
e f First rope for securing the apex in its position.
f g Second rope for farther securing the apex in its position.
h Last rope on that side of the stack.
i Last rope on the opposite side of the stack.
l Eave of thatch.
l k Eave-rope.
c d Diameter of the stack, 15 feet.

a number of coils of ropes from his assistant, which he keeps before him between the steps of the ladder.

The thatch-straw is made smooth by being stroked down with a supple rod of willow, before the ropes are successively put on. Holding on by the loosened end of a coil of rope, he throws the coil from where he stands on the ladder down to the right hand to his assistant, who, holding it in the hand, allows the thatcher to coil it up again upon his hand without ruffling the covering of the stack, till as much of it is left as to allow the assistant to fasten it to the side of the stack, while the thatcher adjusts its position parallel to the rope he had placed round the apex. The thatcher then throws the other end of the coil to the right hand to his assistant, who takes hold of its end, while he retains the rope in his hands, and places its double parallel with the rope round the apex, and the assistant pulls it tightly down, and makes it fast to the stack, or perhaps to a brick or other weight.

The reason why the thatcher coils up the second half of the rope before it is thrown down is, that a loose straw-rope cannot be thrown down within reach of the assistant. Thus the thatcher puts on every rope parallel to each other till the last one is near the eave.

The ropes have a tighter fit after receiving a tap here and there with the fork from the thatcher, whilst the assistant is pulling the last end tight.

He then takes the ladder to the opposite side of the stack, and puts on each rope on that side, as he had done on the other side.

Lozenge Roping.—Ropes thus placed parallel from opposite sides of the stack, crossing each other, make the lozenge-shape in fig. 536.

Number of Ropes.—On a stack 15 feet in diameter at the base, 16 feet diameter at the eave, 12 feet high in the body, and 6½ feet high in the top, 10 ropes on each side will secure the thatch.

Tying Ropes.—The ends of the ropes are fastened to the stack by pulling out a little straw from a sheaf, twisting the rope and straw together, and pushing through the twisted end between the rope and the stack.

Windy gusty weather is unfavourable for the thatching of stacks.

Another Method of Roping.—Another method of roping the thatching of a stack is fig. 537. The thatching of straw is put on in the same manner as described above. The ropes cross over the crown of the stack, and subdivide the top into equal triangles, their ends being fastened to the side of the stack. The ropes, at their crossing over the crown, are fastened together by a straw-rope, which is tied above them with cord, and cut off in the form of a rosette. The cross-ropes are either put on spirally round the top till they terminate at the eave, or in separate bands, parallel to the eave. In either case the cross-ropes are twisted round each crown-rope, at equal intervals, from the top to the eave.

This mode of roping requires more

ropes than the last, but it secures the thatch against any force of wind, and is therefore well adapted for exposed situations.

Round Tops.—A third mode of roping the covering of a stack is applicable to

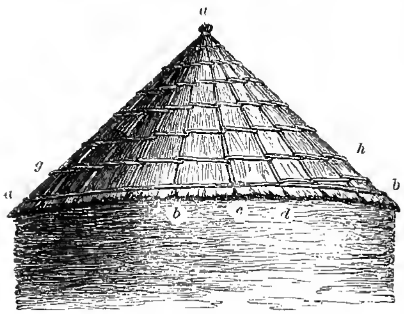


Fig. 537.—*Net-mesh mode of roping the covering of a corn-stack.*

a Top or rosette.
a b, *a c*, *a d* Form of triangles on the thatch.
a to *d* is the spiral rope round the top, from the top to the eave.
g h are ropes round the top parallel to the eave

where the eave is formed of sheaves projecting beyond the body. It is shown in fig. 538, and is common on the Borders. The first thing is to put a strong eave-rope round the stack, below the projecting row of sheaves. The covering straw is

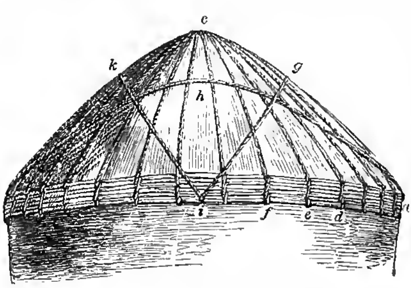


Fig. 538.—*Border mode of roping the covering of a corn-stack.*

c Crown of stack, upon which the thatcher stands.
c b to *c a* Ropes passing over the crown of the stack.
f e d Ends of ropes fastened to the eave-rope.
a b Band of rope-ends round the stack.
h, *i k*, *i g* Strap-ropes quartering the top of the stack.

then put on in a similar manner to that described, but rather thicker, and it projects farther down than the line of the eave-rope. The tops of the finishing sheaves of the stack are then pressed down, and a hard bundle of short straw is placed upon them, to serve as a cushion for the ropes to rest upon. Upon this the thatcher perches himself, where he receives the ropes as thrown up to him on the prongs of a long fork.

Throwing Rope-coils.—Some dexterity is required to throw a coil of straw-rope to, as well as to catch it on the point of a fork on, the top of a stack. To throw it up, stand as far from the stack as to see the thatcher clearly, and, having a coil by the small end, pitch it upwards with a full swing of the arm, parallel to the covering of the stack, towards the thatcher's feet, and he will catch it firmly on the prongs of the fork; if aimed higher, or to either side, the fork will most likely miss it, the thatcher not having the freedom of his body, but only his arms. He thus receives a number of coils, and places them at his feet.

Uncoiling half of a rope by coiling it on his right hand, the thatcher throws the hand-coil over the eave to an assistant, who holds on by that end while he throws the other coiled half down in the opposite direction, across the top of the stack, to the other assistant, who lays hold of its end: then both assistants pull the rope, the thatcher tapping it firmly with the fork, and the ends are fastened on opposite sides of the stack. One assistant may suffice, by tying first one end of the rope, and then the other; but with two assistants the roping is done quicker and more firmly. Thus rope after rope is thrown, at equal intervals, to the number of thirty.

The ropes, crossing at the top, are tied together with a piece of straw-rope, to prevent their slipping. A ladder is placed upon the thatching, down which the thatcher descends to the ground.

An English Custom.—A mode of thatching stacks, common in England, is the insertion of handfuls of well-drawn wheat-straw into the butts of the sheaves, which are kept down with stobs of willows, or sewed on with tarred twine, being an imitation of thatching cottages. No straw-ropes are used, and, finished by an experienced thatcher, it gives the stacks a neat and permanent appearance. This method would not resist much wind, but its smooth surface would detain the snow a much less time than any of the ropings described above.

Thatching with machine-made thatch is much more expeditious and more simple than any of the methods described above.

Finishing Stacks.—Seldom is the thatching of a stack finished when the straw and ropes are put on; the object of these being to place, in the shortest time, stacks beyond danger of rain. Besides, stacks subside in bulk after covering. Stacks to be early threshed, as barley, seldom receive finishing; and many farmers only finish the outside row of stacks. It is slovenly management to leave stacks unfinished in the thatching, as wind readily strips them of their thatching.

The finishing of the thatching in fig. 536 is done in this manner: A rope is spun long and strong enough to go round the stack as an eave-rope. Wherever two ropes from opposite directions cross the eave-rope, they are passed round it, and, on being cut short with a knife, are fastened to the stack. After all the ends of the crossed ropes are thus fastened to the stack, the projecting part of the thatch at the eave is cut of equal length with a knife round the stack. Of all the modes of thatching, there is none more efficient or better-looking than the lozenge-shaped.

The finishing of thatching, fig. 537, is as follows: An eave-rope is first put round the stack. The crown-ropes are passed at each end round the eave-rope, and fastened to the stack. The projecting straw at the eave is cut with a knife at equal length.

The difficult part of roping, fig. 538, is in finishing the eave, which, if well done, looks neat; if not, slovenly. The eave is finished in this way: The eave-rope having been put up at the thatching, the ends of the ropes are loosened from the stack, and passed between the eave-rope and the stack, and each successive end is so passed and carried horizontally along its length; and thus every rope all the way round the stack at both ends is treated; and in carrying the ends of the ropes round the eave, the band of ropes should be of the same breadth round the stack. From four to eight ropes, according to the exposure of the situation, are strapped across the crown-ropes, quartering the top of the stack, and fastened to the eave-rope.

Cutting Thatch.

Where rough grass grows on a farm, as on a bog which is partially dry in summer, it should be mown and sheafed, for thatching stacks. One or two days given to mowing such grass, after the harvest is over, are well spent, even at the rate of wages and food of ordinary harvest-work. Such vegetable materials save the drawing of clean straw when it is scarce, and form good covering for stacks soon to be threshed; and when it has served the purpose of thatch, it is suitable for littering courts. Bog-reeds, *Arundo phragmites*, might be used in the same way where it does not find a profitable market as thatch for cottages. Such materials add many tons to the manure-heap.

Stack-heating.

Barley.—Of all kinds of corn, barley is most liable to heat in the stack, partly owing to the soft and moist character of the straw, and partly because clover is usually mixed with it. On this account it is advisable, in most seasons, to make barley-stacks smaller than the others, both in diameter and height, and to build them upon bosses. Much care should be bestowed on building barley-stacks to heart them properly, which is the best expedient to prevent heating.

Injury from Heating.—The least heat spoils barley for malting, and it should be remembered that malting barley always fetches the highest price in the market. Besides injuring the grain, heating compresses barley-straw very firmly, and soon rots it.

Remedy.—When a stack is seen to heat, it should be instantly carried into the barn and threshed, to cool both grain and straw. If this should be inconvenient, the stack might be "turned"—that is, forked down and rebuilt, the hotter sheaves being kept to the exterior.

Symptoms of Heating.—When a stack begins to lean to one side about twenty-four hours after being built, or shows a depression in the top a little above the eave, you may suspect heating to have proceeded to a serious degree. Incipient symptoms of heating are moisture on the top of a stack early in the morning—indicated by cobwebs—before the sun evaporates it, as also when heated air is felt, or steam seen to rise.

Heated barley lubricates the threshing-machine with a gummy matter.

Oats.—Oats are less apt to heat than barley, though their heating is stronger. If sap remain in the joints of the straw, oats will be sure to heat in the stack. Heating gives to oat-straw and grain a reddish tinge, may render the straw unfit for fodder, and give the corn a bitter taste.

Wheat.—Wheat seldom heats, but when it does the heat is most violent. Heated wheat is bitter to the taste.

Partial Heating.—Partial heating is induced in a compressed part of a stack caused by bad building, and it is indicated by the stack leaning over.

Propping Stacks.—To prevent a stack from leaning to one side, props of weedings of plantations are loosely set around it to guide subsidence, especially if it has been rapidly built; but in using props caution is required not to push one harder in than others. Stacks often sway whenever their top is finished, when props should be set to keep them upright. To push a prop firmly into a stack much swayed requires the strength of two men—one to push up backwards between the stack and the prop, with both hands clasped upon the outside of the prop, the other to push forward with the shoulder planted against the prop below the other man's hands.

Stack Ventilators.

Various contrivances have been introduced as safeguards against heating in stacks. These are most generally wooden structures, in Scotland named *bosses*, which signify hollows. The mode of using them is to occupy the space which would have been filled with the heads of the sheaves of corn, with a void into which the air shall find access. When stacks are built on bosses erected on stathels, the air finds access through the stathel; but when built upon the ground, a trestle of woodwork may be connected with the boss, by which the air is led into the interior of the stack. When such a trestle is placed at both sides of a boss, a ventilation is maintained through the body of the stack.

Common Boss.—The most common form of boss is a three-sided pyramid, formed of three small trees, of larch or Scots fir, tied together at the small ends, and the thick ends placed at equal distances upon the stathel or ground. A common boss is shown in fig. 539, where

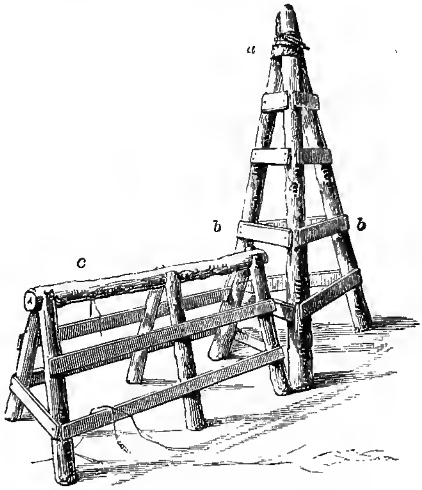


Fig. 539.—*Pyramidal boss and trestle.*
a Tying of 3 sticks together. b b Fillets of wood. c Trestle.

three trees are tied at the top, standing about 8 feet in height and 3 feet asunder. They are fixed together by rows of fillets of wood nailed on, stiffening the pyramid and preventing the sheaves passing into the boss. A trestle, about 2 feet high, is placed on one side to conduct the air into the boss.

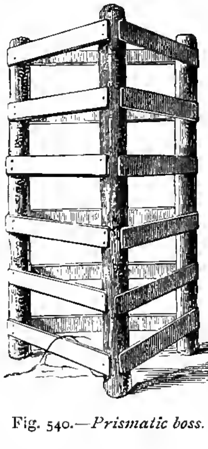


Fig. 540.—*Prismatic boss.*

An objection to this form of boss is, that as the stack subsides, the sharp apex penetrates through the sheaves and disfigures the upper part of the stack.

Prismatic Boss.—A form of boss which many prefer, is shown in fig. 540. It consists of three stems of small trees, 7 feet long, held together in the form of a prism, 3 feet in width, by fillets of wood nailed to them. The prism is set on end, and upon a stathel, which is nailed to it; but as a further means of stability, a spur from each tree might be nailed to the stathel within the prism. Upon the ground it requires a trestle for the conveyance of air.

The advantage of this boss over the other is, that it supports the top of the stack evenly when it subsides, thereby relieving the body of the stack of the weight of its top.

Other Methods.—Other means are employed to form a hollow in the heart of a stack, such as by setting the upright sheaves which form the foundation of the stack around a long cylindrical bundle of straw, firmly wound with straw-rope, or sack filled with hay, and as the stack rises in height, the bundle or sack is drawn up through its centre to the top, where it is removed, leaving a hole through the height of the stack. This hole creates a current of air through the stack, allowing the heated air to escape, while the cool air enters from below by means of a trestle or stathel.

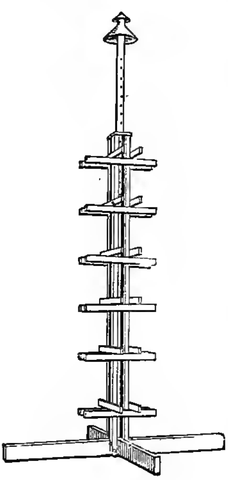


Fig. 541.—*Taylor's stack ventilator.*

Measuring Heat in Stacks.—The degree of heating in a stack may be found by the stack-thermometer.

Improved Ventilator.—An excellent stack ventilator of an improved pattern is represented in fig. 541. It is made by Taylor & Sons, Hawick, and is a most effectual ventilator, alike for stacks of grain and hay.

STACKING IN WET WEATHER.

In wet harvests farmers are often sorely perplexed to know how their crops may be prevented from injury after they are cut.

Small Stacks or "Ricklings."—As explained on p. 86, some farmers resort to the plan of building two or three stooks together in small stacks in the field. Others cart the partially dried corn to the stackyard, and there build it into small loosely formed stacks, which are afterwards, in one, two, or three weeks, according to the character of the weather, either transformed into stacks of the usual dimensions, or put through the threshing-machine.

This double stacking is tedious, costly, and in most respects undesirable; yet it is preferable to allowing partially dried corn to be injured in the field, and is largely pursued in late districts in wet harvests.

Field Stacks.—It is a common practice with some farmers to build a portion of the crop in the field. This is not commendable in good weather, as, besides the trouble of carrying thatch to the field, much waste is experienced in carrying corn to the steading in winter, when the stacks are wanted, perhaps in bad weather or through deep snow. The stacks there are beyond protection, and subject to depredation. A scheme may be justifiable under peculiar circumstances which would not be in ordinary practice, and the building of stacks in the field is one of them.

ARTIFICIAL DRYING.

Many attempts have been made to introduce some practical method of drying the cereal crops by artificial means. So far, however, little success has been attained.

Hot-air Drying.—The system of drying by a hot-air blast, referred to in the chapter on Haymaking, pp. 37-39, was at one time looked to with considerable hope. Unfortunately, however, it has proved to be impracticable.

Nelson System.—This method, also described in the chapter on Haymaking, pp. 37-39, has been tried with fairly good results by some farmers; but it has nowhere come into general or extensive use.

Drying Racks.—Perhaps the most successful and useful efforts have been those directed to the devising of what are known as "drying racks." These racks consist of contrivances by means of which the sheaves of damp corn may be stored in thin layers in such form as to induce the play of currents of air, and expose the sheaves to the drying influence thus created or encouraged.

In late wet districts it has long been the custom, in cases of slow drying, to build imperfectly dried corn on hurdles or other wooden erections in what is called the "sow" form. The sheaves are built, perhaps only one sheaf deep, on both sides, and on the top of a long wooden frame. The hollow centre is left open at both ends, and a current of air is thus kept playing upon the thin layers of sheaves. The sheaves are built with the head towards the hollow centre of the rack, so that the grain is not only protected from wet, but directly exposed to the internal current of air.

By resorting to some such plan as this, corn which would otherwise be seriously damaged is often tolerably well preserved.

Richmond's Rack.

An ingenious and efficient rack, invented and brought into use by Mr John Richmond, Dron, Bridge of Earn, Perthshire, is worthy of special notice.

Construction.—Mr Richmond's plan, first successfully carried into practice in 1889, consists in laying the sheaves in

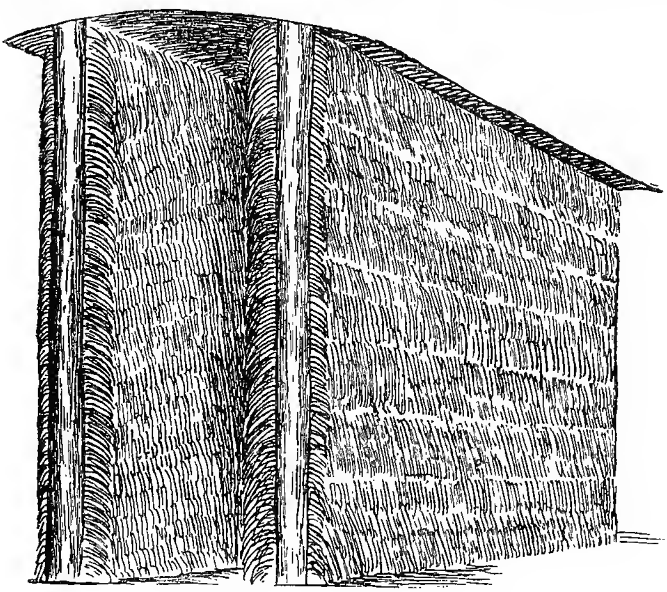


Fig. 542.—*Richmond's corn-rack.*

the "sow" form on the wires of two parallel titanic wire fences, about 5 feet apart. The wires on either side are fixed in triple rows from end to end of the rack, the first two being 8 inches from each other, and the third being 10 inches from the second, and at this third wire there is a subsidiary wire from the other side of the standard to prevent the sheaves from slipping. A row of sheaves is placed on each wire, the heads of the sheaves all pointing to the centre of the rack, so that the grain may be always exposed to the draught through the centre of the rack. The double wire every third space prevents the sheaves from slipping, and by means of the greater distance allotted to this third row provision is made for a transverse through draught every third row. The wires are supported on the intermediate standards by strong nails or pins driven into the standards at a sharp upward angle, so that when the workman is filling one row he may lift the next wire up to a higher pin, so as to give him greater freedom of action. The rack is made about 15 feet high, which provides for twenty rows of sheaves on either side. The straining-posts and intermediate standards are strongly fixed and well spurred to guard against wind pressure, and the whole rack is covered with a roof of corrugated iron.[1]

Testing the Rack.—In the harvest of 1889 Mr Richmond had this rack submitted to a searching trial. In the presence of a number of practical farmers he had it filled with barley which was cut the same day. Grass and clover seeds had been sown along with the barley, and the sheaves were thick with grass in the bottom, just the kind of sheaves most difficult of all to dry. The weather was very dull and muggy for some time after the rack was filled, yet the trial was a complete success. The barley dried beautifully, and was threshed in the following March without a trace of discoloration on either the grain or straw.

Advantages of the Rack.—The efficiency of the rack in drying fresh-cut sheaves having been thus established, it is obvious that Mr Richmond's invention possesses great practical value. The chief merit of the rack, of course, is, that it is capable of saving a crop which might otherwise be lost or seriously damaged. But other advantages are also claimed for it. These are, that it dispenses with stooking, saves stack-thatching, lessens the labour-bill by making it unnecessary for the farmer to retain extra hands through a protracted harvest, and enables the farmer to clear the stubble land for ploughing as soon as the crop is cut, thus facilitating preparations for the crops of the succeeding year.

Cost of the Rack.—Mr Richmond estimates that the cost of constructing the rack will be about £2 per acre—that is, that the cost of rack capacity, sufficient to hold the average crop of one acre, will be about that sum. Without the corrugated iron roof the cost would be only about £1. It is obvious that the rack, if strongly erected, would last for many years, and thus for a very small annual charge—the interest on the original cost of £2 per acre capacity, say 2s. per acre per annum—the farmer may provide effectual means of having his grain crops dried without injury from inclement weather.

Removing the Rack.—The materials composing this rack can nearly all be easily removed at the end of the tenancy, as the strainers only are sunk in the ground. The intermediate standards rest upon bricks, which are laid on the surface of the ground.

Utility of the Rack.—It will be readily understood that a rack of this kind would be a great boon where the harvest is usually late and the climate moist. In the upland glens it should be of great benefit, and here the cost of construction might be lessened by substituting heather or broom for the roof of corrugated iron. It is not likely that many

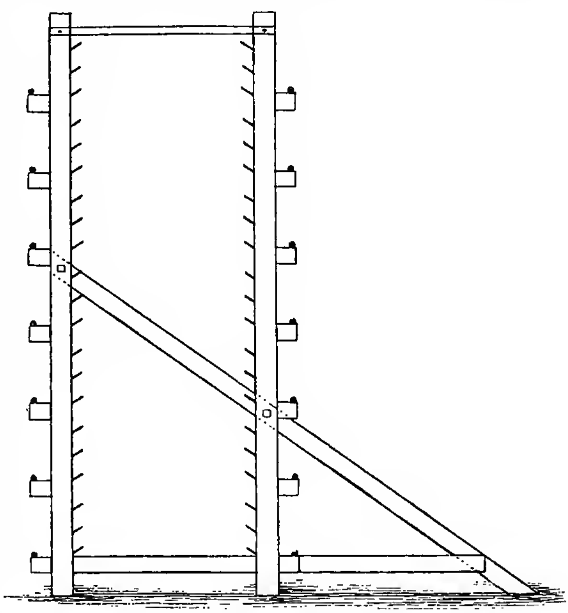


Fig. 543.—*Richmond's corn-rack—section.*

[1] *N. B. Agriculturist*, 1890, 226.

farmers will erect rack accommodation sufficient to hold their entire crop, but on most farms a large rack would be a profitable investment.

The Rack in Dry Seasons.—In dry seasons, when not required for drying the crop, the rack might be easily converted into a shed in which the crop might be stacked, as in a hay-barn or covered stackyard. For this purpose the wires of the rack may be easily removed.

Capacity of the Rack.—This rack, 15 feet high, will hold in the double rows 756 sheaves in a section of four yards. This will be rather more than the produce of one acre. It will be seen from figs. 542, 543, that in each rack there is a double row of sheaves, with an open space in the centre. This open space varies with the length of the sheaves, the wires of the two rows being 5 feet apart.

Filling the Rack.—The filling of the rack entails more labour than ordinary stack-building. One forker can keep two persons going in placing the sheaves in the racks, but the placing is so simple work that it can be done by any farm hand of ordinary intelligence.

Preventing Bird Injury.—By very simple and inexpensive means birds can be prevented from consuming or injuring grain in this rack. The heads of the sheaves, we have seen, are turned towards the centre of the rack. The ends of the rack are made bird-proof by galvanised wire-netting, now procurable at a trifling cost.

Mr Richmond has patented his rack, but intends giving the right to erect it on payment of a very small royalty.

Mr Duncan's Rack.

A rack of a different pattern, but also very useful, has long been employed by Mr James Duncan, Panlathie Mill, Forfarshire. Instead of the wires used by Mr Richmond to carry the sheaves, Mr Duncan uses movable wooden rails, and mainly with the idea of economising space he builds three sheaf-lengths of average grain on each shelf. To prevent the devouring of the grain by birds, he places the heads of the sheaves inwards, leaving the butt-ends exposed to the centre tunnel of the rack and towards the outside.

In this rack Mr Duncan has successfully stored grain carried to it immediately on being cut. In this case, however, the sheaves have to be laid loosely, and in average weather the crop takes long to dry thoroughly. He thinks it better that the grain should first be exposed in the stook in the ordinary way for a few days, and then taken to the rack to have the drying completed. If exposed in stook for two days in fairly dry weather, the crop may be put into one-third less space in the rack than if racked immediately on being cut.

GENERAL NOTES.

Length of Stubble.—The improved reaping-machine cuts the crop very close to the ground, and the advantage of this is greater than many would at first thought imagine. The following statement may be depended on as being the result of experiment:—

Weight of straw from one acre, when cut to within

	cwt.	qr.	lb.
2 inches of the ground .	26	1	0
8 " " .	23	1	6
12 " " .	21	0	2

It is thus seen that ½ cwt. of straw is left on one acre with one inch of stubble—a point which farmers should keep in view. Still there are cases in which it would be doubtful economy to cut very close to the ground. If grass and clover seeds have been sown with the grain crop, very close cutting may be undesirable, both for the grain and the grass and clover. A rank stubble in such cases will afford an excellent run for sheep, and be especially useful in flushing ewes before tupping.

Proportion of Grain to Straw.—The proportion which the grain and straw bear to each other cannot be stated with reliable accuracy. We received the following statement of their relative weights in the neighbourhood of Edinburgh from Andrew Gibson of the Dean Farm: From a crop of wheat, of 40 bushels to one acre, or of 2600 lb., at 65 lb. of one bushel, the straw will weigh 9 kemples of 440 lb. each, or 3960 lb., affording just one-half more weight of straw than of grain. From a crop of barley of 60 bushels, weighing 56 lb. of one bushel, or 3360 lb. on one acre, the weight of straw is 7 kemples, or 3080 lb., being one-tenth of less weight of straw than of grain. From a crop of 60 bushels of oats, at 45 lb. of one bushel, or 2700 lb. on one acre, the weight of straw is 8 kemples, or 3520 lb., being one-third more weight of straw than of grain. These are all average quantities.

In ordinary crops at a distance from towns, the straw is about twice the weight of the grain. P. M'Lagan of Pumpherston made experiments for this work in 1849 on the relative proportion of grain and straw, and these results were obtained: Of four experiments with oats *dibbled*, the average weight of grain from one acre was 3479 lb., and of straw and chaff 7260 lb., or more than two times the weight of straw to one of grain. Of six experiments with oats *drilled*, the average weight of the grain was 2974 lb. on one acre, and that of the straw and chaff 5836¼ lb., being less than two times the weight of straw to one of grain. Of four experiments with oats sown *broadcast*, the grain weighed on one acre 3176¼ lb., and the straw and chaff 6428⅛ lb., or rather more than two times the weight of straw to one of grain: two times the weight of straw to one of grain of oats may thus be regarded as near the truth at a distance from large towns, while in their immediate vicinity the grain bears a larger proportion to the straw.

Proportion of Crop and Roots.—Another point of interest is the relation which the stubble and roots left in the ground bear to the straw and corn carried off it. P. M'Lagan's experiments give results which are both surprising and anomalous. Thus:—

DIBBLED.

Plants in 1 square yard.	Weight of straw and chaff on 1 acre.	Weight of stubble and roots on 1 acre.
	lb.	lb.
26	6050	19,360
49	8470	27,830
75	4840	29,040
120	9680	10,588

Where there were 75 plants in one square yard, the stubble and roots weighed six times the weight of straw and chaff; and where there were 120 plants, the straw and chaff, and stubble and roots, were nearly equal in weight.

DRILLED.

Plants in 1 square yard.	Weight of straw and chaff on 1 acre.	Weight of stubble and roots on 1 acre.
	lb.	lb.
32	5445	18,150
53	7260	37,510
78	4235	14,520
94	6656	14,520
140	5748	12,100
208	6050	17,244

With the exception of 53 plants to one square yard, which yielded five times of stubble and roots to the straw and chaff, the difference in the relation between them is one to two and three.

BROADCAST.

Plants in 1 square yard.	Weight of straw and chaff on 1 acre.	Weight of stubble and roots on 1 acre.
	lb.	lb.
19	3932	13,330
52	6050	20,570

Roots of Hay.—Here the difference is again one to two and three. Johnston mentions that, according to the experiments of Hlubek in the agricultural garden at Laybach, the sheep's fescue and perennial rye-grass left of roots in the soil three times the weight of the hay produced; and in old pasture the roots were four times as heavy as the hay. Even after the roots had been thoroughly dried, they weighed half as heavy again as the crop.[1]

Total Weight of Growth.—The same data show the comparatively small weight of the seed to the crop. Thus:—

		lb.	tons cwt. lb.
Dibbled.	Grain . . .	3,479	
	Straw and chaff .	7,260	
	Stubble and roots	21,704	
		32,443 =	14 9 75
Drilled.	Grain . . .	2,974	
	Straw and chaff .	5,836	
	Stubble and roots	19,007	
		27,817 =	12 8 41

[1] Johnston's *Lect. Agric. Chem.*, 2d ed., 746.

		lb.	tons cwt. lb.
Broad-cast.	Grain	3,176	
	Straw and chaff	6,428	
	Stubble and roots	11,450	
		21,054=	9 7 110

It thus appears that dibbling raised the largest weight of crop from the smallest weight of seed, and broadcast the smallest weight of crop from the largest weight of seed.

Boussingault's Experiments.—Boussingault made experiments on the stubble and roots of wheat, oats, and clover in 1839, dried in the sun and air, and their weights per acre were as follows:—

	cwt.
Wheat stubble and roots	5¾
Oat	8
Clover	15 4/5 [1]

Number of Grains.—In prosecuting these experiments to an end, P. M'Lagan obtained the numbers of grains of oats from various numbers of plants on one square yard, thus:—

DIBBLED.

Plants in 1 square yard.	Number of grains raised in 1 square yard.	Weight of grain on 1 acre.	Number of bushels of 40 lb. per acre.	Increase in fold.
		lb.		
26	7,500	2724	68	288
49	11,700	3859	96	240
75	5,400	2118	53	72

DRILLED.

Plants in 1 square yard.	Number of grains raised in 1 square yard.	Weight of grain on 1 acre.	Number of bushels of 40 lb. per acre.	Increase in fold.
		lb.		
32	7500	3025	75	234
53	7900	3632	91	150
78	5600	2420	60	72
94	6900	3025	75	73

BROADCAST.

Plants in 1 square yard.	Number of grains raised in 1 square yard.	Weight of grain on 1 acre.	Number of bushels of 40 lb. per acre.	Increase in fold.
		lb.		
19	5100	2117	53	270
52	8000	3113	78	154
68	8700	3632	91	128

[1] Boussingault's *Rur. Econ.*, 486, 487—Law's tr.

P. M'Lagan remarks: "There is one thing that strikes me as curious and interesting—namely, the great preponderance of pickles reaped when only 2 pickles were put into the hole compared to the result when 3 were put in. One pickle in a hole gave a much better yield than 3. Might we not argue from this, that if dibbling is to be much practised, it will be better to make more holes, and put fewer seeds into each hole? There is some confirmation of this from the results obtained from broadcast, where there is a gradual increase of produce according to the quantity sown—owing, I suppose, to the seeds being more equally distributed over the ground. The rest of the field not experimented on was sown the same day as the parts on which the above observations were made, at the rate of 4 4/5 bushels to the acre. It was in full ear on the 9th and 11th July, and was reaped on the 8th of September. I also sowed some at the rate of 2 2/5 and 3 1/5 bushels to the acre. It was also a good crop, and was nearly as soon ready for reaping as the rest of the field. I made several observations about the time the corn came into ear, and found that it came into ear according to the thickness of sowing, the thickest sown being first in ear, and the drilled portion being always the most forward. The thinnest sown had strong straws and magnificent heads, but I was obliged to cut them before they were ripe. Although several parcels were cut on the same day, they were not equally ripe, the thinnest sown always being greenest."

Weeds and Harvest Work.—Farmers neglecting to keep their land free from weeds give reapers much uneasiness and waste much time while getting rid of large weeds, some of which injure the hands seriously. The corn dead-nettle, *Galeopsis tetrahit*, is dangerous, causing swellings, heat, and pain in the hands; as also the biennial spear-thistle, *Cnicus lanceolatus*, the spines of which, breaking in the flesh, inflict acute pain when touched, and are exceedingly troublesome to extract. The only safeguard against such injuries is to wear harvest gloves.

Tidy Stackyards.

The practice of many farmers, who leave the stackyard in a slovenly state after the carrying of the corn and the thatching of the stacks are finished, is much to be deprecated. The stackyard is often left for a long time littered thick with the refuse of the thatching-straw, which, when wetted with rain, is useless as litter, soon heats, and causes an unpleasant odour among the stacks. The bunched straw should be taken to the straw-barn, and the loose to the sheds of the hammels for litter to the cattle, which will soon occupy them as their winter quarters. The ground should be raked clean. The air will then become sweet, the stacks have a free circulation of air amongst them, and the poultry have the chance of picking up every grain that may have fallen from the sheaves.

REAPING BEANS, PEAS, AND TARES.

The leguminous crops, having stiff or trailing stems, are more difficult to reap than the cereals.

Beans.

If sown tolerably early beans will likely in an average season be ready for reaping towards the end of September. They should not be so ripe as that the pods will open and allow the beans to escape. Examine the crop carefully as it approaches maturity, and cut it whenever the eye of the bean is black and the skin has acquired a yellowish colour and leather-like appearance.

The reaping is generally done by the common sickle, and the produce of four drills is laid in handfuls in one row.

In some cases the beans are left lying in this form for a few days, and then turned, and shortly afterwards lifted and bound into sheaves with short straw-ropes, previously provided, and the sheaves are then stooked. In other cases they are bound and stooked as reaped.

In many instances the reaping-machine is now employed in cutting beans.

When peas are sown with beans, the haulm of the peas makes excellent bands. A writer in the Isle of Ely maintains that beans can be well bound by their own straw. He says: "I must remind the incredulous objectors that, different from any other corn, the bean-sheaf 'couches' together in drying, and thus does not require so tight a band to hold it together. The only art in tying the sheaf with bean-stalks consists in not bending the thick end of the stalk. Our plan is as follows: The reaper, who generally cuts with a long-handled hook, first pulls up by the roots 3 or 4 stalks; on these the sheaf is laid as cut, and in about 3 days the straw is sufficiently withered to admit of the thinner end of the stalks forming the band being bent over the sheaf, and twisted tightly round the root-end, which need be bent upwards from the ground scarcely at all, so that the shape of the band when tied might be described by a semicircle."

A bean-stook, which consists of 4 or more sheaves, is never hooded. Bean-sheaves should always be kept on end, as they then resist most rain. If allowed to remain on their side after being blown over by the wind, little rain soaks them, and a succeeding drought causes the pods to burst and spill the beans upon the ground.

Sometimes to admit of preparations for a succeeding wheat crop, the beans as soon as cut are removed from the field and stooked elsewhere.

Peas.

Whenever the straw and pods of peas become brown they are fit for reaping. In seasons when the straw grows luxuriantly, it is cut down whilst retaining much of its greenness. On account of their trailing stems, peas are difficult to cut, and the best work is perhaps made by the hook. The reaping-machine and scythe are, however, both used for the purpose.

Peas as a rule are not bound at first, but laid on the ground in separate bundles, where, after drying for some time, according to the state of the weather, the bundles are rolled into an oblong form, and made firm by a wisp of their own straw. The bundles may be set together in pairs to form a sort of stook, or left singly over the surface of the field. Pea-bundles are bound by women as well as by men.

Tares.

Tares are most easily and quickly reaped by the reaping-machine or scythe. To win they are placed in bundles by the gatherers, and afterwards bound in a similar manner to the pea.

In dry and warm seasons, peas and tares may be harvested as early as the cereal grains; but beans are always long in winning, and sometimes are not harvested until three weeks after the other crops.

STACKING PEAS AND BEANS.

Peas.—The bundles of peas are turned in the field till they are dry, and they are made smaller by being tied with a wisp of their own straw. Pea-straw is very apt to compress in the stack, and to heat, and should therefore be built with bosses, either in round stalks or oblong ones like a haystack. When peas become very dry in the field, the pods are apt to open and spill the corn in sunny weather —to avoid which, they should be carried and built on bosses.

Beans.—Beans are a long time of winning in the field in calm weather. If the land they grow on is desired for wheat, they should be carried to a lea-field and stooked till ready to be stacked. Being hard and open in the straw, they keep well in small stacks, though not quite dry; and there is risk of keeping them in the field in dry weather after much rain, when the pods are apt to burst and spill the corn. In building both pea and bean stacks, the sheaves are laid with their corn-end inwards, and tramped with the feet. The stacks receive but little trimming, the peas none at all, the beans with the back of a shovel.

Thatching Peas and Beans.—The thatching of pea and bean stacks is done in the manner described for grain, but less pains are bestowed in finishing it. As, however, a good deal of corn is exposed on the outside of pea and bean stacks, their bodies are also thatched with straw, kept on with straw-ropes.

REAPING BUCKWHEAT.

The buckwheat is a plant remarkably affected by the weather. It requires dry weather on being sown, and it springs in the greatest drought. But after putting forth its third leaf, it must have rain for the development of its flowers. During the long time it continues in flower, alternate rain and sunshine are requisite to set the flower. The flower drops off in thunderstorms, and it withers in cold east winds. After flowering, dry weather brings the seed to maturity.

"The ripening of the grain is very unequal," says Thäer, "for the plant is continually flowering and setting. We must therefore cut it at the time the greatest quantity of grain is ripe. It sometimes happens that the first flowers do not set, or that they produce nothing but barren seeds, destitute of farina, while those which come out later yield better seed. But the grain will ripen, and even the flowers set, while the crop is lying on the ground after cutting, especially if rain fall. This occurrence is therefore considered favourable." [1]

In the south of England a period of hot and dry weather is necessary in autumn to harvest buckwheat.

Cutting.—Buckwheat may be reaped with the sickle, scythe, or machine, or it may be pulled up by the roots, which last method is recommended by some as less likely to shed the seed when fully ripe. In dry weather it should be reaped early in the morning, or late in the evening, when the dew is upon it, and should not be moved too much in the day.

Drying.—Buckwheat may be tied up in sheaves, or made into bundles like peas; but, in either way, it should be protected from birds, which are very fond of the seed. Owing to the thick knotty stems of the straw, the green state in which it is cut, and the late period it comes to harvest, a succession of fourteen or fifteen fine days is requisite to dry it sufficiently for stacking. It should be turned and moved several times in preparing it for the stack; and these acts should be done gently and in the dew, the least to disturb the seed; but the plant does not easily spoil when lying on the ground. To be early carried, it should be built in small stacks with bosses.

Produce.—A diversity of opinion exists as to the productiveness of buckwheat—Thäer considering 20 bushels on one acre an extraordinary crop very rare-

[1] Thäer's *Prin. Agric.*, ii. 484—Shaw and Johnson's transl.

ly to be obtained; while Hewitt Davis says that he has reaped 70 quarters from 12 acres, which is rather more than 46 bushels on one acre.[1]

Feeding Properties.—The straw of buckwheat is excellent fodder for cattle as long as it is fresh; and the green plant, when raised with manure, affords a forage in summer which causes great increase of milk in cows, but produces a stupefying effect upon them. It is also a valuable manure for wheat.

No grain is so eagerly eaten by poultry and game, or makes poultry lay eggs so soon and abundantly, as buckwheat. It is relished by horses amongst oats. Its meal fattens both poultry and pigs.

Its flour makes good unleavened cakes, which must be eaten fresh, as they soon turn sour. Its blossom is considered, in Flanders, to afford the best food for bees.

HARVESTING THE SUNFLOWER.

When the stems and discs of the sunflower become withered, and the seeds shining and dark-coloured, the plant is ready to be reaped. It is simply pulled up by the roots, which in a strong crop requires force; but the stem can be easily cut through with a sharp sickle. The discs are afterwards cut off with a sharp knife, and the seeds rubbed out.

Produce.—Lawson says that from 30 to 40 bushels of seed on one acre is a fair crop of sunflower. These will yield 50 gallons of oil; the refuse will make 1500 lb. of oilcake; and the stalks burnt into ash will afford a half ton of potash. Professor Johnston mentions that the seed yields 15 per cent of oil.

Sunflower Oil.—Lawson says: "The seeds of both the common and dwarf sunflower yield an oil little inferior to that of the olive for domestic purposes. In Portugal the seeds are made into bread, as also into a kind of meal. In America they are roasted, and used as a substitute for coffee; but the purpose for which they seem best adapted is the feeding of domestic fowls, pheasants, and other game. The greatest objection to their culture is, that they require very superior soil, and are a most impoverishing crop, particularly the taller-growing sort, *Helianthus annuus*, from which circumstance the dwarf species, *Helianthus indicus*, has been preferred by some cultivators in France, who assert that, as its dwarf habit of growth admits of a greater number of plants being grown on a given space, it is not so much inferior to the other in quantity of produce as, from its appearance, one would be led to expect. In addition to the uses above mentioned, some French authors assert that the leaves, either in a green or dried state, form excellent food for cows, and that they are greedily eaten by them. The stems also form good fuel."[2]

BIRDS DESTRUCTIVE TO CORN CROPS.

There has from time to time been much discussion as to the question whether birds do more good to the farmer and gardener by devouring destructive insects than harm in eating and spilling fruit and seed. The prevalent opinion at one time was, that every bird consumed seeds to support their young, and hence the quantity consumed must be great. Now it is known beyond doubt that most birds feed their young on animal, and not on vegetable, food. Birds are neither entirely insectivorous nor entirely granivorous. They generally feed their young on insects and molluscs, while feeding themselves with fruits and seeds, the product of the garden or the field.

This being the true state of the case, let us determine which of the birds really destroy corn or valuable seeds in the fields.

Greenfinch.—The greenfinch, *Linaria chloris*, in the seed season, accompanied by the young brood, will attack almost every sort of seed that is ripe or ripening, but more particularly turnip-seed and flax. Oat-fields, and even wheat-fields, near woods and hedges suffer considerably, the greenfinch being seldom idle, shelling and munching from sunrise to sunset.

Yellow-hammer.—The yellow-ham-

[1] Davis's *Farm. Ess.*, 68.

[2] Lawson's *Agric. Man.*, 292.

mer, *Emberiza citrinella*, prefers for its own eating corn and seeds, particularly oats; and in new-sown fields of oats, as well as wheat, it may be seen busily picking up the grain from the moment it is sown till the period of its brairding. By autumn, when the broods are reared and the corn crops begin to ripen, they assemble with sparrows and corn-buntings, and leave little alongside the hedges but empty husks on the standing straw. When feeding in the stubble-fields, they advance by short leaps, with their breasts near the ground; when danger approaches, crouch down motionless; and when alarmed, give out their ordinary short note, *yite, yite*. They are more shy than chaffinches, but less so than the corn-buntings.

Seed-bunting.—The seed-bunting, or black-bonnet, *Emberiza schœniculus*, lives mostly on seeds, though small patches of oats on the crofts in the upland districts attract its notice. Not being shy, it is not easily scared away. It is migratory in most parts of Scotland, departing in October, and reappearing in the beginning of April.

Corn-bunting.—The corn-bunting, *Emberiza miliaria*, feeds wholly on corn, and in spring, together with the yellowhammer and others, devours considerable quantities of seed-corn of oats and barley. After the breeding season it feeds on beans, peas, wheat, oats, or barley, while during autumn it feeds on the stubble-lands, sits close, and is shy. It visits the new-sown fallow and potato-wheat. In winter it is remarkably fat, and superior as an article of food to most of our small birds.

"It could hardly be supposed," observes Knapp, "that this bird, not larger than a lark, is capable of doing serious injury; yet I this morning witnessed a rick of barley, standing in a detached field, entirely stripped of its thatching, which this bunting effected by seizing the end of the straw, and deliberately drawing it out to search for any grain the ear might yet contain—the base of the rick being entirely surrounded by the straw, one end resting on the ground, and the other against the snow, as it slid down from the summit, and regularly placed as if by the hand; and so completely was the thatching pulled off, that the immediate removal of the corn became necessary. The sparrow and other birds burrow into the stack, and pilfer the corn, but the deliberate operation of unroofing the edifice appears to be the habit of the bunting alone."

A circumstance such as this shows the risk to which stacks built in the field are exposed, when they would be safe in the stackyard.

Skylark.—The common skylark, or laverock, *Alauda arvensis*, is more destructive than the corn-bunting to seed-corn and crops, inasmuch as it is more numerous. But who would grudge the laverock all that it can find in the fields? In winter, larks assemble in flocks, grow fat, and are taken in numbers for the table, and sent to the markets in London and other English cities. In Scotland they are not in request.

Linnet.—The grey or brown linnet (rose lintie), *Linaria cannabina*, does more damage than is generally supposed. It visits patches of turnips left for seed, and frequents the newly sown turnip-fields. When the young families begin to wander in small companies as the corn becomes ripe, they devour large quantities of the standing corn, voraciously living upon it from the moment it begins to whiten until led to the stackyard. After this period the smaller families associate in larger flocks, frequently combining with the greenfinch, and subsist on the stubbles. It frequents newly sown wheat-fields, and thins the seed-corn in detached patches so much, that the scantiness of the braird is ascribed to the attacks of a grub. It is easily scared.

Chaffinch.—The chaffinch (shilfa), *Fringilla cœlebs*, frequents the vicinity of houses in autumn, searching for food in fields and farmyards. It devours more seeds of weeds than of corn, and is useful in keeping them down, and may be ranked as a benefactor to the farmer, the same as the goldfinch, *Carduelis elegans*.

Bechstein says "that the passion for the chaffinch is carried to such an extent in Thuringia, and those which sing well are sought for with so much activity, that scarcely a single chaffinch that warbles tolerably can be found throughout the province. In Rhul, a large manufacturing town in Thuringia, the inhabitants, who are mostly cutlers, have such a passion for chaffinches, that some of them have gone 90 miles from home to take with bird-lime one of those birds, distinguished by its song, and have given one of their cows for a fair songster, from which has arisen their usual proverb—*a chaffinch is worth a cow.* A common workman will give as much as 16s. for a chaffinch he admires, and will willingly live on bread-and-water to save the money for this purpose."[1]

The peasantry here are not attracted by the song of the chaffinch.

House-sparrow.—The house-sparrow, *Passer domesticus*, is a well-known depredator in our corn-fields. It feeds upon corn and peas, which it abundantly obtains during several weeks in autumn in standing corn and in gardens. Buffon observes that "sparrows follow the sower in seed-time, and the reaper in harvest; they attend the thresher at the barns, and the poulterer when he scatters grain to his fowls; they visit the pigeon-house, and pierce the craws of the young pigeons to extract the food."

It is said that a sparrow eats its own weight of corn every day, if it can get it for the taking; and Buffon calculates that a pair of sparrows will eat 20 lb. of corn every year. When as many as 3000 have been caught on one farm in one day with a net, we may calculate from such data the quantity of corn they consume.[2]

The plague of sparrows has been increasing rather than diminishing, and in some districts farmers suffer great damage from it. The sparrow multiplies very rapidly, and is difficult to keep in check. This has been well illustrated in the United States of America, whither it was introduced from this country, and where, as here, it has become in some parts a serious plague to the farmer.

These are the principal passerine birds which live upon our corn-fields.

Pheasant.—Among others of larger description, the pheasant, *Phasianus colchicus*, is accused of committing great havoc amongst corn crops. Its true habits are thus described by Macgillivray: "Its favourite places of resort are thick plantations or tangled woods by streams, where, among the long grasses, brambles, and other shrubs, it passes the night, sleeping on the ground in summer and autumn, but commonly roosting on the trees in winter. Early in the morning it betakes itself to the open fields to search for its food, which consists of the tender shoots of various plants, grasses, bulbous roots of grasses, and *Potentilla anserina*, turnip-tops, as well as acorns and insects. In autumn, and the early part of winter, it obtains a plentiful supply of grain, acorns, beech-mast, and small fruits. In severe weather, however, especially where great numbers are kept, the pheasants require to be fed with grain, when they learn to attend to the call of the keeper."

In the natural state, and in small numbers, pheasants prefer insects and the young shoots of plants to corn, of which they pick at a time only a few grains; but when semi-domesticated, and congregated in large numbers, they assume the habits of the domestic fowl, and will eat and trample down extensive patches of the growing corn in the immediate vicinity of their preserves—and this they do between the ripening and the reaping of the crop.

Wood-pigeon.—A far more destructive bird than the pheasant is the ringed dove, or cushat, or wood-pigeon, *Columba palumbus*. Its powers of destruction may be estimated by the wholesale levy it makes on the products of the fields and of the woods, as thus enumerated by Macgillivray: From its roost in the larger branches of trees, "it issues at sunrise to search the open fields for its food, which consists of seeds of the cultivated cereal grasses—wheat, barley, and oats; as well as of leguminous plants—beans and peas, and of the field-mustard and charlock. In spring it also feeds on the leaves of the turnips and picks the young blades of the red and white clovers. At this season I have several times found its crop distended with the farinaceous roots of *Potentilla anserina*, obtained in the ploughed fields. This root is highly nutritious; and formerly, in seasons of scarcity, was collected in the West Highlands and Hebrides as an article of food, and eaten either boiled or roasted in the peat-ashes. In summer they eat grass, and other vegetable substances; in autumn grain, beech-mast, acorns, and leguminous seeds. The beech-masts and

[1] Bechstein's *Cage Birds*, 183, note.
[2] *Jour. Agric.*, vii. 284-98.

acorns they swallow entire, their bill not being sufficiently strong to break them up."[1]

The wood-pigeon destroys the growing crop in the manner described by an eye-witness watching near, shy as it naturally is: "The wood-pigeon has a weak bill, but nature has provided her with very strong wings. When the flock, therefore, settle upon the lying portion of a wheat-field, instead of breaking off the heads and carrying them away, they lay themselves down upon their breasts upon the grain, and, using their wings as flails, they beat out the pickles from the heads, and then proceed to eat them. The consequence is, that the pickles having been thrashed out upon a matting of straw, a great proportion of them fall down through it to the ground, and are lost even to the wood-pigeon; in short, they do not eat one pickle for twenty which they thrash from the stalk. I have repeatedly watched this process from behind the trunk of a large willow-tree, growing in a thick-set hedge on the edge of a wheat-field, and seen the operation go on within two yards of me. The pigeons descend first singly; but, having left a watcher upon the highest tree in the neighbourhood, the whole flock are soon at work on the same spot, and the loss of corn to the farmer is very great. They are also gluttons in quantity."[2]

This bird has increased to almost incredible numbers in Scotland, and in many parts inflicts great injury on farmers.

Partridge.—The common partridge, *Perdix cinerea*, doubtless devours corn in the fields; but however plentifully it may breed in any locality, it leaves no marks upon any crop, and is always a favoured bird with people in the country.

Crows.—The rook or crow, *Corvus frugilegus*, has a bad reputation amongst farmers, and not without cause; for however sedulously it will follow the plough and harrow, in search of worms and insects, as long as it has to support its young, there is no doubt that, after that period, it becomes omnivorous, and will eat anything that comes in its way. It will pick meat clean off the bone—it will pick horse-flesh as long as it is fresh; it will eat fish; it will go to the sea-coast in search of shell-fish when food is scarce on the land; it will carry off and eat stray eggs it may happen to find at the steading; it will eat the boiled potatoes and oatmeal porridge set down for the poultry; and when a bowl of barley-broth comes within its reach, it will soon empty it, and the sooner the thicker the barley is in the broth; it will eat the boiled barley and peas out of the horses' mash-tub; it will take up the young plants of potatoes after they have sprouted; it will pull up young plants of turnips, to get at insects that may happen to be near their roots in the manure—and it is poor comfort to the farmer to be told that the plants were destroyed that insects might be captured; it will eat fruit off the trees; it will alight upon laid corn of all kinds, and pick and scratch out much more than it can eat; it alights also on stooks of corn, and pulls out the ears, and eats the corn; it will fly to a great distance to eat the crowberry, *Empetrum nigrum*; and it will even break into the thatch of stacks to get at the corn. These facts are sufficient in number to support the assertion that it is a destructive bird to the farm. In moderate numbers, it would do no material injury in the fields, and many people have a liking for "a few" crows around them. But crows have a pertinacious habit of growing beyond a few, and for the sake of the farmer's crop their increase must be kept in check. This may be most easily and effectually done by destroying nests; but good may also be done by shooting the grown birds.

Crows are wonderfully cute. They travel long distances to obtain their food; and it is said they do this in order to keep in good favour with the farmers near their rookeries. He who asserts that the rook does no harm to crops, and does good alone by the removal of insects from the soil, must either be a prejudiced or inaccurate observer of its habits.

Birds Devouring Insects.—It is contended by many that birds do more good than harm to farmers—that by devouring insects which would prey upon crops they save more of the farmer's crops than they destroy. This is a much debated

[1] Macgillivray's *Brit. Birds*, i. 123, 263.

[2] Burn Murdoch's *Obser. on Game*, 11.

point, difficult to determine satisfactorily. Unquestionably birds do live to a large extent upon insects, which would otherwise be liable to injure crops. It has been observed, for instance, that the grub which attack grain crops are wonderfully kept in check by crows, which devour them greedily. Upon the whole, however, the verdict must be emphatically against a few of the more voracious birds, such as the sparrow and the crow.

Methods of Prevention.

Scaring Birds.—Many devices have been tried to scare destructive birds from corn-fields and green crops. The most common is the *scarecrow*. Scarecrows are made of various forms and materials, but the most common is the similitude of men and women in the tattered rags of beggars. Pieces of bright tin are made to flicker in the sunbeams, at the ends of strings. Lines of white threads are hooked on from one object to another.

But as soon as birds become familiarised with the form of these expedients, they lose their terrors. The contempt shown for them by birds is told us by Cobbett in his own quaint way: "Shoy-hoys," he observes, "exercise their influence but for a very short space of time. The birds quickly perceive that their guardianship of the treasures of the farmer is a mere *sham;* and, like the sparrows in my neighbour's garden at Botley, they will, in a short time, make the top of the hat of a shoy-hoy a table whereon to enjoy the repast which they have purloined."

Destroying Sparrows.—Where ivy is plentiful, in which sparrows delight to harbour, a net has captured as many as 3000 in one day. Sparrows are easily shot with sparrow-hail, when congregated on a bare piece of ground, lured thereon by a favourite sort of food.

Poisoning Birds.—In regard to the use of poison in killing birds, Taylor answers this important query, "*Is the flesh of poisoned animals poisonous?* This is a question which it is necessary to consider, because poultry and game are not unfrequently poisoned wilfully or accidentally, and in this state they may be eaten unsuspectingly. It is well known that grain is often saturated with a solution of arsenic for agricultural purposes before it is sown: if this grain be eaten by poultry, it will destroy them; and a question may arise as to the effects which the flesh of the animals so poisoned is liable to produce on man. In other instances, poison has been placed in the way of these animals with the malicious object of destroying them. Thus oats saturated with arsenic, or with that poison intermixed, have been placed in game-preserves for the purpose of destroying pheasants and other birds. During the last spring (1846) two black-cocks were sent to me for examination from the extensive preserves of a nobleman in Scotland. They had been found dead on the ground. A quantity of arsenic was discovered intermixed with oats and the shoots of the larch in the crops and gizzards of each bird, and arsenic also existed in the pectoral muscles and soft organs. There had been previously a very large destruction of game on the estate, as it was inferred, from poison. There is hardly a doubt that, when the animal dies soon after the ingestion of poison, and obviously from its effects, the flesh would be poisonous to man, although it might require a large quantity of the flesh to produce a fatal result. Professor Christison reports a case which renders this opinion highly probable."[1]

Gunpowder.—Gunpowder is the most effectual means of any of scaring birds from fields. Rags steeped in a solution of gunpowder, dried, placed on the windward side of a field, and set on fire to smoulder, will act as a scare as long as they last, but the renewal of them is troublesome.

Other Methods.—By organised raids on the nests, and by persistent shooting, much may and should be done to keep the destructive birds within reasonable numbers.

Prevention, not Extermination.—But while it is necessary that steps should be taken to prevent destructive birds from becoming so numerous as to inflict serious injury upon the farmer, it is not to be assumed that we would advocate the extermination of any of our feathered songsters. All that is desired in the interests of the farmer is that the

[1] Taylor *On Poisons*, 164.

birds and beasts which prey upon his crops should be kept in reasonable numbers.

Poultry injuring Crops.

No wild birds are so destructive to standing corn as domestic fowls. The common hens pull down standing stalks of corn, and after shaking a few grains out of an ear, leave it and pull down another stalk; and where the corn is laid they scratch the straw and ears with their feet, and cause many more grains to come out than they consume.

Turkeys, being tall, are still more destructive than hens, and are less easily satisfied.

Geese pull down standing corn, nibble the grain out of the ear, trample laid corn quite flat, and greatly injure the straw.

Ducks usually content themselves in shovelling off the ground the grain the hens and turkeys have spilt, but they also trample laid corn flat.

Pigeons rest upon laid patches of wheat, and on picking the ears shake out the grain, which falls between the straws to the ground.

Prevention.—The only means of saving growing crops from destruction when near the steading is to confine the poultry within the steading or other enclosure for a time before the corn is ripe, until it is cut down. They do comparatively little harm to stooks. In these enclosures food and water must be given daily, as well as sand and gravel, dry earth or ashes.

The value of the corn and straw destroyed by poultry may not be as much as the cost of maintaining them; but the negligence evinced in allowing poultry to roam at large in corn-fields is discreditable to a farmer.

ANIMALS DESTROYING CROPS.

Ground Game.—There are animals as well as birds which destroy corn crops, and the most mischievous of them is the rabbit, which has in some parts increased beyond calculation.

Hares are also blamed for injuring crops; but we believe that a hare does much less damage to a growing crop of corn than a rabbit, as it eats the herbage, which retards and even injures its growth, whereas the rabbit will return to the same plant and eat out its heart, and thus destroy it altogether. The hare does more damage to the turnip than to corn crops. It bites holes in every bulb, exposing them to frost, and thereby to putrefaction when thaw succeeds.

By the passing of the Ground Game Act, the farmer obtained the inalienable right to protect his crops from ground game.

Rats.—The brown rat burrows in the fields, occupying the holes of rabbits when it can find them, and eats both the cereal and root crops.

A plague of rats has lately been experienced in the Lothians of Scotland, where incalculable damage was done in steadings and stackyards. Organised raids were made upon the rats, and at some steadings several thousands were trapped and poisoned. Similar plagues have occurred in different parts of England. The practice of game-preservers of killing weasels and other beasts that prey upon rats as well as upon game, has been alleged as one of the causes of these plagues. The main cause, we suspect, is the failure of certain farmers to take reasonable steps to prevent the rats from increasing.

Mice.—When mice get lodged in an old grain stack, they devour a great quantity of the corn, while the stack preserves its external appearance. When a weasel takes up its abode in a stack it should not be disturbed, as not a mouse will dare remain there.

Field-mice do much damage in some cases, and if once allowed to increase to great numbers, are very difficult to exterminate.

RAISING POTATOES.

The harvest work of a farm cannot be said to be completed until the potato crop has been taken out of the ground, and secured against the winter's frost.

Early potatoes are now in use before the summer is completed, but the main bulk of the crop is seldom ready for lifting before the month of October.

Symptoms of Ripeness.—Potatoes indicate fitness for being lifted by decay of the haulms. As long as these are green, the tubers have not arrived at maturity. In an early season some potatoes ripen before October; and although the weather should continue fine, it is best to let them remain in the ground until all the corn crops have been carried in. But in ordinary seasons the corn is cut down and carried before the potatoes are ready for lifting. Immediately after the corn-fields are cleared, the potatoes should be taken up, to allow the land to be ploughed for wheat.

A Phenomenal Season.—The dry season of 1868 was remarkably early for potatoes. Instead of being early taken up, however, the potatoes were allowed to remain in the ground until the ordinary season. Before this time rain had fallen, and then it was found that from many of the tubers a sprout had been put out which bore new potatoes which had grown to a useful size. It was averred that the second crop did no injury to the original crop; but that tubers which have produced tubers should not be thereby affected in their quality cannot be easily conceived. At any rate, the new crop had not time to become matured.

Methods of Potato-raising.

Potatoes are harvested in three different ways—viz., by the digging graip or fork, by the plough, and by the potato-digger.

Digging Early Potatoes.—The practice of consuming potatoes before they are fully matured is steadily increasing. These potatoes are always raised by the graip, because at that time the tubers have a firm hold on the roots, and are themselves so tender in the skin, that, even if the tubers could be separated from the roots, they would be so bruised by the plough or digger that the damage done would be more than the total cost of raising them by the graip. By careful working, the ordinary steel graip or dung-fork may be used in digging potatoes without any serious injury being done to the tubers. There is a special kind of potato graip or fork, however, which is often used. This has flattened prongs, as shown in fig. 544 (Spear & Jackson), sometimes three, but generally four prongs.

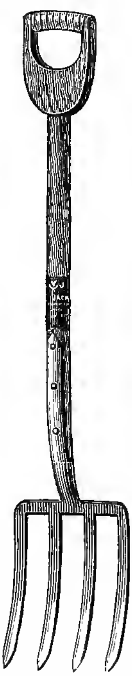


Fig. 544.—*Potato-graip.*

Raising by the Graip.—In raising potatoes by the graip, each person, as a rule, digs one or two drills at a time, and the digger sometimes gathers, and sometimes does not gather, his or her own potatoes. In some districts digging is done by men, women or boys doing the gathering; but in many cases, in Scotland, the bulk of the digging is now done by women, who each dig and gather their own drills.

The first digging of the season in Scotland takes place on the sandy lands along the Ayrshire coast, where raising often begins in June. There women can do the work easily enough, because the drills are small and the land light and loose. In later districts, with heavier land, men are preferred as diggers when they can be got, the women then generally doing the gathering.

Speed of Digging.—In digging green potatoes for immediate consumption, ten to twelve double graips, or twenty to twenty-four single graips, are generally supposed to do an acre each day. Much, of course, depends on the cleanness of the land, the weight of the crop, and the ease with which it can be dug.

Barrels for Early Potatoes.—At this season of the year potatoes are sent to market in barrels holding 1½ cwt., barrels being used because in them the potatoes do not rub so much the one against the other in handling, as they do in bags, their skins being thereby prevented from being ruffled and torn, as they are sure to be if put into sacks.

While the potatoes are being gathered, the tubers over 1½ inch in diameter or thereby are put into one basket and those under that size into another. The large ones are put into barrels on the spot without weighing, all barrels used being about the one size.

Preparing Barrels.—As a rule the barrels have been used previously for bringing flour from America or from the home mills, and before being employed for potatoes they are strengthened by an extra hoop or two, and strings put on the top. For this purpose six or eight half-inch holes are bored in the staves of the barrel an inch or more from the top. Cord, three-eighths of an inch thick, is then taken and passed through one hole forward to the centre of the barrel, and then back through the next hole. A knot is now put on each end of the cord on the outside of the barrel, and large enough for the cord knot not to pass through the hole. The other holes are then roped in the same way, when the barrel is ready for use.

Filling Barrels.—When the barrel is being filled, a very few of the best-shaped potatoes are dropped into a basket at the side of the barrel, and when about filled, the barrel is completed by putting as many as are necessary of those in the basket on the top. A few green potato-stems are now taken and packed firmly over the top, and slightly above the rim of the barrel. A stout string, a foot or so in length, is then put through each of the loops of rope fixed on the top of the barrel, which, when tightly drawn and knotted, securely holds down the top.

Handling Barrels.—In letting the barrels down from a man's shoulders, or from a cart, they are always dropped on the mouth. If dropped in any other manner the barrel would run a great risk of being damaged.

Speedy Marketing.—Where the circumstances permit, the usual custom is to send as many of the potatoes which have been dug on any particular day, to the railway station that evening, so that they may be carried during the cool of the night to the place where they are to be consumed. Early potatoes being very soft and immature, very soon lose their flavour, and deteriorate in quality, if allowed to lie about.

Small Potatoes.—As soon as the crop has begun to harden and ripen a little, the small potatoes are usually carried to a bare smooth place in the field, where they are redressed, the tubers over 1¼ inch or so being set aside for sale at a low price early in the season, and for seed purposes. Those tubers under an inch or inch and quarter in diameter are used for feeding cattle or pigs.

The medium-sized ones, or seconds as they are commonly called, when they are to be preserved for seed, are at once packed in the sprouting boxes referred to on p. 274, vol. iv., and carefully stored in any well-ventilated shed or empty byre. Even although very immature, they can be preserved in this way with comparatively little loss, whereas were they stored in the usual way in pits till the end of the year, before putting them in the boxes, a very large proportion of them would be spoiled.

Disease.—At this season of the year disease has rarely made its appearance; but later on, when it is plentiful on the foliage, although scarcely perceptible on the tubers, the small seed, even although more mature than previously, keeps very much worse, and is often almost entirely lost. The reason is supposed to be that in digging, the disease spores, owing to the shaking the plant receives to separate the tubers from the roots, are shed from the leaves over the potatoes, where they vegetate and live after the potatoes are stored. If during digging any diseased potatoes are seen, they are thrown into the basket containing the small ones, to be afterwards rejected if the small ones are dressed for seed purposes. If the small tubers are not to be used for seed, all go for cattle food.

Potato-digger.

Previous to the beginning of October very few potatoes are *stored* for future use, and until storing commences, digging as a rule is done by the graip. When, however, the leaves have been dead for a couple of weeks or so, storing may begin. The work now to be accomplished in a limited time is too great for such a slow

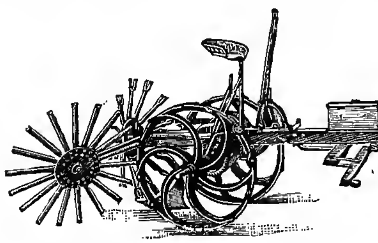


Fig. 545.—*Powell Brothers & Whittaker's potato-digger.*

tool as the graip. On most large holdings the potato-digger is therefore called into use, and admirably it performs the duties required of it.

Two excellent modern improved potato-diggers are here illustrated—that in fig. 545, made by Powell Brothers & Whittaker, Wrexham, and to which was awarded the first prize at the trials of the Royal English Agricultural Society at Newcastle-on-Tyne in 1887; and that in fig. 546, made by Alex. Jack & Sons,

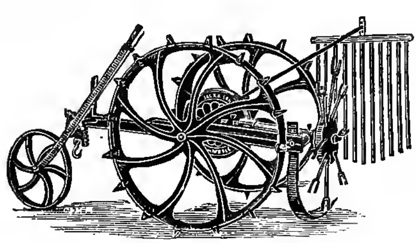


Fig. 546.—*Jack's potato-digger.*

Maybole, Scotland, and very largely used all over the country.

Speed.—With three good sharp-moving horses, and in a fairly large field, where everything is in readiness for it, and a sufficiency of gatherers are at hand, the digger will accomplish from 4 to 5 acres per day. If digging is done only one way, as is the usual custom on small farms or on steep land, from 2 to 2½ acres will be a good day's work.

Preparing for the Digger.—When the digging is to be done one way only, one drill, and in many cases two drills, should be dug by the graip or plough along the side at which a beginning is desired to be made, before the digger is brought on the field. Besides, if the head-ridges have been planted with potatoes, which they occasionally are, one drill should be dug next to the hedge all round the field, and the potatoes from it gathered. The digger may then commence at any convenient corner and go round the field, taking a new drill each time, till the whole head-ridge drills, and an equal number at both sides, are dug.

Force of Gatherers.—If there is no disease in the crop, and if the crop is moderate, and all the potatoes large and small are thrown into one basket, from twenty to twenty-four persons will keep a digger constantly going in this manner. If there are diseased tubers in the crop, or if the small and diseased are to be in any way separated, thirty to thirty-two persons may be required to keep a digger going, according to the weight of the crop, and amount of diseased ones to be taken out.

Arranging the Gatherers. — The gatherers should be arranged in pairs, or singly as is thought most desirable, each plan according to circumstances having its advantages. If full baskets have to be carried by the gatherers to carts or sacks, then pairs will be the best; if not, they may work singly. If there is no disease, and the small tubers are not taken out, two baskets will be sufficient for each gatherer; but if the diseased or small tubers are to be separated, three baskets at least must be given to each.

Before beginning, the land should be measured off into equal lengths for each gatherer or pair of gatherers, a lath, twig, pole, or other mark being put in where the one's lot ends and the other's begins.

The gatherers begin to collect from the end of their division nearest to where the digger starts, and work towards the other end.

Harrows following Digger. — As soon as the first space is gathered, a boy should follow with a pony or other light quiet horse, yoked to a single division of a set of zigzag harrows, or, better still, to a half of a set of the old pattern of hinged harrows. The latter is about the proper breadth, while the former is a little too narrow. The harrow should be of moderate weight, but should have good long tines, so that it may fully search the loose earth thrown out by the digger, and bring the buried potatoes to the surface.

As soon as the harrow has passed the first division, the gatherer of that piece of ground picks up the exposed potatoes, and works towards the end where a beginning was made. By the time the gatherer has collected the potatoes exposed by the harrow, the digger will again be round at the place where a beginning was made—that is, if the number of gatherers has been properly proportioned to the work which the digger can do. In the next and succeeding drills the same routine is of course followed.

Collecting Carts.—When the digger has made a circuit of the field, one or more carts should follow, into which each basket should be emptied as it proceeds. The ordinary farm-cart (fig. 547, made by Alexander Jack & Sons, Maybole, Ayrshire, and figs. 348, 349 and 350, pp. 349, 350 Divisional vol. iv.) is used in carting potatoes. The emptying should be the work of the man in charge of the cart, and not the gatherers. If twenty gatherers are employed, and each gathers from 1½ to 2 baskets of, say, 3 stones each, a full box-cart will be got in each drill or less, so that a cart should at least go round every time the digger goes round.

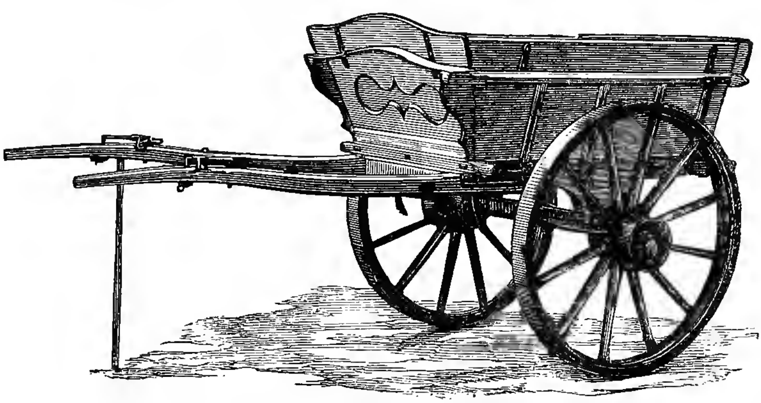


Fig. 547.—*Jack's farm-cart.*

Diseased Tubers.—If many diseased or small tubers are taken out, a separate cart will be required to carry these away as soon as the baskets holding them are full, or nearly so. Every potato showing the slightest symptoms of disease should be separated as the work proceeds. These are of some value at digging time, and not only of no value later on, but they become positively hurtful by conveying the disease to those healthy tubers with which they come in contact.

Tubers free from Earth. — The gatherers should take care to put the full baskets far enough to the side to prevent the digger throwing the earth on them when passing, as the more free potatoes are from earth, the less they are liable to sprout in the pit.

While the headlands and drills along the side of the field are being dug in above manner, a single drill should be dug by hand from one end of the field to the other—say sixty drills from the side of the field. If there are not sufficient persons to dig and gather such a drill, it may be done by the double mouldboard or other plough, if the land is thoroughly clean and the shaws quite rotted. The harrow must of course follow the plough in the same way as it follows the digger, and in many cases it will be advisable to turn the drill to one side with the single plough, and as soon as the potatoes are gathered to turn it back again to the other side, after which the harrow should level the land before the digger comes along the next drill.

Process of Digging.—One drill having been cleared by any of the above methods, the regular digging of the field should begin. According to the side of the field from which the drills were counted, the digger should either go along the outside drill, and back the one next to the hand-dug one, or else along it first and then back the one next the fence. Digging is proceeded with in this way until the space dug at the side next the hand-dug drill is at least 15 or 20 feet wide, after which the digger may go down one side of the hand-dug drill and back the other.

This course is necessary, or at least advisable, to allow space for the digger to throw out the potatoes to each side, and still leave enough space between the two rows of ungathered potatoes for the carts to go along without bruising the potatoes.

The carts should not pass each other in this narrow space, but come in empty at the end furthest from where they are to be stored, and fill towards the other end. After a space has been dug quite wide enough to allow the carts sufficient space, and when it becomes inconvenient for the carters to lift the potatoes from both sides at once, owing to their increasing width, the carts should follow the direction of the digger, and empty the baskets along the one side, and then return along the other.

When the space so dug equals the number of drills remaining next the side of the field, the digger should then go round about them until they are finished. By proceeding in this manner, the greatest amount of land is dug with the least travelling across the ends, and fewest shifts of the gatherers.

It is seldom the headlands are sufficiently wide to allow the digger to get easily out and in without missing some of the potatoes. To prevent loss here, it is advisable to have a person with a graip at one or both ends, digging as much as gives the horses quite space enough to turn easily.

One-way Digging.—If the land is steep, or the number of gatherers limited, it may be advisable to dig only along one side of the field. In this case digging is always done down-hill, the machine returning up-hill out of gear. As in the other system, the gatherers have each their own division; but digging drills at intervals through the field by hand are done away with after it has been properly opened up.

Force of Horses.—While three horses are required to work the digger when digging both ways, two may do where only one side is dug. In the latter case the number of gatherers is of course correspondingly small.

There are few operations on the farm which require greater personal supervision than potato-digging.

Adjusting the Digger.—Before beginning, the farmer or other person in charge should examine the digger carefully and see that it is in good working order. They should in particular see that the graips or forks are the proper distance behind the sock, and the sock sufficiently below the graips to allow a considerable proportion of earth to pass through, without compelling the forks to throw it to the side, or making it so wide that the potatoes pass through without being brought to the surface by the forks. If the forks are about three-fourths of an inch behind the sock, and the sock fully an inch below their points, it will be found that the digger is easier drawn, and scatters the potatoes better than if either are kept wider or narrower.

Depth of Digging.—Whenever a commencement has been made in digging, particular attention should be directed to the depth at which the digger is working. If too shallow, some of the potatoes will be cut, and others left in the ground below the reach of the harrows; and in both cases they are, practically speaking, lost. A digger working badly in this manner may cause as many potatoes to be damaged and left in the soil as would nearly pay for properly digging the whole crop. If, again, the digger is set too deep, owing to the extra quantity of earth which the forks have to displace, a considerable number more of the potatoes are covered than if it is set a little shallower, while the difference in draught will be not a little.

Adjusting the Sock.—Several causes influence the depth at which the sock moves, all of which should be well understood by the person working the digger. The principal are the depth at which it is set, the depth of the drills in which the digger is for the time working, and the condition of the sock itself. After the sock has been set at any particular depth by the lever regulating it, the height at which the wheels stand thereafter regulate the level at which it moves. If the crop has been high-ploughed up, the space between the drills will be deeper; and the digger-wheels getting deeper compel the sock to go also deeper, so that high-ploughed drills require the sock set at less depth than where the drills are more flat.

Again, a new sock, broad and thin on the face, goes to a much greater depth with the lever set at any particular place than one badly worn, short and thick on the face. A worn sock may work satisfactorily enough on soft easy land, such as moss or sand, while it would be of no use in a drier, harder, and firmer soil.

The most of the potatoes which have been raised by the digger and buried will, as a rule, be found a little out from the point of the sock. The centre of the harrow should therefore move along there. Contrary to expectation, the finer and more sandy a soil is, the more potatoes will be left in it after the digger. The reason for this is that the unseen potatoes are covered with a very thin film of soil, which in great part would have rolled off and exposed the tubers had the soil been rougher.

Adjusting Force of Labour.—Where the labour of one person depends so much on that of some other, as in raising potatoes by the digger, it is of the utmost importance that each class of labour should bear a certain due proportion to all the others. As many gatherers should be provided as will keep the digger moving at a moderate, steady pace; and as many carts should be employed as easily remove the potatoes when collected; while great care should be taken that each gatherer is provided with a sufficiency of baskets. Plenty of baskets helps considerably to steady working, for if a cart may at a time be a little longer in coming than another, the whole work is brought to a standstill if the baskets are full; whereas, had a few more been provided, no interruption would have occurred.

Second Harrowing.—It is customary to harrow the land and gather all remaining potatoes as soon as possible after being dug. But if the work is at first carefully and methodically performed, this second harrowing and gathering, at present prices of labour and potatoes, will not pay expenses. If, however, a second harrowing and gathering are to take place, they should be done every evening, either by the horses from the digger and the whole company of gatherers, or by a separate pair of horses and another company of gatherers. In the potato-digging season the weather is so uncertain that it is impossible to say what a day or night may bring forth; and potatoes in dug land which have been subjected to rain or frost are rarely afterwards worth the cost of collecting. As potatoes collected after the harrows usually contain a large proportion of small, diseased, and damaged ones, they should invariably be put into a pit by themselves. They rarely keep so well as the ordinary crop.

Weather and Digging.—Potato-digging should not be persevered with during very showery weather, nor when the land is wet. A large proportion of the potatoes are left unseen in the land when the soil is damp and adhesive; and those tubers which are collected in a wet condition seldom keep well.

Plough Digging.

On farms where the potato-digger has not been introduced, or on fields very steep and otherwise unsuitable for the digger, the aid of a plough of one kind or other is usually invoked in lifting potatoes. In some cases the double mould-board plough is used; in others, it is the ordinary single furrow swing-plough; in others, the American chill plough; while not a few employ specially fitted "potato-ploughs."

Potato-plough.—The "potato-plough" may be an entirely distinct implement, or an ordinary plough fitted with a potato-raiser—a series of iron or steel fingers running out from one or both sides of the body of the plough.

The specially fitted ploughs are certainly superior to the ordinary ploughs for lifting potatoes, yet it is generally agreed that if a separate implement is to be procured for this work, that implement should be the potato-digger proper.

The original form of potato-raiser attached to an ordinary plough, by Mr J. Lawson, Elgin, is shown in fig. 548; but numerous modifications have been introduced by different makers. The cutter of the plough should be removed, so as to avoid injury to the potatoes.

Digging by Drill-ploughs.—If it is desired to raise potatoes by the double mould-board plough, every second drill should be split by it, the mould-boards being set much wider than for drilling, or removed altogether, and the potato-prongs put on. Each gatherer has a section to collect, in the same way as behind the digger. And when nearly a half-day's work has been done by splitting every second drill, the ploughman then begins and splits the remaining drills. All drills which have been split during the day should get a double stroke of the harrows before night, the gatherers all the time keeping close up to the harrows.

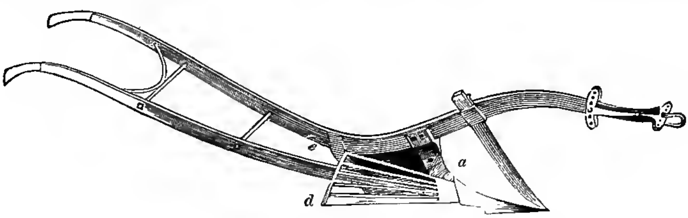


Fig. 548.—*Potato-raiser attached to a plough.*

a Narrow end of brander. *e* Upper angle of brander. *d* Lower angle of brander.

Small Plough.—If the single mould-board is used, the ploughman should proceed in much the same way as if he were to plough four ridges, going along the one side and back the other until the whole is finished, after which he begins another set of drills.

Harrowing.—As soon as the gatherers have collected their potatoes, a harrow should pass along in the same manner as was described in connection with the digger; and any tubers exposed by the harrow should be collected before another drill is turned over by the plough. The harrowing is a most important part of the operation of potato-raising, and one which should not be neglected, either when the plough or the digger is used.

Forking after Ploughs.—In many cases it is the practice to further scatter with the graip the drills which have been split by the plough. This makes more thorough work, leaving less to be done by the harrows, and making it easier work for the gatherers. But this forking, although much more speedily done than the forking of drills which have not been split, entails a good deal of extra labour.

Improved Digger best.—Where a proper digger is not available, a plough of some sort should certainly be used to split the drills; but while lifting with the plough is a decided step in advance of lifting with the graip or fork, both methods are much inferior to lifting with the improved digger.

STORING POTATOES.

Supplies of Early Potatoes.—Formerly it was necessary to store a larger quantity of potatoes for use in winter, spring, and early summer than is now required. Very early in spring large quantities of new potatoes are now imported from Malta; and as soon as these are exhausted, supplies come in from Jersey and early districts along the south coast of England. Then about the middle of June the first Ayrshire crops are generally ready, and this is at least a month, if not six weeks, earlier than potatoes could be depended on prior to 1860. Moreover, the nation as a whole would appear to be using fewer potatoes and more bread than formerly. And when new potatoes can be obtained at anything like moderate prices, they are preferred to old ones which have been stored.

Potatoes more difficult to Preserve.—For some reason or reasons not very well known, potatoes are now more difficult to store successfully than they were prior to the middle of the present century. Then they could be stored safely in pits at least double the capacity which can be trusted now; and in what were then called potato-houses, they were easily preserved many feet deep, while now they would spoil if kept two or three feet deep.

Field Pits.—Where large quantities have to be handled, storing in pits in the open field is the easiest, cheapest, and most satisfactory plan at the present day. A situation is selected near the farmhouse, if possible, having a dry bottom and free-working soil. There shallow trenches, from 2½ to 3 feet wide are made, running as nearly south by west and north by east as the lie of the land will permit. If the land is not thoroughly dry in the bottom, or is very clayey, no trench should be made, the potatoes being placed on the surface and piled up into long conical heaps, the sides of the heaps being kept as steep as possible. If the subsoil is naturally dry and open, a trench from 6 to 12 or 14 inches deep may be dug out between the two guiding lines. The earth taken out should be neatly packed on the sides, a considerable slope being given to the sides of the trench.

Into this trench the potatoes are emptied from the carts as they come from the field, the heap carefully and neatly built as high as possible by hand.

This pit is known as the long or prismatic pit, and is shown in fig. 549.

Conical Pit.—A conical pit is often preferred for storing small quantities of potatoes. It is well adapted for small

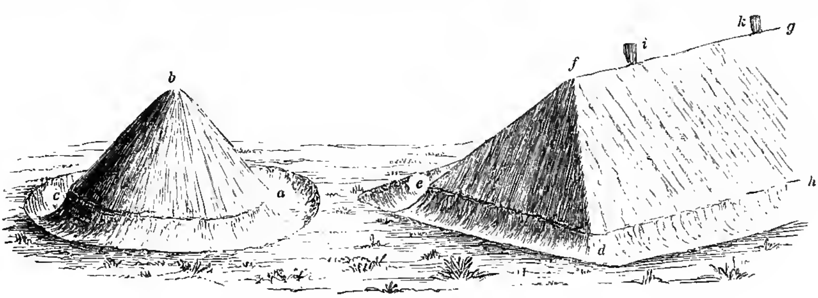


Fig. 549.—*Conical and prismatic potato-pits.*

a b c Conical pit of potatoes.
b Apex of cone.
c a Diameter of cone and inner edge of trench round the cone.

e d h g Prismatic potato-pit.
d h Side of pit.
d e End of pit.
f g Crest of pit.
i k Straw chimneys.

farms and cottars; the prismatic being used for storing larger quantities.

A common method of forming a conical pit is as follows: if the soil is of ordinary tenacity, and not very dry, let a small spot of its surface be made smooth with the spade. Upon this let the potatoes, as taken out of the cart, be built up by hand in a cone not exceeding two feet in height, which height will give the diameter of the cone at its base 6 feet. The potatoes are then covered thick with dry clean straw—not drawn. Drawn straw is apt to let in the frost between the straws.. Earth is then dug with a spade from the ground as a trench around the pit, the inner edge of which, fig. 549, being dug as far from the pile of potatoes as to allow the covering of straw and earth to be put upon it, about one foot. The first spadeful is laid upon the lower edge of the straw, round the circle of the heap — the earth being chopped fine, and clapped down with the spade, to keep out frost. Spadeful after spadeful of earth is thus taken from the trench and heaped on the straw, until the entire cone is formed, which is then beaten smooth and round with the back of the spade.

The apex of the cone is about 3 feet 3 inches in height, and the diameter about 8 feet. The trench round the pit should be cleared of earth, and an open cut made at its lowest side to allow surface-water to run freely away.

When the soil is naturally dry, the pit may be dug out of the solid ground a spade-depth, and the height of the heap will be proportionally less. But unless the soil is as dry as sand or gravel, potatoes should be piled upon the surface of the ground.

Covering Pits.—The heap or pit is covered with a little straw. Along the ridge of the heap on the top of the straw, should be laid a straight pole from 4 to 6 inches in diameter, and from 8 to 10 feet in length. In stormy weather this pole keeps the straw in its place, and when the whole heap has been covered with earth and the pole removed, a narrow gutter is left along the ridge, which serves as an easy egress for any heat which may be generated. In putting on the earth the workman begins by cutting with his spade along a line set a foot or so from the edge of the straw on the potatoes, after which he removes the earth from the outside of this line, and packs it on the potatoes, to the depth of about 6 inches.

Ventilating Pits.—Small sheaves of straw are placed along the gutter left by the pole after its removal, on each of which a spadeful of earth is put to keep it in position. This straw provides thorough ventilation, and it, at the same time, keeps out rain and frost until the whole crop is secured, or opportunity is afforded of covering them more securely.

Instead of leaving a gutter the whole way along the ridge, it is the custom in some localities to only put in wisps of straw here and there, the rest of the ridge being covered with earth. Where the crop is thoroughly matured and firmly grown, such a provision against heating is probably ample enough; but in many seasons and in many circumstances, particularly with late varieties, it is not sufficient.

Heating.—As a rule, even the best ripened potatoes, after being put in the pit and closed on the sides, generate more or less heat, and give off moisture which passes out at the top and through the earth on the sides. For this reason it is never advisable to heavily cover up potatoes when first brought in from the field, no matter how well ripened they may appear to be; for should a mild autumn and winter follow, premature growing, if not worse, will be almost sure to follow.

Seed Pits.—If the potatoes are intended for seed, the pits should be made specially narrow, in order to reduce premature sprouting to the lowest limit possible.

Storing Wet Potatoes.—Any potatoes which come in wet from passing showers, which are common at this season of the year, should be put in a pit by themselves, or along with those gathered behind the harrows. Potatoes stored wet rarely keep well. On this account it is advisable to clear these off as soon as possible after the whole crop has been safely secured.

Final Covering.—As soon as the whole crop has been raised, a little earth should be laid along the ridges of the pits, over the top of the straw in the gutter, in order to prevent severe frost from getting access to the potatoes. The sides are then thatched by placing along them a good covering of straight wheat or barley straw, say from 4 to 6 inches thick. In putting on this straw three persons work best together, one on each side putting on straw, and another placing earth along the centre of the ridge, to hold the straw in position. The straw, if moderately long, and the pit not too large, should meet at the ridge from both sides, where the ends of the one side should be bent down and overlapped by the other, on which a spadeful of earth should be placed. When the whole pit has been gone over in this manner, earth should be placed in spadefuls along the bottom ends of the straw.

It will be remembered that the workman, in putting earth on the pit, was told to keep at least a foot from the edge of the potatoes when digging the trench on the outside of the pit, so as to get earth to cover it. This covering of earth was supposed to be only 6 inches thick, so that at the base of the side of the heap a shoulder remains, 6 inches broad, after the covering of earth has been put on. On this shoulder the bottom ends of the thatch rests, and also on it the workman now places a continuous row of spadefuls of earth to fix the thatch. In even the most exposed situations, these three rows of earth, one along the ridge, and another at each side, and a third at the bottom, will be sufficient to keep the thatch in position, while the work is speedily and cheaply done.

A double quantity of straw and earth being on the ridge, rain never enters there, but following the straw, runs off into the gutter alongside the pit, the bottom of which should always be lower than the lowest layer of potatoes in the pit.

Potato-pits are occasionally thatched in much the same manner as an ordinary stack, the ropes running lengthways and crossways, being fixed to wooden pins driven into the sides. All this trouble is, however, quite unnecessary, as the former plan is equally as secure, and costs much less. Many persons also put on a second covering of earth before putting on the thatch. This also is unnecessary, unless where thatch is very scarce and labour plentiful, as 6 inches of straw, with 6 inches of dry earth under, will keep out more frost than 18 inches of bare earth unthatched.

It is of great importance that the straw should be put on as early as possible after the crop is stored, and before the earth on the sides has become soaked with rain, as in the damp stage it takes in frost much more readily than when dry.

Shaws as Thatch.—Instead of putting on ropes or earth over the top of the thatch, some farmers spread a thick covering of potato-shaws. This practice has become pretty common since the "Champion" potato with its rank shaws was introduced; but it has not much to recommend it, as the cost of putting on and taking off the shaws is considerable. Owing to their open nature, the shaws themselves keep out little frost, and the earth or straw under them, when once wet, is not very easily dried.

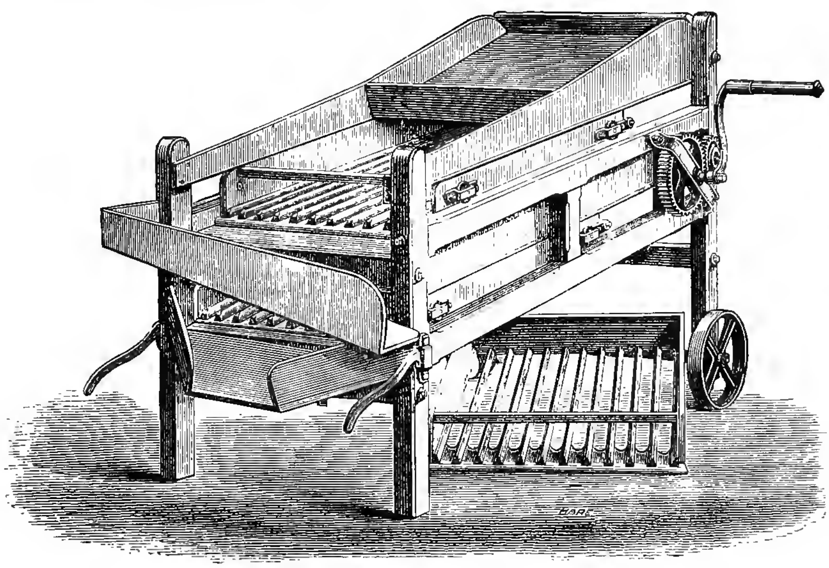


Fig. 550.—*Potato-separator.*

Frosted Potatoes.—"When potatoes are exposed to the action of frost, it is well known that they become soft, and acquire a sweet taste. This taste is succeeded by a sour taste, owing to the rapid evolution of acetic acid, and the root soon passes to putrefaction. From the experiments of Einhoff we learn that the sugar is formed at the expense of the mucilage, for the other ingredients were found in potatoes sweetened by frost in the usual proportion. He considers this sweetening process as connected with the vegetative powers of the root."[1]

Potato-separator.—The sorting of potatoes into different sizes, suitable and unsuitable for marketing, is an operation of considerable importance. By the use of such an appliance as the improved separator shown in fig. 550, the work is greatly facilitated. At one operation this machine, made by Penny & Co., Limited, Lincoln, separates potatoes into three sizes—small, seed, and marketable—and riddles away the soil. It is made in different sizes, by which from eight to fifteen sacks may be separated in an hour.

SOWING CEREALS IN AUTUMN.

SOWING WHEAT.

"How ceaseless is the round of rural labour!" No sooner does the farmer secure the present than he begins preparations for a future crop. The plough, indeed, is often at work before the harvest is finished.

Land intended for autumn or winter wheat is ploughed as early in autumn as possible.

Fallow Wheat.—Bare fallow, as we have seen, is now much curtailed in extent. But any portion of land which has been fallowed during the summer is the first to be prepared for wheat. It has perhaps received a dressing of dung,

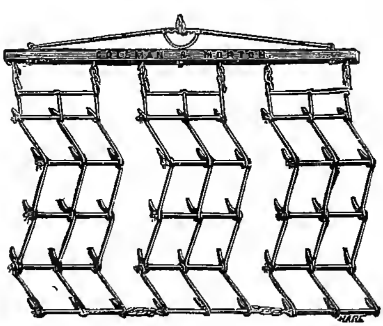


Fig. 551.—*Iron harrows.*

which may have been drilled in. If so, the first operation is levelling the drills which cover the dung by harrowing them across with one double turn of the harrows—of iron harrows such as shown in figs. 267 or 268, p. 196, Divisional vol. iii., or in fig. 551, made by Coleman & Morton, Chelmsford. After the land has been harrowed down, any root-weeds brought to the surface should be removed, but the surface-weeds will soon wither.

Ploughing for Wheat.—The land is then feered, to be gathered up into ridges; and if thoroughly drained, or naturally dry, one gathering-up makes a good seed-bed; but wet land, to lie in a good state all winter, should be twice gathered up. The second gathering-up should not be immediately after the first, for a short interval should elapse to allow the land to subside, which rain will accelerate.

Should the fallow have had the dung spread upon the surface and ploughed in with feered ridges in gathering up, the feering left half-ridge at the sides of the field, now that the land is gathered up for the seed-furrow, is converted into one whole ridge.

Grubbing for Wheat.—But a practice has come into use, since the introduction of the grubber, that possesses advantages on strong land in a dry state, which is, to put the seed-wheat into the ground with the grubber, upon gathered-up ridges that covered in the dung of the fallow, and to finish the work with one double-tine harrowing along the ridges. When the grubber is so used, the land is gathered up in finished ridges in the fallow, as grubbing cannot alter the form of ridges.

Advantages of Grubbing.—When a tough waxy clod arises on ploughing strong land, rather wet below, for a seed-furrow, or when unsettled weather threatens, the grubber will keep the dry

[1] Thomson's *Org. Chem.*—"Vege.," 481.

ameliorated soil upon the surface, and accelerate the seed-time considerably.

New or Old Seed.—The land being thus prepared for the seed, it is quite possible for a part of the new crop to be thrashed out for seed in time for sowing in autumn; but those who sow early cannot procure new seed, and must use the old. But although the new crop were secured in good time to afford seed for sowing in autumn, it is better to sow old wheat than new. New wheat germinates quicker than old, but is more easily affected by bad weather and insects; and consequently its braird is neither so thick nor so strong as from old wheat—that is, from seed of the preceding year; for very old wheat may have been weakened in vitality even in the stack, or been much injured by the weevil in the granary.

Time for Sowing.—Some farmers sow wheat on fallow early in September; and where there are much fallow and strong land this is a proper season to begin. The objection is, that should late autumn and early winter prove mild, the plant will become too rank before cold weather sets in to check its growth. October is considered by many the best period for sowing winter wheat, as the risk of rank growth is avoided.

Variety to Sow.—The varieties of white wheat well suited to be sown in autumn are now so numerous that it is impossible here to indicate which is the best for a particular locality. Upon inferior soils it is safest to sow a red wheat, which, although realising a lower price in the market, will yield a larger increase. In this matter the farmers in the different localities must exercise their own judgment, giving due consideration to the opinions of farmers in the neighbourhood as to the varieties best suited to the locality.

Pickling and Sowing.—Wheat sown in autumn is pickled in the same manner as that sown in spring. See p. 190, Divisional vol. iii.

Having time to push down a tap-root and to tiller, wheat is sown thinner in autumn than in spring. See p. 190, Divisional vol. iii.

Wheat may be sown broadcast, drilled, and dibbled in autumn as in spring. Broadcast sowing is still most common in Scotland. Drilling has not extended as was at one time expected. It is more common in England.

Water-courses.—The finishing processes of harrowing and of water-furrowing are the same as in spring; but as water is more likely to stand upon the land in winter, gaw-cuts must be made with the spade in every hollow on the surface and across head-ridges, even on thoroughly drained land, to quickly carry off large falls of rain.

Harrowing.—As regards the harrowing, it is right to leave on wheat-land in winter a round clod upon the surface. Such clods afford shelter to the young plants from wind and frost, and, when gradually mouldered by frost, also increase the depth of the loose soil.

Frost throwing out Plants.—Wherever land is harrowed to a fine tilth in autumn, rain batters its surface into a crust, and frost heaves it up in spring like fermented dough, by which the plants are raised up with the soil, and, when the earth subsides in a thaw, left upon the surface almost drawn out by the roots. Thorough-draining is the only safeguard against rain and frost acting in this manner upon a fine surface in winter.

When land is naturally strong enough to grow wheat, and yet is somewhat soft and wet below, to make it probable that the plant will be thrown out, *ribbing* with the small plough will give a deeper hold to the plant than common ploughing. The wheat is sown broadcast over the ribs, and harrowed in with one double tine along them. Ribbing is not suitable on fresh-ploughed land, as even the small plough would go too deep, and make the drills too wide; nor is it advisable on land that has not been ridged up.

Another mode of preventing the throwing out of wheat on soft land, is first to feer the land into ridges, sow the seed broadcast between the feerings, plough the seed in with a light furrow with the common plough, and leave the surface unharrowed and rough all winter.

Deep sowing—from 1¼ to 1¾ inch deep—is regarded by many as the surest preventive.

Rolling.—Rolling wheat in autumn is rarely practised, except to consolidate soft land. In reference to this point, a writer says: "We have for the last three seasons rolled nearly the whole of the autumn-sown wheat when a favourable opportunity could be obtained, making the surface perfectly smooth and fine. The old idea of rough lumps lying here and there being of advantage for shelter, is neither more nor less than an antiquated fallacy. After wheat is sown, the land cannot be made too firm. We hear some exclaim, 'This is all very well for light land.' It is good for all land where a roller can be used without what is called *poaching* the soil. We have tried repeated experiments, and the rolled portions were always the best. Let any one who doubts give the system a fair trial, and we have no fear but he will repeat it. We admit the young wheat-plants obtain shelter during winter from those lumps of clay we designate *as clods;* but how difficult it is for the young shoots to run out and make fresh rootlets on this uneven surface! It is true the wheat is rolled in spring whenever the season will permit; but these clods are pressed down and for a time retard this, and check the tillering power of the plant. The autumn-rolled wheat requires only to be harrowed or hoed in spring. These observations are made from a three-years' trial of the system."[1] A firm seed-bed is unquestionably, as we have already pointed out, beneficial to wheat. But so are surface clods in winter and spring. The clods lying on or in the surface cannot possibly prevent fresh rootlets pushing their way into the soil around them.

Wheat after Beans.—The bean-land is the next sown with wheat in autumn; and the land occupied by summer tares, or other summer forage crop, if in the same field with the beans, is sown with wheat at the same time. The land is feered and gathered up and sown when the soil has been allowed to subside for a few days.

Where bean-land is strong and the ridges sufficiently round, a four-horse grubber may be used to make the seed-furrow instead of the plough. The grubber succeeds in this case very well as far as the wheat is concerned, and it has the advantage in a late autumn of getting through the work expeditiously, and keeping the aerated soil upon the surface. But on strong soil, not thorough-drained, and in a comparatively flat state, grubbing is not the best preparation for wheat after beans, because the seed is apt to rot and the soil become sour.

Grubbed soil may require only one double tine of the harrows along the ridges.

Wheat after Potatoes.—The potato-land, having been harrowed after the potatoes have been raised, is feered and gathered up, and sown with wheat. It is better to let the soil subside a little, although the usual practice is to sow the wheat as soon as it is ploughed, the season getting late by the end of October.

Firm Seed-bed for Wheat.—We have frequently recommended the subsidence of the land before being sown with wheat, because that plant always thrives better in soil in a firm state than when it is as loose as the plough leaves it. The effect of subsidence is best obtained by employing the presser-roller (figs. 269 and 270, pp. 199 and 200, Divisional vol. iii.), which follows the plough in every third furrow, and compresses the soil effectually.

Wheat after Grass.—To a large extent wheat follows grass and clover in the rotation. In this case, however, the sowing is usually deferred till spring—see p. 199, Divisional vol. iii. Farmers are naturally reluctant to plough up grass-land so early as would be necessary to permit of sowing wheat in autumn or winter.

Manuring Wheat.—Enough has already been said on this subject—see "Manures and Manuring," pp. 89-185, and "Manuring Wheat," p. 201, Divisional vol. iii.

SOWING BARLEY.

Barley cannot stand the winter as wheat does. When the winter is mild and the spring dry, as in the south of France, Italy, and Spain, or where the snow lies deep all winter, and the sun is powerful immediately after the melting of the snow in spring, as in Russia, Poland, and North America, barley may be sown in winter. Wherever the winter consists

[1] *The Farmer*, 14th Oct. 1868, 482.

of alternate snows and thaws, and the early part of spring is wet, as in the north of England, in Scotland, and Ireland, winter barley is apt to suffer, and spring-sown is a more certain crop. In the south of Europe, barley is grown as food for horses; but no such inducement exists in this country, where horses are better fed on oats.

The 6 and 4 rowed, or square-headed barley, is what is termed winter barley; so that the Scotch bere or bigg should be the sort best suited for sowing in autumn.

Should you determine to sow barley instead of wheat after beans, potatoes, or tares—for no one would think of substituting barley for wheat on fallow—the culture of barley is the same as for wheat, whether the land is feered for ploughing, or when grubbed or ribbed.

Barley may also be sown broadcast by hand or machine, drilled by machine, or dibbled by machine. The finishing operations are also the same as for wheat.

When sown after beans or after potatoes, the operations are the same as for wheat.

Barley that has withstood the winter produces a heavier grain than when sown in spring.

Barley as a Forage Crop.—For cutting in spring as a forage crop, barley is sown in autumn, end of August, or beginning of September. Thäer mentions a variety of barley named the Siberian or quadrangular naked barley, *Hordeum cœleste*, which, when sown early, is cut several times in the course of the summer, and in the succeeding year yields a good crop.[1] This seems a valuable forage plant, and its grain is reckoned as good as rye for bread and distillation.

SOWING RYE.

Rye is sown for its grain and straw, and also for forage. Where land is too light and sandy for wheat, after any green crop, rye may be sown in autumn; and its culture is the same as for wheat. One gathering-up suffices, and two tines of the harrows finishes the surface, 2½ bushels of seed being sown per acre.

Rye will thrive in drifting sand, and will endure the hardest frost. It grows very rapidly, and in Germany, where it is largely grown for bread, it is often housed before the end of June.

As an ordinary cereal crop, however, it is now grown in this country only to a very limited extent.

Rye for Forage.—The value and culture of rye as a forage plant are already noticed in p. 258, Divisional vol. iii. For use as a forage crop rye is often sown on the stubble of the last crop of the rotation on light soil or on sandy loam. The land is feered for casting, is manured moderately, ploughed, the seed sown at the rate of from 2 to 3 bushels, sometimes with one peck of rape-seed or one peck of winter tares, and harrowed in with two turns of the harrow. Should any weeds be brought to the surface by the harrows, they should be taken off by the hand.

By the end of March or beginning of April the rye will be fit for use; but if delayed till the end of April, the stock will have a full bite. The crop should be cut or eaten down, but not too bare, and then unpastured until it grows again, when the stock will be well served before the seed-stalk begins to shoot.

After the second crop has been eaten bare, the land may be ploughed for a crop of turnips. Two ploughings or one ploughing and one grubbing are required, both of them along, not across, the ridges—the one reversing the other. The harrows will smooth the surface, and any weeds brought up should be gathered and driven off. If rough, the roller will make the surface ready to be drilled up for the dung, and the turnip-culture prosecuted in the usual way.

Green Rye as Manure.—Rye forage is often ploughed in as manure. "It often happens," says Sydney Evershed, "that more rye is sown than is wanted for food in the spring; that which is not fed is ploughed in for the root-crop, which is one of the best preparations for roots on light friable soils. The rye may be allowed to grow 3 or 4 feet high, and can be perfectly buried by attaching a stout chain to the head of the plough, which, with a sufficient weight at the end,

[1] Thäer's *Prin. Agric.*, ii. 430—Shaw and Johnson's transl.

folds over the left side of the beam, then passes under it immediately before the skim coulter, and with the weight passing along between the last-turned furrow and that to be turned next, the chain pulls every straw into its proper place, and effectually buries the whole without perceptibly increasing the draught."[1]

SOWING PEAS.

Peas are sown in the field in autumn in some parts of England. Although manure is rarely given to peas sown in spring, it is given in moderate quantity to that sown in autumn. On clean oat-stubble the manure, 8 to 10 cart-loads to the acre, should be spread on the surface, and ploughed in with the common plough. In every third furrow the seed is sown with the bean drill-barrow. The ploughed surface should have two tines of the harrow, to close the openings in the ploughing and protect the seed from frost.

The crop ripens earlier than when sown in spring, and the land is worked, cleaned, and manured again for sowing wheat upon it in autumn. The after-culture and harvesting are the same as for peas sown in spring.

Such a course of cropping as this seldom affords any advantage to the farmer. When the soil is light enough for peas, it is better to take a green crop after the stubble, such as turnips or mangels; and where the soil is strong, beans are a much better crop.

German Practice.—Thäer mentions a practice in a few places in Germany, where "the farmers are in the habit of covering a field sown with peas with a layer of straw, and then leaving the peas to make their way through it, to vegetate. By this means the weeds are all stifled, the soil kept moist, and those stems which fall to the ground prevented from rotting. Where there is a plentiful supply of straw this may be done with advantage, and the straw will afterwards be available as manure."[2]

[1] *Jour. Eng. Agric. Soc.*, ii. 218, xix. 85.
[2] Thäer's *Princ. Agric.*, ii. 466—Shaw and Johnson's transl.

SOWING VARIETIES OF CORN TOGETHER.

On the continent of Europe it is not an uncommon practice to grow different sorts of cereal and leguminous crops together. That practice is seldom pursued in this country, the desire being to have every species of corn free from admixture from other sorts.

Mixed Flour preferred.—It has been recommended that more than one variety of wheat should be sown together, because bakers prefer a mixed flour to make good bread. Many bakers are of this opinion; but their object would be better attained were varieties of wheat mixed together on being ground into flour.

Increased Yield from Mixed Varieties.—It is quite correct in theory to expect enlarged yield by sowing different varieties of corn together, since different varieties of plants have different habits of growth. The theory is confirmed by growing cereals and legumes together.

Irregular Ripening.—But practice experiences the difficulty of selecting the varieties which attain maturity at the same time. This might be overcome, but the forced conjunction of varieties might not produce the best result. To avoid disappointment, it would be better not to attempt the combination.

Meslin.—The most common mixture grown on the Continent is wheat and rye, for bread, and is called *meslin.* Flat barley and oats are grown together, the oats predominating, and both are said to give a large yield. Some persons add spring rye to their mixture on light soils. In certain parts of the north-east of Scotland a small extent of meslin or "maslach"—in this case, perhaps, oats, barley, and rye—was at one time grown, to produce meal for use on the farm. The practice, however, has been abandoned.

In the south-west of Scotland three-fourths or seven-eighths of oats and one-quarter or one-eighth of beans are sometimes sown together, the mixture being called "mashlam." The produce is now generally used as food for horses, but was formerly a common article of human food.

Legumes and Cereals.—The most common mixture of cereals and legumes is that of oats and vetches, which makes good food for cattle when prepared with the straw-cutter, whether the crop be allowed to ripen, or mown in a green state. Both barley and spring wheat are also sown with vetches. Peas in small quantities are associated with spring wheat, and the quantity of wheat, it is said, is not thereby diminished. On sandy soils peas are associated with spring rye. On calcareous, clayey, and meagre soils, it is usual to sow beans amongst oats.

A mixture of beans, vetches, and oats is grown together for green food for cattle, and goes by the name of *beans*. It is cut when the seeds begin to form, and in some countries the horses are entirely fed on it. The character of the mixture is determined by the nature of the soil. In clayey soils the beans are increased in quantity, and in the lighter soils more vetches are sown. Vetches are also mixed with buckwheat when the crop is to be cut in a green state.[1]

Mixed Oats.—Some farmers in Scotland sow different varieties of oats together. The practice probably originated in some varieties having occupied the ground too sparsely. The Georgian oat, for example, always came up thin, whatever quantity of seeds were sown; and the Hopetoun oat, though a good variety, indicates a similar habit of growth. To fill up the spaces in the Hopetoun oat, other varieties are sown with it in certain proportions, according to situation and the nature of the soil—and the compound crop is superior to that of either by itself.

Whatever varieties of oats are sown together, they should all ripen at the same time, otherwise the sample of one or other will be deteriorated.

J. Finnie, Swanston, near Edinburgh, gives the following results of his experiments:—

	Bushels.
Potato-oats alone produced, on 1 acre	59
Hopetoun . . .	52
Early Angus	62
Kildrummie	62
Dun . .	61
Blainslie .	56
Grey Angus . .	51
Sandy—seed changed .	49
Sandy—seed unchanged .	45
5 of Hopetoun and 1 of Kildrummie produced, on 1 acre . .	68
5 of Hopetoun and 1 of Sandy	64
5 of Hopetoun and 1 of Early Angus	61
5 of Potato and 1 of Early Angus .	53
5 of Potato and 1 of Sandy . .	53

It thus appears that mixtures with the Hopetoun oat produced larger crops than did the Hopetoun alone; but with the potato-oat the results were otherwise.[2]

PLANTING POTATOES.

Amongst the expedients suggested for evading the potato disease was planting the sets in autumn. The plan, however, has been only partially tried.

Autumn Planting unsuitable.—Planting potatoes in autumn cannot be practised everywhere nor extensively anywhere. Potatoes are not only a green but a fallow or cleaning crop, and a green crop being taken after a crop of corn, the stubble of the corn crop is not in a fit state to receive manure before undergoing the process of cleansing by the plough, the harrow, and the grubber, as the land for a fallow crop ought to be; and, in Scotland, too short time intervenes between the harvesting of the corn crops and bad weather in winter to permit the land to be sufficiently cleaned. Hence very few cases occur in which the stubble can be manured in October for potatoes, which occupy so important a position as a green crop. This is perhaps to be regretted, for in the majority of cases where autumn planting was tried it seemed to check the disease.

Method of Autumn Planting.—Potato-planting in autumn is the same as in spring; but there will not be time to stir the land as much. The stubble

[1] Thäer's *Princ. Agric.*, ii. 486-89—Shaw and Johnson's transl.

[2] *Trans. High. Agric. Soc.*, 1850, p. 316.

should be cross-ploughed or grubbed to a considerable depth. Harrowing with a double tine brings up any weeds there are, and these should be gathered off. If the land is first cross-ploughed, the grubber may follow, to cut the furrows in pieces, if there be time for that efficient operation; but if not, the land should be drilled up in the double way, in preparation for the dung.

The after operations are the same as in spring.

Seed.—Many think it advisable to use whole potatoes for seed instead of cut sets in autumn. Small potatoes answer well, and save time in cutting. The whole potatoes should be planted in the drill at from 10 to 12 inches asunder.

Water-channels.

Much attention is required at this season to prevent water collecting and lying on the surface. After any crop is committed to the ground, surface-channels leading into the adjoining ditch or outfall of the field should be cut with the spade, wherever there is the least chance of water standing for a time.

SUBSIDIARY FARM CROPS.

As the times change it is necessary that farmers change with them, not only in their tastes and manner of living, but also in their practices in cropping land. The time was when even turnips and potatoes were garden-grown crops, and the time has arrived when many other crops, at present known as garden crops, might be successfully and advantageously cultivated in the field.

Fruit, Vegetables, and Flowers.

The decline in the prices of ordinary farm products has brought into notice in certain districts a new class of farmers, who, instead of entirely devoting their land and means to the production of grain and beef or mutton, have centred their attention on vegetables, fruit, and in some cases flowers, for the use and adornment of the dwellers in city, who have no facilities for the growth of such, but are able and willing to pay good prices for them. The area under these crops is largely on the increase in this country.

Vegetable culture, as a rule, is extensively carried on only in the vicinity of some populous centres. Fruit is easier of transit than vegetables, and may be cultivated anywhere, where the soil, climate, railway facilities, and supply of manure are suitable; while the same may be said of flowers.

Dairying and Market-gardening.—Very often the growth of vegetables, fruit, and flowers is combined in one establishment, and to this system of farming a profitable adjunct is a dairy. The cows composing it can get almost all the year round a supply of green stuff very suitable as food, which would scarcely pay for its cartage to a more distant dairy, and which is too valuable for manure, and as such is often difficult to plough under.

For this purpose imperfectly grown kale, cabbages, cauliflower, broccoli, and Brussels sprouts are available almost through the entire year. Then carrots and parsnips, unfit for table use, make good food for cows, and their leaves, which are very bulky where a heavy crop is grown, are much relished by cows, and weight for weight appear to be as valuable as turnips. In the culture of turnips for table use, as well as of such other plants as beet, peas, and beans, there is also always a considerable quantity of what would otherwise be waste food, which can be turned to good account through the medium of milk-cows. Then in the growth of such crops there are plots of land which are bare at a season of the year when it is unsuitable to put these under any of the regular crops, and which may be profitably utilised in growing tares for the cows. Tares, with the winter and spring varieties, form a very accommodating and valuable crop for such circumstances. They do not necessarily occupy the ground for any great length of time, and they generally do well on heavily manured land.

For these and many other reasons the growth of market-garden crops should, if possible, be always combined with dairying. And unless there are circumstances of an exceptional character, the class of dairying most suitable will be the production of milk, and the sale of it fresh from the cow.

This system of combined dairying and market-gardening has been pursued extensively and with success by Mr John Speir, Newton Farm, Glasgow, and to him we are indebted for the following notes on the culture of subsidiary farm crops.

VEGETABLES.

Cabbages.

When the farm lies within easy carting distance of the centre of consumption, cabbages are about the first crop that will be attempted by the ordinary farmer, who contemplates turning the whole or part of the produce of his farm into market-garden crops.

Culture.—The culture of cabbages for table use differs very little from the culture of the ordinary cow cabbage. The table cabbage being smaller, a slightly different manner of drilling has to be adopted.

Table cabbages are most in demand early in the season. An endeavour should therefore be made to get the crop forward as quickly as possible. Quickly grown cabbages are also much more crisp, and less tough and leathery than those more slowly grown, and thus to hasten growth they should be well supplied with manure.

When the plants are one-third grown, they should get from one to two cwt. of nitrate of soda per acre, which will keep them green and crisp till ready for cutting.

Second Growth.—If spring-planted and cut early, say in June or July, the plants throw out a large quantity of second growth, which in almost any season amounts to a considerable bulk by autumn. This second growth is very suitable as food for sheep or milk-cows—the land being thereafter sown with wheat or other suitable crop.

Autumn Planting.—In the finer climates of the country large breadths of cabbages, to stand over the winter, are planted in August or the first week of September. These are generally put on land which has carried a crop of winter onions, or other crop which is early cleared off. This class of the land is indeed seldom ploughed at all, being only slightly grubbed or harrowed, and all weeds removed. Plants put into this firm land stand a severe winter much better than where planted on lately moved soil.

All the manure this crop gets is a good dressing of nitrate of soda or sulphate of ammonia, as soon as growth has begun in the spring.

Savoys.

The culture of the savoy is much the same as of the cabbage, and equally as easy. Plantations are usually made at intervals from spring to midsummer, the later plantings generally following some early cleared spring or winter crop.

Around Dublin they are grown to an enormous extent. The Dublin population are probably the heaviest cabbage-eating people in Britain; while large quantities are also annually exported to Glasgow, Liverpool, Manchester, and Bristol.

The farmers around Dublin grow first a crop of early potatoes, which is cleared off in June and July. The land is then immediately planted with savoys, which form good heads by the New Year, thus allowing the land to be cleared in time for any spring-planted crop.

Greens, Cauliflowers, &c.

Instead of savoys, greens or kale may be planted after an early potato crop is cleared off. This custom is followed very largely around Belfast, and on some of the earliest farms along the Ayrshire coast, from Girvan northwards. Greens are always in fair demand, and often give a good return per acre.

Brussels sprouts, cauliflower, and broccoli resemble the cabbage and savoy very much in culture; and in manure they all have much the same requirements.

Carrots, Parsnips, and Beet.

Carrots, parsnips, and beet-root may also be grown on any farm where the surroundings are suitable, and in some cases a return is obtained which is quite astonishing. Their culture is in no way different from that of an ordinary farm green crop, unless that with carrots, and occasionally with the others, two rows are sown on one drill. This of course requires a special machine for the purpose. Carrots succeed best on sand or moss, parsnips on loam or clay, and beet-root on any free soil, which, however, must be in the very highest state of cultivation and in a good climate. Further information as to the culture of carrots and parsnips will be found in Divisional vol. iv., pp. 384-386.

Storing Carrots.

Liability to Rot.—Of all the root crops of the farm or garden, carrots are the most difficult to preserve. Unless under exceptional circumstances, they are too tender to be allowed to stand out all winter; and in pits (more particularly in wet or mild winters) they are often extremely difficult to keep till May or June. A little mould may be all that is noticed, with an odd soft carrot here and there, and in a couple of weeks after the whole pit may be a mass of pulp. Where, therefore, carrots are grown, their proper storing is a matter requiring the most careful consideration.

Time of Storing.—Unless in the very earliest districts, carrots are rarely ripe enough to be stored before the last few days of October or the first week in November. In every case the latter is to be preferred to the former.

Pulling.—One person should pull the roots by catching them tightly and close by the bottom of the leaves, laying them out in rows flat along the top of the drill in which they grew; while another should be intrusted with the selecting and cutting off the leaves. Each pair of pullers should be provided with a potato-graip, with which to dig out any roots the leaves of which may happen to break. Between each pair of those cutting off the leaves, one basket should be provided for holding all split, forked, or otherwise deformed roots; while one or two baskets should be provided for each cutter, into which to put the selected roots. A cart generally goes behind and empties each basket as it becomes full, the extra baskets being filled while the cart is away.

Carrot-leaves.—The leaves should be kept clean and thrown into heaps behind the baskets, in readiness to be carted to the cattle and sheep at the farm. All classes of cattle are exceptionally fond of these leaves, and thrive well upon them.

Growing and Heating in Pits.—It is of the utmost importance that the leaves of carrots be cut off as near to the crown as possible. If such is not done, the roots grow much quicker in the pits, heat is thereby generated, and the whole in a very short time becomes a mass of putrefaction.

Carrot-pits.—The pits in which carrots are stored should never be so large as potato-pits, from 2 feet to 2½ feet wide being quite large enough. The sides should be as steep as possible, so as to keep them thoroughly dry, and at first they should not be very heavily covered. In other respects the pitting is much the same as has been recommended for potatoes. Carrots, however, require more ventilation, and must on no account be pitted wet.

In a winter in which there is very little frost, a carrot will keep quite sound and fresh lying on the surface of the ground exposed to wind and rain; but shut it up in an unventilated and warm pit, and it will become soft in a week. As a protection against frost, there is not the same necessity to thatch carrot-pits as potato ones; but as a protection against rain, thatch is about as needful for the one as for the other.

Onions.

Onions, principally of the Lisbon, Portugal, and Spanish varieties, may also be extensively grown as a farm crop where manure is plentiful, labour cheap and plentiful, and a market near at hand. They are sown either in beds or in rows, from 10 inches to a foot apart. The crop is seldom ripened in Scotland, but is pulled up green—there being a much better market for onions in that stage than later.

A portion of the crop is often sown in early autumn. This is cleared off before the spring-sown onions are ready to pull, while they in their turn are removed by the beginning of September to make room for leeks.

Leeks.

Leeks are constantly in demand from September till April, when new autumn-sown onions again come in. There is thus a sale for the one or the other throughout the whole year.

Leeks, owing to their excessive demand for manure, are not so easily grown as a field crop as onions. There is, however, no great difficulty in cultivating them successfully where the land is clean and in moderate condition.

Manuring.—Probably no crop can stand so much forcing with nitrogenous manures as leeks, so that, whenever they are not growing to one's mind, a thorough weeding and heavy dressing of any soluble nitrogenous manure will be sure to bring them away rapidly.

Culture.—Leeks are generally sown in beds or frames, from which they are afterwards transplanted in the field in rows about a foot wide, with about four inches between each plant in the row. In dibbling in the young plants, they are put as deep in as the size of the plant will permit, so that when full grown they shall have as much of the stalk blanched as possible. It is also found that the plants grow much better when only a minute quantity of earth is put into the dibble hole after the plant has been dropped in. When the plants are grown so shallow as to whiten only an inch or two of the stem, they are generally earthed up, to increase as much as possible the length of white stem.

Turnips for Table Use.

Turnips for table use are also a very suitable crop for growing on most farms near large towns. Their culture is in no way different from the ordinary field culture of turnips, except that two rows are generally sown along one drill. This is necessitated by the smallness of the bulbs and the tops, which, if sown on one drill only, would return a very small crop per acre. Moreover, with only one row of these small roots, a considerable portion of the land would be left bare, and would be immediately monopolised by the weeds. Such turnips are usually taken to market with their tops on, the tops being used to tie them in bundles of a dozen or fourteen.

Turnip-tops.—Farmers in the counties around London and some other large towns derive a substantial return by selling turnip-tops, particularly the young sprouts in spring, for use as "greens" in soups and with meat.

Beans and Peas.

Beans and peas can also be profitably grown where there is a market for them in a green state. In most large towns they are bought up in large quantities. Both are pulled green and sent to market in hampers or sacks, and sold at so much per stone or cwt. The return per acre is not generally very high, but the crop does not require much manure, and the ground is early cleared for something else.

Beans do best on moderately firm clay-land thoroughly drained, while peas are more suitable for free-working lands. When grown on a large scale for green pulling for market, peas are seldom staked. The drills are made from 3 to 4 feet apart, and the haulm is allowed to grow along the ground, but not to catch the next row.

FRUIT.

Where climate, land, labour, and railway facilities are suitable, fruit-growing may also be entered on by the ordinary farmer. If properly conducted it may prove a profitable adjunct to the farm.

Strawberries.

Strawberries are the fruit easiest brought to a bearing condition and requiring least skill for their culture. They therefore form the fruit most suitable for the ordinary farmer to begin with. In the valley of the Clyde, between Lanark and Hamilton, the growth of this fruit has been largely pursued by the farmers. The farms there are all more or less devoted to dairying, yet for a distance of six or seven miles along both banks of the river every one has made a trial of strawberries.

Irregular Produce.—A year occurs every now and again when they give a comparatively poor return; but on the other hand there are years when an enormous production is obtained.

To such an extent has their culture been carried in this locality, that as many as fifteen railway waggon-loads of strawberries have been known to leave a single station in one day, and yet there are three stations which are all more or less fed from this district.

Near Crieff, Dumbarton, and Aberdeen, in Scotland, and in different parts of England, strawberry culture has likewise made rapid progress in recent years.

Planting.—The plants are generally dibbled in beds in spring, three rows, about 15 inches apart, being allowed to each bed.

The Fruit.—The finest of the fruit is sent to market each morning for dessert purposes, the remainder being pulled during the day for making preserves.

Price.—The preserve-makers generally arrange at the opening of the season for so many tons from each grower, the ordinary price of recent years being from £16 to £28 per ton. Few have ever been sold at less than £12 per ton, and occasionally the price exceeds £30 per ton.

Duration of Plants.—The plants yield no fruit worth speaking of the first year, and are at their best the second and third years, after which they deteriorate quickly. Most growers do not crop them more than four years, after which the plantations are ploughed down, and a grain or green crop taken.

The best plants for making a new plantation are yielded by those which have been put down the year previous.

Labour and Soil.—To enable the cultivation of strawberries to be successfully carried on, a plentiful and cheap supply of labour must be at hand. The soil should lean to the heavy side rather than the light. They rarely do well on very light soil.

Bush Fruit.

The cultivation of bush fruit, be it black, red, or white currants, or gooseberries, is not so easy of attainment as that of strawberries, and is not so well suited for a farmer holding land under a short lease.

Cost of Planting.—The purchase of the young bushes is a rather costly business, and instead of only one year being lost before fruit-bearing begins, as with strawberries, two, three, or even four may be said to elapse before a very large return is obtained, even where the climate is good and the bushes fairly well grown when put in.

Catch Cropping.—As the rows of bushes are, however, generally from 5 to 6 feet apart, a good deal can be made out of the spaces between the rows by growing vegetables. In these spaces turnips, cabbages, cauliflowers, beet, parsley, leeks, and onions may advantageously be grown; and if the culture of flowers is attempted, these spaces form very suitable places for the growth of wallflowers, anemones, narcissi, snowdrop, and annuals generally.

Disease in Black Currants.—Black currants, when they do yield well, usually bring the highest price of any berries in the market, not because they bear a heavier crop than the others, but because of their extreme liability to disease. To such an extent has this pest prevailed in the fruit-growing districts of the Clyde, that it has almost killed out every plantation in the locality. The disease prevents the formation of blooms, and is caused by a gall-mite called *Phytoptus ribis*, which belongs to the same family as the birch gall-mite. When once the disease appears, it spreads rapidly, with disastrous results. When a plantation has become affected, it is best to root out and burn every bush, for it will never after be of any use.

This disease does not attack the red and white currant.

Gooseberries.—Gooseberries are occasionally troublesome on account of the caterpillar, but it does not carry with it any of the destructive effects of the black-currant disease. Although bad one season, it does not necessarily follow that it will be bad the one following, while it is at all times amenable to treatment. In recent years, gooseberries have not been bringing anything like the same price in the market as formerly, and in consequence growers are rather chary of making new plantations. From £8 to £12 per ton are common prices for good gooseberries.

Orchards.

In many parts of England, especially in the southern counties, the cultivation of tree-fruit, such as pears, apples, plums, and damsons, is carried on to a large extent and with good results.

It is only on a very limited area of Scotland that the cultivation of large or tree fruit for the purpose of sale has been attempted. The largest breadth in one lot probably centres round the village of Crossford on the Clyde below Lanark. Both sides of the river there are for several miles devoted to the cultivation of fruit-trees, which has been carried on for a very long time. During the days of the old stage-coaches, it was a common remark that a handful of plums could always be gathered in the season from the trees on the roadside, while the coach passed underneath them. There is still a considerable extent in plums; but apples hold the largest share, pears being grown to a less extent.

New orchards are being continually planted and old ones uprooted, the new ones being as a rule planted with small fruit in the intervening spaces. Owing to the shelter which the deep and narrow valley affords, this locality is extremely well suited for fruit, and all the farmers in the valley have more or less of their land under it. Considerable orchards at one time existed in the Carses of Stirling and Gowrie, but lately these have not been well attended to, and are fast disappearing. Fruit importations have considerably checked home planting; but with due care, a proper selection of varieties, and an increase of the knowledge of the best means of cultivation, large fruit might yet be made to pay in Scotland.

FLOWERS.

The demand for pot-plants for house decoration, and cut flowers for the house, personal decoration, marriages, and funerals, has so much increased among the dwellers in towns, that there is ample room for the growth of these by those farmers who have a taste for flowers, are conversant with their growth, and suitably situated in regard to climate, soil, and disposal.

In sheltered and early situations, wallflowers may be grown by the acre, and if early or late enough, are sure to give a fairly good return. In the middle of the season it may often be difficult to sell the wallflowers even at the cost of carriage; but at the beginning and end of the season they generally do well. The same may be said regarding mignonnette, forget-me-nots, and many other flowers of a similar class, which are likely to be grown by the farmer attempting flower-cultivation as an adjunct to his farm.

Bulbs.—Amongst bulbous plants which may be grown for cut blooms, we may mention the whole narcissi family, iris, anemone, and ranunculus as plants which are easy of growth, and the blooms of which sell well. The great drawback against the culture of such on a more extended scale than most persons have yet attempted, is the enormous first cost of the bulbs. One farmer near Glasgow grows several acres of these bulbs alone, and is generally presumed to be doing well.

For sale as plants, the farmer might also grow wallflowers, daisies, pinks, primroses, &c., and other flowering plants, a limited quantity of which can profitably be sold in most large towns.

Indoor plants cannot be grown without the aid of glass, and therefore need not be noticed here.

LIVE STOCK IN AUTUMN.

The treatment of farm live stock in the earlier part of the autumn consists for the most part of a continuation of their treatment during summer. As the season advances, and a lower temperature prevails, extra attention, both as to food and shelter, may be necessary or advisable for certain classes of stock. The transition period between the heat of summer and the rigours of winter teems with anxieties for the stock-owner, and demands his most careful and constant supervision. Neglect at this time may spoil the results of the whole year.

CATTLE IN AUTUMN.

In the earlier volumes of this work, the feeding and general treatment of cattle have been discussed so fully that here a few sentences will suffice.

We began with cattle in Divisional volume i. (p. 213), when they were being housed for the winter months. In Divisional volume iv. we left them in their summer quarters, mostly on the pasture-fields. In completing the blank thus remaining in the yearly circuit, only a few points have to be considered.

Food and Shelter.—The chief points to be attended to are the providing of extra food as the supply of pasture becomes insufficient, and of shelter when the weather gets so cold and inclement as to render it desirable. The different classes of cattle require different treatment, and much also depends on the general character of the season and the weather at the time.

Fattening Stock.—Cattle that are being fattened, or are intended to be fattened early in winter, particularly those to be sold fat by Christmas, will require very careful and liberal treatment in autumn. Most likely they will have been receiving cake on the pasture during the latter part, if not the whole, of the summer. As the autumn advances, and the supply of grass becomes less, the allowance of cake may be increased to 3 lb., 4 lb., 5 lb., or even more per day, according to the supply of grass, the size and condition of the animals, and the time they are intended for sale.

Housing Fattening Cattle.—When the nights become chilly, these fattening animals should be housed in the evening and returned to the pasture next morning. It is a matter of great importance for cattle being fattened that they are not exposed to cold wet weather. Sudden changes from heat to cold are particularly detrimental to them, liable not merely to check their progress, but to cause an actual loss of condition. It is a good plan, therefore, to begin housing fattening animals overnight as soon as the chilly evenings set in. And they should be early housed for winter, so that they may consume their food in comfort, and thus be able to turn it to full advantage in the formation of flesh and fat.

House-feeding.—When taken in overnight, the fattening cattle may then receive their cake or other extra food in the house, in one feed in the morning, or in a small feed in the evening and a larger one in the morning, according to the quantity to be given. So long as the days are tolerably warm, the animals will relish a few hours on the fields daily; but if the supply of good fattening pasture is limited, the house-feeding must be liberal, so that the progress of the cattle may be continuous and sufficiently rapid.

Forage Crops for Cattle.—Now is the time when the advantage of a plentiful supply of forage crops would be felt and appreciated. The grass is falling short, and the turnips are not yet ready. Concentrated food may be had conveniently in cake and grain; but for a bulky succulent food, so essential for cattle of all classes, the farmer is often at his wits' end at this season of the year. Aftermath is often saved for the purpose, and it suits fairly well. A better plan, however, is to grow a portion of some forage crop, such as tares, which would be ready for cutting at this time, and with which the cattle could be carried on till the early turnips are ready for consumption. Stock-owners would find it advantageous to provide a larger supply of green food than is usually furnished, to carry their cattle from the grazing to the turnip season.

Dairy Cows.—On dairy farms, cows in milk are attended to with great care and liberality in the autumn. They are housed overnight as soon as the chilly evenings begin, and in cold wet days they are not allowed out. This treatment is especially desirable for milk-cows; for it is well known by dairy farmers that, in spite of the most liberal feeding, exposure to cold and wet will materially reduce the yield of milk.

A plentiful supply of green succulent food for consumption in the house towards the end of autumn is as essential for cows as for fattening cattle. On well-managed farms this is amply provided by growing tares or other forage crop.

Dairy cows and fattening cattle are housed for the winter about the same time.

Store Cattle.—Young growing cattle and breeding cows are kept longer on the pasture-fields than dairy cows or fattening stock. In average seasons they will need little or no extra food until housed for the winter, when the early turnips are fit for consumption. Still many successful farmers think it a good plan to house these animals on chilly wet nights, and give them cut green food or hay in the stall or shed some time before there is any necessity to put them into their winter quarters. This is assuredly good practice, for it promotes the steady progress of growing animals, and maintains breeding cows in a healthy and profitable condition.

Exposing Cattle.—Enough has been said in Divisional vols. i. and ii. as to the losses sustained by the imprudent exposure of stock. These remarks are peculiarly applicable at this season of the year, and may at this stage be perused with advantage.

SHEEP IN AUTUMN.

The two chief events in the autumn work on sheep-farms are "dipping" or "smearing," and mating the ewes and rams. Both are important, and afford ample scope for the exercise of careful and skilful management.

BATHING, SMEARING, DIPPING.

Object of Dressing.—One or other of these operations is necessary to prevent insect attacks, and promote the health and comfort of the sheep. It is a "sanitary measure" of the utmost benefit to the fleecy community.

Fly and Scab.—During summer and autumn sheep are subject to attacks by the "maggot-fly" (Divisional vol. iv. p. 436), and to become infested with various parasites. Chief amongst the latter is the "ked," "keb," or "sheep-tick," which, if no remedy is applied, increases in size and number as the wool grows longer, and inflicts great discomfort and injury upon the sheep. Then there is that troublesome contagious disease known as "scab." This is caused by the presence of insects (*acari*) which burrow in the skin and cause intense itching, resulting in the loss of wool and condition in the sheep. To prevent or remove these ailments, sheep are at various times dressed with or dipped in different kinds of liquid mixtures.

Former Customs.—Formerly it was the custom to "bathe" the sheep on lowland and arable farms, while the sheep on hill-farms were "smeared." The latter method was preferred for high-lying farms, because "smearing" tends to keep sheep warmer in exposed parts, and to render them less liable to be affected by changes in the weather.

Bathing and smearing have both to a very large extent given place to "dipping," yet it will be useful to indicate briefly how these older methods were carried out.

Bathing.

Utensils.—For bathing, or "pouring" as it was sometimes called, the utensils required are,—a bathing-stool, such as is shown in fig. 552; a tin bottle with a quill or pipe passed through the cork, or a bath-jug, as in fig. 553; and a tub or other vessel to hold the bathing mixture.

Method.—Provided with these, and with the assistance of a boy or other labourer, the shepherd can proceed. The sheep being caught, it is placed on its belly on the stool, with its legs passed through the rungs, the head

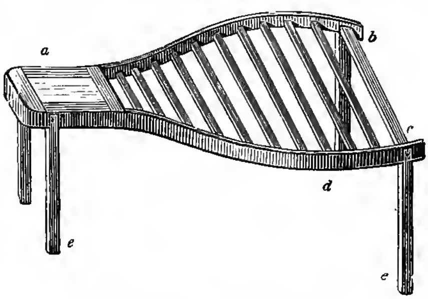


Fig. 552.—*Bath-stool for sheep.*
a Seat for shepherd. *d* Widest part of frame.
a b, *a c* Sparred frame. *e e* Feet.

being towards the shepherd, who sits on the end of the stool, *a*, fig. 552. The shepherd then with his thumbs and fore-fingers sheds the wool along the centre of the back from the head to the tail, and opens the shed with the palms of his hands. The boy then pours the liquid from the tin or jug along the shed, following the shepherd's hands, from the tail to the head of the sheep. Other sheds are made, about 3 inches apart, until the whole animal

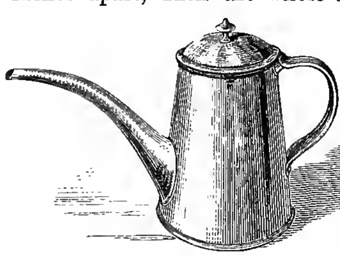


Fig. 553.—*Bath-jug.*

is covered, and from these sheds the liquid bathes the entire skin of the sheep.

The sheep is turned on its sides and its back, to obtain access to these several parts. When the sheep is lying on its back, its legs not being tied, the assistant should beware of a kick from a hind-foot on the face, or the flask. Some liquor is put on the tail-head, scrotum, inside of the thighs, brisket, root of the neck, and top of the shoulder, these being parts most likely to be affected by scab, and are chiefly the seats of *nidi* of insects. The shepherd and his assistant will bath 40 sheep in one day. The bathed sheep are put into a different pen from the unbathed. Fig. 554 shows the old style of bathing.

Keds. — Shortly after bathing, the keds will be seen adhering to the points of the wool, dead. Keds become most numerous when sheep get from a lean to a better condition, on change of food, as cattle are affected with lice when improving in condition on turnips. Hoggs are most liable to keds when getting rapidly into condition after being weaned, and having a large quantity of wool.

Bathing for Scab.—When the sheep suffer from scab, the sheds have to be made closer, and the shepherd rubs the liquid into the affected parts. Moreover, in the case of scab some specially strong mixture will be used; but this will be referred to in speaking of the bathing or dipping mixtures.

Smearing.

Smearing is done in a manner similar to bathing, although the materials used are different. The smearing mixture consists of tar and butter, made up in such proportion as to be sufficiently consistent to be readily lifted on the finger of the operator. It is applied in the sheds of the wool by the shepherd himself, who takes from the kit or tub beside him a portion of the mixture with his fore-finger, and rubs it into the shed. The sheds are made closer than for bathing, perhaps an inch or an inch and a quarter apart. The entire body is thus gone over, so that the sheep becomes enveloped in a close matted covering of wool, tar, and butter.

Smearing Reviving. — The dipping process had almost entirely superseded smearing by about 1885; but some farmers have again returned to the practice for wether stocks on exposed hill-ground. The smearing, of course, lessens the value of the fleece per pound, but it increases the number of pounds to such an extent as to partly make up for that. Moreover, many farmers maintain that with smearing their stock thrive better, and keep longer clean, while they have fewer deaths than with bathing or dipping.

Smearing Clean and Dirty Sheep.—Sheep which are clean—that is, free from skin affection—when smeared are not afterwards nearly so liable as bathed or dipped sheep to contract these ailments. It is a fatal mistake, however, to smear sheep suffering from a skin disease such as "scab." It will most likely result in serious loss of wool, and subsequent injury to the sheep from unseasonable exposure.

Dipping.

This is the most expeditious and now almost the universal method of dressing sheep.

Process.—The operation of dipping is simple in the extreme. The sheep are either plunged or made to swim through a specially prepared tub, bath, or tank,

Fig. 554.—*Bathing sheep.*

containing the dipping liquid, after which they are kept on a drainer until the liquid ceases dripping from their fleeces.

The chief recommendations of dipping, therefore, are cheapness, efficiency, and remarkable despatch.

Construction of Dipping-bath.

Dipping-baths of many different patterns are in use throughout the country. Some are small and movable, others large and permanently fixed.

Wood's Swimming-bath.—For large flocks the modern swimming-bath is the most convenient. For directions as to the construction and working of a bath of this kind, we cannot do better than quote the following from Mr David Wood's admirable treatise on 'Sheep-Dipping.'[1]

With the old style of baths the sheep had to be lifted both in and out, but now the baths are so constructed that the animals walk into them and swim out. The importance of this improvement is enforced by Mr Wood, who says:—

"I have constructed several baths of the new style on different farms on Mr Duncan's estate, but, whilst retaining the essential feature of a swimming-bath, there are not two of them alike, and I claim but little that is novel in their construction. I have simply adapted their construction to position, circumstances, and size of flock; and if I

[1] W. Blackwood & Sons. Price 1s.

refer to them more than to others, it will simply be because I am more familiar with them. . . .

Size of Dipper, and Number of Hands.—"If we were asked to give an opinion as to the length or size of dipper for different numbers of sheep, from our own experience we think the following would be approximate sizes. We will start with a bath 8 feet long, as we think this is the shortest practicable length for a swimming-bath.

For	200 sheep or under, bath	8 feet,	3	men and a boy.
,,	300	do.	10 do.	4	do.
,,	500	do.	12 do.	4	do.
,,	700	do.	13 do.	4	do.
,,	900	do.	14 do.	5	do.
,,	1100	do.	15 do.	5	do.
,,	1300	do.	16 do.	6	do.
,,	1600 sheep and upwards,		18 do.	6	do.

This number of attendants, if the arrangements are good, is amply sufficient for the work. We wish it to be understood that, though we have named dippers of a less length than 12 feet as being capable of dipping the numbers noted, we prefer them to be not less than 12 feet for the work to be well done in an autumn or spring day of eight hours. If the sheep are let away to their pastures without 'keiling' or marking, a less number of men might do; if grease or oil is applied, more will be needed.

Concrete Bath.—"For the benefit of those who have no opportunity of seeing the construction of one of these new baths, we will describe one of concrete. Of course it is cheaper and easier to make them in wood, and the internal size and shape must or should be the same; but where the dipping apparatus is to be a permanent fixture, concrete is decidedly the best and cheapest.

"We will assume that a complete set of bath, dipper, and catching-pen are to be constructed without reference to or hindrance from any building or other obstacle. If it is possible to utilise any building or part of an existing sheep-fank for this purpose, so much the better.

Situation.—"It is of importance in choosing a site, if it is convenient, to fix upon the slope of a bank, as by that means an advantage is gained by placing the dripper at the highest point, and thus securing a natural fall into the bath. We will suppose that they have to be constructed on the level ground. We recommend that the top of the bath be about 2½ feet above the ordinary ground-level. This will make the deepest part of the bath 1 foot 9 inches below.

Depth of Bath.—"We have fixed the depth of our bath at 4 feet 3 inches in the deepest part for black-faced stock. If, however, the stocks are composed of the larger varieties, it will be necessary to make the bath a little deeper. We are aware that we are making ours a little deeper than some do, but this both prevents waste of dip and guards the operators.

"Should the ground be tolerably dry where the bath is constructed, it may be put deeper, and thereby save a little expense in constructing the dripper, as it will be evident that the lower the bath is sunk, the less soil or stones will have to be carted to form the bottom of the dripper, if formed of concrete. Whilst thus pointing out some advantages of sinking the bath, we would advise that the top on no account be less than 18 inches above the ground-level, as there should be a level path or platform on each side of the bath 2 feet 6 inches or 2 feet 8 inches from the top. By thus allowing the operators to stand nearly upright and in a natural and easy position, they will do more work with far less fatigue.

"And hence the outsides of the bath should be free from all abutments in the space in which the men work, as the knees are soon made sore by knocking against these projections. The top also of the walls of the bath should be rounded and made as smooth as possible, to prevent the skinning of the arms.

"All our measurements will be given, assuming that the top of the bath is 2 feet 3 inches above the ground, 2 feet below, and the bath 16 feet long.

"First of all dig out a trench 18 feet long, 3 feet 6 inches wide, and 2 feet 6 inches deep. Now get a joiner to set up casings so as to form two walls, the outside faces of which are perpendicular, and 2 feet 6 inches wide, 4 feet 9 inches high, outside measurement, allowing 6 inches for floor. Let standards be set up and the casings nailed lightly to their inside faces. To form the inner faces of the walls, boards must be set up 8 inches from the other at the bottom, tapering outwards to a little under, if anything, 4 inches at the top. Let all the standards be firmly fixed, and if light boards are used, they should not be more than about 30 inches apart, so that the walls may be true and free from bulging. When the concrete is filled in betwixt the two spaces thus formed, and the boards taken away, you will have two walls standing 8 inches thick at the bottom and 4 inches at the top, with a space betwixt them of 14 inches at the bottom and 22 inches at the top. When the bottom is put in, and the walls plastered, you will have a bath about 13½ inches wide at the bottom, and 21½ inches at the top. The reasons for making the walls tapering are, to reduce the amount of liquor where it is not needed, and to strengthen the walls.

"We prefer that the end wall next the gathering or catching pen (gripping 'bucht'), be built square up to within 8 inches of the top of the side walls; and instead of the ordinary sloping end of the bath, a stout smooth board should be firmly fixed, about 2 feet 4 inches long, and inclining downwards at a sharp angle. By those means the sheep are plunged into the full depth of the tank, getting the benefit at once, and losing that foothold which they take such vigorous advantage of. This sloping board is also a very great check on the violent motion of the dip, and very greatly prevents it from washing out at the end with the splashings of the sheep.

"The floor of the bath is continued level for about 9 feet, then a square rise takes place of about 12 inches, and a sloping gangway is then formed to within 6 inches of the top of the side walls; and all the way up this gangway ridges of concrete should be formed at intervals of about 7 inches, to give foothold to the sheep in walking out of the bath into the dripper. There should be a deep groove formed at the top of this gangway, say about 2½ inches deep by 2½ inches broad; and at one or both ends of this groove, holes must be formed through the walls: this is to prevent any rain from finding its way into the bath when not in use. Of course when busy dripping, these holes must be stopped up, and a piece of wood dropped into the groove to save the feet of the sheep.

"We prefer the walls of the bath to be level throughout, for the convenience of dropping a light cover over the dip, so as to keep out rain and prevent cattle from drinking it. The guards at each end of the bath are not only as cheaply formed of boards, but are far more convenient, and in fixing them considerable stability is lent to the walls. Put down a light post on each side of the wall at the end next the catching-pen at a distance of about 3 feet 6 inches from the end, and to the inside faces of these and the framework of the catching-pen, nail ⅝ or ¾ boards, starting nearly the full height of catching-pen, and tapering down, and in a neat style, to the level of the bath, terminating at the post. Proceed in the same fashion at the dripper end of the bath; only in that case the post must be put about 4 feet from the end on account of the sloping gangway.

Emptying the Bath.—"In some cases, where it is convenient, a hole is made through the wall at the lowest part for a plug, in order to empty the bath when necessary. We have made two in that style; but unless the slope of the ground is very favourable for putting in a drain, we shall not trouble about it again. The bath is but seldom emptied, and when done, a man or a smart boy will make short work of that with a pail.

The Dripper.—"Proceeding to form a dripper, the lower end of the floor should be half an inch above the sloping gangway, and will be about 2 feet above the ground-line. If it is decided on grounds of economy to form the floor of the dripper only of concrete and the remainder of wood, the following appears to us to be a good plan, and one we have adopted in forming a dripper we are now engaged upon. The dimensions are 16 feet 6 inches long by 9 feet 6 inches wide, inside measurement. As already stated, the lower end of this, supposing the ground was level, would be 2 feet high; but as the ground is an irregular slope, it is not quite so much.

"To facilitate the formation, I have had oak posts put down at each corner and along the sides: the upper or further end being 1 foot higher than those next the bath, thus giving 1 foot fall for the drainings to go back into the bath. On the top of these posts, larch framing, 7 inches by 3¼ inches, is firmly nailed all round, thus forming a stout framework in which to insert the posts for the framework of the pens. The soil dug out of the pit for the bath was wheeled in here, and helped to fill up the requisite height before putting down the concrete floor. Up the centre of the floor another piece of larch, 6 inches by 3 inches, runs the whole length, and is half checked into the framing across the ends to give it stability, being 1½ inch lower than the two sides and the upper end; but the framing at the lower end is cut away to the level of the centre pieces, to allow the drainings to run back into the bath—the floor of the dripper not only sloping from the further end, but also from the sides to the centre. The soil and stones used to raise the floor of the dripper must be well rammed, and extended some distance beyond the framework, or the floor will crack.

Making the Concrete.—"Be careful to use really good cement. . . . In forming the walls of the bath, be specially careful to have the gravel free from dirt. A little sharp coarse sand is not objectionable; but the strongest work that can be made in concrete, if gravel be used, will be to have it perfectly free from dirt or dirty sand: size of gravel from 2 inches down to very coarse sand, with but little of the latter. The proportions of cement to gravel: 1 part of best Portland cement to 7 parts of gravel for the lower part of the wall.

"When approaching the top of the wall, it is wise to make it a little stronger, say 1 part cement to 5½ of gravel, or stones broken small and free from dirt. There is no difficulty in mixing concrete. Proceed as follows: Take a pail, and fill, say, seven times, with gravel—having first put down a large door or board for mixing on. Now take a pailful of cement and empty on the top of the gravel; turn the whole twice over in a dry state, taking care to get the cement evenly distributed. Let some one stand with a pail of water and put a little on as the men turn it a third time. Let it be turned again, taking care that the coarse and fine gravel is thoroughly mixed and all made wet, when it will be ready for placing where required.

"The proportions for the floor of the dripper will do quite well 1 part cement to 7 parts of gravel or broken stones; and if the soil or stones have been well rammed and made solid, 4 inches of concrete will be sufficient. We strongly recommend that the floor be finished off with a coat of plaster before it is quite set, and not polished too smoothly. If it is made very smooth, the sheep are constantly falling down; whilst if finished off with coarse sand, and levelled off with the wood-float instead of being polished with a trowel, the sheep have good foothold.

Finishing the Bath.—"Regarding the finishing of the bath: after filling it must be allowed to stand three days at the least to set. At the end of that time, let the inside boards be carefully taken away, and one day more allowed to elapse before attempting to plaster, unless the weather be extra dry, when plastering may be proceeded with at once. As it is a confined space for the plasterer to work in, it is well to leave the outside casing standing until the inside is finished, to prevent cracking of the walls. Let the plaster be put on of good quality, and well pressed and rubbed into the wall, and there need be no fear of its coming off. If the bath should be built of brick, a good body of plaster must be put on, or the first touch of frost will fetch it all off again. The formation of the sloping gangway is a very simple matter when the outer walls of the bath are formed, and needs no further explanation. The sloping gangway can be formed, if preferred, when the foundation is put down, and thus save a little wall.

"But little need be said regarding the railing of the dripper, as its construction is so well known among sheep-farmers generally, and plans and elevation, &c.,

annexed, will, we think, show all sufficiently clear.

Catching - pen.—"As regards the catching-pen, it can be constructed entirely of rough woodwork: the only part needing to be carefully made is just opposite the entrance to the bath, where a sloping gangway should be made so as to lead the sheep gradually and easily down to the end of the sloping board already spoken of. This small portion should be made watertight. The end of the bath next this pen can be formed of concrete, or built up with bricks at pleasure, but must stop 8 inches from the top of side walls, as named already, and on the top of this end wall will rest the sloping board, which must be embedded in cement, to make the end watertight. The floor of the catching-pen should be raised to within about 2 inches of the top of the side walls of the bath.

Process of Dipping.—"All being ready for starting, we will suppose a good number has to be dipped: two persons will be needed to bring the sheep forward; two, or, better still, three should stand at the side of the bath, to guide the sheep through. Let the one nearest the catching or entrance pen take hold of each sheep with one hand as it comes forward and as it walks down the sloping board, and with the other hand press down the hinder part of the sheep, keeping the head above the mixture. It will be found when the sheep has a good coat of wool upon it, that considerable pressure is needed to get it down, but it is of great advantage to do so. Let the sheep then be passed on to the next assistant, and so on until it gets foothold up the sloping gangway. . . .

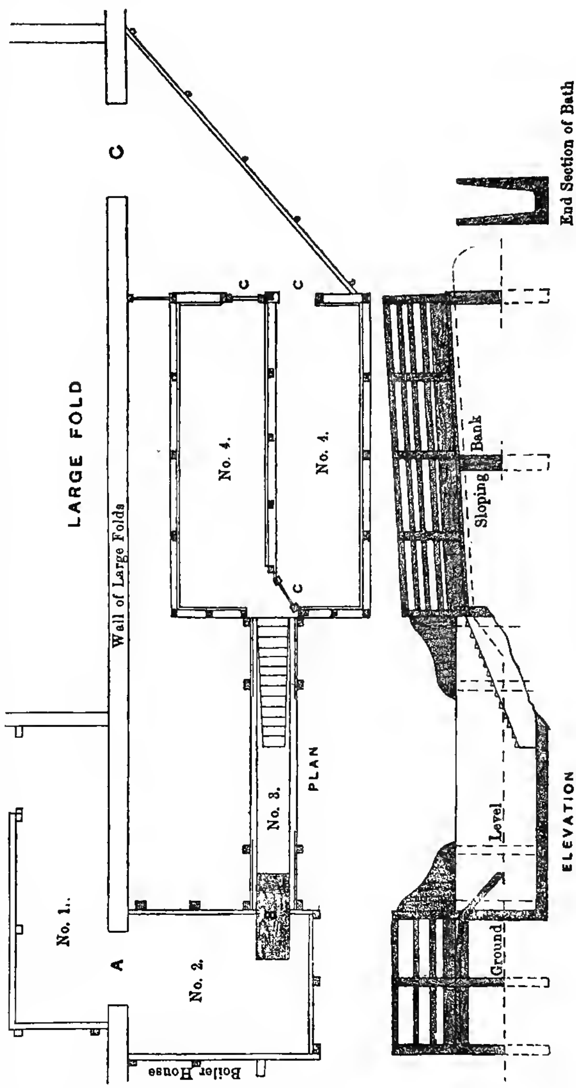


Fig. 555.—*Dipping-bath.*

Plans of Bath.—"The plan and elevation annexed (fig. 555), are drawings of a complete set we have just constructed for Mr Duncan at Balliemore Farm, Strachur. They are built so as to take advantage of large fank or fold. The sheep enter the catching or gathering pens at No. 1, which is formed inside one large division of fold; through gateway A pass into No. 2; through gateway B, thence into the bath, No. 3, passing up into the dripper, No. 4. When drained, they pass out of the upper end of dripper back into a second division of large fold through gateway C. Pens Nos. 1 and 2 will hold about as many sheep as both divisions of dripper 4, 4. The boiler-house is built so as to take advantage of wall of large fold; one side of it forming a side of pen No. 2. Plan of this house could not be shown for want of space.

Cost of Bath.—"As a rough guide to any one contemplating erecting a set, we give the cost of all but the boiler-house.

Erecting woodwork of dripper, 42 hours, at 7d., . . .	£1	4	6
Fixing boards for forming concrete bath, 24 hours, at 7d., .	0	14	0
Forming pens 1 and 2, 27 hours,	0	15	9
Ironmongery, . .	0	12	0
Portland cement used for bath, 18 cwt., at 2s. 3d., .	2	0	6
Do., for dripper, 5½ cwt., .	0	12	4½
Plasterer's time, 18 hours, at 7½d.,	0	11	3
Plumber's work, .	0	6	0

All labourers' work was done by the ordinary farm hands, at odd times, under my own directions. Their time, which was accurately kept, amounted in all to twenty days at 3s. = 60s. The carting is not included. This was also done at odd times. Wood used—all home-grown stuff—not valued.

"As the whole is a permanent fixture, it was not necessary to study lightness, as is the case with portable ones, so the whole of the woodwork is put together off the saw, and tarred. Allowing a few shillings for tarring, and odds and ends, it will thus be seen that, exclusive of timber and carting, also my own attention, that £10 about covers all expenses for gathering-pen, bath, and dripper."

Writing to the editor of this work in November 1887, Mr Wood says: "After two years' observation and inquiry, I have come across nothing equal to the arrangement I have already described. Indeed the whole arrangement works so well that it leaves nothing to be desired.

Length of Bath.—"I would suggest that no bath should be under 15 feet, or more than 20 feet in length—18 feet makes a splendid bath. If the bath is too long it takes too much dip to fill up the bath. A bath of 20 feet long is ample for any flock in this country, and a shorter one does quite well for medium flocks."

Stone and Wood Baths.—The main plan of the bath and dipper described by Mr Wood is well suited for swimming-baths of all sizes. Different materials, however, are often used in their construction. Wood is largely employed; but the best kind of material is the Caithness flagstone—that is, where it or any similar flagstones can be obtained conveniently, and at reasonable cost.

Tossing Sheep into Bath.—The construction of the passage leading into the bath, so as to facilitate the driving of the sheep into the latter, requires consideration. The sheep are of course reluctant to walk into the liquid. It is a good plan to let the floor of the passage terminate in a trap-board, which capsizing forwards, tosses the sheep into the bath in true bathing attitude.

Some farmers consider that the catching or "gripping" pen may be advantageously dispensed with—a short passage or "shedder" being formed between the gathering-pen and the bath. The best method of regulating the passage of the sheep is by hanging a small gate just inside the trap-board, and keeping a lad in charge of it. By adopting this method the services of the "grippers" are unnecessary, and the rough handling the sheep might otherwise experience is avoided.

Plunge-bath.—For small flocks the small plunge-bath is still most largely used. It is generally constructed of wood or flagstone, and the sheep have to be lifted both into and out of it.

Dipping Mixtures.

The flock-owner has almost unlimited choice as to the material to be used in bathing or dipping his sheep. Prepared sheep-dips are in the market by the score. To say that they are all good would be saying too much. There are at least a dozen, however, which are extensively employed, and each of which is cordially commended by different flock-owners.

In these circumstances it would be unsafe, it would be imprudent in this work, to specially distinguish any particular dip.

Non-poisonous Dips. — These dips are roughly classified into poisonous and non-poisonous dips, those which contain poisonous ingredients and those which do not. This classification, however, is not perfect, for some of the so-called non-poisonous dips are such only in name. Indeed it is affirmed by many farmers that perfectly non-poisonous dips would be ineffectual in destroying keds and other insects unless used at greater strength than directed by their makers —perhaps even as much as one and a half times the prescribed strength.

The object of dipping is not only to kill the insects already developed, but also to destroy the eggs and embryo of future generations. Non-poisonous dips will kill the insects, but not the embryo or eggs. These develop later; and for this reason, those who use non-poisonous dips have to dip twice, in order to thoroughly cleanse their sheep. The interval between the two dippings usually extends to ten days or a fortnight.

Composition of Non-poisonous Dips.—Non-poisonous dips are, as a rule, made up of carbolic acid in one form or other; an alkali soft soap, with sometimes a slight addition of sulphur. Most of these dips have also an admixture of some other substance with a long name, and generally poisonous.

Poisonous Dips.—The poisonous dips are in most cases supplied in the form of powder, and are usually made up of arsenic and alkali, soda, or potash, occasionally with the addition of sulphur. These poisonous dips are, of course, the most effective in killing insects and embryo, but they have to be kept and used with great carefulness.

It is right to say that, while it is believed these remarks correctly indicate the prevailing ingredients of sheep-dips, the exact composition of several of the specific preparations offered as sheep-dips is guarded by their makers as a valuable secret.

Home-made Dips.—There has been much discussion from time to time as to the advisability of farmers purchasing the raw materials and preparing the dip for themselves. Many contend that by doing so they may have, at a lower cost, a dip as effective as any offered for sale.

In reference to this point, Mr George Brown, Watten Mains, Caithness, says: "One gallon carbolic acid in 85 gallons of water, with 2 lb. of arsenic, 2 lb. soda, and 5 lb. soft soap, will be found to be as good and as efficient a dip for 100 sheep as any in the market. The arsenic and soda are mixed together and brought to the boiling-point, when the soft soap is added. When all is dissolved, this mixture is well stirred into the bath containing 85 gallons of water. This would dip 100 sheep at a smaller cost than any of the prepared dips.

Objections to Home-made Dips.—"The only objection we have heard to this plan of using a home-made dip is that shepherds are said to be so careless that they cannot be trusted to work with such a dangerous poison as arsenic.

A Safe Method.—"This difficulty might be overcome by having the materials weighed up in quantities suitable for 50 or 100 sheep. The bath should be marked to show the depth of the liquid required for say 50 and 100 sheep, and the mixture should be frequently well stirred. The bath might first be filled to the 100 mark, then when reduced to the 50 mark the quantity for other 50 might be added. The residue will no doubt have a tendency to become stronger, and when say about 200 sheep have been run through, it might be well to add 8 or 10 gallons of water to what remains of the mixture.

Stirring.—"A very important point is to have the liquid well stirred in the bath when the dipping is going on."

A Good Mixture.—Mr David Wood, author of that useful little volume, "Sheep Dipping,"[1] says: "I have not a word to utter against arsenical preparations. Rather would I praise them, where they can be used without the possibility of cattle getting at the mixture, or grazing after sheep newly dipped. But I am fully convinced that, where it

[1] W. Blackwood & Sons. Price 1s.

is possible and convenient to dip in October and February, the following mixture will be found to answer admirably, and though not a non-poisonous mixture, it is not dangerous to cattle or sheep, either from drinking the water or eating the grass contaminated, as the smell arising from it will prevent them from touching grass on, or in, which it exists: 1 gallon of spirits of tar and ½ gallon of carbolic acid to 80 gallons of water. It is necessary to have hot water at hand, and dissolve in it a little common washing-soda, to facilitate the mixing of the spirits of tar. Let the operator take half a pailful of hot water and put in a quart of spirits of tar, and then a quart or two of the soda mixture, according to the strength, and stir. The carbolic acid can be put straight into the bath, and simply well stirred."

When a halt is made in the dipping, the liquid should be particularly well stirred before the work is resumed.

Quantity of Arsenic.—"Another essential point is to take care that the quantity of arsenic never exceeds 2 lb. to 80 or 85 gallons of water. Many of the accidents which occur in dipping may be traced to neglect of these precautions. We sometimes hear of 4 lb. of arsenic being used in about 80 gallons of water for 100 sheep, with the result that a few deaths follow. The wonder, indeed, is that the whole flock is not destroyed by such treatment."

Mixing Poisonous and Non-poisonous Dips.—It is the practice with some sheep-farmers to use manufactured poisonous and non-poisonous dips mixed together. The poisonous powder-dip is added to kill the eggs of insects. A packet intended for 50 sheep is for this purpose sufficient for 100 sheep, along with the non-poisonous dip.

Time for Dipping.—The end of autumn and beginning of winter is the most general time for dipping. The general dipping of the flock usually takes place at least ten days or a fortnight before the rams are put amongst the ewes, as to which the practice varies greatly throughout the country. It is a common practice to dip lambs when they are weaned, about August, and to repeat the operation about November. In many places the summer dipping is deferred, and the ewes and lambs dipped together about two weeks before tupping begins. In other cases the dipping of adult sheep is deferred until the New Year, or even until spring; the practice varying with the locality, and the liability of the sheep to be struck by the fly, and the prevalence of other parasites. In the north of Scotland old sheep are, as a rule, dipped only once a-year, about October or November, and lambs twice, in August and November.

Weather for Dipping.—It is very essential that dry weather be chosen for the operation, otherwise little benefit will be derived from it. If the sheep are wet the wool will not absorb the dip properly; and if after dipping they are exposed to heavy rain, before the fleece has become perfectly dry, the solution will in all probability be washed out of it.

Dressing for Scab.—When scab appears in a flock it is a good plan to "bathe" instead of "dip" the sheep. By the bathing system the mixture can be more thoroughly rubbed into the affected parts, while a stronger mixture can be used with safety. For this purpose a good dressing for 50 sheep is made of 1½ gallon spirits of tar, 2 lb. tobacco (infused), 5 lb. soft soap, 4 lb. soda, and 2 lb. hellebore. Many add 1 gallon of oil. All the ingredients except the spirits of tar are mixed together, the spirits of tar being added to the pouring-jug directly, at the rate of 1½ whisky-glassful to each sheep. The exact quantity required will of course depend a little upon the size of the sheep. If they are small or weak, 1 gallon of spirits of tar may be sufficient for 50 sheep.

One careful dressing with the above mixture may be relied upon to destroy the scab.

Oil in Dips.—There is considerable difference of opinion as to the advantage of using oil in sheep-dip. Some contend that it is highly beneficial to the fleece, in particular enabling it to throw off water more readily. Others discount this idea, contending that oil and caustic potash do harm by destroying the "yolk," and forming a soap which is readily washed out of the fleece by rain.

TUPPING SEASON.

The autumn and early winter is the mating season on sheep-farms. The precise time for introducing the rams to the ewes, as we shall presently see, varies considerably throughout the country.

Flushing Ewes.—It has been found a good plan to "flush" the ewes just before tupping—that is, to give them an exceptionally abundant supply of succulent food for about two weeks before tupping, so as to have them in an improving condition when mated. This treatment hastens tupping, tends to increase the number of twin-lambs, and to lessen the number of barren ewes.

If possible, a portion of rich pasture should be preserved for this purpose, or the ewes may have a run of the new grass and stubbles after harvest. On some farms where pasture is not available, a small breadth of rape is grown for the ewes, and in other cases a moderate feed of bruised oats is allowed.

On hill-farms farmers are not so anxious for twin-lambs, for on these lands one good lamb is sufficient for a ewe to rear satisfactorily. Hill-farmers therefore give less attention than lowland farmers to "flushing" the ewes. Still many of them save low pasture upon which to feed them two or three weeks before tupping.

Some flock-owners, however, question the propriety of flushing stock ewes, as they find that when a big crop of lambs has been got one season by "flushing," the crop of lambs in the following season will be much smaller, however much the ewes may be flushed.

Mating.—An important matter to be attended to at this time is the assorting of the ewes and the rams to suit each other. The ewes are drafted into lots to suit the different rams. Ewes of similar character as to fleece and form go together, and if they exhibit any deficiency in any particular point, a ram exceptionally strong in that point is chosen to associate with them. In this way, also, the flock-owner manipulates the different strains of blood as may be desired.

Number of Ewes to each Ram.—This varies from 30 to 65, about 50 or 60 being most general. In deciding as to the number of ewes to each ram, the character of the ground as well as of the sheep must be taken into account. On high rough land and poor pasture it would not be prudent to allow more than about 35 to each ram. On low level land and good pasture a specially active adult ram may serve 70 or 80, or even more. Sixty-five should be the maximum. The best plan is to have each ram and his companions in a field or division by themselves. When the size and number of enclosures, or other arrangements of the farm, do not permit of the division of the flock into such small lots, then each lot may consist of the number sufficient for two rams.

Age of Tups for Using.—Opinions have changed as to the age at which tups may be used for breeding. Formerly rams were seldom used until about a year and a half old. Now ram lambs are used very extensively. If the lambs are strong and well fed, and have not more than 30 to 35 ewes, they are quite reliable, and produce a big crop of rapid-growing lambs.

By using these precocious immature sires, the early maturing properties of sheep have been further developed, but unless the system is pursued with good judgment, there may be some risk of the constitutional stamina of the flocks being impaired.

Age of Ewes for Breeding.—In a few cases in England the ewe lambs are put to the ram in their first year. The rule, however, is to delay mating till the ewe is in her second year.

Service Marks.—To guide the shepherd as to when certain ewes may be expected to lamb, various marks are employed to distinguish the ewes in the order in which they have been tupped. Before the ram is put amongst the ewes, his breast is marked with, say, red keel, and this being repeated every morning, the ewes receive a mark from him as they are tupped. After the first week a differently coloured keel may be used, or some other plan of marking the ewes adopted. By these marks the shepherd can reckon to within a few days the time the various ewes should lamb, and will accordingly be able to give them the desired attention.

Changing Tups.—When the tups

have been two or three weeks amongst the ewes, many farmers change them from one lot of ewes to another. This often results in the successful service of ewes which would otherwise have been barren. If a ewe should break service to one ram, she should be mated with another tup, a fresh one if possible. Another plan is now being pursued on some farms. Two or three young rams are kept away from the ewes and well fed until the last week or so, when the rams that have been used as sires are taken away, and the young fresh rams introduced to the ewes.

Treatment of Tups.—It is the custom with many farmers to take the rams into an enclosure or house, and give them extra food, such as bruised oats, every night during the tupping season.

Time for Tupping.—The exact time for putting the rams amongst the ewes depends upon the climate of the locality, the character of the farm, the variety of sheep, and the purposes for which the produce are intended, whether for feeding off as fat lambs or other purposes. In the chapter upon the lambing season, Divisional vol. iv. pp. 47-87, the great variation in the time of mating ewes and rams has been fully indicated.

Each farmer decides what is the best time for him, in his particular circumstances, and for his peculiar objects, to have his lambs dropped, and the mating the ewes and rams is arranged accordingly, bearing in mind that pregnancy in the ewe usually extends to 21 weeks—Divisional vol. iv. p. 87.

Speaking generally, it may be said that the tupping season ranges from early in September to the end of November. The northern hill-farms, of course, come last.

The rams usually remain with the ewes six weeks.

Ram-breeding on Hill-farms.

In previous portions of this work the breeding of rams on low country and arable farms has been discussed. Here we may append a few notes as to the breeding of rams on hill-farms.

Selecting and Mating Ewes.—When the tupping season arrives, the stock of ewes is carefully examined, and say 50 of the best are selected from each hirsel. These lots of 50 are kept separate, and with each is placed a carefully chosen ram, most likely bought in from some noted flock. Each lot is tended by a young man or lad, who takes care that no other sheep get near them. When tupping is completed, the ewes are marked with the hirsel and tup mark, and put back to their respective hirsels.

Selecting Ram Lambs.—When the lambs are about three weeks old, the lambs from these selected ewes are carefully examined, and such of the male ones as may be "weedy" or unsatisfactory in any way are castrated with the others of the flock. A few weeks later the selected ram lambs are again closely examined, and any inferior ones assigned for sale, for slaughter, or castrated.

The two lots of specially chosen ram lambs are now joined, and carefully and liberally fed.

Intermixing Blood.—In using these home-bred ram lambs, those bred from hirsel No. 1 are put amongst hirsel No. 2, and *vice versa.* The same routine is pursued every year, fresh blood being introduced now and again.

HORSES IN AUTUMN.

There are few points connected with horses which demand any special notice in the autumn season. Work-horses will be fed and treated generally in accordance with the duties required of them.

Young horses, and breeding animals which may have been on the pasture-fields during summer and early autumn, will be housed in the evenings when the chilly nights begin. Perhaps till the very end of autumn, or even later, they may be put to the fields for a few hours daily, much depending upon the locality and the character of the weather. Young horses are all the better of being reared so as to make them hardy outdoor rather than delicate indoor plants. A considerable amount of cold will do them no harm, if they have a dry well-sheltered bed in which to spend the night.

SHOEING.

As yet nothing has been said regarding the shoeing of horses. It is an important subject, now, happily, better understood than formerly.

Faulty Shoeing.—It was notorious that the system of shoeing practised by country blacksmiths was, as a rule, faulty in principle and still more unsatisfactory in execution. It was rare to find a blacksmith who had taken the trouble to inform himself as to the formation of the horse's foot and the real objects of shoeing, so that the work was usually done in a rough, haphazard fashion, often permanently impairing the usefulness of a valuable animal.

Too often the rough-and-ready shoer would pare and file away at the hoof until it was seriously weakened; the foot being made to suit the shoe, instead of the shoe adjusted to fit the foot.

Improvement in Shoeing.—There was thus much need for improvement in the practice of horse-shoeing, and with considerable success a movement for this purpose was taken up about 1887. Shoeing competitions became a feature at the Royal English and other shows, handsome prizes being offered to expert black smiths to exhibit their handiwork. Both by writing and speaking, as well as by ocular demonstration, a good deal has been done in recent years to arouse the interest of blacksmiths in the proper methods of shoeing,—to convince them of the faultiness and injurious influence of the old haphazard practice, and acquaint them with the details of the most approved methods.

Shoeing not always Necessary.—There has from time to time been much discussion as to the necessity for shoeing horses. Horses working on land can do very well without shoes, and in some parts of the Shires, the counties around London, it is common to see unshod horses at work. Young horses and breeding animals, not being worked, are better without than with shoes.

It is the rule, however, to have farm-horses shod, and it is the universal practice in this country with horses working on roads and streets.

Object of Shoeing.—The object of shoeing is not to improve or remodel the foot; it is merely to assist the hoof in protecting the foot from injury from the concussion and friction to which it is exposed when the animal is working on hard surface. The unshod horse, indeed, has a perfect foot—short toe, wide heels, and large frog—see fig. 556. In shoeing, therefore, the object should be to follow nature as closely as possible.

There is no higher authority upon horse-shoeing than Dr Fleming, principal veterinary surgeon of the army; and

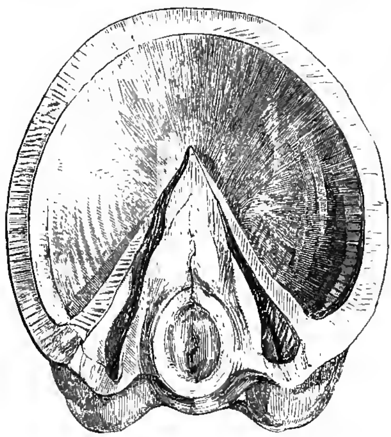


Fig. 556.—*Horse's foot in the natural state.*

from his admirable volume, the 'Practical Horse-Keeper,' we take the following notes on this subject:—

The Hoof.—"In order to understand the general principles of shoeing, a glance at the different parts of the hoof is necessary. The 'wall' is that portion which surrounds the foot, and is alone seen when this is placed on the ground. It is fibrous in structure, the fibres passing from above to below, as they grow from where the skin terminates. Externally, these fibres are dense and resisting, but those nearer the interior gradually become soft and spongy. The growth of the wall is indefinite, it being the part which has to sustain wear through contact with the ground.

"When the foot is lifted, the sole and the frog are seen on its lower or ground surface.

Sole.—"The sole is usually more or less concave in a healthy foot. It is fibrous, like the wall, its fibres passing in the same direction; but they are much softer, and their growth is definite, they breaking off in the form of flakes when they have attained a certain length.

Frog.—"The frog is a triangular mass of somewhat soft and elastic fibrous horn, situated at the posterior part of the sole. Like that part, its fibres are also of definite growth, and flake off in large patches from time to time.

Functions of Parts.—"The wall sustains weight and wear on all kinds of ground; the sole is adapted for sustaining weight, on soft ground more particularly; while the frog has a most important use in acting as a cushion to support the powerful tendon which flexes the limb, in diminishing jar, and in preventing slipping.

"The unpared sole and frog of the healthy foot need no protection on any kind of soil. The flakes of loose horn on the former serve a very useful purpose in retaining moisture, and so keeping the solid horn beneath soft and elastic, while they act as so many springs when the foot is placed on projecting stones. The more the frog is exposed to wear, the larger and sounder it grows, and the better it is for the foot and limb.

Fore and Hind Feet.—"The fore-foot is of more importance, in the matter of shoeing, than the hind one; inasmuch as it has to support much more weight, and is consequently more exposed to disease and injury.

"The fore-foot, when well formed, is nearly, if not quite, circular; the hind-foot is somewhat oval, the frog smaller, and the sole more concave.

Hoof Growing.—"When the hoof is shod the wall is not exposed to wear, and therefore would grow to an indefinite, and, consequently, most inconvenient length, if the shoe should chance to be retained too long, and the excessive growth of horn not removed. The sole and frog, on the contrary, never cause inconvenience, as their growth is limited.

Principles of Shoeing.—"What is required in shoeing, then, in principle, is merely protection from undue wear, with the least possible interference with, or disturbance to, the functions of the foot and limb. The excess in length of the wall must be removed at frequent intervals — between a fortnight and a month—according to the activity of the growth; but the sole and frog, if healthy, should not be disturbed.

Weight of Shoes.—"Not a grain of iron more than is absolutely necessary should be allowed as a protection; and this question of weight of shoes is an important one, especially with horses which are compelled to travel beyond a walk. There are no muscles below the knee and hock, and those which are chiefly concerned in the movements of the limb arise high up, and act upon short levers. An ounce weight at the shoulder or stifle, therefore, progressively and rapidly increases, until at the foot it has become several pounds. Therefore it is, that a shoe six or twelve ounces heavier than is absolutely necessary to protect the wall from wear, occasions a great waste of muscular power of the limb, and consequent fatigue. If we consider the rapidity with which the weight increases from the shoulder or hip towards the foot, the number of steps a horse takes in a journey of a few hours, and that there are four feet so surcharged, we shall gain some notion of the many needless tons which the animal has been compelled to carry, and the strain thrown upon foot and limb—a strain they were never intended, and are not adapted by nature, to bear. All shoes should, then, be as light as may be compatible with the wear demanded from them.

Form of Shoes.—"For all horses except, perhaps, the heaviest animals employed in drays and heavy waggons, the lower or ground face of the shoes should be concave, and the upper or foot surface plane, or nearly so. They should be retained by the smallest number of nails possible—six or seven in the fore-shoes and eight in the hind-shoes. Calks should never be employed for light horses. With the heaviest horses—the dray or waggon animals—it may be advantageous to have toe and heel calks to afford secure foothold.

Process of Shoeing.—"The procedure in shoeing is simple in the extreme. When the old shoe is removed from the hoof, nothing more is required than to remove the excessive growth of the wall by means of the rasp, applied to the lower margin or ground, or sole border—not the front of the wall. The amount to be removed will depend upon the growth, and of this the farrier's skill in his art should enable him to judge. It is at the toe or front portion that the excess is usually found, and this should be removed until, in an ordinary hoof, when placed on the ground, the angle should be about 50° to 52°. The angle can be easily measured by the experienced eye. The sole or frog should not be touched, not even the loose flakes removed; and all the work ought to be accomplished by means of the rasp. Paring out and hacking at these parts with the drawing-knife should be absolutely condemned as destructive to the foot.

Have the Foot Level.—"In reducing the wall to a proper length, care should be exercised in keeping both sides of the hoof of the same height; as, if one is left higher than the other, the foot, fetlock, and, indeed, the whole limb, will be thrown out of the perpendicular. This causes the horse to travel painfully, as it twists the joints, and in time leads to disease. *Nearly always the inside of the foot is left higher than the outside*, and this throws severe strain on the outside of the foot and fetlock. Standing in front of the horse when the foot is on the ground, one can perceive at once whether this deviation is present. In a well-formed foot and leg, a plumb-line should fall from the point of the shoulder through the middle of the knee, shank, pastern, and front of the hoof.

Fitting the Shoe.—"The wall having been reduced sufficiently, the shoe should fit *full* all round the circumference, and project slightly beyond the heels. Heat is not absolutely necessary in fitting it, or procuring accurate coaptation between it and the hoof.

Nails.—"The nails should take a short, thick hold of the wall, so that, if possible, the old nail-holes may be obliterated when the excess of horn is removed at the succeeding shoeing. In the fore-foot the nails should be driven home more firmly at the toe than the heels, particularly the inside heel.

Rasping.—"The clinches must be laid down as smoothly as possible, and with only the most trifling rasping. The front of the hoof or wall should on no account be otherwise touched with the rasp, but ought to pass in a straight line from the top, or coronet, to the shoe. Rasping this part of the hoof is most injurious, and should not be tolerated on any consideration. It removes the dense tough fibres which are best adapted for holding the nails that retain the shoe, and exposes the soft spongy horn beneath; this soon dries, cracks, and breaks, and does not afford sufficient support to the nails.

Evils of Shoeing.—"The evils of shoeing, as too often practised, are—(1) paring of the sole and frog; (2) applying shoes too heavy and of a faulty shape; (3) employing too many or too large nails; (4) applying shoes too small, and removing the wall of the hoofs to make the feet fit the shoes; (5) rasping the front of the hoof.

"The shoe should give the hoof a level natural bearing on the ground.

Calkings.—"Calkings are hurtful to fast-moving horses, and may be dispensed with if the shoes have a concave ground surface, and the frog is allowed to come fully in contact with the ground; if they are resorted to, their injurious effects should be averted by employing a toe-piece of the same height.

Charlier Method.—"Knowing that the horse's foot is admirably constructed to perform certain definite functions, and that the hoof, in ordinary conditions, is designed to act as the medium through which the most important of these are carried out, but that its circumference is liable to be broken away and worn when unduly exposed, we have only to substitute for a certain portion of this perishable horn, an equivalent portion of a more durable material, and the hoof is secured from damage by wear, while its natural functions remain unimpaired.

"With this object in view, what has been designated the Periplantar or Charlier method of shoeing has been introduced, and with considerable success.

"In this method the sole and frog, as well as the bars, are left unpared. The crust or wall is bevelled off at the edge by the rasp, and by means of a special knife, with a movable guide, a groove or recess is made along this bevelled edge to receive the shoe. Into this groove is fitted the shoe. This is a narrow, but somewhat deep, band of iron (or, as now, a mixture of iron and steel; or, better still, *Bessemer steel*). It is perforated by from four to six oval nail-holes of small size, and, if required, may be provided with a clip at the toe, though this is seldom found necessary.

"Its upper inner edge is rounded by the file to prevent it pressing too much against the angle of the sole, and the ends of the branches are narrow and bevelled off towards the ground.

"The nails are very small, and have a conical head and neck. They must be of the finest quality.

Fitting the Charlier Shoe.—"It is best to fit the shoe in a hot state, as it must have a level bed, and follow exactly the outline of the wall. After it has been fitted, it is desirable to remove, by a small drawing-knife, a little of the horn from the angle of the groove of the hoof, to correspond with the rounded inner edge of the shoe. This ensures the proper amount of space between the latter and the soft horn, at the margin of the pedal bone.

"In strong hoofs the shoe is almost entirely buried in the groove; but in those which have the soles flat or convex, with low heels, or which have been partially ruined by the ordinary method of shoeing, it is not safe to embed it so deeply, at least to commence with.

Shoeing for Ice.—"Provided the frog comes largely in contact with the ground, there is not usually much danger of slipping; but as it is not always possible to secure this, recourse is had to artificial means. Among these are calkins, which, as has been already mentioned, are objectionable in all but slow-paced horses; and india-rubber pads of various forms to fit between the shoe and the hoof, and come in contact with the ground, aiding, as well, in diminishing concussion.

Roughing.—"For ice-covered roads there are numerous contrivances. In ordinary 'roughing,' the shoes are taken off and a sharp calkin is turned up; but this requires a forge, much time, is injurious to the horse's feet, does not last long, and is expensive.

Frost-nails.—"'Frost-nails' are sometimes employed, but these also require a farrier, last a very short time, and likewise damage the hoofs.

Studs. — "Screw studs or pegs are more convenient, screw-holes being made in the shoes when they are first put on, into which sharp or blunt pegs are screwed as occasion may require. But these sometimes break at the neck, or fall out, require to be screwed in, and the thread is liable to become rusty, while they are somewhat expensive.

"Another much simpler and cheaper method is the introduction of a sharp square peg into a square hole punched in each branch of the shoe, and, if necessary, at the toe—this stud and the hole having a slight taper, which permits the former to be inserted and removed: it should not project beyond the foot surface of the shoe. Or, the studs and holes may be round and tapering in the same manner.

"Blunt studs may be used when there is not ice, or on wooden pavements, or asphalte. When required to be used, these studs are merely inserted into the holes and require a smart blow; when it is desired to remove them, a few taps on each side, and a blow on the face of the shoe, will generally make them jump out."

POULTRY IN AUTUMN.

MANAGEMENT OF FOWLS.

Hatching in Autumn.—The hatching of the common fowl should not extend beyond the end of August or beginning of September, unless more than ordinary care can be bestowed on the rearing of the broods. The chickens hatched up to that time will be in excellent condition at Christmas and New Year, and be valuable in a pecuniary point of view, should the farmer choose to avail himself of a market.

But for the farmer's own enjoyment in a delicacy on his table, the hatching may be continued until the cold weather set in.

Hatching Periods. — The natural periods of hatching fowls are spring and early autumn, a cessation being expedient in the warm months of June and July. It is well to attend to this hint from nature, though hatching is quite possible in the warmest months by having cool retreats for the broods, and careful treatment.

Stray Hatching.—Notwithstanding the utmost attention bestowed on fowls, the hen will make her own nest and bring out broods in the corn-fields, at the roots of hedges, and under the cover of shrubs. After being away for a time, she will return home with a fine healthy brood, all alike in size and colour, to seek subsistence for herself and numerous offspring; and joyous is the welcome she receives with her treasure. As long as there is plenty of food for them in the fields, she will rear them there in preference to bringing them home, and by the time she returns, the chickens will be strong and well fledged. But when the hatching is late, and food scarce, she returns early to her home.

Fowls that hatch broods in the fields are liable to destruction by vermin, and many a brood-mother has been destroyed with all her young by the ruthless fox.

Preventing Clucking.—Many cruel expedients are resorted to by country people to prevent hens clucking when they wish to sit and hatch, such as dipping them overhead in water for a few seconds, pulling feathers from parts of the body, confining them together under a tub for days without food, and other barbarities—all alike ineffectual. When more than one hen is confined under a clucking tub,—which is set with its mouth raised a little from the ground, allowing as much light as to let the hens see each other,—they fight until their scalps are bared to the bone, and one of them probably pecked and trampled to death.

Some writers recommend the hens to be indulged in their desire for hatching, but as most laying hens have a desire to sit when the ovarium for the time is emptied of its contents, the number of broods would be increased beyond the powers of the household to superintend them with the requisite care. A hen sitting without eggs will sit till she injures herself.

Humane Methods.—A humane method of suppressing clucking, is to put a single hen under a small tub, high enough to let her stand up, and perforated with holes for air, and to deprive her of food and water for two days and nights, or even more. Or she may be placed in a coop with barred floor, so that she will not find a place comfortable enough to encourage the broodiness.

A hen will lay eggs when she is tending her brood, and she will choose a nest for herself. But if her nest be known, and although the eggs be removed, the desire for sitting will come upon her at the appointed time.

Selecting Winter Layers.—Autumn is the season for selecting hens for laying eggs in winter. They should be young and strong, but of different ages, that a succession in the laying may be maintained. Hens readily take to the nests made for them at this season, evincing no desire to wander into the fields.

Moulting.—Autumn is the season of moulting for fowls. The care they require in this periodic visitation, is to have them in a warm place at night, and to receive food of a rather better description. The nights of September become chilly for fowls, for they are of tropical origin.

Prevailing Laying Period.—Hens begin to lay about the beginning of March, and continue to the beginning of October. They do not lay every twenty-four hours—some laying every other day, some missing one day in three. Some lay about two dozen of eggs at one period, then cease for two or three weeks, and again lay other two dozen; and so on for the number of months mentioned. Of these months they lay most constantly in March and April. After each period of laying they are inclined to sit.

Non-sitters.—The above remarks as to laying do not, of course, apply to the non-sitting varieties, which in recent years have become so popular. These will lay on for a long period with occasional rests, and in some cases will produce two hundred eggs per annum.

Nests.—Whenever a hen is observed to indicate a desire to lay, a nest should be provided her in a quiet and convenient place; and if directed to it at the commencement of her laying, she will continue to frequent it if undisturbed.

But a nest is not required for every laying hen, as several will lay in succession in the same nest, some hens laying earlier in the day than others; and so tenacious are they of their right to particular nests, that two will not unfrequently occupy the same nest at the same time.

Every place is not equally suitable for a hen's nest. In other places than the hen-house, hens are not fond of laying their eggs on a level with the ground, though a quiet corner in a shed, under shelter, is not unfrequently selected by themselves for the purpose. But they prefer to lay at an elevation above the ground, such as in the mangers of stables, in a trough of a shed or hammel, in the straw-barn upon the top of the mow of straw, in a stack of straw in the stackyard, on a compost dunghill, or on the top of the wall of a stable, byre, or outhouse, under the roof.

When nests are made in such places as hens would themselves prefer, they will be more quietly frequented than when nests are made for them elsewhere.

Collecting Eggs.—The hen-wife should visit every nest and collect the eggs every day; and the time for collecting the largest number, and disturbing the hens the least, is in the afternoon between two and three o'clock, before they retire to roost. Eggs are most conveniently collected in a small hand-basket, and a short light ladder will afford access to nests above reach of the ground.

Nest-egg.—A nest-egg should be left in every nest, as it is an established fact that hens prefer laying in nests having an egg—the thrift of a "nest-egg" is no doubt founded on this instinct. Nest-eggs of stoneware fulfil the purpose admirably.

Weight of Eggs.—Eggs vary greatly in size, as well as to some extent in shape and colour. As a rule, from seven to nine eggs will make 1 lb. weight.

Care of Laying Hens.—Neither dogs nor children should be allowed to run after laying hens; the chasing and fright make them part with their eggs before they are encrusted with the shell. Guinea-fowls are incessant chasers of hens.

Shell-less Eggs.—Eggs are sometimes laid by fowls a portion of which is devoid of shell; and should such be desired for breeding from a favourite breed of fowls, the vitality of the egg may be secured by covering the part wanting the shell with paper and gum, or with a thin paste of stucco.

Individuality of Eggs.—The Rev. Mr Dixon makes these true remarks on the integrity of the eggs laid by the same hen. "To every hen," he observes, belongs an individual peculiarity in the form, colour, and size of the eggs she lays, which never changes during her whole lifetime, so long as she remains in health, and which is as well known to those who are in the habit of taking her produce as the handwriting of their nearest acquaintance. Some hens lay smooth cream-coloured eggs, others rough, chalky, granulated ones. There is the buff, the snow-white, the spherical, the oval, the pear-shaped, and the emphatically egg-shaped egg. A farmer's wife who interests herself in the matter, will tell you with precision, in looking over her stores, 'this egg was laid by such a hen'—a favourite perhaps—'this by such another'; and it would be possible that she could go on so throughout the whole flock of poultry. Of course, the greater the number kept, the greater becomes the difficulty in learning the precise marks of each.

"From a basket of thirty eggs, gathered in a farmyard as they came to hand, eleven laid by one or two hens whose race we were desirous to continue, were selected in about two minutes by the friend who supplied us with them. If four dozen eggs, laid by no more than four different hens, were put at random on a table, the chances are that it would be as easy to so sort them as the four suits in a pack of cards." [1]

Preserving Eggs.—Whether eggs are used at home or sold to egg merchants, they should be kept in a fresh state for some time. This end is attained by preventing the air penetrating the pores of the shell, and the yolk coming in contact with it. Smearing the shell, while yet warm, with butter or melted suet, will prevent the air penetrating it. Keeping in salt or flour has been found to answer well. Immersion in a fluid is used for the same purpose, but the air is not thereby effectually excluded.

The only means of preventing the contact of the yolk with the shell is changing the position of the egg every day. The general mode of treating eggs in farmhouses, whether intended for use at home or for sale, is the slovenly way

[1] Dixon's *Orna. Dom. Poul.*, 152.

of keeping them in promiscuous heaps in the state taken from the nests.

In recent years prizes have been offered at several shows for the best lots of preserved eggs, and these contests have shown that, of the many methods of preserving which the competitors had tried, only two could be relied upon to successfully preserve eggs for any considerable period of time. In the one case lime, and in the other salt, was the chief preserving agent. The processes of preserving eggs by the use of lime and salt are thus described by Professor Long:[1]—

Preserving with Lime.—"Lime affords one of the simplest possible means for the preservation of eggs. The plan to adopt is to select a vessel, preferably of earthenware, into which a number of eggs are placed; a mixture of lime and water is then poured over the eggs. The liquid may, if necessary, reach the mouth of the vessel, so that other eggs can, from time to time, be dropped in. A frequent mistake is in making the lime too thick. In this case, that which is not held in solution by the water—for water can only take up a certain quantity of lime—remains at the bottom of the vessel, and the eggs become embedded in it, and are sometimes difficult to remove without breaking.

Preserving with Salt.—"Eggs have been packed in salt for years, with more or less success—generally less, for those who have made the attempt have fallen into the mistake of using salt in the state in which it was purchased. The great secret of preserving in salt is to use a sample which is absolutely dry, and then to keep it dry. The best plan is to use a box sufficiently large to hold fifty eggs—this is a convenient size. The bottom, as well as the lid, should be so fixed that it can be taken off without breaking. In practice, a layer of salt is laid upon the bottom, and on this the eggs are placed, upon their sides; these are then covered with another layer of salt, when a second batch of eggs is placed in the box, and so on until the top is reached. During the process of packing, the salt must be pressed down as tightly as possible, more especially round the sides; and when the box is full, before the lid is fixed, every means should be taken to pack and press the salt as closely and firmly as possible without breaking the eggs. The box should then be stored away in a perfectly dry place. When the eggs are to be used, care should be taken to remove the bottom of the box, so that the stalest eggs—*i.e.*, those first put in—may be first used.

"Any person may safely store eggs by either of the above systems; and provided proper care has been taken, it will be found that the losses are trifling, and that eggs which have been kept four months are almost equal to those new laid."

Packing Eggs.—When eggs are sent to a distance for hatching, they should *not* be smeared, but be wrapped in soft paper, and packed on end in moss or soft hay in a hamper or box.

Other Methods.—It is easy to preserve eggs in summer by first smearing them, while warm, with butter or melted suet, and then packing them on the small end in barrels in oats or wheat. The eggs are placed upon their small end, because the yolk has the less chance of coming in contact with the shell, while at the large end the space filled with air should be kept uppermost. The yolk is held in the centre of the egg by a membrane. Salt imparts a salt taste to fresh eggs if unsmeared with butter, but not when smeared. Oats and wheat make a good packing, and may afterwards be used by the fowls. Suet used for eggs should be quite fresh, and rendered pure by melting on a slow fire, which effects the separation of the tendonous matter. Eggs preserved by either of these methods we have found fresh for months, even to containing the milk in them—which is the popular criterion of a fresh egg, but is not so, since an egg may contain it which is not new laid.

Eggs for Preserving.—Eggs which are to be preserved should be perfectly fresh, newly laid, when stored. And it is considered by some that they should be *unfertile*—that is, they should be laid by hens which have not been in company with a male fowl for two or three weeks previously.

[1] *Poultry for Prizes and Profit.* L. Upcott Gill.

Rearing Turkeys.—Although the turkey hen is a very careful and watchful mother, the brood requires daily tending from cold blasts and heavy showers until they become robust, which will be in five or six weeks. When disposed to lay, the hen slips away from her poults and makes a rude nest amongst weeds; and although the egg be removed, she will lay in the same nest until her ovarium is exhausted.

Turkey eggs are justly regarded as a great delicacy at breakfast.

The turkey should not be allowed to sit to bring out a second brood, as the birds will be too late to be of use the same season, unless great pains are taken to keep them warm. Otherwise, being very susceptible of cold, their growth will be much dwarfed.

Geese.—Goslings are easily injured by hailstones and heavy rains until five or six weeks old, and should be placed in shelter until the storm subsides. A later brood of geese may be brought up through the winter, and will become fine large birds by the Michaelmas of next year.

A goose egg is not relished, being strong-tasted.

Ducks.—Ducks are great layers, dropping an egg almost every day. They commence at the beginning of April and cease in July. They are very careless layers, leaving their eggs wherever they seek their food; and these, on being discovered by the pigs, are champed up as the most delicate morsels that fall in their way.

To secure the eggs of ducks, the laying birds should be examined before being let out in the morning; and those indicating hard with egg, confined in the house till they have laid, and afterwards set at large. They are easily examined by suspending them in the left hand by the wings, and simply applying the points of the fingers of the right hand a little under the tail.

Many people enjoy the flavour of a new-laid duck egg. They are used in cookery as freely as hen eggs, but they will not beat up into a smooth mass.

Pigeons.—The dove-cot should be examined at least once a-month all summer and autumn. Young pigeons grow so rapidly in warm weather, that unless the time is marked when pairs will be ready, they may have taken their flight. Pigeons should be regularly fed with the poultry; and even with that, such is the keenness of their appetite, they will go to the fields in search of every species of corn, turnip-seeds, seed-wheat, and in the stubbles.

Specific Gravity of Eggs.—The specific gravity of a new-laid egg varies from 1.080 to 1.090; an egg, therefore, is heavier than sea-water, the specific gravity of which is 1.030. When kept, eggs rapidly lose weight, and become specifically lighter than water—this is owing to the diminution of bulk in the contents of the egg; the consequence of which is, that a portion of the inside of the egg comes to be filled with air. Prout kept au egg two years, and found that it lost weight daily, at an average rate of 0.744 grains. The original weight was 907.5 grains, and after two years' exposure to the atmosphere it weighed only 363.2 grains. The total loss amounted to 544.3 grains, or considerably more than half the original weight. The loss in summer was somewhat greater than in winter, owing, no doubt, to the difference of temperature. When an egg is therefore employed as a test of the strength of brine, the newer it is, the stronger is the brine that floats it.

When an egg is boiled in water, it loses weight, particularly if it be removed from the water when boiling, and be permitted to cool in the open air. The water will be found to contain a portion of the saline constituents of the egg. The loss of weight from boiling is not constant, varying from 20 to 30 grains, supposing the original weight to have been 1000 grains.

Nutrition in an Egg.—The formula of the nutritive properties of eggs as food is:—

Water . . .	75.00
Flesh-formers . . .	12.60
Heat and fat giver, oil or fat	11.00
Equivalents of starch .	26.40
Mineral matters .	1.40
Total carbon .	15.26[1]

Fancy Prices for Poultry.—The prices fixed on the pens at poultry-shows are often fabulous, in many cases, in-

[1] *Physio. at the Farm*, 580.

deed, simply prohibitory. But specimens of game and Cochins have often been sold at £100 each, the highest recorded price being £105 for a game cock. Frequently £10, £20, and £30 are given for fowls, and £50 has more than once been paid for a Bantam cock.

ANIMALS DESTRUCTIVE OF POULTRY.

The Fox.—The common fox, *Vulpes vulgaris*, is the most formidable destroyer of poultry. If undisturbed, he will return to their haunts and carry off one by one, until a large number is abducted. The season in which he is most active in his predatory excursions is summer, when he has his young cubs to support; and he does not confine his roamings to the shades of night, but will boldly enter steadings in the afternoon when the animals are at pasture, and the people at work. Just before the poultry go to roost he pays a visit to the steading, and snatches up a fowl or duck, or even a goose or a turkey, and runs off with it to his earth. The theft is so quietly done that the fowl may not be missed until next morning, unless it happen to be a noted bird. He does not carry off a young bird if he can lay hold of an old one.

The farmer puts up with the loss; for, whatever precaution he may use in spring for the protection of his new-dropped lambs, he would acquire an unenviable reputation amongst sportsmen were he to lie in wait for a fox.

But watching would be useless, for the fox is too knowing to be deceived; and he takes care to keep off a rival from a distance, so that the missing bird is almost certain to have been stolen from the nearest steading. Foxes scent hens and turkeys to their nests in the fields, and carry them off. The remains of birds, chiefly feathers, are often found at the coverts in the neighbourhood. Like the dog which buries his bone, the fox buries his plunder in the earth.

Foxes are not so numerous now as formerly, and the amount of injury which they inflict on poultry-yards is comparatively trifling.

Wild Cats.—Polecats, *Mustela putorius*, visit steadings under night, and if a hole in the door, or a slit in the wall, by which poultry enter, be left open, they will creep in and commit great havoc among the grown-up fowls, sucking the blood and leaving the carcasses. It is only by the negligence of the hen-wife that they can find access into the hen-house. Polecats may be caught by placing a steel trap immediately behind the inside of the hole of the door of a hen-house, covered with a little chaff. One of their fore-feet will spring the trap and feel its grip.

These creatures are now rarely seen.

Weasels.—Weasels, *Mustela vulgaris*, frequent steadings, and do both harm and good. They do good in destroying rats and mice, by sucking their blood. When a weasel takes up its abode in a corn-stack, not a mouse dares remain in it; and if a pole is placed from the stack to an open window of the granary, the weasel finds its way into it, and deters rat or mouse from remaining in it.

But, on the other hand, weasels kill young poultry by sucking their blood: a chicken, a duckling, or a gosling, basking in the sun at the bottom of a wall or hedge, runs a great risk of destruction from weasels. They steal eggs by rolling the egg forwards with the fore-paws to their store. We have found such a store under logs of timber with seventeen hen eggs in it, quite fresh.

Rats.—Rats are the most troublesome vermin in the steading. They make every place they frequent dirty and disgusting. The mischief they do in cutting holes in boarded floors, in undermining stone pavements, gnawing harness, holes in sacks, consuming every edible thing, and killing hens and pigeons sitting on their eggs, is unendurable.

The old black rat of the country, *Mus rattus*, is now nearly extirpated; and the fiercer, dirtier, more mischievous foreign brown rat, *Mus decumanus*, has taken its place. Of the many plans devised for the destruction of the rat, steel traps are the safest and most effectual, and when used with skill occasionally, not constantly, large numbers may be destroyed in a short time. Besides mechanical means, others have also been devised for the destruction of rats. It is said that coal-tar smeared around the mouth of their holes will drive them away. Poison is a favourite expedient for the destruction of this vermin. Rabbit-flesh or a salt herring chopped up with arsenic, carbonate of barytes, or fried cork, are recommended. Special preparations for killing rats and other vermin are sold by many chemists.

Mice.—Mice are very numerous in some countries. Gloger relates that in 1857, on a property near Breslau, in Silesia, 200,000 mice were caught in one week.

There is no way of scaring rats and mice from a steading so effectually as by the presence of *cats*. Let one or two cats be brought up in a steading, if situate at a distance from dwelling-houses, and they will become vigilant guards against vermin. The house-cat frequently visits the steading. When kept in the steading, let each cat receive daily, at its own particular place, and at a stated hour, say 11 o'clock A.M., a mess of sweet milk and porridge, when it will attend to receive it as the hour arrives; and let each have a soft, warm, comfortable bed made for it in some quiet part of the steading. At night, and early in the morning, they will watch and hunt on their respective beats; and in the course of a short time, with free access to every apartment, the vermin will disappear altogether.

Well-fed Cats the best Hunters.—Cats are common about steadings and stables; but they are generally neglected as regards food, in the erroneous belief that, if fed, they become lazy and will not hunt. So far from this being the case, a regularly fed cat makes the best hunter, because it then hunts for sport; and not feeling pressed by hunger, it will watch at the same spot for hours. Being strong from its daily wholesome food, it feels courage to encounter any vermin, and will kill numbers in the course of a day. A starved cat which hunts for food eats the first prey it catches, and, gorging itself, lies down to sleep, in accordance with the habits of the feline race.

The proper use of the cat is to scare away, not devour, vermin; and when obliged by starvation to leave the steading in search of food—it may not find vermin when it is hungry—it will go to the hen-house for an egg, to the hatching-house for a young chicken, or to the dovecot for a young pigeon. It will even go and hunt the fields for game. People who will not take the trouble to feed a cat daily and regularly in the steading, must be troubled with vermin in it, for the cat will not *remain* in it to destroy and scare away vermin when food can be obtained more easily elsewhere.

The Greeks tied bunches of rue under the wings of their fowls, to prevent cats worrying them, as cats have a strong aversion to that herb, while they are very fond of valerian.

Rooks. — Rooks, *Corvus frugilegus*, pry about steadings, when all is quiet in a summer afternoon, for stray eggs that may have been dropped upon litter in the courtyards, or near a watering-pond, and carry them off in their bills.

Carrion - crow.— The carrion - crow, *Corvus corone*, also carries off eggs and young poultry; but its art in effecting destruction is simple compared with the cunning and vigilance of the magpie.

Magpies.—The habits of the magpie, *Pica melanoleuca*, are thus described by Macgillivray: "The food of the magpie consists of testaceous mollusca, slugs, larvæ, worms, young birds, eggs, small quadrupeds, carrion, sometimes grain, and fruits of different kinds, in search of which it frequents the fields, hedges, thickets, and orchards, occasionally visits the farmyard, prowls among the stacks, perches on the house-top, whence it sallies at times, and examines the dunghill and places around. Although it searches for larvæ and worms in the ploughed fields, it never ventures, like the rook and several species of gulls, to follow the plough as it turns over each successive furrow. It has been accused of picking the eyes of lambs and sickly sheep, I think with injustice; but it sometimes carries off a chicken or duckling, and sucks an egg that may have been dropped abroad."

BEE-KEEPING.

The following notes on bee-keeping are from the pen of the late Mr William Raitt, Beecroft, Blairgowrie, who was well known as one of the leading authorities on the subject in the country:—

One of the most evident results of the recent phenomenal depression in agriculture is the greater attention being given to what were at no distant date considered as trifling accessories of the farm. The dairy, the piggery, the poultry-yard, and the orchard have all more or less come to the front, and between them in many cases go far towards making ends meet. Foreign competition loses force in these minor industries, as is proved by the relatively good prices still obtainable for their produce.

Bee-keeping as a Farm Industry.—Besides the industries mentioned, bee-keeping ought to receive more attention as a farm industry than has hitherto been devoted to it. To our certain knowledge it has in not a few instances been cultivated as such with the best results. It is an industry peculiarly adapted for a place on the farm, as is indicated by the ancient and sacred association of "milk and honey." The same pastures yield both—though, alas! the latter is too often left to waste its sweetness on the air.

In America and many Continental countries bee-keeping already occupies a prominent place among rural industries, and is generally most successful when associated with farming. A few regions, like San Diego County in California, the Basswood tracts in other States, and, to a degree, our own heath-clad hills, afford unlimited natural honey-yielding bloom.

Clover for Bees.—But more generally success depends on the neighbourhood of clover-fields. Than these there are no better pastures for bees, as every farmer must perceive when he hears the joyous hum of *other people's* bees rollicking amongst *his* clover heads.

These "small cattle" are so independent of fences, that in a notice we saw not long ago of the sale of an apiary, there was added after the inventory of hives, "with unlimited right of pasturage." But just because these cattle are so small, they are often neglected. One forgets, however, that what they lack in bulk, they compensate for in energy and in strength of numbers, so that the results of their labours are, under proper conditions, out of all proportion to their "stature."

Bees *v.* Shorthorns.—Some years ago the writer was at tea in the company of several farmers, who chaffed him not a little on having a "bee in his bonnet." *Their* talk was of shorthorns. "I'll tell you what it is," said I, "I have a single bee at home that has this year put more money into my purse than the best shorthorn cow you have has done into yours." I of course referred to the queen-bee of one of my hives, the mother of all its inhabitants. It so happened that I had that season taken from that stock no less than 130 lb. of first-class honey, in such splendid condition that I sold it to a dealer, after winning a handsome prize besides, for £10, 16s. That was a clencher!

Produce of Hives.—It is but fair to say, however, that that result was exceptional, though I have several times greatly exceeded it in quantity since. For instance, I had in one season from a single hive 204 lb. of bottled honey of first-class quality, and an almost equal amount from a hive the year before, and all without killing the bees or interfering with their necessary winter stores. These figures indicate the possibilities that lie in bee-keeping—though, taking one season with another, I should estimate the average produce of a well-managed apiary at from 30s. to 40s. per hive.

Commencing.

The times are propitious for commencing this industry.

Improved Practice.—The thirty years up to 1888 were a period of revolution. The old straw skep and brimstone system have been improved away, and the new humane and profitable movable comb system has taken its place.

After many years' experiments with mixed success, the best form of hive and system of management have become pretty well fixed. The era of experiment is past, and everything is getting simplified.

Cheap and Improved Appliances.—Not only so, but while a few years ago the new hives and appliances were rather expensive articles, the tendency has ever been towards simplicity, and consequently everything needed is now very moderate in price. I remember when no hive was considered good for anything under £1 or 30s. Now they can be had for half the amount, and simpler forms for a good deal less—so simple that with one as a pattern any handy man can make his own.

When I first began the manufacture of the indispensable article of comb-foundation in 1876, it was selling at 6s. a pound; now we retail it at under 2s. My first sections cost 8s. per 100; now they are retailed at 20s. per 1000.

Marketing Honey.—Moreover, the chief initial difficulties connected with making a market for honey are overcome. It has become a staple article of trade in the best shops of all our large towns. To be sure the price, like that of all other sweets, has come down in late years; but even yet it has not fallen to the price that used to be considered a fair one for old-fashioned skep honey, and it is not likely to come lower.

Bee Information.—And lastly, information is now more easily attainable than ever it was before. Besides weekly and monthly journals entirely devoted to bees, most agricultural and horticultural weeklies have columns devoted to the industry and to the queries of correspondents. And special handbooks and more elaborate volumes are easily obtained.

Exhibitions illustrative of the whole art and mystery are held annually in connection with the great shows of the three leading agricultural societies in the three kingdoms, and in many parts of the country besides. Then almost everywhere a handy man can be picked up who will be delighted to tell all he knows, and give all the help he can to intending beginners.

Knowledge necessary.—Bee-keeping as much as sheep-farming and other rural employments requires the application of a good deal of acquired information. One may, however, commence practice and the study of principles at the same time—that is, commencing on a small scale, and increasing one's stocks as one's knowledge and ability advance. The limits of our space here forbid anything more than a digest of the knowledge any one may easily acquire more fully from books and experience.

In regard to books, beginners should be careful to get only the latest editions of the latest published works. 'Modern Bee-keeping' (6d.), published by Longmans & Co., is a good and reliable guide, to be followed by some larger work not more than a year or two old. The beginners should on no account allow themselves to become enraptured over any particular form of hive recommended by the maker. Study the latest information obtained from a disinterested quarter, and then judge for yourself what would best suit the object you have in view in the way of system and appliances.

After having thus formed a decided plan of operations, there need be no objections to reading any good works on bees, with a view to obtaining more scientific knowledge than most handy manuals can afford to give. Much also may be at the same time learned, and more especially in the art of handling bees, by a visit to some successful bee-keeper.

Principles of Bee-keeping Knowledge.—As some guide towards judging as to the suitableness of any reading that may be undertaken, we give the following condensed summary of what we consider ought to be learnt from it. That modern bee-keeping is an art founded on strict scientific principles; that it can be depended upon, weather alone permitting, for yielding certain fixed results, as surely as can any other industry about a farm; and that to enable one to use his scientific knowledge to advantage, hives must be adopted that give every facility for controlling all the operations of the bees, and for assisting them by the use of comb-foundations and other modern aids.

Hives.—Such hives are variously called bar-frame or movable comb-hives, and the tendency is towards great simplicity in these. The books and dealers' lists may, with great plausibility, recommend costly hives with elaborate fittings and adjuncts; but for profit and convenience none excel those that consist of simple box bodies fitted with plain frames with roof and floorboard. To allow of tiering up, with a view to the production of either comb or extracted honey, the bodies should all be exactly alike, and so fitted as to sit accurately one over another. That is, one may have any number of bodies or storeys in use as a hive or stock, though with only one roof and floorboard. Hives with fixed legs should specially be avoided, any plain stand being substituted.

Appliances for Special Conditions.—The student ought also to learn that in certain localities and under certain circumstances, it may be better to adopt appliances specially with a view to producing comb-honey, this especially where heather is plentiful; or that it may be better to work for extracted honey, as may be in most demand; or to work for both—say for clover-honey to be extracted, and for heather-honey in the comb.

Study Surroundings.—At the same time he ought to have his observing powers at work, more especially noticing the favoured bee-flowers peculiar to his neighbourhood, and their period of bloom. This knowledge will greatly aid him in forming his plan, for one of the great secrets of success is in having one's stocks in the very best condition, just when the prevailing honey-flow comes on, and not either still weak from spring neglect, or what is almost as bad, weakened by swarming after having been strong. The peculiarities of his location as to climate and exposure, also merit attention. And as a result of all, he must make up his mind whether he can afford to give his bees the necessary time and attention, and in what particular direction he shall go to work.

Caution in Practice

Obtaining Stocks.—Should such preliminaries chance to occupy him during the winter or early spring months, he may at once look out for the needful stocks. If these are already on hand, even though domiciled in ancient straw-skeps, so much the better; otherwise he may easily obtain by purchase one or more such. These are usually to be had so much cheaper than stocks in modern hives, and the experience gained in the course of working them into the new system is so valuable, all the more so because it compels him to "go slowly," that on the whole we generally advise beginners to commence with such.

By exceptional diligence in gathering information, and with that knack of managing live stock that many have as a peculiar gift, it might be safe enough to embark boldly in a wholesale fashion at first, but generally we recommend caution.

"Bee-fever."—Few become really successful bee-keepers until they have at least one whole year's experience, and it is better to try and control the "bee-fever," than to let it run riot, to the imminent danger of collapse and misfortune.

Appliances.

The needful appliances are by no means so numerous or costly as some of the many large and finely illustrated price-lists now issued by dealers may suggest.

To begin with, at any rate, one's wants may be sufficiently met by the possession of a hat-veil, a smoker, a supply of hives, with the necessary frames, crates, and sections, and a stock of comb-foundations.

Hat-veil.—The veil is simply a yard and a half of black hexagon net, sewed up one seam with an elastic band, to go round a broad-brimmed hat, the lower edge to be tucked away inside the vest.

Smoker.—The smoker is a bellows contrivance for burning rags, brown paper, or touchwood in such a way as to permit of directing a stream of smoke upon the bees when they are to be handled. A loosely tied roll of rag (corduroy or moleskin is best) may serve a turn instead, or the fumes of tobacco may be utilised by those who can use the pipe. This frightens and quiets the bees.

Hives.—The hives, as we already

hinted, should be of simple construction, each body made to hold not more than eleven frames.

The frames should be of the standard size used in the neighbourhood, hung in the hives, so that ten of them occupy a space of 14½ inches, that being also the dimension of the hive the other way. We prefer eleven frames, so that our hives inside measure 14½ × 16 inches, and are deep enough to hold the frames suspended, with the necessary bee-space below and around.

This size of hive is just about right for permitting ordinary-sized crates of sections to be piled up inside the upper storeys.

Sections.—Sections are those neat dovetailed boxes to hold one or two pounds of honeycomb, and are generally imported from America, and sold by dealers very cheaply.

Crates.—Crates are the bottomless boxes or trays in which the sections are arranged in groups of 21 or less, according to their size.

Comb-foundations.—Comb-foundations are sheets of bee's-wax impressed with the exact form of the cells as made by the bees. These are turned out by special machinery, and are a great help both in supplying the bees with material of which to build combs, and in compelling them to build them straight in the frames or sections where wanted, at the same time putting it in the power of the bee-keeper to limit the production of useless drones.

Other Appliances. — A few other minor appliances might be found useful, though not absolutely necessary, such as a queen cage or two, some queen-excluding zinc, bottle-feeders, and a honey-knife. The cast carpets or blankets about the house will supply all the quilts needed for a commencement.

Honey Extractor.—The question of having the rather expensive machine for emptying combs without breaking them —called the honey extractor—may be deferred till experience warrants the expense.

Management—Preliminary.

Driving Bees.—The first concern of those commencing should be, as soon as may be best, to get their bees domiciled in the new frame-hives. It is quite easy for experts to transfer both bees and combs from the one to the other at almost any season. The bees are "driven" into an empty skep, according to directions in the book referred to; the combs are then cut out, and pieced and tied into the new frames; these, with the bees, are then placed in the new hive, when they soon fix all nicely up.

But we advise rather to await the natural swarming season, when either swarms may be allowed to come off or the plan afterwards described adopted.

New Swarms.—If natural swarms be got, they should be treated thus: the first that comes off should be placed in the new hive on the stool where the skep stood, the latter being removed to a new location. This causes many more bees, accustomed to the old place, to join the swarm and strengthen it. The likelihood is that the skep will not swarm again. Should it do so, the swarm should be returned, and more ventilation given, as a preventive, till the 21st day from first swarming, when all brood will have been hatched out.

A second good bar-frame stock can now be had by driving all the bees and transferring any combs found straight and sweet. On no account would we advise more than two stocks to be made from one.

Another Plan.—The other plan is to set the skep when crowded with bees on top of a new hive fitted with comb-foundation, compelling the bees to work downwards through a 6-inch hole in the quilt, by closing their old entrance. If it be done at the right time, the bees will generally have some combs worked out below within a week, when an examination should be made of these to see whether the queen has gone below. The presence of eggs in the cells may generally be accepted as proof sufficient, but we should prefer in all cases to see her majesty. This being so, the skep may be lifted off and set in a new location, to be afterwards treated as if it had swarmed naturally, as before described.

Rapid Increase of Stocks.—To those anxious to increase their stocks as much as possible, it is a good plan to rear or purchase spare queens, so as to be able to introduce one into each skep as soon as it has been removed from its old place and queen. In that case the same process of stocking new hives may be carried out at the rate of one every fortnight or three weeks during the honey season.

In backward and ungenial seasons less must be expected, and, indeed, it is common to leave the skep in place on the first hive until all its brood is hatched out, when it is taken and treated as a honey super.

Purchasing Swarms.—Some may prefer, or have no alternative but to make a start by purchasing swarms wherewith to stock the new hives. These should be secured as early as possible, say by the first week of June in the south of Scotland, and a fortnight later in the north. They ought to weigh not less than 4 lb., an ordinary top skep swarm, though 6 or 7 lb. are usually had in a swarm from a good frame stock.

Collecting Driven Bees.—Still others may adopt the more economical though more troublesome plan of gathering up driven bees in the autumn, and by joining these into large colonies, and feeding rapidly with bottle syrup, get them into good shape before winter. Any one having learned the art of "driving," and having the soft side of cottagers who are going to brimstone their bees, may generally have them for the trouble of driving, though in most localities the cottagers are getting too knowing to give away what they may as well learn to use to their own benefit.

In whatever way obtained, let us suppose the reader to have in the autumn several good stocks of bees in modern hives. We would now indicate in the order of the seasons the system and treatment we consider best for him to adopt.

Wintering.

Secret of Success.—The great secret of successful wintering is in keeping the bees in as quiet a state and as constant a temperature as possible. Of course abundant supplies are the first consideration to this end, the next is careful packing and ventilation, and the third is to let them rest free from the least disturbance till the first of spring.

Preparing for Winter.—A warm day late in November is our chosen time for arranging hives for the winter. If made very comfortable long before this, the bees incline to fly too much and to dwindle. But left just as they were after the honey harvest, they have free ventilation and plenty of room, never get too warm, and stay more at home. As steady cold weather approaches we need not be so afraid, and so we choose such a day as mentioned to make all trim and comfortable.

Armed with smoker or other quieting agent, a bag of chaff, a quantity of extra pieces of carpet or other quilt materials, and some flat cakes of "bee candy," we set to work. Hives still containing bees on every comb, or nearly so, we do not disturb further than to lay a cake on top of frames, cover closely with several thicknesses of quilt, and over all, if the make of the hive permits, pour a few inches of loose chaff, or stuff in a chaff cushion. The doorway is left full width, or at any rate not under six inches long.

The candy is given not solely to increase the supply of food, but because it supports the coverings, so that when eaten away there is a nice warm cavity left that forms the best kind of winter passage from one frame space to another.

Weak Hives.—Weaker hives, containing bees on six frames only, or under, are contracted by removing all the outside beeless combs, inserting division-boards next the remaining combs, and filling the spaces with chaff. Otherwise they are treated as before.

Very small stocks are united two and two, though this should have been done in autumn.

For the rest, no further attention is required till spring, unless one chooses to keep the snow well cleared away from the ground in front, and to watch on sunny days when the snow is soft, keeping the bees at home by heaping soft snow over the entrances. This shades and cools the hive, and affords the necessary water to the bees that are trying to get out to find it.

Bees not shut in.—On no account should bees be actually shut in, as they often get into such a state as to suffocate. Only *tempt* them to stay at home when it is dangerous for them to be out.

Experiments.—Quite probably the experiments we are conducting in the line of cellar-wintering, or by burying the hives in pits or clamps, may result in an improved system in that direction, which is so much in favour in America.

Spring Treatment.

Provided all goes well in wintering, there is really no necessity for disturbing the bees during early spring.

Breeding resumed.—They naturally recommence breeding about the New Year, and their stores thereafter more rapidly diminish; but they ought to have sufficient left them in autumn to carry them through till the first new honey is to be got, or till gooseberry and fruit-trees are in bloom.

Supplementing the Winter Food.—Wherever there is any doubt as to the supply of food, it is our custom to take a peep into all stocks on the first fine day when bees are flying. We are loath to disturb the winter packing, which is of most value when the bees are breeding with diminished numbers in spring. We therefore simply raise the packing and quilts along the back edge of the combs, when it is possible to see whether there remains still a quantity of sealed comb in at least the most of the frames. If so, all is well so far as food is concerned, and it is too soon to inquire into other matters.

Where there is an evident deficiency in food, there must be a more thorough examination, and any want supplied, either by giving back any combs of honey reserved for this purpose, or by laying a cake of candy under the quilt.

Liquid Food.—Liquid food should not be given unless in desperate cases, when it may be poured into empty combs and hung in the hive.

Stimulating Stocks.—Later on, say when willows are in bloom, it will be of advantage to contract the brood-nest by removing all beeless combs and closing in the division boards, though many think it better to leave them alone. All depends on whether the district is one for very early honey, making it necessary to stimulate the bees by every means, so as to come to full strength before the honey season opens. With us the clover is the main harvest, commencing on an average about the 15th June, and our average stocks usually come to swarming strength by that time without any special stimulation, and thus the energies of the queen are conserved for keeping up the population till the close of the harvest.

Stocks stimulated to undue exertions early in the season are more apt to swarm excessively, and thus to imperil the honey returns.

Continuous Treatment.—As the bee-keeper's summer may be considered as commencing with the swarming season, or say from June 1st, we may add that whatever style of treatment may be adopted, in view of getting hives filled with bees and brood, should be continued without intermission till that period arrives. That is, care must be taken to see that once the bees have got started in earnest to brood-rearing there should be suffered no check from want of food or room. Both should be given in moderation, yet continuously; when plenty of natural stores are coming in, leave well alone, but supplement these either by bottle-feeding whenever the weather is unsuitable for outdoor work, or by uncapping portions of their sealed stores every day or two.

Pea-meal may be given as an equivalent or supplement to natural pollen when that is deficient, the meal being sprinkled on shavings in an old skep set to face the sun in a sheltered corner. Room need only be given where combs have previously been removed, by adding one at a time in the centre of the brood-nest, as the bees are able to cover all closely. So soon as the hive is full of bees from side to side, with brood in every frame, the summer treatment should begin.

Summer Treatment.

It should previously be matter for consideration and decision whether the various stocks are to be worked for (1) increase, or (2) honey.

Working for Honey.—If the latter, it has to be decided whether it is for extracted or comb honey. Every preparation should be made accordingly. New hives, ready fitted to receive swarms, should be prepared beforehand, upper storeys filled with spare combs or foundation for extracting purposes, and crates ready fitted with guided sections for comb honey.

Working for Increase of Stocks.—If increase be wanted, some such plan should be followed as indicated on preliminary management.

Extracted or Comb Honey.—As to whether one should follow after getting extracted or comb honey, each must discover for himself which is likely to be more saleable in his district. Generally, however, we may indicate our opinion that extracted honey is likely to be more in demand than comb. They are rapidly approaching each other in price, the former being obtained with more ease and certainty, and in perhaps a third greater quantity. It is in demand all the year round, while comb unfortunately has its "season."

The Writer's Practice.—Our own practice, adopted after many years' experience, is as follows: We work for honey, but allow a moderate natural increase, partly to ensure our having old queens replaced by young ones, partly to keep up our stock, so as to permit of doubling up weak colonies, and partly to allow the bees a little of their own way, which seems to keep them in better heart for work. That is, we do all we can towards getting honey, and in doing so to *prevent* swarming; but as occasional swarms will come off in spite of us, we do not try to thwart the bees by returning these, but make the best of them, by giving them a good start on combs ready built, or on combs of brood and foundation.

If second swarms issue, we cut out all royal cells and return the swarm.

By placing first swarms on the old stool, they are made stronger by the old bees returning to their accustomed place, and the removed stock is so weakened that it does not often swarm a second time. Sometimes we break up the latter, giving nearly all the bees to the new swarm, and dividing the combs of brood amongst those not yet at full strength. Of course we cut out royal cells, in case they may tempt the other stocks to swarm.

Controlling Swarming.—To prevent swarming, or at least reduce it to the lowest as a natural impulse, we find it generally enough to see that the bees have plenty of doorway and plenty of room for storage and for clustering inside.

This room we give them by tiering on upper storeys of combs for extracting, or of crates of sections, and this as long as the honey season seems to warrant. That is, from experience we know about what date the honey-flow, say from clover, usually ceases, and we take care not to give more accommodation than is likely to be made use of.

This is important when finished comb honey is wanted, though of little consequence if extracted honey is the object. The latter can be taken at the close of the season, whether in full-finished combs or not.

Securing well-ripened Honey.—To get either extracted or comb honey well ripened and sealed, we require at least two upper storeys or two crates of sections to each hive. As soon as the first put on is well forward, and the bees need more room, we raise it, placing the empty one between. If the latter have foundation only, the bees are compelled to store all their honey for a day or more in the upper storey, which generally ensures its being well finished.

Produce.—Towards the close of the season we place the empty tier uppermost, as the other has more chance of being finished off when left next the brood-nest. By careful calculation, and with favourable weather, we thus get from good stocks from 50 lb. to 100 lb., and often more, of nice comb honey each, and from others 150 lb. to 200 lb of extracted honey.

For details of how to manipulate the bees and combs when harvesting the honey, or of using the extractor, and preparing the honey for show or market, and for other minute matters, the reader must seek in books and journals specially dealing with bees.

Autumn Management.

In many districts the autumn treatment includes part of the honey harvest—viz., the heather.

Heather Honey.—Usually a week or ten days intervene between the close of the clover season and the time that heather yields. Where this most magnificent of all honeys is to be had, special pains must be taken to secure it.

The secret is, barring the weather, to have only strong stocks, and to make them warmer by soft coverings than during the earlier season. Where swarming has been allowed *ad libitum*, neither swarms nor old stocks are fit to do much in the way of surplus. Stocks previously worked for extracting are best of all. They have always more bees left than those which have been worked for comb.

There should be some change in the plan of working these — that is, comb honey only should be sought from heather. Heather honey will not leave the combs in the extractor, but has to be broken up and pressed; nor does it sell so well as in the comb.

There should be no more room given than the bees can crowd comfortably into, as the nights are chilly, causing them sometimes to desert the supers.

After Honey Harvest.—The general autumn treatment for stocks after the honey harvest consists mainly in doing all one can to keep the bees quiet, and so prevent robbing.

Bees Plundering. — Not a drop of honey or bit of comb should be left anywhere within their reach, for if once started, the bees get on at once for plunder; and so vicious do they then become, that the apiary is a place to be dreaded by man and beast. As soon as all surplus honey is taken, and that under every precaution, all hives should be closely though not warmly covered, doorways contracted a little, and left alone till early winter.

Necessary operations should be done towards evening, when flying bees have all gone home. If food be needed, either as a result of a poor season, or of the honey having nearly all been stored in supers, it should be given rapidly as soon as the supers are taken away, and before the time of dearth and robbery has come.

Queenless stocks should be attended to, weak hives united till strong, and all left to settle till the time for winter treatment arrives.

Food for Bees.

Liquid Food for Bees.—Boil together 5 lb. white sugar and 1 quart of water; a few minutes' boiling will suffice. It is improved by boiling with it a pinch of cream of tartar. This is the proper food for autumn. Spring food may have a half more water, and the tartar omitted.

Sugar-cake for Bees in Winter.—Boil together 5 lb. white sugar, less than a pint of water, and a pinch of cream of tartar, until a drop cooled on a plate stiffens so as to draw out as a thread. Take off the fire and set in a cool place, or in cold water, stirring briskly until the mass begins to cool and turn white and thick. Then pour out on thin sheets of paper laid in flat dinner-plates. When cold, the cakes should be white and firm, yet not hard.

Spring Food.—For early spring food, a handful of flour for each pound of sugar may be stirred in shortly before pouring out. These cakes should be slipped under the quilts, paper side up.

ROTATION OF CROPS.

Necessity is the mother of invention. "Rotation" in cropping was first introduced because it was found the land would no longer yield a profitable return of the same kind of crop.

Virgin Soils. — Thus in countries newly settled the virgin land is cropped continually with cereals until it will no longer give a profitable return. It is then abandoned, lies in absolute neglect for a number of years, regains in this period of rest some of its lost fertility, and is again made to yield profitable crops, this time under a more liberal and enlightened system of farming. We have here the crudest and most elementary form of "rotation"—a period of continuous cropping followed by a period of enforced idleness.

Object of Rotation.—The rotation of crops is an economical, not an absolute or scientific, necessity. With the knowledge of plant physiology, of the habits of different forms of plant-growth, and of the manuring of land now at the command of the farmer, it cannot be said to be an absolute impossibility to grow good crops of the same kind on the same land year after year. This indeed is carried out in practice in certain cases—as, for instance, where the land is under permanent pasture and meadow-hay, and on the experimental ground at Rothamsted, where continuous crops of wheat and barley have long been grown with success.

But the practical farmer desires, not to produce a certain result at whatever cost it may entail, but to raise crops which will leave him a profit. The growing of crops in rotation is one of the most effectual and universal agencies employed for this purpose. It affords facilities for clearing the land of weeds, enables the farmer to husband and turn to better account the fertility in the soil, and thus economises and cheapens the entire production of the farm.

By growing crops in well-arranged rotation, instead of having each crop grown continuously on the same land, the farmer can not only greatly increase the production but also materially lessen the outlay for manures, at the same time maintaining, if not indeed raising, the fertility of the soil.

Thus, therefore, rotation of crops is a fundamental principle in successful agriculture.

"Reasons" for Rotation.—The conditions which render it desirable to grow crops in rotation instead of continuously are,—(1) that while all plants tend to exhaust the soil, they do so in different degrees; (2) that all plants do not abstract the same kind of ingredients or in equal proportions; (3) that the habits of growth differ greatly in plants, some searching for their food down into the subsoil, and others feeding in the surface layers—some occupying the ground for a short time and others for a long; (4) that the "crop residues" of crops differ materially; and (5), that the various kinds of plants differently affect the growth of weeds and the presence of insects.

In accordance with these conditions, the systems of rotations pursued have been arranged, modified, of course, by local circumstances as to climate, soil, and outlet or demand for the produce.

Ingredients Removed by Different Crops.—In the chapter on "Fertility of Soils," Divisional vol. i. p. 56, much information bearing on the rotation of crops has already been given. The table on page 63 states the amounts of the different elements of plant-food removed by the various farm crops. Here we at once see the importance of alternating the crops. The turnip crop, for instance, removes from three to five times as much potash, and from seven to eight times as much lime, as the cereal crops, while these latter absorb ten or twelve times as much silica as turnips. By alternating these crops, therefore, the exhaustion of the soil is deferred, and its natural resources turned to better account.

And there is more to be considered than the actual quantities of plant-food removed from the soil. It is well known that the fertility of the soil is much affected by the characteristics and habits of growth of the different crops.

Range of Roots.—Some of the farm crops have long roots which penetrate deeply into the subsoil, and others have shorter roots which ramify nearer the surface. The former, such as red clover, lucerne, mangel, and wheat, draw from the subsoil nourishment which would there be beyond the reach of such shallow-rooted plants as barley, turnips, potatoes, and white clover. And thus, by alternating deeply rooted and shallow-rooted crops, the subsoil and surface soil are made to contribute in turn to the produce of the farm, thus giving a greater yield than would be derived from the continuous growth of plants with the same range of roots.

Grass and Soil Nitrogen.—Practical farmers know well that when land lies for three or four years under grass and clover, it becomes enriched with ash constituents and nitrogen, and suitably prepared for cereal crops. The deep searching roots of the grasses and clovers draw from the subsoil ash constituents, which, if consumed by animals, are returned to the surface of the land in the dung. Then in the surface soil nitrogen is collected both from the subsoil and the atmosphere, and is held there chiefly in the form of vegetable matter and humus, from which the succeeding cereal crops will derive appropriate food.

Moreover, grass land not only gathers increased supplies of nitrogen to the surface soil, but also conserves its nitrogen better than does bare land, for it is now well established that the loss of nitrates in drainage is reduced to a minimum when the land is covered by vegetation.

Humus.—By being kept under grass for a time land becomes enriched in humus, an element of great value in soils. It consists of decayed vegetable matter, and "acts effectually as a cement in sandy soils, holding the particles together. Humus is the principal nitrogenous ingredient of soils. A black soil, rich in humus, is sure to be also rich in nitrogen; a soil destitute of humus will contain scarcely any nitrogen. The fertility of virgin soils is largely due to the nitrogenous humus which they contain." [1]

Thus, it is easily understood how land becomes enriched for cereal crops by lying for a time in grass, and why it is easier to maintain fertility with a rotation embracing three or four years' grass than with grass for one or two years.

Leguminous Crops and Soil Nitrogen.—It has been proved conclusively that leguminous crops possess in a remarkable degree the valuable property of being able to accumulate nitrogen in the surface soil. They not only draw nitrogen from the subsoil, but also to an exceptional, though still uncertain extent, from the atmosphere. "Red clover," says Mr Warington, "is a striking instance of this action. Its roots extend further perhaps than those of any other farm crop, save lucerne and sainfoin, and being biennial it has a long period of growth. The accumulation of nitrogen at the surface, in the form of roots, stubble, and decayed vegetable matter, is in the case of a good crop of clover so considerable, that the whole of the above-ground growth may be removed as hay, and the land yet remain greatly enriched with nitrogen, and in an excellent condition for producing a crop of wheat." Again: "If crops of winter beans and winter wheat are grown on similar unmanured land, the bean crop will generally contain twice as much nitrogen as wheat. The land is not, however, impoverished for wheat by the growth of beans, for wheat after beans will be a far better crop than wheat after wheat, thus affording a striking example of the advantages of a rotation." [2]

Period of Growth.—The period of growth and the season of the year during which the crop occupies the ground also have a bearing upon soil fertility and the most economical rotation. It will be seen from the table on page 63, Divisional vol. i., that wheat requires much less nitrogen than turnips, and yet it is well known in practice that the liberal application of nitrogenous manure is much more essential for wheat than for turnips. This arises from the difference in the periods and seasons of the growth of the two crops.

We have seen that nitrification, the production of nitrates in the soil, is most active during summer and autumn, that it becomes greatly diminished or ceases altogether during winter and spring, and that the loss of nitrates by washing away in drain-water is greatest in autumn and winter. Thus the cereal crops grow and occupy the ground just at the time when the soil is comparatively deficient of nitrates. "The autumn and winter rains have frequently washed out the greater part of the nitrates contained in the soil before the growth of the cereal crop commences, and nitrification in the soil has not long recommenced its activity in the summer months when the crop becomes too mature to appropriate fresh supplies of nitrogen. Continuous wheat cropping thus results in a gradual impoverishment of soil nitrogen by winter drainage, over and above the nitrogen actually removed in crops, and thus necessitates a considerable application of nitrogenous manure if fertility is to be maintained.

"A root crop sown early in summer, on the other hand, has at its disposal all the nitrates that would be available for wheat or barley, and in addition, the large supply of nitrates formed in the soil during summer and early autumn. A great part of the nitrates which would be lost by drainage during cereal cultivation is thus assimilated and retained by a root crop, and such crops are found to stand in less need of nitrogenous manure

[1] *Chem. of the Farm*, 17.

[2] *Ibid.*, 60 and 63.

than cereals. By consuming the roots on the land the nitrates collected by the crop are returned to the soil in the form of animal manure, and the land thus prepared to carry a cereal crop. Similar remarks might be made respecting other green crops whose active growth extends into the autumn." [1]

We thus again see additional reason for the alternation of grain and root crops.

Accumulation of Nitrogen. — We have seen that grass and leguminous crops tend to enrich the surface soil in nitrogen. A portion of this increased nitrogen may be drawn from the subsoil, and another portion received from the rain which falls on the ground. A third source is the free ammonia of the atmosphere, but to what extent the soil and the plants growing upon it are able to absorb nitrogen from that source is still a matter of uncertainty. Mr Warington states the amount of nitrogen supplied by the rainfall at "say 4 or 5 lb. per acre," and as to the probable amount directly absorbed from the atmosphere he says: "In the four-course manured rotation upon the heavy land at Rothamsted, the nitrogen annually removed in the crops, on an average of thirty-six years, has exceeded by 34 lb. the quantity supplied in the manure. If the crops on this experimental rotation should be permanently maintained in quantity, of which at present we cannot be certain, we must conclude that these 34 lb. of nitrogen, together with the unknown additional quantity lost as nitrate by drainage, have been annually derived from the atmosphere — partly as rain, but mostly by direct absorption by soil or crop. It appears possible, therefore, that the amount of nitrogen contributed by the atmosphere in the course of a rotation may be much more considerable than is usually supposed, but the subject is at present very obscure." [2]

It would seem that leguminous plants, by means of excrescences on their roots, possess in an especial degree the power to appropriate nitrogen from the atmosphere, and thus leave the soil richer in nitrogen than it was before.

[1] *Chem. of the Farm*, 61.
[2] *Ibid.*, 66.

Loss and Conservation of Nitrogen.—It has been seen that the loss of nitrates in drainage water is greatest when the soil is bare of vegetation in the autumn and early winter. Thus by growing only short-lived crops such as cereals the land would be subject to great deterioration in these seasons. On the other hand, by growing crops such as grass and roots, which occupy the land during the entire year, or on through the summer, autumn, and greater part of winter, the nitrogen of the soil is conserved and kept in the surface soil ready for the crops of the succeeding year.

As a special means of conserving soil-nitrogen and preventing waste in drainage, it is a good plan to sow mustard, rape, rye, or turnips broadcast on the stubbles just after the grain crop has been removed. This green crop will grow up rapidly, and will hold in its roots, stems, and leaves much of the nitrogen that might otherwise have been washed away through the drains. The green crop may be fed off by sheep or ploughed in late in winter or early in spring.

Weeds.—The cleaning of the land and keeping it free from weeds are important considerations in arranging the scheme of cropping. Some crops encourage the growth of weeds more than others, and it is only with certain crops that the land can be submitted to a thorough cleaning. With cereals and grasses it is very difficult, indeed almost impossible, to keep down weeds. The root crops, on the other hand, afford excellent opportunities for the thorough cleaning of the land as well as for its perfect tillage.

In this respect the root crop takes the place of the once esteemed but now discounted bare fallow, and apart from its value in itself the root crop fulfils a highly important function in the prevailing systems of rotation. It not only affords admirable facilities for the thorough cleaning and tilling of the soil, but also supplies a convenient opportunity for introducing farmyard dung and other manure to the soil.

"Crop Sickness." — An important consideration in the rotation of crops is the fact that when certain crops are grown continuously or too frequently on the same field the soil is liable to become what is popularly known as "sick" of that particular crop. Thus there is the very stubborn ailment known as "clover sickness," due, it is believed, to some insects, the presence of which is favoured by the too frequent growing of clover on that particular spot. With turnips there has been similar experience. When grown too frequently on the same land, the risk of loss from "anbury" and "finger-and-toe" would seem to become greater, and to avoid this rotations have been lengthened, by letting the land lie a year or two longer in grass, or by some other variation.

Rotation and Live Stock.—A judicious alternation of crops is as advantageous to stock-rearing as it is to the soil itself. It provides, for one thing, a greater variety of palatable and nourishing food. It also has a freshening or purifying influence on the soil, which conduces to the wellbeing of live stock.

When turnips are grown very frequently on the same land, and consumed thereon by sheep, it would appear that the land is liable to become foul or "stained," so that the sheep folded on it do not thrive properly, becoming subject to stomach and bowel derangement, often even resulting in death, unless an immediate change of food and situation is provided for them. By being put through a course of cropping, and allowed to lie in grass for two or three years, this land, which would seem to have become tired of sheep, is found to be almost as fresh and as suitable for them as ever.

Local Circumstances.—In the foregoing notes we have indicated the chief considerations which regulate rotation in the abstract. In practice it is found advisable to modify the rotation in accordance with soil, climate, and outlet for the produce. Every farmer should proceed upon some well-thought-out plan of cropping, for it is only in this way, assuredly not by any haphazard system, that he will make the most of his land. Yet the intelligent farmer should not be bound, or bind himself, to follow slavishly any particular method of rotation, irrespective of variation in seasons or prices of different commodities. Subject to certain well-understood conditions, essential to ensure that the farm is worked in accordance with the rules of good husbandry, the intelligent farmer should be allowed ample scope to vary the rotation with times and seasons.

Soil and Rotation.—In adapting the rotation to the character of the soil, the farmer has an excellent opportunity for the exercise of good judgement and experience. It is well known that systems of rotation admirably suited for light or medium soils might speedily ruin a farmer on heavy land. Peaty soil, again, requires different treatment from chalky soil.

Generally speaking, the crops which preponderate on clayey soils are wheat, beans, and grass—with a growing tendency for less tillage and more grazing; for loamy soils, oats, turnips, potatoes, barley, and grass seeds.

Climate and Rotation.—The prevailing climate must, to a large extent, influence the system of cropping. Thus, in the eastern counties of Great Britain, we have corn-growing alternating with root-culture and clover; while in the western districts, with their wet mild climate, we find a preponderance of the pastoral and dairying elements, for which a greater variety and extent of green crops are grown, with just enough corn, oats chiefly, to keep the fields in rotation—two-thirds of the farm perhaps being sown out in permanent pasture.

Rotation and Outlet for Produce.—It goes almost without saying that the prudent farmer will grow the crop which he can sell to best advantage. The situation of the farm with regard to market or outlet for the produce is therefore an important element in deciding as to the course of cropping.

Rotation and Labour.—The question of labour must likewise be considered by the farmer in arranging his course of cropping from time to time. When labour is scarce and dear, it will at once be seen that the best course for the farmer to adopt is to grow crops which require the least amount of labour. To effect this, the extent of root cultivation will most likely be curtailed, and a larger area devoted to grazing purposes.

In such circumstances, a system of mixed rotation might be most suitable

—such, for instance, as taking two white crops in succession on the cleanest of the land when broken out of lea which may have lain for three or four years. This would give plenty of fodder for cattle, and the supply of turnips may be "drawn out" by the economical use of artificial foods. Another method would be to reduce the stock of cattle and increase that of sheep. The latter can be fed with fewer turnips than cattle. With a very small allowance of roots and a well-balanced ration of chaffed hay and corn and cake, sheep will thrive admirably, and also contribute to the fertility of the soil.

Grass and Rotation.—The suitability of the soil to carry pasture grasses is another element of importance in the matter of rotation. In some soils the pasture deteriorates so rapidly after the second year as to be practically worthless, while on other soils it maintains a thick luxuriant growth for three, four, or more years. Thus in the former case the land must be sooner returned to the domain of the plough than is necessary with the latter soil.

Having thus reviewed in detail the chief considerations which should influence the farmer in deciding as to the course of cropping to be pursued, we may follow up with a few typical rotations pursued in different parts of the country.

Sample Rotations.

Old Three-field Rotation.—Following the elementary system of new countries—a period of continuous cropping followed by a time of enforced rest—came the three-field method of cropping, which is still practised in many parts of Germany. It consists of fallow, followed by wheat, oats, or barley, two-thirds of the land being under cereals, and one-third in fallow.

In the early development of agriculture, when money was scarce and most of the payments were made in kind, this system would allow men whose hands were perhaps better acquainted with the sword than with the plough to settle down and begin the life of a tiller of the soil with little outlay, followed by a large income. Two-thirds of the land would be always under grain, which in those days would amply repay the cost of cultivation.

Infield and Outfield.—In most parts of this country the arable land was at one time roughly divided into "infield" and "outfield" land. The former consisted of the land within easy reach of the farm-steading, and the extent in this division was regulated chiefly by the quantity of dung made on the holding.

This "infield" land was usually cropped thus:—

1. Wheat or barley.
2. Oats or barley.
3. Beans or peas.

All the dung made on the farm was applied to this division, and when the quantity of dung was insufficient, or the land became very dirty, it was bare-fallowed in small sections.

The "outfield" land was cropped on a "starvation" system. It was cropped with oats two or three years in succession, and then left for two or three more years under such grass as might grow up naturally; no grass seeds being then sown. A certain portion of this "outfield" land was always under corn, and the dung resulting from the crops grown on the "outfield" shifts was applied to the "infield" land, so that the latter was sustained at the expense of the former.

Modern Three-years' Course.—The introduction of turnip culture and the use of artificial manures made it possible for the farmer to adopt new methods of cropping much superior to the primitive systems of earlier times. The earliest rotation of turnips was the three-years' course:—

1. Wheat, barley, or oats.
2. Clover.
3. Potatoes, turnips, cabbages, &c.

Wheat prevailed on the good land, and barley and oats on the poorer soils. It was soon found that this rotation was too short. There was too much of the holding under root crops, and these and the clover were coming upon the same land too frequently. In some cases the clover was omitted, and oats or barley followed the root crop. This was also objectionable—too exhausting for most soils.

Norfolk Four-course.—Next came the famous Norfolk four-course rotation, thus:—

1. Wheat.
2. Turnips and potatoes.
3. Barley or oats.
4. Clover and grass.

In most parts of Scotland the first crop is oats instead of wheat.

This system raises a great quantity of straw and roots, and is with slight modifications practised very largely throughout the country. Indeed it may be taken as the basis of most other rotations.

In this as in the three-years' system it has been found that in most soils the recurrence of clover and turnip crops on the same soil is too frequent, encouraging "clover sickness," "finger-and-toe," and "anbury." To avert these dangers, the four-course system may either be followed with catch-crop variations or extended into a longer course.

Variations of the Four-course.—The most common method of varying the cropping under this system, without departing from its leading principles, is to alternate swedes, mangels, potatoes, cabbages, kohl-rabi, &c., on the root break, so that turnips may be grown on exactly the same spot only once in every eight or twelve years, instead of once in every four years. Then the recurrence of clover may be similarly delayed by substituting beans, peas, vetches, &c. In some cases wheat and barley are taken in succession, followed by clover for two years, cut the first year and grazed the second, or with (instead of clover) swedes, after an early crop of Italian rye-grass, followed next year by mangels or cabbage. In other cases wheat is followed by winter beans, succeeded by a catch crop of rape and turnips, the third crop being wheat followed by a catch crop of vetches and winter oats, swedes completing the course. On other farms, or on part of the same holdings, peas take the place of beans, barley that of wheat in the third year, and mangels that of turnips.

It is, of course, only in southern counties that these catch crops can be grown to advantage.

Five-years' Course. — The most effective means of averting the evils of the four-course system is to extend the rotation by introducing two or more years' lea. The five-years' course, so extensively pursued in Scotland and other parts of the country, is as follows :—

1. Wheat or oats.
2. Turnips and potatoes.
3. Barley or oats.
4. Clover and grass seeds, cut.
5. Clover and grass seeds, grazed.

This method of cropping has much to recommend it, affording as it does ample scope for farming at high pressure, and yet keeping the bills for labour and manures within reasonable bounds.

Six-years' Course. — A still more economical system is the six-years' course, in which the land is allowed to lie in grass for three years. The labour bill is lessened, and so is that for manure, while the summer food for live stock is increased, and the farming risks diminished all round. With the decline in the price of grain and the increase in the cost of labour there has been a great increase in the extent of land left under grass for two and three years. Indeed, where the land is well suited for carrying grass, it is now often left under it for four or more years.

In many parts, however, notably in dry districts and on porous soils, the land will not satisfactorily carry grass for more than two years, so that the character of the soil and climate, as well as prices and other influences, has to be considered in arranging the methods of cropping.

Varieties of Six-years' Course.—On stiff soils with an early climate the following six-years' course is sometimes pursued :—

1. Wheat.	4. Wheat.
2. Beans.	5. Clover, &c.
3. Fallow.	6. Roots.

On medium soils in high condition the system may be varied thus :—

1. Wheat.	4. Clover, &c.
2. Turnips.	5. Oats.
3. Barley.	6. Potatoes.

This, it will be seen, is a heavy course of cropping, requiring liberal and frequent manuring to prevent the exhaustion of the soil. If the turnips are not consumed on the land by sheep, it may be advisable to top-dress the crops of barley and oats.

The five and six years' rotation is pursued with numerous other variations. The following are examples of the latter :

Year.	No. 1.	No. 2.	No. 3.	No. 4.	No. 5.	No. 6.	No. 7.
1st.	Potatoes.	Oats.	Oats.	Oats.	Oats.	Wheat.	Wheat.
2d.	Wheat.	Wheat.	Beans or potatoes.	Roots.	Turnips.	Roots.	Barley.
3d.	Turnips.	Roots.	Wheat.	Wheat.	Wheat.	Wheat.	Roots.
4th.	Barley or oats.	Barley.	Roots.	Barley.	Beans.	Beans.	Oats.
5th.	Clover and grass.	Clover and grass.	Wheat or barley.	Clover and grasses.	Wheat.	Barley.	Clover and grass.
6th.	Pasture.	Pasture.	Clover and grass.	Pasture.	Clover and grass.	Clover and grass.	Pasture.

The first of the above is pursued on many farms in the south of Scotland and elsewhere. Nos. 2, 4, and 7 are met with in the midland counties of England and elsewhere; No. 3 is the prevailing East Lothian six-course; No. 4 is found in the west of Scotland and other parts; and No. 6 on strong soils in Bedford and other English counties.

Seven-years' Course.—There are also many varieties of seven-years' rotations. In Scotland there are usually three or four years' grass in this course. In potato-growing districts of Scotland the following course, or one similar, is often pursued:—

1. Oats or potatoes.
2. Potatoes or beans.
3. Wheat.
4. Turnips.
5. Barley or oats.
6. Clover and grass.
7. Pasture.

Others take in succession oats, potatoes, turnips, and barley, followed by clover and grass for three years.

A seven-years' course pursued with success on some good farms in the north of Scotland is as follows:—

1. Oats.
2. Barley.
3. Turnips.
4. Oats.
5. Clover and grass.
6. do. do.
7. Clover and grass.

For the barley crop after oats a light dressing of dung is spread in the autumn and covered with a break-furrow. In spring the land is harrowed and ploughed with a shallow furrow.

A course of cropping pursued on the wolds of Yorkshire is as follows:—

1. Wheat.
2. Roots.
3. Barley.
4. Peas.
5. Roots.
6. Oats.
7. Clover and grass.

Others think it better to let oats follow the clover and grass, and take wheat in the sixth year, after roots.

Many more samples might be given, for in the courses of cropping pursued throughout the United Kingdom there is almost endless variety. Enough has been said to enforce the importance of every farmer considering carefully his own peculiar circumstances as to soil, climate, market, supply of labour, &c., and thus be able to pursue such a course of cropping as will give him the best results.

General Rules.

In deciding as to the course of cropping to be pursued, the following general rules should be kept in view: (1) crops which have deep penetrating roots should be followed by those having shallow wide-spreading roots; (2) crops of the same order should not too frequently succeed each other; (3) crops which encourage the growth of weeds and prevent the cleaning of the land should be separated by as wide intervals as the circumstances of the farm will permit; (4) crops which are grown for seeds should be succeeded by those grown for their roots or foliage, and which are largely consumed on the land on which they are grown.

Food-supply.—An important object to bear in mind is to so order the succession of crops as to provide an even and continuous supply of food for the stock, so that the farmer may not be under the necessity of one year buying a large number of stock, and next year greatly reducing the number.

Distributing Labour. — Another point of great importance is the distribution of labour over the year—growing crops which require labour at different times, and avoiding an excess of those which press for labour at one particular season, leaving the rest of the year with comparatively little to employ the farm hands.

REALISATION.

PHYSICAL GEOGRAPHY OF FARMS.

Now that the pupil-farmer has acquired a competent knowledge of farming to conduct a farm on his own account, by having become acquainted with the entire routine of operations throughout the four seasons, and by having studied the instructions contained in the preceding pages, as a guide to anticipate the several operations as they succeed each other, the time has come to look out for a farm for himself.

Looking for a Farm.—But before doing that, he will have to aquire a knowledge of subjects somewhat different from merely conducting a farm, and which are essential for him to know. These subjects are, to judge of land, to bargain for a lease, and to provide stocking for the farm. On taking possession of the farm, he may have more to do than these. He may have to enclose and drain the farm, and to erect buildings upon it. He should know the correct principles upon which the breeding and rearing of the domesticated animals are founded. These particulars are as yet unknown to the pupil-farmer, but he must become acquainted with them; and he will now proceed to acquire them.

Diversity of Farms and Farming.—The farms of the United Kingdom occupy every available space of ground, from the tops of the highest mountains to the sea-margin—the highest and the lowest level affording food for our domesticated animals. In such a diversity of level, the physical features of the farms must present diversified aspects, and farms occupying such diversified aspects must impose diverse modes of farming. The highest crowns of the mountains cannot be farmed in the same manner as the land along the sea-margin; and accordingly we have many methods of farming, each of which has its distinctive character.

The more obvious diversities of farming are that on the mountains and that on the plains. The mountain-farms are chiefly under permanent grass; farms on the plains are largely occupied with arable culture. Mountain-farming consists of two subdivisions—sheep and cattle breeding. The farming of the plains consists of raising corn and green crops, and the rearing and feeding of live stock according to local circumstances. Now the pupil-farmer, when he has made up his mind to farm on his own account, must determine which of the modes of farming he would wish to follow. To enable him to determine, he should be made acquainted with the peculiarities of each mode, and then he can fix upon that which best suits his capital and views in life.

Hill-farming.—To begin with hill or mountain farming: Sheep can occupy the whole range of grass from the mountain-tops to the plains. Cattle limit their range of grass from the secondary or lower mountain-tops to the plains. Hence the highest mountain-range is occupied solely by sheep, and by appropriate breeds, the Blackfaced and Cheviot, and this constitutes the first class of pastoral farms. From the high elevation of these sheep-farms, they are necessarily subjected to much wind and rain, occasioning both wet and cold; and were it not that the tops of mountains face different directions—one part affording shelter and comparative warmth, while the opposite may be experiencing the fiercest onsets of the elements—such grass-land could not be shaped into farms, nor occupied by even the most hardy breed of sheep.

Configuration of Hill-farms.—On looking at such a farm with the view of taking it and occupying it in comfort, the farmer should see that the ground should have diversified aspects, and not lie in one long stretch of level or of inclination to the S. or N.; because in winter even the S. face of a hill will be covered deep with snow, while the N. is almost clear, which is mostly the case when a storm comes from the N. On steep slopes the snow cannot lie to any great depth.

Geology of Hill-farms.—The geological structure of the surface should be considered. Where *débris* covers rock the subsoil will be porous and the grass green, with little heather; and where no *débris* occurs, the rock will be covered with peat-earth and heather. The rocks on such farms are generally of the primary formation; and where granite or clay-slate prevails, *débris* may be looked for, from the action of the atmosphere on them; but neither gneiss nor mica-slate affords *débris*, and are covered only with peat-earth, which bears little but heather.

Intermediate Elevations.—Since sheep can occupy the whole range of grass, and cattle only from the lower hills to the plains, it follows that both sheep and cattle may be reared on the second description of pastoral farms. The surface is diversified with large round-backed hills, with long hollow dells, and suited to afford good shelter to stock. Should these hollows be expanded into valleys having considerable breadth, and abundance of haugh-land along the banks of a stream, they will most likely be well suited to the rearing of cattle, by themselves or with sheep; but where narrow and steep valleys prevail, sheep would most probably suit better than cattle.

Cattle and Sheep Mixed or Separate.—As a rule, instead of rearing both cattle and sheep on the same farm, either is preferred according to the configuration of the ground. Few stockmasters desire to be troubled with both cattle and sheep breeding where accommodation for stock in steadings is limited, and variety of winter food not abundant.

Features of Intermediate Farms.—On reviewing such a farm, the farmer should see that it is well provided with grass, which it will be if the subjacent rocks are of slaty structure, as greywacke slate, and slate clay, through the fissures of which the water passes as through a porous subsoil, and more quickly than through their *débris*, which contains a large proportion of clay. Where such *débris* exists are swamps and bogs, which may be dried by drainage, the fall for drains being ample, and drain pipe-tiles affording an easy means of filling them.

Arable and Pastoral Farming Combined.—Where arable culture exists on farms at intermediate elevations—upon the best haugh-ground, and on the slopes adjacent thereto—and commodious steadings set down, both cattle and sheep might be reared with advantage both to the tenant and the land, inasmuch as, when the grass is managed in summer by a proper admixture and distribution of stock, it affords a larger quantity of food for cattle and sheep than for either alone, and with less waste. Sheep follow and bite the grass closer than cattle, and the aftermath springs up quickly after sheep.

To derive the greatest advantage from such a farm, the arable land should be drained, and the grass enclosed, to confine the stock in one enclosure until the grass grow in another.

Exposure.—Such an arable pastoral farm should have one S. exposure. The direction of the valley in which the steading is situated is a point worth noting; the strongest winds are from the S.W., and the greatest colds from the N.E.—every valley running S.W. to N.E. will be exposed both in winter and summer.

Planting for Shelter.—A plantation thrown across the valley above and another below the arable land would screen the steading and the farmhouse, while a high hill on the N. would form a good screen.

Arable Farms.—Upon the slopes from the foot of the lower mountains into the plains are the sites of arable farms. The soil may rest on trap alone, sandstone alone, limestone alone, or sandstone and limestone disrupted by projections of trap. Such soils are eminently adapted for turnips and grass; and accordingly we find there the mixed, the dairy, the common, and the suburban systems of farming. The surface is diversified by undulations, the soil on rock requiring draining; and where it does not, it consists of travelled gravel and sand, constituting *débris* brought from a distance, and covering the rocks.

Alluvial Deposits.—On the margins of rivers making their way to the sea or to an estuary, large deposits of alluvial clay and of drift-sand are found. Alluvial clay is unfit for the preceding modes of culture, and is cultivated in a manner peculiar to itself, called *carse* farming.

It requires draining; but even after being drained, it is unfit to be worked, or even meddled with, in winter, in rain, snow, or frost, on account of its unctuous aluminous character. It will grow turnips after being drained, but will not receive sheep upon it in winter. It cannot be pastured in summer in a wet season, the surface being poached with the beasts' feet. It is devoted to the raising of corn, straw, and hay, which it grows abundantly, and is well adapted for soiling cattle in hammels in summer upon the clover which it grows in luxuriance. It is pre-eminently the wheat soil.

The sand-drift is cultivated for root crops, and affords short sweet pasture to sheep, and is the opposite of carse farming.

Conditions Regulating Rent.—Besides these aspects of farms, other circumstances affect their value. The land may have a steep inclination, and require increased labour to work it. The soil may be too strong or too loose, too wet or too dry. Its natural condition may be poor. The fields may want water in summer. Water may not be from springs. The fences may be too numerous or too scanty, or in a state of dilapidation. The farm may be entirely exposed to the N. The surface of the fields may be irregular and abrupt. The farm may be exposed in an open country all round, or sheltered on all sides by natural or artificial objects. Coal and lime may be far off, or near at hand. The market town may be distant or near, and may or may not supply manure. The roads well placed, kept in good repair, or a railroad within reach.—The effect of all these particulars, individually and collectively, upon the money value of land, may not be easily determined; but that they, as well as the market price of produce, must have an effect in the value of a farm, is obvious to every one.

CLIMATE.

Climate is too little considered by farmers when they are on the outlook for a farm, and yet yearly experience teaches them it has a marked effect upon their crops.

What constitutes Climate.—Distribution of heat over the globe constitutes *climate.* General climate is measured from the equator to the polar circles in zones, which are classified into the torrid, temperate, and frigid—names indicative of different degrees of temperature.

The Zones.—The *torrid* zone includes the space inscribed by the ecliptic, extending to 23° 28′ on each side of the equator, a belt of 46° 56′ in breadth. It is the hottest part of the globe, the sun being over the zenith, and the temperature ranging from 84.2° to 78.8° Fahrenheit. A *temperate* zone lies on each side of the torrid, embracing a range of latitude in each hemisphere of 43° 4′, and extending to latitude 66° 32′, the temperature varying from 78.8° to 39.9°. The *frigid* zones each comprehends as many degrees from the poles as the torrid zone extends from the equator—namely, 23° 28′, the temperature varying from 39.9° to 31°. Within 10° of the poles the temperature differs little; and the same is the case within 10° of the equator.

Temperature and Latitude.—Thus the temperature of the air diminishes gradually from the equator to the poles, and the diminution is in an arithmetical progression. Hence it is calculated that of the annual mean temperature of the months, January is the coldest month in all latitudes above 48°; and that, in latitudes below that, August is the warmest month. In the N. hemisphere, the temperature rises from about the middle of January, slowly at first, more rapidly in April and May, to reach its maximum point in July and August, when it begins to fall again until mid-January, when it is at its minimum. The difference in temperature between the hottest and coldest months increases in proportion to the distance from the equator. At the equator the mean temperature is 84.2°, at the ecliptic it is 78.8°.

Temperature and Configuration of Earth's Surface.—Modifications of temperature occur with a difference of configuration of the earth's surface. Were that surface uniform, the power of the soil to absorb and radiate heat would be everywhere alike, and the climate of a place would depend on its geographical position: the isothermal lines would all be parallel with the equator. But diversity of surface causes the soil to be dry in one place and swampy in another; to be here a moving sandy desert, and there an umbrageous forest—all which cause corresponding varieties in climate, in proportion as the surface becomes heated in different degrees in those different conditions.

It is the radiation of heat from the earth's surface that warms the air, and not the direct rays of the sun. In penetrating great continents from the sea-coast, the temperature in summer and winter becomes extreme. An island, a peninsula, and the sea-coast experience a more temperate and equable climate—the summers less sultry, the winters more mild — than a continent. One of the grand characteristics of a maritime climate is the small difference between the mean temperatures of summer and winter, the uniformity being maintained by vicinity to the ocean.

"The climates of different parts of the earth's surface are unquestionably owing in great measure to their position with respect to the sun. At the equator, where the sun is always nearly vertical, any given part of the surface receives a much greater quantity of light and heat than an equal portion near the poles; and it is also still more affected by the sun's vertical rays, because their passage through the atmosphere is shorter than that of the oblique rays. As far as the sun's mean altitude is concerned, it appears from Simpson's calculations that the heat received at the equator in the whole year is nearly 2½ times as great as at the poles—this proportion being nearly the same as that of the meridian heat of a vertical sun to the heat derived at 23½° from the poles, in the middle of the long annual day at the poles. But the difference is rendered still greater by the effect of the atmosphere, which intercepts a greater proportion of the heat at the poles than elsewhere. Bouguer has calculated, upon the supposition of the similarity of the effects of light and heat, that in lat. 45°, 80 parts of 100 are transmitted at noon in July, and 55 only in December. It is obvious that, at any individual place, the climate in summer must approach in some degree to the equatorial climate, the sun's altitude being greater, and in winter to the climate of the polar regions."[1]

Mean and Actual Temperatures.—But annual *mean* temperatures do not acquaint us with the climate which affects the products of the farm. Mean temperatures are derived from observations made on thermometers placed in the shade. But as our crops are not placed in the shade, and are exposed in the day to the sun's light and heat, and at night to neither, what we desiderate, before we can determine the agricultural climate of any place, is results from thermometers placed amongst the crops and exposed in the open air to the weather day and night, summer and winter. We would thus be acquainted with the actual temperature of every month in the year during day and night.[2]

A comparison of mean temperatures lets us know which of two places enjoys the greater heat on the average of days, or months, or years, but does not tell us the greatest and lowest degrees of heat at them in any season; and it is evidently the knowledge of these extremes that most interests us in the cultivation of our crops. We know that a given number of days, at a certain range of temperature, are necessary to bring a certain crop to perfection, while we also know that another range of temperature would destroy that crop; but the mean temperature could not tell us whether the crop should thrive or be destroyed.

Temperature of Wheat Ripening.—Thus, in Venezuela, according to Codazzi, wheat requires 92 days to ripen at Turmero, at a mean temperature of 75.6°, which is equivalent to 6955°; and 100 days at Truxillo, the mean temperature being 72.1°, which is equivalent to 7210°. We may be sure that the wheat at Truxillo is not so fine as that at Turmero.

Now in Scotland neither of these degrees of temperature would suffice to bring wheat to perfection; for, on wheat sown in autumn, active vegetation commences at the 14th of February, and it cannot be reaped before the 15th of August — that is, 182 days; and the mean temperature of Edinburgh being 47.4°, the number of degrees of heat re-

[1] Polehampton's *Gall. Nat. and Art*, iv. 42.
[2] *Jour. Scot. Meteo. Soc.*

quired to ripen it would be 8625°, being 1670° more than required at Turmero, and 1415° more than at Truxillo.

But if we take the case of spring wheat, the difference will be still greater; for if sown on the 14th of February, it cannot be reaped before the 1st of September, which is 198 days; and at 47.4° of mean temperature it gives 9385°, being no less than 2430° more than required at Turmero, and 2175° than at Truxillo. Boussingault tells us that in Alsace, with a mean temperature of 59°, *wheat* requires 137 days, or 8083°, to ripen; at Paris, with a mean temperature of 56°, 160 days, or 8960°; at New York, with a mean temperature of 63°, 122 days, or 7680°.

In Egypt, on the banks of the Nile, with a mean temperature of 70°, *barley* requires 90 days, or 6300°, to ripen; at Santa Fé de Bogota, with a mean temperature of 58.5°, 122 days, or 7137°.

In S. America, *maize* comes to maturity in 92 days, with a mean temperature of 81.5°, or 7497°; or in 183 days, with a mean temperature of 59°, or 10,797°.

At Maracaibo, near the lake of Valencia, *potatoes* require 120 days, with a mean temperature of 78°, or 9360°, to ripen; and at Antisana they require 276 days to be in the ground, with a mean temperature of 52°, or 14,352°.

Duration of Vegetation and Temperature. — Hence Boussingault concludes that "the duration of vegetation appears to be in the inverse ratio of the mean temperature; so that if we multiply the number of days during which a given plant grows in different climates by the mean temperature of each, we obtain numbers that are nearly equal. The result is not only remarkable, in so far as it seems to indicate that upon every parallel of latitude, at all elevations above the level of the sea, the same plant receives in the course of its existence an equal quantity of heat, but it may find its direct application by enabling us to foresee the possibility of acclimating a vegetable in a country, the mean temperature of the several months of which is known."

In coming to this conclusion, Boussingault, we see, does not take the mean temperature of the year of any place, but that of the season in which the particular crop grows, and which, in truth, comprehends the whole temperature of the growing period of the crop.

Plant Growth and Temperature.— Another conclusion by Boussingault is, "that plants in general, those of tropical countries very obviously so, spring up, live, and flourish in temperatures that are nearly the same. In Europe and in N. America, an annual plant is subjected to climatic influences of the greatest diversity. The cereals, for example, germinate at from 43° to 47° or 48°; they get through the winter alive, making no progress; but in the spring they shoot up, and the ear attains maturity at a season when the temperature, which has risen gradually, is somewhat steady at from 74° to 78°.

"In equatorial countries things pass differently: the germination, growth, and ripening of grain take place under degrees of heat which are nearly invariable. At Santa Fé the thermometer indicates 79° at seed as at harvest time. In Europe the potato is planted with the thermometer at from 50° to 54°, and it does not ripen until it has had the heats of July and August. Germination, and the evolution of those organs by which vegetables perform their functions in the soil and in the air, take place at temperatures that vary between 32° and 112°; but the most important epoch of their life—ripening—generally happens within much smaller limits, and which indicate the climate best adapted to their cultivation, if not always to their growth. . . .

"In high latitudes the disappearance of vigorous vegetation in plants may depend quite as much on intensity of winter colds as on insufficiency of summer heat. The equable climate of the equatorial regions is therefore much better adapted than that of Europe to determine the extreme limits of temperature between which the vegetable species of different kinds will attain to maturity."[1]

Range of Temperature for Crops.— In pursuance of this idea in regard to the plants of the farm, the extremes of the temperatures of the ordinary plants may be stated as follows:—

[1] Boussingault's *Rur. Econ.*, 647-59—Law's transl.

Wheat	from	78°	to	44°
Barley	"	80°	"	59°
Potatoes	"	78°	"	52°
Flax	"	74°	"	54°

Temperature of Soil and Atmosphere.—The temperature of the ground has a close connection with that of the air immediately above it, and is mainly affected by the extent of the thermometrical variations in the superincumbent air in the course of the year. By the observations of the Meteorological Society of Scotland, made at 3, 12, 18, 22, 36, and 48 inches under the surface, a small increase of temperature is found below 3 inches. Below a limited distance the temperature ceases to be affected by the temperature of the general atmosphere, which is called the point of *invariable temperature*. In climes of great constancy this point will be found near the surface, and at the equator about the surface.

Drainage and Soil Temperature.—Drainage raises the temperature under the surface—that is, it permits the temperature of the atmosphere to penetrate deeper into the soil. In one quoted case in a garden in Hampshire, the temperature of the heavy soil was raised 15° by drains of 4½ feet deep.[1] And drainage not only permits the heat to penetrate deeper into the soil, but also enables the soil to retain it a longer time. It is no matter of wonder that drainage should effect this change in the soil. Over undrained land there is a constant evaporation of moisture, which is as constantly attended by a falling temperature. When the moisture is removed by drainage, the cause of the lower temperature is at the same time removed, and the temperature of the air rises.

Evaporation.—The evaporation of the water in the ground is caused in this way: Rain falls and penetrates the ground by gravity, and as it is gradually absorbed a succeeding rain descends, thrusting the first still lower, until an equilibrium of moisture is established from top to bottom of the ground. Whilst this is going on, the air takes from the surface a portion of its humidity, and evaporation takes place. The upper layer, dried in consequence, draws moisture from that which is more moist beneath; and this moisture in its turn is also taken up by the atmosphere, and hence the source of constant cold over the surface.

Evaporation from Water and Earth.—"Having observed for several days," observes R. Thomson of the Chiswick Gardens, "the relative amount of evaporation from a surface of water, and that from earth completely saturated, in the month of August 1849, and under a temperature of 73° to 75°, the following were the results:—

	Evaporation from the water. inch.	Evaporation from the earth. inch.
1st day	.590	.161
2d "	.531	.097
3d "	.452	.070
4th "	.472	.051
5th "	.460	.051
6th "	.433	.047
7th "	.370	.051
	3.308	0.528

We see from the above with what rapidity evaporation goes on when the soil is completely saturated. On the first day it is more than one-fourth of the evaporation from the surface of the water; but it diminishes, and at the end of seven days it is scarcely one-seventh. When the surface becomes dry, the evaporation is almost inappreciable. On the second day the upper layer of soil is dried under the above temperature to the depth of one-tenth of an inch; and at the end of eight days, plants of which the roots extend only to the depth of 4 inches begin to suffer, and require watering. From some observations made by Hales on the amount of evaporation from soil, he concluded that it was in the proportion of 3 to 10, as compared with that from a surface of water.[2]

Elevation and Temperature.—Another disturbing cause of the equable temperature on the surface of the earth is the inequality of surface into hill and dale. As we ascend a mountain the heat rapidly decreases, and it decreases more rapidly during the day than during the night, during summer than during winter, where the mountain is abrupt than where it rises in steps, and near

[1] *Garden. Chron.*, 20th Oct. 1849.

[2] *Ibid.*, Dec. 1849.

the surface than at a distance from it. If we take 590½ feet as an average height, under the circumstances mentioned above, to be ascended to obtain a decrease of 1° of temperature, we shall not be far from the truth.[1] This height corresponds nearly with a depression of the barometric column of .7 of an inch.

The cold which prevails among lofty mountains is ascribed to the dilatation which the air from the lower regions experiences in its upward ascent, to a more rapid evaporation under diminished pressure, and to the intensity of nocturnal radiation.

Perpetual Snow-line.—As the temperature of the atmosphere constantly diminishes on ascending above the level of the sea, the temperature of congelation must be attained at a certain height above every latitude; consequently mountains which rear their heads above their limit must be covered with perpetual snow. In the higher regions of the atmosphere the temperature varies but little throughout the year; and hence in brilliant climates the line of perpetual congelation is strongly and distinctly marked. But in countries remote from the equator the boundary of frost descends after the heat of summer as the influence of winter prevails, thus varying its position over a belt of some considerable breadth.

Beyond the line of congelation is another, which forms the boundary of the ascent of visible vapour; and this point, it is obvious, must be less liable to change than the point of congelation. At the equator the highest point of vapour is 28,000 feet, at the pole 3432 feet, and in N. lat. 54° it is 6647 feet. In tracing this point successively along every latitude, we learn that heat diminishes as we ascend, in an arithmetical progression. Hence it follows that the heat of the air above the surface of the earth is not owing to the ascent of hot strata of air from the surface, but to the conducting power of the air itself.[2]

Mountains and Climatic Variations.—Plains present only one species of climate which differs in its seasonal characters alone; but mountains exhibit every variety, from their latitude to the pole along the meridian of the quadrant. For this reason high mountains situate in the tropics present every variety of climate. "If we take each mountain," says Mudie, "which rises above the line of perpetual snow, as the index to its own meridian, we shall find that each one expresses, by its vegetation, all the varieties of climate between it and the pole; and thus those lofty mountains become means of far more extensive information than places which are situated near the main level of the sea, and more especially than plains, which, when their surfaces are nearly flat, have no story to tell, but the same uniform and monotonous one, for many miles." "Upon each particular rock of the rapid slope of the Cordillera," observes Humboldt, "in the series of climates superimposed in stages, we find inscribed the laws of the decrease of caloric, and of the geographical distribution of vegetable forms."

Elevation above the surface has the same effect in diminishing temperature as ascent in latitude. "Say that the altitude of the mountain under the equator," continues Mudie, "upon which the seasonal action is displayed, is a little more than 3 miles. Then, estimating in round numbers, 1 foot of altitude on the mountain will correspond to about 16,000 feet on the meridian—that is, 1 single foot of elevation on the mountain is equivalent, in difference of temperature, to about 3 miles, or more nearly 3 minutes of 1 degree in latitude, and therefore 20 feet are equal to a whole degree; and when one once arrives at the mean temperature of London, 400 feet more of elevation will bring one to the climate of Lapland."[3]

Climate and Plant Distribution.—The habitudes of plants being extremely various, one germinating at 38°, a little above the freezing-point, and another requiring a heat of 100° or 120°, the geographical distribution of plants is a consequence of the distribution of heat over the surface—that is, of climate.

From an extensive series of observations made by Glaisher with thermometers fully exposed to the sky, the means,

[1] Kaemtz's *Course of Meteoro.*, 211-16.
[2] *Ency. Brit.*—"Climate," 7th ed.
[3] Mudie's *World*, 132-36.

as compared with those *on long grass*, were these:—

At	1 inch above long grass,	.	+ 2°.76
"	3 " "		+ 4°.39
"	6 " "	.	+ 6°.02
"	12 " "	.	+ 7°.31
"	24 " "		+ 7°.67
"	48 " "	.	+ 7°.81
"	96 " "	.	+ 8°.26
"	144 " "	.	+ 8°.27

Hence the necessity of placing thermometers at the same height above the ground to render the results comparable.[1]

Local Climate.—The characteristics of local climate engage the attention of the farmer more than the general climate of the country which he inhabits. Local climate may be defined to signify that peculiar condition of the atmosphere, in regard to heat, moisture, and wind, which prevails in any given place. The diversified character which it displays has been generally referred to the combined operation of several different causes, which are all, however, reducible to these two—*distance from the equator*, and *height above the level of the sea;* so that latitude and elevation form the great basis of the law of local climate; and the modifications of this law by other causes have generally but a partial and limited influence.

The climate of every individual country may be regarded as local, in reference to that of all other countries in the same degree of latitude. Thus islands are warmer than continents. The E. coast of all countries is colder than the W. The W. coast is moister than the E. Countries lying to the leeward of great ranges of mountains or extensive forests are warmer than those to windward. Small seas are warmer in summer and colder in winter than portions of great oceans, they being affected by the condition of the surrounding land. Low countries are warmer than high, and level plains than mountainous regions.

Places situated upon the same mountain-chain, nearly in the same latitude and at the same height, have often very different climates. The temperature which would be proper to a place is necessarily modified by a considerable number of circumstances. Thus the radiation of a heated plain of considerable extent, the nature and colour of the rocks, the thickness of the forest, the moisture or dryness of the soil, the vicinity of a glacier, the prevalence of particular winds, hotter or colder, moister or drier, the accumulation of clouds, are so many causes which tend to modify the meteorological condition of any place, whatever be its geographical position.

In no other part of the globe is the diminution of temperature occasioned by a rise of level above the sea more remarkable than among equatorial mountain-ranges; and it is not without astonishment that the European, leaving the burning districts which produce the banana and cocoa-nut tree, frequently reaches, in the course of a few hours, barren regions which are covered with everlasting snow.

Pulsations of Temperature.—There is a phenomenon which has a material effect on local climate—the darting of cold pulsations downwards from the upper region of the atmosphere, and of warm pulsations upwards from the earth. This is different from radiant heat.[2]

Elevation and Local Climate.—From these facts and reasonings it appears that a slight difference of elevation in a mountainous district of this country, which has so high a parallel of latitude, may have a considerable influence on local climate; and that, other things remaining the same, one farm which is highly elevated has a greater chance of being affected by changes of climate than one on a lower level.

Other Conditions affecting Local Climate.—Yet, independently of elevation, other local influences have a material effect in rendering the position of a farm less desirable; such as, vicinity to a lake or marsh, or a position at the foot of a hill or side of a large wood against which the wind generally blows—all which objects tend to lower the temperature below that of the country.

A position in a long narrow valley, or upon the haunch of a large isolated hill, or in a pass betwixt two mountains separating plains, is more subject to violent winds than the open country,

[1] Buchan's *Handy Meteoro.*, 57.

[2] *Ency. Brit.*—"Climate," 7th ed.

the wind acquiring an accelerated velocity in such localities.

Desirable and Undesirable Situations.—An elevated table-land, being subject to a lower temperature and higher winds than a plain of the same extent on a lower level, is to be avoided.

The leeward side of a hill or large wood, or on flat ground backed with hills and woods to the N. and E., ensure a higher temperature and less wind than other parts of the country.

An extensive plain or valley, through which no large river passes, or in which no large lake or wood exists, is very little subject to violent winds.

In exposed situations the snow lies long, and the winds are keen; while in sheltered situations the snow soon melts, and the wind is gentle.

Variations of Local Climate.—These different circumstances produce a sensible effect on the local climate of a small country like Great Britain; and varied as it is in its physical geography, and surrounded on all sides by water, they have the effect of dividing the country into as many climates as there are varieties of surface and differences of position.

Such local influences, in most seasons, have a greater effect on the time of growth, quantity and quality of the produce of the earth, than the general climate of the country, although the general climate exercises a predominating influence in seasons of excessive heat or rain, and overcome all local influences, so as to stamp a general character over the season.

Measuring Altitude.—The height of a farm above the sea is now quickly and accurately ascertained by means of the aneroid barometer, which is small and portable.

Local Climate and Land Value.—On looking at a farm, you should keep in mind these conditions of climate, an item of judging land which is often neglected by those who value farms, and which is as often a cause of discontent to the tenant after he has found out its bad climate by dear-bought experience.

Let us scan over the particulars which require serious attention on this subject.

Temperature and Produce of Crops.—The temperature of the locality has great influence on all crops. Playfair concluded that the lowest temperature at which corn will vegetate is 40°, and that corn will not ripen below a temperature of 48°. He proposed to date the vegetating season from 20th March to the 20th October, and considered 56° as the mean temperature of a good vegetating season.[1] It may therefore be assumed that if the mean temperature at a farm between March and October is below 56°, it will not mature crops.

The *altitude* of a place affects its temperature materially. As we have already seen, an altitude of 590½ feet makes a difference of 1° of mean temperature—making the effect of elevation the same as an increase of latitude. This is a point which is liable to be overlooked in the interior of the country, where an elevation is insensibly gained much beyond belief. The country may appear pleasant, and everything indicative of a good climate, but on inquiry it may be found to be 600 or 800 feet above the level of the sea—an elevation in which, if but 1° of temperature is below 56°, wheat may not ripen, and at 800 feet even barley may be a precarious crop in most seasons. At such elevations it is probable that a crop may now and again be lost.

Daily Range of Temperature.—In such situations, the daily range of the temperature is great, descending low at night, and ascending high during the day. Every farmer knows that a low temperature in the night injures the crops; and that warm nights following warm days protect plants from a checked growth.

In travelling at night in England in summer, nothing strikes a Scotsman so readily as feeling the night air about as warm as in a cloudy day in his own country. Hence, harvests in England are earlier than in Scotland.

Rainfall.—The fall of rain in the vegetating season is an interesting and important factor — falling frequently being less favourable to vegetation than larger quantities at longer intervals; and a locality much affected by *vapour* renders the atmosphere in it more cloudy than desirable.

[1] *Trans. Roy. Soc. Edin. for* 1830.

The vicinity of the ocean affords an equable temperature; and while an inland shallow lake depresses temperature, a deep one elevates it.

Wind.—The direction of the wind should be studied. A S.W. wind is moist and warm, being equatorial and oceanic; a N.E. wind is dry, being continental and polar.

Mountain-ranges affect the direction of winds. If the range lies across the direction of the wind, it will divert it from it; if it lie along it, it will accelerate its force.

Mountain-ranges and Temperature.—"But the chief effect mountain-ranges have on the temperature," says Buchan, "is to drain the winds which cross them of their moisture, and then to cause cold winters and hot summers in places to the leeward, as compared with places to the windward, by more fully exposing them to both solar and terrestrial radiation."

Forests and Temperature.—"Trees are heated and cooled by solar and nocturnal radiation in the same manner as other bodies. They do not acquire their maximum temperature till after sunset. This occurs in summer at 9 P.M., while in the air the maximum temperature occurs between 2 and 3 P.M. Hence trees may be conceived as reservoirs in which the heat of the day is stored up against the cold of the night. Changes of temperature take place very slowly in the tree, but in the air they are very rapid. Hence the effect of forests on the daily temperature is to make the nights and the days cooler. It follows that forests diminish the summer temperature and maintain the winter temperature higher than it would be. This enables us to understand how forests increase the rainfall."

"The temperature is found to be warmer at the base of a mountain and up its sides when the slopes above are covered with trees. The beneficial influence of forests is exerted in two ways—viz., in the diminished radiation from the surface protected by the trees, and in the obstacle they oppose to the descending currents of cold air. On the contrary, the cold of winter is more severely felt in those localities where the slopes above are destitute of vegetation, and consist only of bare soil and rocks, or of snow."[1]

It is thus seen that the relation between local climate and the growth of different crops is deserving of the most careful attention. What precise effect it has upon the money-value of land it is not easy to determine; but that land unfavourably situated as to local climate is of less value than that which is not affected by such local influences cannot admit of doubt.

JUDGING LAND.

Land cannot be judged of at all seasons or in every state. It may be covered by snow, and thus shrouded from all inspection. It may be saturated with rain, when it cannot be walked upon. It may be hard frozen, when it will yield to neither foot nor spade. It may be concealed by a corn crop, when its texture cannot be examined. It can be best examined when under bare fallow, green crop, and grass.

Examining a Known Farm.—When a farm is well known, the best season to inspect it is just before harvest, when the crop is in the fullest luxuriance and indicating its true condition.

Examining an Unknown Farm.—When a farm is unknown, the best season to look at it for the first time is in spring — March — in dry weather, after the largest proportion of the soil has been exposed by the plough, and when its actual state, in regard to dryness and wetness and condition, cannot be concealed. This is the season when the farm most fully exposes its varieties of soil—whether or not it requires drainage, whether any draining which has been done is still in good condition, and whether it is in a fair or poor condition as to fertility.

Local Knowledge necessary.—In judging a farm, the safest course for an intending offerer is to obtain the assistance of a friend experienced in farming, who is well acquainted with the part of the country in which it is situate, if such a one can be had. Indeed we regard local knowledge as in all cases most essential.

[1] Buchan's *Handy Meteoro.*, 2d ed., 103.

To judge strange land in a strange locality is most unsafe. There is much truth in the old saying that no man can judge land a hundred miles from home.

Etiquette of Farm-seeking.—It is considered amongst farmers a dishonourable act to look at a farm until it is in the market—that is, until it is known that the tenant is leaving it. It is bad behaviour to go over a tenant's farm, if he wants to keep it, even although it may be advertised.

Examining Soil and Subsoil.—On judging soil, the subsoil requires as much attention as the upper soil. Pits are dug through soil and subsoil in every field to ascertain their nature and texture, and whether they are similar or dissimilar in character. Most commonly they are dissimilar; because cultivation by the effects of manures, and the roots of growing plants, will have so changed the upper soil as to render it distinct from the subsoil, however similar they may have been originally.

From the uniform nature of the deposit in the Carse of Gowrie, it is evident that the agricultural soil and subsoil must have at one time been the same, and any difference remarked now is the effect of cultivation. The following analysis of the soil and subsoil by Anderson of Inchyra, Carse of Gowrie, shows what has been stated:—

	Soil.	Subsoil.
Potash	2.8001	2.1761
Soda	1.4392	1.0450
Lime	0.8300	1.2756
Magnesia	1.0200	1.3938
Peroxide of iron	4.8700	6.2303
Sulphuric acid	0.0911	0.0396
Phosphoric acid	0.2400	0.2680
Carbonic acid	0.0500	...
Chlorine	0.0098	0.0200
Alumina	14.0400	14.2470
Silica	63.1954	61.6358
Organic matter	8.5508	6.8270
Water	2.7000	4.5750
	99.8364	99.7332[1]

The soil contains more potash and soda than the subsoil, no doubt added to it by the ingredients of the manure. This soil has never been known to have been limed, and hence cultivation has taken away a portion of that; and the same remark applies to magnesia. No doubt, also, cultivation would decompose a part of the peroxide of iron. Silica would be increased by cultivation, and so would organic matter, even in greater proportion; and the subsoil may be supposed to have had more water than the soil, but draining has reduced it.

[1] *Trans. High. Agric. Soc.*, July 1850, 296.

Variety of Soils on a Farm.—A considerable variety of soil is to be looked for on every farm. The most uniform soils are diluvial deposits and peaty soils, the greatest diversity being presented between sandy and clay soils. Variety of soils is no objection to a farm, as it admits of differences in the rotations of cropping, and in conforming to the exigencies of particular seasons. A variety of soils, to be most convenient for a farm, should occupy separate fields apart from each other.

Characteristics of Soils.

The characteristics and comparative fertility and agricultural value of the various soils have been so fully discussed in Divisional vol. i. pp. 40 to 68, that little further need be said here. The pupil-farmer should go back to that chapter, and study it carefully when selecting a farm.

Clay Soils.—A variety of soil often encountered in looking for a farm is a clay loam resting upon a porous or a retentive subsoil. A naturally porous subsoil makes the upper soil good for every kind of crop, and easily rendered fertile. A retentive subsoil requires draining before it can render the upper soil fertile.

Thin hard clay is often met with, and always on a retentive subsoil, which requires deep draining to dry it, and deep ploughing to make it thicker, loose, and friable. Ultimately it becomes a tolerably good soil, and will bear fair crops, provided it is liberally manured and worked in a judicious rotation.

Light Soil.—*Thin light soil* resting on *retentive subsoil*, is often met with. The subsoil requires draining. The soil is weak in constitution, hungry for manure, never easily satisfied, whilst its capacity is small at a time, requiring frequent feeding. A mixture of the subsoil by trench-ploughing does much good, especially if followed by liberal manuring.

Without liberal manuring, trench-ploughing sometimes does harm on thin soils. Deep cultivation, with a grubber or cultivator, is often preferable to deep ploughing. Kind treatment, in eating off turnips with sheep, will make it carry fair crops.

Black Soil.—A soil of a *black colour* is not unfrequently met with, deep enough in as far as the plough is concerned. It is deaf, soft, and apt to be carried forward on the breast of the plough. The straw it grows is thick enough, but soft and weak, and apt to lodge in wet weather; and the corn, though bulky, is thick-skinned and light.

Such a soil, resting upon *retentive clay*, is easily affected by wet, and will withstand drought for a long time. This soil has at one time been a moor, and yields crops readily at first, but does not continue to improve.

The subsoil must be thorough-drained, and mixed with the soil by trench-ploughing, which would much improve its texture; and lime operates as a charm upon it when given in large doses.

Gravel Soil.—A soil of quite an opposite character may be found—a sharp gravel upon a gravelly porous subsoil, which is admirably adapted to raise turnips, makes the best lair for sheep on turnips in winter, and never fails to fatten the animals well, both internally and externally. Both straw and corn from this soil, though scanty, are of fine quality.

Tenacious Clay.—A variety of soil, not so common, is a deep unctuous clay of uniform texture, from the surface to under the reach of the plough. It is capable of growing large crops of corn and straw, and difficult to work, requiring watching to catch the favourable weather. Draining the subsoil renders it capable of growing splendid green crops and clover.

Alluvial Soils.—Deep, dry, rich alluvial deposits, along the banks of rivers or in the bottom of valleys, form a good soil. It is fit to grow corn and green crops, is easily maintained in a high state of fertility, and is easily wrought. The subsoil requires little or no draining, being usually porous rather than otherwise.

Peaty Soils.—A thin peaty soil is found in large extent upon many of our pastoral farms, and is much improved in its capability to grow natural grasses by sheep-drains upon and under the surface, which also render it sounder land for the sheep.

Boggy Soils.—Boggy soils are met with to large extent in hollows, in a low, level, or an elevated plain. They must be drained ere they can be ploughed; but with draining and liming, they yield large returns in corn, green crops, hay, or pasture.

Sandy Soil.—Soils which seem to consist of almost pure sand are met with adjoining the margin of the sea or estuaries. When drained—for they are wet below—and cultivated with the plough—they yield good crops with a constant supply of manure, and in pasture afford short sweet herbage for sheep.

Method of Soil Inspection.—All these varieties of soil are judged of in the same manner. Every field must be walked over; and where a variety of surface exists, the knolls and hollows must be traversed. On the knolls will be found the thinnest, and in the hollows the thickest, part of the soil. The spade thrust into the bottom of an open furrow will show at once whether the soil is thick or thin; and if thick in the furrow, it cannot fail to be so on the crown.

Character of Good and Bad Soils.—It is not easy to describe in words the characters of a good or bad soil, or their state of fertility. It is only their physical characters that we can ascertain. Land to be judged requires to be in its ordinary workable state—not saturated with rain, not frozen, not burnt up with drought.

As a rule, clay soils feel hard under the foot; loams are softer; smooth deep soils feel as a thick carpet; thin soils as a thin carpet on a deal floor. Soils in high condition are friable; in poor condition are hard or too loose. The mark of the foot in soil in good condition is soon obliterated, by the elasticity of its particles; but in poor condition or tenacious clay, the footmark remains for a time impressed. In low condition, soils seem bleached by the weather, are much diversified in colour, appear to be in want of something, and are apt to be foul with weeds. Thin clays, hungry and deaf soils, are uncertain in character and yield.

Soils that have been drained, wrought, limed, and well farmed, and still indicate weakness, want of stamina, exhaustion, or a bleached appearance, may be concluded to be incapable of further improvement; but should they have been ill farmed, and yet indicate a natural strength, by good treatment they may yield fair crops in a few years.

Proportion of Good and Bad Soil.—When a variety of soil is found on a farm, it should be observed whether they occupy different fields, which is a favourable allotment; for much variety in the same field is troublesome. The amount of the good and bad soils should be summed up separately, and seen which prevail. If the bad occupy only from one-fourth to one-third of the whole, the farm may be regarded a good one, and its character for excellence will depend on the quality of its good soil; but should one-half of it be bad, the proportion is too great for the good soil to do justice to itself, and assist the bad; and where the proportion of bad increases beyond the one-half, the value of the good is reduced very rapidly.

Succeeding Good and Bad Farmers.—Whether on good soil or bad, it is better to succeed an easy-going farmer than one who has pushed the land to the utmost. The former may have neglected and left the land foul, yet it may be improved; while the worst farmer to succeed is one who wears out his land, for no land is so difficult to restore as that which has been worn out. The fortunate chance is to succeed a farmer who has brought his farm into, and has kept it, and leaves it, in high condition.

Uncultivated Soil.—Part of the farm may be in an uncultivated state, which is not so objectionable as a worn-out farm. Its uncultivated soil will be fresh, and can be brought to bear sooner than worn-out land. The fresh portion, when brought in, would permit the older land to lie in grass to recruit and recover its tone.

Desirable Farms.—Desirable properties for a farm of mixed husbandry to possess are these: Extent from 300 to 1000 acres. Soil deep light clay-loam, capable of bearing turnips and wheat, incumbent on a naturally porous subsoil. A turnpike and a parish road crossing at its centre. Fields rectangular, and comprehending from 20 to 30 acres each. Fences of thorn-hedges. Surface gently sloping or undulating to the S. Elevation not exceeding 200 feet above the sea. Water from springs or rivulets accessible to every field. Steading situate near the crossing of the roads, capacious enough to contain all the cattle in winter, and convenient for every barn-work. Two or three paddocks of old grass near the steading for calves and other stock; and some good old grass for grazing cattle. Comfortable farmhouse and neat garden not far from the steading. Shelter by higher land or woods from the N., whence come cold winds and frost, and from the S.W., whence blow the strongest and most shaking winds. Market town of moderate size and near at hand. A railway station on the farm or within easy distance, where coal and lime and extraneous manures may be had. Grinding-mill of wheat and oats in the vicinity. Distant from broad shallow lakes. Not among coal-fields, or near iron and chemical works.

It is barely possible for one farm to possess all these advantages, and it is not possible for every farm of a country to possess them all; but the more of these conditions that are conjoined, the better for the farm. It is not easy to determine the difference in the money value arising from the presence or absence of all these conveniences, but it cannot fail to be considerable.

ESTIMATING RENT.

All the varieties of soil described above are to be found on the farms of this country. The value of these soils is not estimated on the same principle, since some produce chiefly grain, and others are devoted mainly to the support of live stock; but whatever be the products, the money value of every soil must depend upon its own capability.

Method of Estimating Rent.—The fixed money-rent of arable land is estimated by taking the gross amount of corn the farm is capable of yielding, and the number of live stock it can dispose of in the course of a year; and deducting from the value of these at present market prices the expenses incidental to cultivation and the care and cost of stock, and a reasonable percentage on the capital to be invested, the remainder is the sum available for profit to the tenant and rent to the landlord.

The product is usually estimated according to the condition of the land at the time, and not what it may produce, or might have produced, by superior or inferior cultivation. If the farm is very dirty or reduced in condition, the rent may be fixed in accordance with what it may be estimated to produce in fair condition, and an allowance made for two or three years for putting into a proper state of fertility. This mode of estimating rent is applicable to carse farming, to town farms, to common farming, and to mixed husbandry.

The fixed money-rent of a pastoral farm is also estimated by the gross number of stock, whether of sheep or cattle, or of both, the farm can support in the course of a year, deducting the expenses attending the rearing of the stock, and a percentage on the capital invested in them.

Another mode of estimating rent is to pay so much money per head of the stock the farm will maintain.

The fixed money-rent of a dairy farm is also estimated by the gross amount of milk, butter, and cheese it will yield, and the live stock it will dispose of in the course of a year, deducting the expenses attending its management, and a percentage on the capital invested.

Another estimate of rent is to pay a sum for every cow the farm will support during the year—in which case the landlord has the farm in his own hands, and supplies the cows with food.

Term of Tenancy.—These estimates of fixed rent may be for a term of years or for a tenancy from year to year. Formerly the almost universal practice in Scotland as well as in the north of England, was to let farms upon leases of nineteen years' duration. This long term gave the tenant a feeling of security which he much appreciated. It enabled him to effect improvements upon his holding and recoup himself, or at least derive some benefit from them, before he could be disturbed in his tenancy. So long as prices of farm produce continued to rise or maintain a high and steady level, the nineteen years' lease was in much repute. It has been said with some degree of truth that it was the "making of Scotch farming." Unquestionably it served well its day and generation. A change was at hand, however. The tide of prices turned, and the depression which set in in 1879 deprived the nineteen years' lease of the place which it held in the affection of Scotch farmers. Obviously with falling prices a long lease is a disadvantage to the tenant.

Occasionally a Scotch farm is still let upon a nineteen years' lease, but shorter terms are now the rule. Leases of fifteen or nineteen years, with mutual breaks at intervals of three or five years —by a year's previous notice in writing by either landowner or tenant—have become common in Scotland. In some cases the right to break at intervals is secured to the tenant only.

The prevailing custom in the midland and southern counties of England is still a yearly tenancy, with twelve months' notice to quit from either party. This custom has also taken root in Scotland, and with reasonable provision of compensation to the outgoing tenant for unexhausted manures and improvements, the yearly tenancies would grow in favour.

In Ireland the old-established customs have been upset by legislation which places the Irish tenant in an exceptionally advantageous position.

Produce-rent.—Were the value of farm-produce a fixed quantity, a fixed money-rent would undisputably be best for tenant and landlord. Prices, however, are liable to great fluctuation, and there has from time to time, especially in periods of depression, been much discussion as to the propriety of introducing some sort of "produce-rent,"—a rent equivalent to the current market value of so much of the produce of the farm—a rent regulated by a scale which would slide up and down with the fluctuations of prices.

In theory this system has much to commend it, but it is difficult to carry into practice. Indeed a thoroughly workable plan of determining produce-rents has never yet been elaborated. The prices of grain have long been accurately ascertained and recorded, but it is not so with the prices of live stock and dead meat. And it is necessary for the perfect working of the system that the prices of the entire produce of each farm should be taken into account. Moreover, the fluctuations in the cost of manures, feeding stuffs, and labour, as well as the prices of produce, must be regarded; and with all these difficulties in the way, it is not surprising that in practice the system of produce-rents has made little headway.

Sliding Scale.—By the "sliding scale" system the plan adopted is to take the average price of produce at entry and the price current when a change in rental is desired, and upon the basis thus obtained calculate the fair rent. The following is an example for a farm of £500 rent at entry, worked in the fifth shift, the rent being allocated as under:—

	Price at time of entry. s.	d.	Price at time of re-valuation. s.	d.
£200 on oats and barley	29	6 per qr.	20	0
£100 on hay	105	0 per ton.	60	0
£100 on potatoes	95	0 "	40	0
£100 sheep and cattle	77	0 per cwt.	60	0

The new rent is worked out by simple proportion, as under:—

				£	s.	d.
Oats and barley	29½	: 20	: : 200=	£135	11	10
Hay	105	: 60	: : 100=	57	2	10
Potatoes	95	: 40	: : 100=	42	2	1
Sheep, &c.	77	: 60	: : 100=	77	18	5
Rent in 1890				£312	15	2
Do. in 1875				500	0	0
Reduction necessary				£187	4	10

The once common custom of *grain-rent*—the value of a certain quantity of grain—was long ago proved unsound in principle, and has been abandoned.

Mixed Rents.—As a compromise between the fixed money and fluctuating grain rents, the plan of paying one half in a fixed money-rent and the other in the current market value of so much grain was at one time largely resorted to. The following is an example of the working of this system: A rent estimated at £1000 a-year. The average price of wheat 40s., barley 22s., and oats 16s. per quarter, their cumulative values would be 78s. and average 26s.; and if 128 quarters of each sort of grain made up half the rent, the state of the rent would stand thus:—

The rent						£1000 0 0
In cash					£500 0 0	
In grain—						
Wheat,	128 qrs.	at	40s.	£256 0 0		
Barley,	128	"	22s.	140 16 0		
Oats,	128	"	16s.	102 8 0		
			3)78s.			
"	384	"	26s.	499 4 0	500 0 0	999 4 0

In future no change would take place in the £500 paid in cash; but the £499, 4s. obtained from the prices of the year, fixed the quantity of grain for that year at 128 quarters of each sort of grain, but which quantity would vary every year with the average prices. Or the conversion of the £500, half of £1000, into a grain equivalent may be done in this way: Suppose the £1000 a-year is 25s. for one acre, then 78s., the cumulative price of wheat, barley, and oats, : 8, the bushels in one quarter, : : 25s. : 2.564 bushels of each kind of grain, which, at their respective prices, give 24s. 11¾d. for one acre.

Interest, Profit, and Rent.—The rate of interest on money should enter as an element in the calculation of rent; and the rate of profit derivable from capital invested in a farm should be equal to that derivable from trade. A general rule is to reckon interest at 5 per cent, and the profit upon capital employed in farming should be at least 10 per cent.

Fixed Money-Rents.—The fixed money-rent is much more simple and workable than any sort of produce-rent, and practical men of mature experience rarely go far wrong in estimating what should be the rent of a farm well known to them. They estimate the amount of grain which the land will produce, and the quantity of stock it will support, in the condition they see it; and, calculating these at current prices, and having in view the cost of manures, feeding stuffs, and labour, they determine the rent which the farm can pay. While they estimate the rent in the existing condition of the farm, they judge whether it is capable of producing more by better farming, and this affords a latitude in the offer of rent to be made. Upon this uncertain element of their opinion, rents are too often offered beyond the value of the land; and when bad seasons occur, or prices fall, or the tenant proves an indifferent farmer, the rent is soon found to be too high.

Advantages of a Fixed Money-rent.—Besides greater simplicity the fixed money-rent has, in the opinion of many farmers, several other points in its favour. A fixed rent gives the tenant a setled conviction in his mind what he has to pay and the landlord what he has to receive. To a tenant certainty is a stimulus to exertion; uncertainty sets his mind a-wandering after what may be unattainable, or at least prove speculative and unprofitable.

Rent and Land Value.—When calculated in the manner described, rent may be regarded as the *natural* value of the land. It is based on the supposition that the land is worth the sum at the time of the estimate. It also takes for granted that the farm is complete in all its appointments—the house, the steading, the fences—and also that the land is in fair condition. It may also be regarded as a rack-rent—that is, the highest value the land can bear at the time. But when these appointments are incomplete—the house bad or awanting—the steading incommodious—the fences dilapidated, or the land in wretched condition,—the rent must be modified to suit the particular state of the farm.

Deductions for Deficient Appointments and Bad Condition.—What proportion of the rent ought to be deducted for a bad farm-house, a bad steading, bad fences, it is not easy to decide; but from 2s. 6d. to 5s. an acre may not be unreasonable. And for bad condition of the soil, from 5s. to 10s. an acre is not too great a deduction, since it may require from £5 to £10 an acre to put it into good condition.

"Covenanted" Rent.—The estimate of the deterioration by these exigencies, in the shape of pecuniary deductions, converts the rent into a *covenanted* one, and it assumes that same character when the tenant undertakes to build, or fence, or drain; but even when the landlord undertakes to supply these deficiencies, the rent is still a covenanted one, because of the percentage paid over and above by the tenant, as the deficiencies are remedied; but whenever the deficiencies are supplied either by landlord or tenant, the rent, including the percentage, becomes the natural rent—that is, the true value of the farm.

OFFERING FOR A FARM.

A common practice with candidates for a farm is to present to the landlord or his agent a written offer of the rent willing to be paid by them. Conditions accompany the offer when the buildings, land, or fences are out of order.

Ill-appointed Farms.—Farms are often presented in the market with the house in disrepair, the steading inadequate or incommodious, fences incomplete or neglected, and the roads in a bad state. No reasonable proprietor should expect a full rent for a farm in an incomplete state. If the buildings and fences are incomplete, it is but right either that the deficiencies should be provided or that the rent should be diminished as much as the interest of the money to be expended by the farmer to put the farm in order.

It is true, the landlord has a right to present farms to the market in any state he pleases; and it is also true, tenants take farms in any state of deterioration; but no conditions of a lease can guarantee the rent, or the respectability of the tenant. It is the true interest of every proprietor himself to put the farm-house, the buildings, fences, and roads in a habitable state before exposing farms to be let, and not to trust to tenants doing such works in a substantial manner. An incoming tenant may expect to find the *land* out of condition, and it is *his* duty to put that right; but the farm should be complete from the hands of the landlord, who will receive a rent in proportion to its state of completeness.

Essential Repairs.—The conditions in a lease may affect many subjects, but those which are indispensable are—the farm-house, which may require extensive repairs or additions to render it suitable to the nature of the farm—the steading may require additional accommodation for stock, which constitutes an important particular on most farms—the fences may require completing, partial renewing, or extensive repairs—and the farm-roads may require to be put into a state serviceable for the farm.

These subjects demand careful attention at the commencement of a lease.

If the offer has been estimated irrespective of these particulars, it is but right that the tenant pay the interest on the sum expended by the landlord to put them right; but when the rent is estimated on the understanding that the farm was in a complete state, the landlord must put it into that condition.

This is the ordinary state of a complete farm, but other conditions may be requisite—such as the thorough drainage of the land; the formation of a large drain or outlet for the drainage, where such is necessary; the improvement of waste land; the substitution of one power to the threshing-machiue for another—as steam or water for horse-power, when buildings have to be suitably changed.

Executing Permanent Improvements.—These constitute permanent improvements, and belong to the landlord to execute; but the tenant may be willing to undertake a share in them, and along with the landlord have them satisfactorily executed. In every case the tenant executes the carriage of materials. When the tenant has capital to pay for such improvements himself, there is no reason why he should not arrange with the landowner to do so; but to ensure his right to compensation on leaving the holding, the tenant should be careful to have the written consent of the landlord to execute these improvements.

It is a bad plan, however, for a tenant to cripple himself by expending on permanent improvements the capital which he would require for the proper working of the farm. These improvements should be executed by the landowner, leaving the tenant's capital free for his proper work of *farming* the land. Draining and improvement of waste land under a long lease often repay the tenant, just as he is repaid for the cost of mechanical power, which saves the wear and tear of horses and harness.

Considering Offers.—Offers are often received by the proprietor from any number of candidates that may choose to offer for the farm. When all the candidates are on an equal footing, as regards capital, skill, and respectability, the one who expresses the fewest wants and offers the highest rent is accepted as tenant. It is not probable that all the candidates, or any two of them, are equal in capital, skill, and respectability; but the rule seems to be, *cæteris paribus*, the candidate who is willing to take the farm as it stands, and offers the highest rent, is sure of being accepted. The accepted offer is intimated to the successful candidate by letter from the proprietor or his agent.

Objections to "Offering" for Farms.—We have always been of opinion that the mode usually chosen by proprietors to present their farms to market is objectionable. The mode is this: When a farm is free for a new tenant, the circumstance is advertised in the newspapers. To this proceeding there can be no objection, since no better mode exists of giving publicity to the fact. In the advertisement is announced that *offers of rent* for the farm will be received until a certain day.

This is objectionable, inasmuch as it puts the farm up to *private* auction—one candidate being pitted against and bidding over others in the dark. In a *public* auction, competitors hear the biddings announced as they are made, and the successful competitor bids the highest price and gets the article. This is fair and above-board.

In a private auction, no candidate knows the offers made by others, nor whether any or what conditions are annexed to them, nor how much the accepted offer is above the next highest. Every candidate is purposely kept in the dark and in suspense, and the unsuccessful ones learn by public report the issue of the concealed contest.

During the period of concealment, undue influences may be exercised in favour of one or more of the candidates, one of whom may possess capital and skill, another may be an adventurer who wishes to have possession of the farm.

In thus accepting valuations of rent, proprietors virtually yield the power of valuing their own properties to other parties—implying that they are themselves incompetent to value their own land: implying that a stranger from a distance, who knows little or nothing of the soil of the district, of its farming, its climate, is more competent to value his land than himself or the tenant who has lived upon it for years.

It is grievous to see proprietors acting as if they did not know the value of their properties.

In every other business—and proprietorship of land is a business—the disposer of goods puts a value upon them, and when he finds he cannot procure a purchaser at the price he has fixed, he lowers it to suit the public demand; but he rarely asks his customers what price *they* will give for his goods.

That something is consciously wrong in the system is evinced by the notice appended to the advertisement that the highest offer may not be accepted. If the system is really good, the highest offer ought, in justice to the offerers, to be accepted.

Landowners "asking" Rent.—A far more dignified and better course for a landed proprietor to pursue is to put a rent on the farm, which he is sure any industrious and skilful tenant could fairly pay, and add such conditions of lease as will protect the farm from a greedy tenant, while affording ample liberty to the skill and judgment of a liberal tenant, and then invite farmers to become candidates, not as valuers of land, but as capitalists who can stock the farm, as farmers who can manage land skilfully, and as men who have respectable characters,—and from them select the one who has the most capital, the best skill, and the greatest respectability.

With the land valued in this way, instead of the prevailing auctioneering system, we are persuaded that better farming would ensue, a more respectable class of tenants be established, rents be more easily and surely paid, and a greater cordiality promoted between landlord and tenant.

English Custom.—This system of the landowner or his agent deciding upon the rent to be accepted, and at once openly stating it to candidates for the farm, is extensively pursued in England, but very rarely in Scotland. On many English estates it is the custom to treat with each candidate as he makes application, informing him of the rent desired and the conditions of tenancy, considering his qualifications as a tenant, and accepting or declining his application before another candidate is admitted for actual negotiation. If the rent asked cannot be obtained in this way an "offer" may be received, and the rule on the best-managed estates is to accept or reject one offer before receiving another.

CONDITIONS OF LEASE.

Most farms, when entered into, are in an incomplete state. Farms get out of repair by long use. There is no time for making repairs between the new tenancy and the old, and there is no use of requiring the outgoing tenant to make repairs, as the incoming tenant may require both repairs and additions different from the actual state of the farm.

Covenants or conditions are required in leases to determine whether the landlord or tenant is to put the farm into a complete state.

On large properties the terms of lease are printed, and a copy given to those inquiring for the farm. Should any of the terms be deemed objectionable, they are commented on when the offer is given in, and the desired alterations indicated.

On small properties, the conditions are obtained verbally or in writing from the proprietor or his agent.

Adventurous Offerers.—Precautions are required between strangers—for there are candidates for farms who are as unprincipled as to offer any amount of rent, and accept any conditions of lease, to get possession of a farm in good order; and on having reaped the first crop, and the rent-day arrives, give much trouble to the landlord in demanding a reduction in the rent, or extensive repairs, or additions to buildings. Hence the utility of previously inquiring into the character of candidates, and selecting persons instead of accepting high offers of rent. When a landlord lays himself open to such annoyance, he proves that he was more desirous of obtaining a high rent than a respectable tenant, and has himself or his agent to blame.

Care in Drafting Conditions.—Most farm leases we have seen are far too elaborate and too strict upon the tenants. Respectable tenants, who know their business, and desire to pursue it in a proper manner, do not need to be hemmed in on all sides by legal provisions. Yet while human nature is as it is, certain conditions of tenancy will be necessary in all bargains extending over a number of years. Conditions concocted by legal advisers for a whole estate are unsatisfactory, simply because they are inapplicable to the nature of every farm. Each farm should have conditions suited to itself—to its soil, its situation, and state it is in; and then, although the conditions may be rather strict, a good farmer will accept them, knowing that restrictive conditions, like penal laws, are applicable only to offenders.

The conditions of a lease are soon adjusted if both parties are desirous of meeting on fair terms. But in many cases, after the rent has been accepted, and the conditions unobjected to, the candidate afterwards proposes other conditions, which he thinks may mitigate the consciously high rent he has offered. In this manœuvre he often deceives himself.

Fair Conditions.—Fair conditions are these: Allowances for draining are stipulated for, and are a proper subject for negotiation when the farm requires it. The steading requires more extensive repairs than the outgoing tenant was bound to make; and even additions and alterations are necessary, such as the removal of the horse-course, and the erection of a boiler-house and chimney-stalk, of a steam-engine for the threshing-mill, or the construction of a dam for a water-wheel. A new or an extended set of feeding-boxes may be required. The courts should be roofed wholly or partially, and fitted up with turnip-troughs around the walls for young cattle. Hay-houses may have to be erected; and rain-spouts put round the eaves of the houses.

Although the outgoing tenant is bound to leave the fences in tenantable repair, a new fence may be wanted across a field to make it smaller, or along the side of a wood or public road—and it should be kept in view that the "tenantable condition" in which the outgoing tenant has to leave fences, &c., is merely tenantable condition, less ordinary tear and wear or natural decay, so that the incoming tenant may not be justified in accepting from the landlord such fences, &c., as in a condition to last his lease. A farm-road is required for access to certain fields, which cannot be reached but by trespassing through other fields. An embankment is required along the side of a rivulet which occasionally overflows its banks and damages the crops of a haugh, or the lower parts of several fields. A watering-pool is required in some of the fields.

All these changes, being of a permanent character, ought to be undertaken by the landlord, and should be stipulated for in the offer, and not afterwards. When demanded afterwards and acceded to, injustice is done to the other offerers. Had they, when they gave in their offer, understood these would be conceded, they would all have been placed on the same footing, and might have given a higher rent; but it is scarcely fair towards them to make large concessions afterwards to one party.

Owner's Rights reserved.—In leases the landlord reserves for himself the right of opening quarries or mines, of making new roads, of entering into woods through fields, and of doing anything on the farm for the benefit of the estate, with the proviso of giving compensation to the tenant where his crop or land is injured. Cutting down woods sometimes does grievous harm to a farm by depriving some part of it of shelter, and in this case a reduction should be made in the rent.

Game Reservations.—Reservation may also be made for hunting and shooting game for the landlord and his friends. The question of damage by game has often caused heart-burnings between landlord and tenant; but most of this has been obviated by the Ground Game Act, which gives the tenant an inalienable right to destroy ground game upon his land.

Farmers are enabled to obtain compensation from the landowners for damage done to their crops by game.

Rent-day.—The dates at which rent is paid are specifically mentioned in the lease. The most convenient times for the tenant are Candlemas and Lammas—February and August. By Candlemas the farmer has had time to dispose of a great part of his corn; and by Lammas he has sold off his fat cattle, sheep, and wool. Both terms being intermedia between Whitsunday and Martinmas—May and November—when the half-year's wages of farm-servants, field-workers, and labourers become due, the farmer escapes large demands at one time. Still, in Scotland farm rents are generally paid in May and November. In England rents are usually paid at Lady-day and Michaelmas—April and October.

Stamping the Lease.—"A minute of lease, like missive letters, must be stamped before action will lie; and it is recommended that, before possession, a formal lease shall be executed."

Conditions of Cropping.

Injurious Restrictions.—It was at one time almost the invariable practice, and it is still the general rule, to tie down the tenant to certain courses of cropping by conditions in the lease or agreement of tenancy. Stringent conditions upon this point may be detrimental not only to the interests of the tenant but also of the landowner himself.

Restrictions may have been necessary when miscropping was the order of the day, and when neither rotation of crops nor manuring were properly understood or practised.

Now, however, with the great progress in the science and practice of manuring, the old-fashioned restrictions on cropping are entirely out of place.

Freedom of Cropping.—It has been pointed out in the chapter on "Manures and Manuring," Divisional vol. iii. p. 88, that in so far as concerns the mere question of the fertility of the soil, the tenant, by making use of the facilities at his hand for manuring the soil, may now with impunity grow what he pleases, and sell what he pleases. Thus the landowner may now with safety give his tenant absolute freedom of cropping, qualified by the two conditions of keeping the land free from weeds and applying proper and adequate manure.

It is known with sufficient precision the quantities of the various elements of plant-food removed from the soil by the different crops. The fertility of the soil will therefore be guarded by conditions requiring the tenant to apply such manures at such times as will adequately and timely recoup the land for what he has taken from it.

Good Husbandry.—This is practically freedom of cropping, subject to the "rules of good husbandry." These rules, which are of course unwritten, may be somewhat variously construed; yet to experienced and intelligent farmers they are well enough understood. Sometimes they are read as meaning "good husbandry" in accordance with the prevailing customs of the particular district. This, however, is a narrow and improper view to adopt. "Good husbandry," in so far as concerns the interests of the landowner, embraces every kind of husbandry, be it common or uncommon, which can be, or is, pursued without in any way, or to any extent, impairing the fertility or deteriorating the value of the land. It is thus easy enough for practical men to determine when a tenant has overstepped the boundary-line of "good husbandry," within which the most enterprising tenant will have all the scope and freedom he can reasonably, or advantageously for himself or others, desire to have.

The practice of letting farms "with freedom of cropping, subject to the rules of good husbandry," is growing in favour, and has certainly much to commend it.

Reasonable Restrictions.—But, with every desire to allow reasonable freedom to the tenants, many landowners think it advantageous, in order to avoid differences, to lay down in plain words certain restrictions upon the system of cropping to be pursued. When the sole object of the landowner is to prevent the deterioration of his property, and not in any way to unduly limit the freedom of the tenant, it is easy to frame such conditions as will be satisfactory to all parties.

Adapting Conditions to Different Farms.—It is unquestionably desirable that such conditions of tenancy as are enforced should not be applied indiscriminately, but should be drawn up so as to suit each individual farm. Inattention to this principle, and adherence to stereotyped conditions, result in many a farm being ill farmed, as well as in disappointment and loss of capital to many a good farmer. Such conditions are usually found on estates where the factor is a lawyer or has little or no practical knowledge of farming, for an agent who has extensive practical knowledge of farming is well aware of the absurdity of such a system.

A weak soil cannot endure the cropping of a strong soil, nor a deaf soil support stock like a sharp soil; each requires different treatment. Why, then, should they be placed under the same conditions? Similarity of conditions is a simple-looking mode of placing all the farms alike on an estate; but in the variety of farms, the similarity in conditions of lease or agreement evinces a want of judgment and discrimination on the part of the author of the conditions.

Let a good farmer exercise his skill according to the nature of the soil; and the improvement of the farm is the best proof that the rotation followed is the best for the farm. But, says an owner who takes a narrow view of the subject, liberty cannot be granted to one tenant without extending it to all; and in that view the skill of a superior tenant is cramped for the sake of maintaining a check upon an unskilful one.

Far better let the skilful tenant be encouraged, and the slovenly one kept under restrictions, by a thoroughly practical agent, than follow a generally depressing system.

The desirability of discriminating the capabilities of farms, and selecting the tenant for his skill and not for high rent, is surely apparent.

Successive Corn Crops.—It is a common practice to introduce into leases or farm agreements a clause prohibiting the tenant from taking two corn crops in succession on the same land. If this condition be observed, land under tillage will not be very readily exhausted. Green crops or grasses and clovers would thus come between the corn crops; and it is well known that root crops will not grow without the direct application of manure.

But while this is, as a rule, a safe measure, it may, if stringently enforced, operate injuriously upon the tenant. The clause should be amended to read that "two corn crops shall not be taken in succession upon the same land, unless the land receives at the time an adequate supply of appropriate manure." If the tenant apply to the land directly and immediately such a dressing of manure as will restore all the fertility the second corn crop withdraws, there is no good reason why he should be prevented from growing a second corn crop. Indeed, if he is sufficiently liberal and judicious with manure and careful as to tillage, he should not be restricted as to the number of corn crops taken in succession, for, as has been well shown in the chapter on "Manures and Manuring" (Divisional vol. iii.), and elsewhere in this work, it is entirely a question of manuring, backed up by skilful and careful tillage.

The growing of two grain crops in succession has been encouraged by the larger area laid down to grass, and by the use of artificial foods. The decrease of arable land tends to curtail the supply of straw, and to make up for this some farmers grow two grain crops in succession.

Disposal of Produce.—In many cases, tenants are prohibited from selling hay or straw to be removed from the farm. This is a remnant of an age and of a condition of matters that long ago ceased to exist. When the farm was entirely or mainly dependent upon the manure made from the consumption of its own produce, it was assuredly prudent to protect it from undue exhaustion by the removal of such raw material as hay and straw.

Now, however, that the supply of extraneous manure is both abundant and cheap, there is no longer any reason why a tenant should be prevented from selling any portion of the raw produce of his farm, if he should find it more profitable to do that than to consume it on the farm.

If any condition whatever is to be enforced as to the disposal of hay or straw, it should be qualified by a clause empowering the tenant to sell and cart away the produce, on the understanding that he brings on to the farm appropriate manure equivalent to the manurial value of the hay or straw removed.

Indeed, with a stipulation to this effect —that is, that any consequent manurial loss shall be made up in purchased manures—the tenant should be allowed unfettered freedom as to the disposal of the produce of his farm.

Manuring.—It is probably right that, especially in the closing years of a tenancy, the landowner should have some check upon the tenant both in the applying and in the withholding of manure.

It is well known that, by the application of an excessive quantity of such manure as nitrate of soda, a tenant may seriously impair the natural fertility of a soil. Such treatment would certainly not be in accordance with the rules of "good husbandry," and under that general condition the landowner would be entitled to redress.

Some think it better, however, to guard against the exhaustion of the soil by stimulating and one-sided manure, by providing in the conditions of tenancy that during the last three, four, or more years of the tenancy the dressings of manure shall conform to a certain standard, embracing in appropriate quantity and due proportion all essential manurial elements required to be applied to such soil.

With the right of compensation for unexhausted manures now secured to him, a condition to this effect, reasonably framed, should not inflict any improper hardship upon the tenant, while it would tend to maintain the natural fertility of the land.

Leaving the Farm in Rotation.—An important and knotty point in farm and estate management is the question of the rotation in which the farm is to be left by an outgoing tenant. Even where absolute freedom of cropping is given to the tenant during his tenancy, it is customary to require him, in the event of his giving up the farm, to leave it in a certain definite rotation, with so much of the land in grass of certain ages, so much set apart for green crop, and so much for corn crops.

What the particular rotation to be stipulated for may be will depend mainly upon the custom of the district and the kind of farming for which the farm and locality are best adapted. It is prudent to be guided in this matter by local custom, for, as a rule, it may be accepted as upon the whole the best. Yet upon estates under enlightened management, the rules as to "retiring rotation" are neither hard nor fast. If a tenant has shown that a certain farm can be worked to good advantage upon a system of cropping different from that prevailing in the district, different perhaps from that stipulated for in the conditions of tenancy, a prudent estate manager will not be so unreasonable as to grumble if the tenant should leave the farm in that rotation—that is, if the peculiar rotation is not of a kind that will injuriously affect the letting of the farm.

The object of the condition providing for the leaving of the farm in a certain rotation is perfectly sound and reasonable. Unless the farm is left with a fair proportion of grass, root, and corn land, the incoming tenant may be seriously handicapped and hampered in his initial efforts, while the letting value of the farm may be sensibly reduced.

This is one of the many points connected with estate management which demand the exercise of practical experience, mature judgment, and sound common-sense. Each individual case should be judged upon its merits. The letter of the law should be enforced only when necessary to protect the legitimate interests of the landowner. The universal, indiscriminate application of cast-iron, lawyer-made regulations to all sorts and conditions of farms and farmers cannot fail to be often the cause of unnecessary hardship upon tenants who deserve better treatment.

Weed-cleaning.—On all well-managed estates emphatic conditions are laid down as to the destruction of weeds. Not a word can be said against the stringent enforcement of these conditions, for the suppression of weeds is as desirable in the interests of the tenant as for the sake of the landowner. Not only should the green crop break be thoroughly cleaned of weeds, but on the pasture-land, roadsides, and every odd corner, rag-weed, thistles, and other weeds should be timely cut down. By the accumulation of weeds many farms have been for years seriously reduced in value. Landowners are assuredly well entitled to protect themselves from losses arising in this way.

Pastoral Farms.—There being no rotation of cropping on a pastoral farm, except on the small portion of ground available for culture, the duration of the tenancy varies greater than with arable farms. As a rule, the leases on pastoral farms have never been so long as for arable farms, there being a mutual desire between landlords and tenants to adjust rents according to the prices of stock and wool every seven to fourteen years.

Penal Clauses.—Penal clauses are inserted into every lease and farm agreement, and seem fair for the protection of the landlord. In cases of miscropping—taking two corn crops in succession without purchasing the manurial equivalent—a penalty of £5 or £10 for one acre, over and above the rent, is provided—a large fine being requisite in this case, otherwise the advantage gained by miscropping might be considerable.

Removal.—An obligation is made imperative upon the tenant to remove from his farm at the time specified in the lease, without the exhibition of legal instruments of dismissal; otherwise the ejectment of a tenant reluctant to leave his farm might be attended with much trouble and considerable expense.

Subletting.—Subletting a lease to another party is usually prevented, as is also its assignation to trustees for behoof of creditors.

Irish Customs.—In Ireland judicial rents and statutory terms of tenancy were introduced by the Land Act of 1881.

Feudal Customs.

In old leases still nominally, if not actually, in existence on some estates, there are found many trifling conditions indicative of the spirit of feudalism. One of these is the payment of *kain* or *cane* fowls, a custom long ago abolished. Personal services, as driving coals or cutting peats for the landlord's use, were also provided for. Drawing coal was a convenience for a landlord who had no work-horses of his own, and was regarded as trivial by the tenants if demanded at a time when field-labour was not urgent.

Land Burdens.

In Scotland the public burdens on land are paid chiefly by the proprietor. In England the public burdens are paid by the tenants. Of the two methods, the Scottish is much the fairer for both parties, it being no more than reasonable that the proprietor should pay the burdens of his own land.

When the tenant is not annoyed by the payment of public burdens, the landlord takes that into account on determining the rent, and so does a tenant when he offers for a farm. When burdens are paid by the tenant on stipulation, he does so for the convenience of the landlord, who deducts the payments from the rent. Some of the public burdens are paid partly by the tenant and partly by the landowner.

COMPENSATION FOR IMPROVEMENTS.

For many years an excited agitation was maintained for legislative recognition of the tenant's right to compensation for unexhausted improvements. The right claimed was, that when a tenant laid out money upon his landlord's land, which has obviously improved it, he shall have the power to make his landlord reimburse him the amount when he leaves the farm. For example, if he laid out money in erecting buildings, forming fences, making farm-roads, draining, liming, manuring, and so forth, he shall be reimbursed for the unexhausted value of one and all of these improvements at the end of the lease.

It was at last generally conceded that the claim was a reasonable one, and its justice was recognised by the Agricultural Holdings (England) Act, 1883, which provided compensation to the tenant under certain restrictions.

For "permanent improvements," such as reclamation of waste land, buildings, road-making, fencing, and draining, this Act gives the outgoing tenant compensation only when he had obtained the previous written consent of the landowner to their execution. No such consent is required to obtain compensation for liming, manuring, and the consumption of purchased foods on the holding; and for the unexhausted value of these, the outgoing tenant, both in England and Scotland, has now an inalienable right to compensation.

In Ireland, by the different Land Acts, the tenant is placed in a still more advantageous position.

ENTERING A FARM.

Scotch Custom.—The usual times of entry to farms in Scotland are at Whitsunday and Martinmas, or at the separation of the crop from the ground. These terms of entry are not equally favourable for the tenant in every species of farming.

Whitsunday Entry.—Entry to the houses and grass at Whitsunday is convenient for a tenant practising mixed husbandry, as it enables him to sow turnips for his stock in winter. Were he to enter wholly at the separation of the crop from the ground, he would have no turnips for his stock but what he purchased, either from the way-going crop on the farm or elsewhere. Entire entry cannot be given to any incoming tenant at Whitsunday, as he cannot enter the ground on which the way-going crop is growing.

Martinmas Entry. — The entry at Martinmas enables the incomer to plough the stubble-land in time for the ensuing green crops. Entire entry at the separation of the crop from the ground is convenient for the tenant who breeds no live stock, as he can purchase them for winter, according to the opportunity afforded him to purchase straw for litter and turnips for food, either from the way-going crop on the farm or elsewhere.

The carse farmer, and he in the neighbourhood of towns, would find this a convenient term of entry.

A dairy farmer finds it most convenient to enter at Whitsunday, having the grass in summer and turnips for winter; and so does the pastoral farmer, whether his stock be of cattle or sheep.

Convenient times of entry for all sorts of farmers is to the houses and grass at Whitsunday, and to the land at the separation of the crop from the ground.

English Custom.—In England the times of entry vary much in the different counties. A common entry is at Old Lady-day to the houses and grass, and to the rest of the land at Michaelmas; but entry is also given as soon as Candlemas in some districts.

Candlemas Entry.—With entry at Candlemas the new tenant lays down the entire crop of that year, and as the retiring tenant has already utilised the crop of the previous year, there is in this case no way-going crop to be dealt with.

Way-going Crops.—The way-going crop of grain (the property of the outgoing tenant) may be left with the incoming tenant, who has to take it at mutual valuation (made by one valuator mutually chosen, or by two valuators and an oversman just before harvesting), or it may be sold privately or by auction to the highest bidder.

Steelbow.—Where the steelbow principle is in operation, the outgoing tenant must leave the straw on the farm. In other words, the grain, but not the straw of the last crop, belongs to him. "By a declaration that the straw and manure are steelbow, it is assumed that they are given by the landlord, and are to be returned to him; or, what is equivalent, delivered to the incoming tenant, to whom the landlord has conveyed his right to them. A sufficiency of manure, and of the materials for its formation, are thus permanently retained on the farm."[1]

The steelbow is a great boon to the incoming tenant, it being equivalent to his possessing as much more capital, at the entry to his farm, as the straw and dung he receives are worth in money — for without it he would have to purchase both somewhere.

Selling Way-going Crop. — When the way-going crop is disposed of by public sale as it grows, the sale takes place a few days before the crop should be cut down. For the convenience of purchasers, the fields may be divided into lots comprehending two or more ridges, according to their length, each containing perhaps from 1 to 5 acres.

As oats and oat-straw are the most useful sort of crop to purchase, the waygoing crop consists as much of that species of corn as practicable.

Disadvantage of the Selling System.—It is obvious that the incoming tenant has no more chance of securing a part or whole of the crop than any other person; and should it fetch higher prices than he is disposed to give, he will have to purchase straw elsewhere. In any case he is obliged to purchase corn, for the sake of securing the straw upon which it grows, and of which he is at the time much in want.

[1] Hunter's *Law of Land and Ten.*, 264.

The practical effect of this system upon the incoming tenant is, that he must possess capital to purchase as much straw as his stock will require in winter, and as much manure as will do justice to the land in summer. Its effect upon the farm is, that should the incoming tenant not have capital beyond the stocking of the farm, he cannot purchase a sufficient quantity of straw and manure; and both his stock and land must suffer privation to that extent. True, he can bring his own way-going crop from the farm he is leaving to the new farm; but unless the two farms are very near, it would be impracticable to carry a crop at a season when everybody is too busy to give him any assistance.

Some leases provide that the outgoing tenant is obliged to offer one-half the crop on valuation to the incoming tenant, or the landlord—and should either refuse the offer, he is at liberty to sell it. In other cases, a private agreement is made for the whole crop between the incoming and outgoing tenants, irrespective of the lease or a sale. The purchaser bears the expense of cutting down and carrying away the part of the crop he has purchased.

In any case, the incoming tenant is placed in a worse position by this than by steelbow, which is a principle that might with advantage be adopted as regards straw and dung on all arable farms except those near towns.

Valuing Crops.—Between incoming and outgoing tenants the value of the crop as it stands depends on the price likely to be obtained for the grain in the market in the ensuing winter. The incoming tenant who enters as a beginner, will consume much of the oat crop in supporting his men and horses, and in sowing the oatbreak of the succeeding crop.

The crops are estimated by the acre, and after deducting the expense of reaping, carrying, stacking, and threshing, the value per acre of the corn becomes known; and that of the straw is so much per quarter of corn.

For example, the crop of wheat is estimated at 4 quarters per acre, and is worth 30s. per quarter; and the straw 12s. per quarter: the value of an acre will stand thus:—

	s.	d.	£	s.	d.
4 qrs. wheat at 30s.			£6	0	0
Straw, 14s. per qr.			2	8	0
			£8	8	0
Deduct reaping per acre	10	0			
" carrying "	6	0			
" threshing, 1s. per qr.	4	0			
			1	0	0
Value of the crop for 1 acre,			£7	8	0

In like manner with other sorts of grain. The value of oat-straw may be taken at 10s., and of barley-straw at 8s. per quarter.

Overlapping of Outgoing and Incoming Tenant.—Whenever the way-going crop is sold on its foot, and it has been cut down and removed by the purchasers, the outgoing tenant takes his departure, and the incoming tenant enters and ploughs the stubble-land. But when the straw is held in steelbow by the farm, the outgoing tenant has a right to be accommodated in the stackyard and the steading until the crop is threshed and delivered, for which purpose he must have the control of the threshing-mill, as much of the work-horse stable as will house as many horses as the threshing-mill requires—and if it be moved by power, as many as will take the grain to market; and as many cottages as should be occupied by 1 man and at least 3 women, to take charge of the crop for threshing and sending it to market.

It is provided in leases on many estates that the outgoing tenant must not thresh his crop faster than the incoming one can consume the straw with his stock, to save it from waste; and that the incoming tenant must not use the straw more slowly than will allow the outgoing to clear the stackyard by the Whitsunday following, when he leaves the farm entirely by giving up the keys of the corn-barn, and withdrawing his work-people and horses from the houses and stables.

Immediate Threshing.—A much simpler method is for the outgoing tenant to thresh out the entire crop as soon as it is ready for stacking. If the straw is carefully stacked, it will keep as well as in the unthreshed stacks, and the outgoing tenant can store or sell the grain at once as he may think best.

Not unfrequently the incoming tenant undertakes for the outgoing the threshing and delivering of the crop to market on payment for the trouble.

Fences and Houses.—There are always questions of minor magnitude, though of importance, to be settled between the landlord or incoming tenant and the outgoing tenant. These include the state of the fences, of the gates, of the steading, and of the dwelling-houses, all of which the outgoing tenant may be bound by his agreement to leave in tenantable repair—less ordinary tear and wear, in most, but not in all, cases.

The most pleasant way of ascertaining the facts connected with these subjects is by *arbitration*, undertaken by competent and experienced men mutually chosen by the outgoing and incoming tenants, with power to the arbiters to appoint an oversman, in case of a difference of opinion arising between them.

When the fences and buildings are obviously in a tenantable state of repair, the business is soon settled; but when otherwise, the arbiters may perhaps appoint tradesmen, acquainted with the respective sorts of works, to inspect the state of the particulars under arbitration, to calculate the costs of repair, and to report their opinions in writing, or give evidence before the arbiters.

The decree of the arbiters containing their awards results in the outgoing tenant paying the expenses of repair to the incoming, who has the repairs executed, and who in his turn becomes obligated to leave the same articles in a tenantable state for his successor.

Repairs and Renewals.—On many of the best-managed properties the tenants' obligation in regard to houses and fences require them merely to execute trifling repairs, such as renewing a broken pane of glass, putting on a hinge on a door or gate, tightening wire, or mending a gate or door. If a house or a fence is so far decayed by tear and wear as to be untenantable, the duty of renewing it devolves upon the landowner. This is as it should be; for, properly speaking, it is no part of a tenant's duty to renew what has been exhausted by ordinary tear and wear.

These are the ordinary subjects of arbitration; but any other subject, such as the value of the way-going crop, may be arbitrated by the same parties.[1]

Adjusting Farm Labour.

The greatest difficulty which the young farmer experiences, on assuming the management of a farm, is in *distributing* and *adjusting* labour. To accomplish these correctly, both as regards the work and the labourer, a thorough knowledge is requisite of the quantity of work that can be performed in a given time by all the means of labour, animate and mechanical, which he possesses. It is the duty of the young farmer to acquire this knowledge with all correctness; for by a skilful *distribution* of the workers, the work can be performed in the most perfect manner in regard to time —with the smallest exertion as regards physical force — and with the best condition of the soil in regard to texture; and a judicious *adjustment* of workers to each other places every one in the position to perform his own share of the work, and no more, with ease and comfort.

Good and Bad Management.—There are few things that strike a practical man more forcibly, in comparing the agriculture of England and Scotland, than the distribution of the work-people in the fields. In England it is not uncommon to see them employed in several fields of a farm at the same time, and the ploughs working scattered here and there. Now the great principle kept in view in Scotland, as regards the work-people, is to concentrate the energies of all on a particular piece of work.

Many operations require the conjoint labour of the teams and field-workers, and when so employed they are confined within a given space of the same field, that the work may be performed in as short a time as practicable; and it is not possible to accomplish this end unless the labourers, of whatever kind, are so distributed and arranged that one party takes the lead and clears the way for another to follow and finish, and that not one individual shall flag in the work. When labourers are scattered over different fields, doing different sorts of work, no emulation exists, and no effectual superintendence can be exercised;

[1] Parker's *Notes Law of Arbit.*

and the consequence is, less work is done, and done not so well.

The manipulation of farm labour is also defective in most parts of Ireland, where the methodical arrangement of the labourers in the fields seems to be imperfectly understood.

Valuing Sheep Stocks.

In the majority of cases either the landowner or the incoming tenant is bound to take over the sheep stock from tenants leaving sheep farms.

The price to be paid is usually fixed in one of the three following methods. 1. Two arbiters visit and examine the stock as to quality at Whitsunday, and fix the price after the October Falkirk Tryst. 2. The incoming and outgoing tenants choose an arbiter each, and these choose an oversman, who fix the price at Whitsunday. 3. The incoming and outgoing tenants choose a mutual arbiter, who fixes the price at once at Whitsunday. This last is the simplest and most natural plan.

In the case of two arbiters and an oversman being appointed, it very often happens that the oversman has most of the actual work to do, the two arbiters being inclined to act rather as advocates than as independent judges.

Excessive Valuations for Sheep.—There has been much discussion from time to time as to the excessive prices at which sheep stocks are often valued over to incoming tenants. It is argued with much truth that a good stock of sheep is worth more to the man who is to continue them on their familiar pastures than they are to any other buyer, and that an outgoing tenant, by being forced to dispose of his entire flock at a certain time in the open market, might sustain serious loss. But while there is much to be said on behalf of the outgoing tenant in this matter, it is unquestionably a much mistaken policy which saddles an incoming tenant with a stock of sheep which have cost him more than their intrinsic worth.

The interests of the incoming tenant are just as important, and as deserving of being safeguarded, as are those of the outgoing tenant; and if the system of handing over flocks by valuation is to be permitted to continue, valuators must be fair and reasonable to both buyer and seller.

STOCKING A FARM.

To convey a practical view of stocking a farm, we will enumerate the implements of husbandry and live stock requisite for a 5-course rotation upon a farm of, say, 500 acres. The *prices* of implements may differ at different places, according as they are purchased at sales or from implement-makers. The prices here noted down are those at Edinburgh in 1890, and it was necessary to name *a* price to make the statement intelligible. This is the statement of the stocking—the entry to the fallow-break being at Martinmas, and to the grass land and houses at Whitsunday, the incoming tenant thus laying down all the crops in his first year:—

11 Work-horses, from 4 to 6 years old, at £40 a-piece	£440	0	0
A brood-mare in foal	35	0	0
A harness-horse, 5 or 6 years old	30	0	0
Poultry	5	0	0
1 2-year-old colt or filly, for the draught	18	0	0
1 1-year-old colt or filly, for the draught	12	0	0
1 Shorthorn bull	25	0	0
10 Cross-bred cows, at £16 each	160	0	0
20 Cross-bred calves, part unweaned, at £3, 10s. each	70	0	0
20 Cross-bred 1-year-old steers and heifers, at from £7 to £9 each, say	160	0	0
120 Ewes and their lambs, at 60s. each	360	0	0
160 Ewe and wether hoggs, at 38s. each	304	0	0
2 Tups	14	0	0
2 Sows, 1 boar, and 4 shotts	10	0	0
14 Calves for rearing, at 35s.	24	10	0
6 Sets of work-harness, each set to contain the following articles: 2 Bridles, 2 collars, 2 cart-saddles and breeching, 3 back-bands, 2 pairs of long and 1 pair of short chains, 2 pairs of cart and 2 pairs of trace chains, 2 cart and 1 trace belly-band, 2 iron back-bands, 1 leading-chain and belt, 1 pair of cart-ropes, long and short cart and plough-reins, 2 nose-bags, at £10, 10s. each set	63	0	0
1 Set of gig-harness	7	0	0
Carry forward,	£1737	10	0

Brought forward,	£1737	10	0
Riding-saddle and bridle, and stall-collar	4	0	0
10 Whole-bodied single-horse carts, at £10	100	0	0
2 Tilt-carts, at £12	24	0	0
10 Frames for single carts, 22s. each	11	0	0
6 Stretchers for trace-horses, at 1s.	0	6	0
6 Iron ploughs, at £4, 10s.	27	0	0
2 Chilled ploughs for stubble and spring ploughing, at 75s. each	7	10	0
6 Slides for ploughs, at 2s. each	0	12	0
3 Iron double mould-board ploughs, at £4	12	0	0
2 Iron scufflers, at 45s.	4	10	0
5 Pairs of harrows, with master swing-tree, at 55s.	13	15	0
1 Carriage for harrows	3	0	0
5 Full sets of swing-trees, at 12s., and an extra one	3	12	0
3 Long swing-trees, for drilling, at 2s. 6d.	0	7	6
6 Feering-poles, with iron points, at 1s. 3d.	0	7	6
1 Pair of harrows for grass-seeds	2	10	0
2 Grubbers, at £7	14	0	0
2 Two-horse rollers, of metal, at £10	20	0	0
1 Notched drill-roller	6	0	0
1 Wheelbarrow	0	16	0
1 Broadcast sowing-machine	14	10	0
1 Drill-machine for sowing corn	22	0	0
1 Turnip double-drill sowing-machine	5	0	0
1 Three-row drill manure distributer	9	0	0
1 Drill-scarifier, for paring sides of turnip drills, &c.	6	0	0
9 Graips for dung, at 2s.	0	18	0
4 Spreading graips, at 1s. 6d.	0	6	0
7 Lime-shovels, at 3s. 6d.	1	4	6
2 Ditching-shovels, at 3s. 3d.	0	6	6
3 Ditching-spades, at 3s. 3d.	0	9	9
1 Hedge-spade	0	3	6
1 Dutch hoe	0	2	0
7 Stable-forks, at 1s. 6d.	0	10	6
2 Long forks, at 2s.	0	4	0
4 Half-long forks, at 1s. 6d.	0	6	0
4 Field and stack forks, at 1s. 6d.	0	6	0
3 Dung-hawks, 1 with 2 prongs, 1 with 3 prongs, and 1 with 4 prongs, for cow-byre, at 3s. 6d.	0	10	6
2 Mud-hoes, at 2s. 3d.	0	4	6
1 Metal trough for pigs, with divisions	1	1	0
1 Hedge-knife, large	0	5	0
1 Pruning-knife	0	3	0
1 Breasting-knife	0	5	0
1 Grindstone	0	15	0
1 Axe	0	3	0
1 Saw	0	5	0
1 Sledge-hammer	0	5	0
Carry forward,	£2057	19	9

Brought forward,	£2057	19	9
2 Hand-picks	0	12	0
1 Mattock	0	6	0
1 Iron foot-pick	0	8	0
2 Small stone-hammers	0	2	8
1 Iron lever and wedges	0	15	0
2 Tar-kits	0	5	0
2 Oil-tins	0	5	0
7 Cows' bands	0	7	0
1 Bull's chain	0	2	0
1 Imperial bushel and strike	0	18	0
2 Sowing sheets	0	4	0
2 Ruskies for carrying seed, at 3s. 6d.	0	7	0
80 Corn-sacks, at 1s.	4	0	0
2 Stable-pails, at 2s. 6d.	0	5	0
2 Horse-sheets, 1 at 20s. and 1 at 10s.	1	10	0
1 Set of phlemes, blood-stick, clyster-pipe, and drink-horn	0	6	0
1 Boring-rod and spirit-level for draining	1	0	0
3 Scythes for mowing grass, at 6s. each	0	18	0
8 Hay-rakes, at 1s. 3d. each	0	10	0
1 Horse hay-rake	8	10	0
1 Long ladder, 20 feet long, at 9d. per foot	0	15	0
2 Half-long do., 12 feet long, at 9d.	0	18	0
6 Short do., at 5s. each	1	10	0
1 Sheep-crook	0	3	6
1 Bathing-stool	0	10	0
2 Tubs for bath for sheep	0	15	0
2 Pair of wool-shears	0	5	0
1 Beam, scales, and weights, for wool	2	10	0
1 Buisting-iron and tar-kettle for sheep	0	3	0
2 Hangers, and skewers for sheep when slaughtered	0	2	0
2 Potato-graips	0	6	0
9 Baskets for potatoes, at 9d.	0	6	9
10 Turnip-hoes, at 9d. each	0	7	6
10 Weed-hooks for weeding corn, at 6d. each	0	5	0
4 Rope-twisters, at 6d.	0	2	0
2 Combined mowing and reaping machines, £16	32	0	0
2 Stubble-rakes for above, £2	4	0	0
2 Wooden hay-collectors, £1, 15s.	3	10	0
2 Hay-rick or corn-stack water-proof covers, 18′ × 18′, 60s.	6	0	0
1 Sheaf-binding harvester	40	0	0
1 Sheaf-carrier, for above	2	0	0
12 Vermin-proof iron corn rick-stands, 14 feet in diameter, at 90s.	54	0	0
1 Liquid manure chain-pump, 10 feet	3	15	0
1 Oil-cake breaker	4	0	0
1 Turnip-rammer, 14s., and trochar, 3s. 6d., for cattle	0	17	6
1 Turnip-cutter for sheep	4	0	0
1 Do. cattle	1	10	0
6 Turnip-pickers, at 2s. each	0	12	0
Carry forward,	£2244	13	8

	£	s.	d.
Brought forward,	£2244	13	8
6 Knives for topping and tailing turnips, at 1s. each	0	6	0
2 Hay-racks for sheep, at 55s. each	5	10	0
20 Sheep-troughs, at 6s.	6	0	0
300 Net-stakes, at 2½d. each	3	2	6
20 Sheep-nets, at 11s. each	11	0	0
1 Mallet for driving stakes	0	2	6
1 Driver for stakes	0	3	0
1 Hay-knife	0	3	6
1 Chaff-cutter	8	10	0
2 Stable-lanterns, at 2s. 6d. each	0	5	0
3 Others, 1 for steward, 1 for shepherd, and 1 for cattle-man	0	7	6
1 Horn for blowing at fodder-time	0	2	0
Threshing-machine, with hummeller, and bruiser, 6-horse water-power	140	0	0
If of high-pressure steam . . £210			
If of horse-power 120			
Dressing-fanners	8	0	0
1 Barn-steelyard and weights	4	5	0
1 Sack-barrow, with wheels	0	16	0
2 Handbarrows for lifting sacks of corn, at 7s. 6d. each	0	15	0
4 Barn weights for filling corn, at 1s. 6d. each	0	6	0
2 Oat wire-riddles, at 2s. each	0	4	0
2 Barley " at 2s. 4d. each	0	4	8
2 Wheat " at 3s. 3d. each	0	6	6
2 Sieves " at 2s. 6d. each	0	5	0
1 Slap-riddle, at 2s.	0	2	0
1 Barn-stool	0	3	0
1 Wooden hoe, for corn	0	1	0
2 Chaff-sheets	0	7	0
6 Barn-brooms	0	3	0
2 Corn-shovels, at 3s. each	0	6	0
6 Sack-needles and clew of twine	0	2	0
1 Meal-ark	3	0	0
6 Milk-tins, 2s. each	0	12	0
6 Small-beer barrels, 3s. each	0	18	0
1 Gantress for large beer-barrel	0	3	0
1 Hedger's axe	0	2	0
Total	£2441	6	10

In addition to this sum of £2441, 6s. 10d., there would be other substantial outlays during the first year, and before the tenant can have any stock or produce to dispose of. The chief of these items would be—manual labour for the year, amounting perhaps to from £430 to £500; artificial manures, say from £140 to £180; seed for the corn and root crops, from £130 to £150; grass and clover seeds, from £75 to £120; corn for the farm-horses, from £110 to £130; six months' hay for ditto, from £70 to £80; half-year's rent and taxes, &c., say £675; various, from £50 to £100; and household furnishings, which vary so much that no particular sum need be named. This would bring the tenant's outlays in the first year to from £4127 to £4382.

Capital per Acre.—The amount of capital represented above is from £8, 5s. to £8, 15s. per acre. In many cases much more would be required, in some cases even less would suffice. With a Whitsunday entry and the new grass to be taken at valuation, more capital is required than with a Martinmas entry.

The amount of capital which the tenant should have will depend largely upon the system of farming to be pursued. Grain-growing employs less than the rearing and feeding of stock, and some farms will of course carry a much larger number of stock than others. Every farm, therefore, must be judged by itself in deciding as to the amount of capital it may require per acre. For good mixed husbandry farms, from £8 to £10 of capital per acre would suffice. Where stock rearing and feeding, and more particularly dairying, are predominating features, from £12 to £20 per acre, or even more, may be profitably employed.

INSURANCE AGAINST FIRE AND DISEASE.

It is short-sighted policy in a farmer to neglect the insurance of his furniture, his stock, and his crop against destruction by *fire*. He should insure his entire furniture, as the chances are it will be consumed before the house is burned down.

The premium for insurance is now so moderate that no farmer should hesitate to provide himself with the comfort and safety which full insurance affords.

The tenant should covenant with the landlord for the payment of insurance on buildings—farm-house, steading, and hinds' houses—for they are the landlord's. The corn and live stock being his own, the tenant should pay for their insurance.

Live Stock and Fire.—We may here mention a pretty sure mode of taking horses out of a stable when it is on fire. The horse is so timid an animal at the sight of fire that he will rather remain in the stable than venture out of it; but if the man who goes to take a horse out of the stable would strip off his coat, or take a sack or chaff-sheet, and throw it over the horse's head, so as to blindfold him, he will easily lead the horse out by the head. Cows may be treated in the same manner, as they are accustomed to be led; but it is doubtful if feeding cattle would submit as easily.

Fire-extinguishers.—Several patent "fire-extinguishers"—liquid enclosed in small bottles to be dashed upon the flame—are now sold, and are found to be of great service in checking a conflagration at the outset.

It is a good plan to have a "fire-hose" with water-pails at convenient points in the steading, so that in the event of fire breaking out something effective might be done to check it.

Insuring Crops.—Farmers may also insure their crops against the loss incurred by *hail-storms*, but this is not done to any great extent. Sometimes hail does material damage in England, especially to the proprietors of hothouses; but in Scotland it is very seldom that serious loss is sustained from this cause.

Live Stock Insurance. — Excellent facilities are now afforded farmers for insuring their live stock, not only against fire, but also against loss by disease and accident, as well as against foaling and calving risks. Several enterprising companies have devoted special attention to live stock insurance, and the terms offered to farmers are very moderate. He is a prudent farmer who provides ample insurance protection against fire, disease, and accident.

Cow-clubs.—Cow-clubs are a sort of mutual insurance against loss. They were established and are supported by labourers and hinds who possess cows, and to whom the loss of their cows by calving or disease would be a very serious matter.

The following are the rules of the 'Brocklesby and Little Lumber Cow-club': The object of the club is to secure each member, by a system of mutual assurance, from sustaining individually the whole loss arising from the death of a cow—the loss being thus divided amongst all the members. Rules: A treasurer to be appointed, who shall conduct the business of the club, and with whom shall rest the decision as to the admission of members. Each member to pay to the treasurer, on the first Saturday in every calendar month, his subscription (in advance) of 1s. for each cow he may have entered. Any member whose cow shall die to be entitled to receive from the club the sum of £10. No allowance to be made to any member in respect to any cow above 12 years of age. When a cow dies, the skin to belong to the owner of the cow; but if the carcass can be sold, the money to be paid to the funds of the club. If a cow dies in calving, the calf to belong to the owner of the cow. Any member neglecting to pay his subscription for three successive months to be deprived of all benefit from the club, and to forfeit what he may have previously paid. Any member leaving the district, or ceasing to keep a cow, to be entitled to receive from the treasurer his proportion of the funds then in hand, after deducting therefrom £20, which was given by Lord Yarborough to the funds on the establishment of the club. A new member to pay on his admission, for each cow he may enter, such a sum as may be the proportion of the general funds to which each cow in the club would be entitled, after deducting therefrom Lord Yarborough's subscription of £20. If the funds in the hands of the treasurer shall at any time not be sufficient to pay the allowance for any cows that may die, the members immediately to make up the deficiency. The monthly subscriptions to be discontinued at the discretion of the treasurer, whenever he shall consider the funds in hand sufficient as a guarantee, until reduced by deaths or otherwise. On the first day of January in every year the treasurer to make out an account, showing his receipts and payments during the preceding year, and the balance remaining in his hands, and cause the same to be printed, and a copy supplied to each member.

Mutual Insurance against Disease.

An admirable example of the benefits which farmers may secure for themselves by a system of mutual insurance against loss in live stock by disease is afforded by the means which the farmers of the Rhins of Galloway protected themselves from the ravages of pleuro-pneumonia and cattle-plague.

This successful scheme of mutual insurance is fully described in the *Transactions of the Highland and Agricultural Society*[1] of 1890, by Mr W. H. Ralston, Culmore, Stranraer; and as the system is one which deserves the consideration of farmers in other parts of the country, and which seems capable of extended operation, we take the liberty of producing here the greater part of Mr Ralston's paper, as follows:—

A Former Effort.—The system of mutual insurance of stock seems to have had a hold among the Rhin farmers for some time—probably the fact of it being entirely a dairying district (dairy stocks having usually a great percentage of deaths) may in some measure account for this—as over twenty years ago we find an insurance society, known as the "Lochans Mutual Cattle Insurance Society," in operation within a given district, whose policies covered deaths of all descriptions among cattle. The office-bearers were chosen from, and the society managed by, the farmers themselves. The premium charged was necessarily high. From what we can learn, it ranged from 2s. 6d. to 4s. per head—evidently depending on the rate of mortality for the year. The method pursued was to have all the insurers' stocks valued at Martinmas in each year, by valuators appointed from among the members for the purpose, who had to be notified when any additional animals were purchased, in order to have them also valued; and when an animal was found ailing, a member of committee was sent for, who saw whether proper means had been taken towards its recovery, and who, in case of death, granted a certificate for production to the treasurer when compensation was sought.

It was ultimately found that a few of the larger farms, carrying from eighty to one hundred and twenty cows, had a greater proportion of deaths than those under sixty cows or so, and were thus receiving more than their share of benefit. This, together with the heavy premium, was the cause of the withdrawal of a number of the members and the break-up of the society.

[1] Fifth ser., ii. 19.

In connection with this society, and showing the benefit to be derived from insurance, one case of a small stock of from twenty-five to thirty cows is mentioned where not a single death of any kind had occurred for years, in which eventually pleuro-pneumonia broke out, and every animal died, or was slaughtered to prevent the disease spreading, the usual compensation being paid. The society was thus the means of preventing further outbreaks, while compensating the farmer in a great measure for the loss of his stock, who must otherwise have been a very heavy loser.

A number of outbreaks of pleuro took place about this time (1868-1871), all of which were summarily dealt with. In every case the stocks were bought up and slaughtered, the healthy carcasses sent to market, and the affected ones buried; while the sum required for compensation was raised partly by voluntary subscription and partly by the local authority.

Insurance Society.—It began to be seen that a society insuring against losses by pleuro, cattle-plague, and other deadly contagious diseases, would be likely to succeed, as it would take the place of voluntary subscriptions in dealing with outbreaks, and each stock-keeper would then be on an equal footing in providing for losses, besides having the right to compensation in case of loss himself. Consequently, in January 1872 a public meeting was called to consider the question, at which a resolution was passed forming what is now known as the "Rhins of Galloway Cattle Insurance Company (Limited)." It must be borne in mind that at this time there was no provision by the Privy Council for dealing with pleuro by slaughter and compensation, the Act for this being passed in 1878. Had the same rules been in force in 1872 as are now, it is probable this company might not have been formed; but the members being now fully alive to its benefit, it is still carried on, particularly as there is no security that the rules at present in force will be continued for any length of time.

Objects.—The objects of the company, as set forth in the "Memorandum and Articles of Association" appended hereto, are to "limit the ravages of diseases of cattle, and to mitigate their pressure on individuals."

Raising Funds.—In order to accomplish this, it was agreed that "the annual payments from members for insurance and voluntary subscriptions shall annually be accumulated and invested by the directors of the company as a fund primarily liable for losses, until it shall amount to the sum of £5000, and until that sum is accumulated no dividend shall be declared." The rate payable by members was 1s. per head annually for every animal insured. The landlords also at first, until the accumulation of the £5000, subscribed at the rate of 2s. per £100 of rental. The sum aimed at was reached in 1884.

Compensation.—The compensation to be paid was at first limited to three-fourths the value of the animals dying; but after 1878, when local authorities were bound to deal with the disease in a somewhat similar way, the compensation for all animals dying by disease or slaughtered was increased to full value—*i.e.*, the difference between what was paid by the local authority and full value was made up by the company.

Stamping out "Pleuro."—At the formation of the company it was universally admitted—in fact, proved by actual experience—although not embodied in the rules, that the only way to free the district of pleuro was by stamping it out; and this has been adhered to with unqualified success, all outbreaks having been thus dealt with, with the result that the disease has never once spread beyond the farm where the original outbreak took place, and this among a class of stock considered peculiarly liable to attack by this disease. As examples of what is done by the company, in 1877 two outbreaks of pleuro occurred. In one case the stock was insured, and was dealt with according to the rules of the company, the sum payable by the company—after deducting the sale of the unaffected carcasses and the sums paid by the local authority—being £160, 6s. In the other case the stock was not insured, but the tenants in the parish where the outbreak occurred raised a voluntary assessment of 1½d. per £1 on their rental, bought up the stock, and had it slaughtered, the insurance company, under a special resolution, repaying its members their assessment, which amounted to £74, 15s. 1d.

Division of Funds.—As before stated, the stipulated sum of £5000 having accumulated in 1884, it was resolved to collect nothing further from members in the meantime, and the capital being well invested, the sum continued to accumulate until February 1888, when it had reached over £6000. It was then resolved to divide the half of the funds in the form of a bonus to the members, according to a scheme of division which was drawn up and approved of by the company.

Reducing Premiums.—As there was now no such immediate need for a rest fund, and the sum of £3000 being in hand, it was resolved to reduce the annual premium from 1s. to 6d. per head for every animal insured, as an inducement to farmers who had not yet become members to do so, and thus widen the scope of the company for good.

Tuberculosis.—There is a feeling abroad among a number of the members that the company ought also to cover deaths from tuberculosis, as no disease among milk stock causes such an annual mortality; while it is held by others that the premium which would be required to cover it in addition would be prohibitive. But as the subject has not been as yet formally before the company, there is no official opinion by which to judge what will ultimately be determined upon.

Lesson Taught.—The success of this insurance company tends to show how much can be done in districts or counties by combination for mutual protection against disease. Here was a sum of £5000 accumulated in a dozen years by the small annual payment of 1s. per head for each animal insured, while at the same time covering and providing for loss from outbreaks of disease. Does it not seem to many to be possible to extend the principle—notwithstanding the present Order in Council—to those districts which have suffered so much in the past from pleuro, and in fact over the whole of Scotland? Should this be done, and the outbreaks be as firmly dealt with as they have been in Wigtownshire, together with the local authorities keeping a strong hand on the movement of cattle, we should hope soon to see the country free from the terrible scourge of pleuro.

The following are the Memorandum and Articles of Association :—

RHINS OF GALLOWAY CATTLE INSURANCE COMPANY, LIMITED.

I.—Memorandum of Association.

1st, The name of the company is "The Rhins of Galloway Cattle Insurance Company, Limited."

2d, The registered office of the company will be situated in Scotland.

3d, The objects for which the company is established are to limit the ravages of diseases of cattle, and to mitigate their pressure on individuals; and those objects embrace mutual insurance against death by rinderpest and pleuro-pneumonia, and the doing all such other things as are incidental or conducive to the attainment of the above objects.

4th, Every member of the company undertakes to contribute to the assets of the company in the event of the same being wound up during the time that he is a member, or within six months afterwards, for payment of the debts and liabilities of the company contracted before the time at which he ceases to be a member, and the costs, charges, and expenses of winding up the same, and for the adjustment of the rights of the contributories amongst themselves, such amount as may be required, not exceeding one pound sterling for every head of dairy cattle insured by him under class first in number 7 of the articles of association, and 13s. 4d. for every head of cattle insured under class second in said article.

Names, Addresses, and Descriptions of Subscribers.

II.—Articles of Association.

1. The company, for the purpose of registration, is declared to consist of two hundred members.

2. The directors hereinafter mentioned may, whenever the business of the association requires it, register an increase of members.

3. Any person desiring to insure with the company shall lodge with the secretary a proposal containing an engagement to abide by these rules, with an inventory of his cattle, on forms to be issued by the secretary; and on the same being accepted by the directors, he shall pay 2s. 6d. of entry money, and a rate of sixpence per head on all cattle owned or possessed by him above one year old, payable yearly on 22d November, which is the beginning of the financial year; and any member entering during the currency of the year shall pay as for the whole year. The first payment of the new rate of sixpence per head shall be made on 22d November next.

4. The proposal shall lie for twenty-one days, after which it will be considered, and if approved and accepted of by the directors, a certificate, signed by two or more directors, shall be issued on payment of entry money and rates, and shall thereafter be in force till the end of the financial or insurance year then current. The directors may decline any proposal without assigning reason therefor. The insured shall in all cases forfeit his insurance, deposits, and right in the funds, by acting as a cattle-dealer; and a person shall be esteemed a cattle-dealer who, in the judgment of the directors, buys and sells for profit from time to time cattle, other than for the *bona fide* use of his own farm.

5. The whole cattle belonging to a member must be included in the insurance, except cast cows to be replaced by others, and which, in the option of the insurer, need not be included. In the event of any cattle being added to the insurer's stock, he must declare them, and pay the deposit for the additional number. If rinderpest or pleuro-pneumonia shall appear in Wigtownshire, no person shall be thereafter admitted to the benefits of the insurance while any stock therein is known to be affected by either of the above diseases.

6. In the event of the annual rates payable by a member as aforesaid remaining unpaid for six months after the 22d November in any year, payment shall not thereafter be accepted (unless as hereinafter provided for) and the insurance of the cattle of such a member shall cease and determine, and he shall forfeit all benefit and claims in respect thereof, excepting always such benefit or claims as shall have become due to him prior to said 22d November in any year—the benefits of the said insurance and the claims of members subsisting only so long as the said annual rates are duly paid as aforesaid. Provided that it shall be in the power of the directors, in their discretion and if they see fit, upon written application being made by such defaulting member within three months after the elapse of the said six months, to accept payment of such arrears of rates, and upon such payment the insurance of such member and his rights thereunder shall be restored in the same way as if he had duly paid the annual rates as aforesaid. Members shall continue liable for their respective shares of losses for six months after they have ceased to have interest under this rule.

7. Cattle for the purpose of insurance shall be classified and valued as follows, viz. :—

Class I. Dairy cows and queys in calf.

Class II. Bulls, oxen, and heifers of one year old and upwards, and, in the option of the insurer, calves.

The value of each animal insured shall, for the purpose of this insurance, be held not to exceed sixteen pounds sterling; but if, during the life or after the death of any animals insured, the person or persons appointed to examine them in terms of article 14 shall certify that such animals were, when in health, of less value than £16 each, their value shall be held to be the sum fixed by the person or persons so to be appointed.

8. Members who are entitled to the benefit of the insurance provided for in these articles

shall be allowed the value, subject to the limitation in article 7, of each animal which shall be certified, to the satisfaction of the directors by the person or persons deputed by them for that purpose, to have died of rinderpest or pleuro, or to have been killed under the provisions of the law, or with approval of the directors, and to have been buried in its skin at least five feet under the ground immediately after death. But declaring always that such compensation shall be subject to the deduction of any compensation which has been received by or is payable to such members from the local authority or any other public source, for or in respect of the same animals—the amount payable by the company in such cases being only such sums as, along with any compensation so received or payable, shall make up the full compensation stipulated in these articles.

9. The directors shall have power to allow any actual loss which may be caused by destroying any healthy animal by their order, with the owner's consent, in order to prevent the spread of infection. They may also, by general or special order, require insured stock, when attacked, or when it has been exposed to risk of infection, to be killed, for which compensation shall be allowed, and they may require any insured animal, when dead to be buried in manner mentioned in article 8.

10. No member insuring shall be responsible, under any circumstances, for a greater amount than one pound per head of the number of the stock insured by him, nor shall members be responsible for one another; and no liability shall attach to any persons who have hitherto contributed or who may hereafter contribute voluntarily to the funds of the company.

11. On any animal showing any symptom of illness, the insurer shall be bound instantly to separate the same, and to keep it separate from his healthy stock, and to give notice within twenty-four hours to the nearest director, and within forty-eight hours to the secretary. The insurer shall use his best endeavours to preserve his stock, as if it had not been insured, and shall take care that they have proper treatment, and shall pay the expense of treatment.

12. Any member who shall knowingly, or under circumstances which, in the judgment of the directors, evince an unjustifiable want of caution, introduce cattle from any infected stock or locality, or any diseased animal, or suffer his stock to mix with diseased stock or put them into any infected or tainted building or place, shall forfeit his insurance, deposits, and payments.

13. Fraud, wilful misstatements, culpable neglect, or the failure to fulfil any of these conditions, or any attempt to impose upon or deceive the company, shall render the insurance void, and the insurer shall thereby forfeit all claims to compensation as well as all deposits and payments made by him.

14. All inspections or valuations shall be made by such person or persons as may be appointed by the directors for that purpose, and their reports, both as to value (subject to art. 7) and as to the cause of death, shall be final and binding on all parties. The directors and their officers are to be at liberty at all times, on reasonable cause, to inspect the stock and premises of the insurer, and the insurer shall supply any information respecting the same which the directors or their officers may require.

15. The decisions of the directors may be appealed against to the next general meeting of the members by a written notice given to the secretary at least ten clear days before the general meeting. But all decisions in questions with or among members, in regard to the insurance or their liabilities under these articles, shall, if not so appealed against, or if affirmed, or as altered by the general meeting, be final and conclusive, and not subject to question or examination on behalf of any member in any court of law.

16. Whereas the accumulated funds of the company now exceed £5000, and it has been resolved to divide amongst the members one-half of the accumulated funds with interest as at Whitsunday 1887, according to scheme made up and approved of by the company,—the remaining half and future rates and income shall be accumulated and invested by the directors as a fund primarily liable for losses until it shall amount to £5000, and until that sum is accumulated no dividend shall be declared or division made. When the accumulated funds amount to the above sum of £5000, the same shall be dealt with as may be resolved by the company.

17. In the event of any member dying, leaving his farm, or becoming bankrupt (but under no other circumstances), he or his representatives shall be entitled to receive back the amount contributed by him, under deduction of his proportion of any losses which may have been paid during his membership.

18. In the event of a loss becoming payable to a member who has not contributed from the beginning, there shall be deducted from the sum so payable an amount equivalent to what would have been the amount of his contributions had he contributed from the first, at the same rate as his actual payments; and the sum so deducted shall be placed to the credit of such member in the state of funds.

19. The directors are authorised, in the event of any circumstances arising not at present anticipated, to take any steps necessary for the interest of the company, but they shall, as soon as possible, call a meeting of the members, should any serious emergency occur. The directors shall also have power to appoint committees of their own number, and also parish committees of members, and to make general bye-laws, for carrying on the business of the company.

20. The directors are twelve in number, who continue in office till the next general meeting of the company, when the first half of them retire, and six are elected in their place,—the

remaining six retaining office for another year, when they in turn retire; and thereafter yearly in the rotation and order above mentioned. All retiring directors shall be eligible for re-election.

21. The annual general meeting of the company shall be held in December in each year.

STRANRAER, *3d and 24th February* 1888.

No.......

PROPOSAL OF INSURANCE

BY

....

....

The stock proposed to be insured is on the farm of ....parish of.................. occupied by the insurer, and the number of animals to be insured, under Class I. is......... and under Class II.........being the whole number possessed by the insurer, except.........cast cattle.

TO THE DIRECTORS.

GENTLEMEN,—I propose to insure my cattle in accordance with the above, and if the proposal is accepted I engage to abide by the Articles of Association prefixed hereto.

Signature......................

Date..................

No........

ACCEPTANCE BY DIRECTORS.

We,..................Directors of the above company, having examined and approved of the above proposal, do hereby accept the same, and declare that the proposer above named, having paid the deposit, is entitled to the privileges of an insured member so long as the number of cattle insured remain on the above farm, subject to all the conditions in the Articles of Association of the company.

Signature of ....
Directors ....

Date.................

ENCLOSURE AND SHELTER.

Whenever we associate arable culture with pasture, a fence between them seems necessary. The fence confines the stock upon the pasture, as well as prevents them trespassing upon the arable land.

On arable farms where no live stock are reared in summer, and on pastoral farms which have a large range of pasturage, there may be little or no necessity for division fences. It is sufficient for them to have a ring-fence, and fences along the public roads that happen to pass through them. In practice, carse farms are seldom enclosed at all, on the idea that the ground is too valuable to be occupied by a fence; but such reasoning does not apply to public roads, whence travellers may trespass.

Dairy and mixed-husbandry farms require to be subdivided into individual fields.

Ring-fences.—The position of a ring-fence is easily determined as being the march between two farms of the same estate, or between the lands of two conterminous properties. On adjoining properties, the ring-fence is usually mutually maintained by both proprietors.

Divisional Fences.—The divisional fences are laid off according to the natural inclination of the land, the requirements of the farm, and the variety of the soil. Fences should run parallel to the ridges, and these should, as a rule, follow the inclination of the ground, north and south being preferable. When the fences and ridges do not run parallel, wedge-shaped ridges, or *butts*, are created at one or both sides of the field. On account of the inequality in the lengths of butts, much more time is consumed in working them than a square piece of ground of the same area. Butts are therefore highly objectionable in fields; but as it is scarcely possible to have full-length parallel ridges on every field of a farm, they are sometimes unavoidable. Butts should be confined to the boundaries of the farm.

Straight Fences.—To preserve neatness and uniformity in the ploughing of fields, the fences should run parallel *in straight lines.*

Shelter from Fences.—A straight fence along the crown of a round-backed ridge of ground affords excellent shelter to both sides of it, whether to the N. and S. or E. and W. A fence occupying elevated ground bestows more shelter to fields than in any other position; and that site should usually be chosen for a fence, particularly for a thorn-hedge.

A serpentine fence in a hollow affords more shelter than a straight one against wind, which always blows with accumulated force in a hollow.

Serpentine Fences.—It often happens that the lower ends of fields cannot be enclosed in straight lines, a rivulet or hollow between two elevations giving their terminations a serpentine form; hence the fence must follow the waving course of the rivulet or hollow ground, to allow surface-water to run to the lowest point.

Shape of Fields.—The shape of fields is greatly determined by unavoidable obstacles, natural and artificial. A winding river or valley will give an irregular line to the fence at that end, and the march-fence may run in a direction to cause butts; and a third side may be made irregular by an old ruin, plantation, or precipice.

Where no obstacles occur, the corners of fields should join at right angles, because the plough can go farther into square corners of a field than into alternate obtuse and acute angled.

It is demonstrable that the shape conducive to the greatest economy in labour is the square, because frequent turnings on short ridges waste much time, and inordinately long ridges fatigue horses and lead to the soil being badly washed by the strong currents which heavy rains form in the long furrows.

Straightening Fields.—Where a rivulet or hollow between the sides of two fields causes irregular butts in each, parallelism of the ridges of both fields would be preserved by running a parallel fence along each field, shutting out the irregular part, and planting it.

Short Ridges Wasting Time.—To show the great waste of time in ploughing short ridges, we may state the results of experiments made for this work by W. Hay of Whiterigg, Roxburghshire, on land in different states of cropping. The ridges were 15 feet in width.

Ploughing stubble for bare fallow, October.

Length of ridge in yards.	Time taken to plough 1 ridge.		Time taken to plough 1 acre.		Loss of time on 1 acre compared with the standard.	
	Hours.	Min.	Hours.	Min.	Hours.	Min.
319	2	40	8	0	Standard.	
290	2	30	8	20½	0	20½
280	2	25	8	21	0	21
139	1	15	8	45	0	45
102	1	0	9	30	1	30
45	0	30	10	45	2	45
37	0	25	10	54	2	54
78	1	0	12	4	4	4
66	0	50	12	13	4	13
Second ploughing for bare fallow, January.						
280	2	20	8	4	Standard.	
172	1	30	8	26½	0	22½
100	0	55	8	52½	0	48½
112	1	5	9	22	1	18
86	0	50	9	23	1	19
137	1	20	9	25	1	21
182	1	48	9	34½	1	30½
37	0	25	10	54	2	50
First ploughing after turnips, April.						
292	2	30	8	17	Standard.	
280	2	25	8	21	0	4
203	2	0	9	32	1	15
101	1	5	10	3	1	46
141	1	30	10	18	2	1

From these statements it appears that short ridges generally take longer time to be ploughed than longer ridges.

Anomalies.—Yet anomalies are observable in the results. For instance, in the first statement 78 and 66 yards took longer time than 45 and 37 yards by 1 hour 19 minutes each. In the second statement, 182 yards took longer time than 86 yards by 11½ minutes. And in the last statement, 141 yards took longer time than 101 yards by 15 minutes to plough 1 acre in each case.

These anomalies might perhaps be explained by the shorter ridges being in a more favourable position or state for being ploughed, as regards inclination, hardness, softness, than the longer, or that the ploughman had given less time to the horses to turn at the landings than on the longer ridges. Be that as it may, every farmer knows that short ridges take longer time to be ploughed than long ones.

As instances of anomalies in ploughing long ridges, we may mention, in experiments made also for this work by Mr P. M'Lagan of Pumpherston, that 1 acre took only 7 hours 40 minutes to be ploughed with ridges of 570 yards, while 420 yards took 8 hours 24 minutes, and 250 yards 9 hours 36 minutes. Depth of furrow, texture of soil, action of horses, and time given in the turnings, come into calculation in ploughing land.

Wayfares and Fences.—Should a public road or canal pass through a farm, a fence should be placed on each side of it; a railway is obliged to fence its own line; and should an old plantation, quarry, or building stand in the middle of the land to be enclosed, butts should be placed next these obstacles.

A public road giving access to fields on both sides is a great convenience to a farm, and saves the making of many farm-roads.

Easy access to and from fields to roads is a great means of maintaining the health and strength of horses, and of saving the wear and tear of carts and harness in winter.

Size of Fields.—The size of fields depends in a great measure on the nature of the farming; and yet economy in labour limits both the smallness and largeness of fields.

Small Fields.—Small fields are advantageous on mixed-husbandry farms, for they enable the farmer to change the stock frequently on the pasture, which, as pointed out in the notes on "Pasturing Cattle" (Divisional vol. iv. p. 458), is a matter of much importance. Small fields are also useful in that they facilitate the separate grazing of different classes of stock.

Large Fields.—Large fields are preferable to small divisions on purely arable farms. They are convenient for harvest work, and more particularly so for steam tillage. Yet even on this class of farms there is a feeling against very extensive fields.

Convenient Fields.—Much of course will depend on the size of the farm: a large field on a farm of 60 acres would be a small field on one of 500 acres. If they are well shaped there will be little loss of time in working fields as small even as 5 acres; and there is a growing fondness for fields of from 5 to 10 acres in extent.

On most farms fields of from 20 to 25 acres will be found to be convenient, and we do not think that they should be smaller than 5 or larger than 40 acres.

Divisions of a Large Farm.—The mixed-husbandry farm of 500 acres gives 4 fields of 25 acres = 100 acres for each division of a rotation of 5 crops. Placing the same crop—green crop and grass in moderately sized fields of 25 acres—on different parts of the farm, and probably in different soils, a good crop in one of the fields will almost be insured every season; and the whole labour of the farm being for the time confined to one moderately sized field, a sufficient time for ploughing land, and a safe seed-time and harvest for a crop, seem to be placed within the power of the farmer against a great or sudden change of weather.

The same mode of reasoning for the size of fields may be applied to every other sort of farming.

Number of Fields.—The number of fields depends partly on the size of the farm and partly on the rotation of crops. The interior of pure clay-land farms devoted to raising wheat should be no more subdivided than in the number of members in the rotation of crops. To subdivide a clay-land farm, on which no stock is reared, into small fields, would be to waste good ground on fences.

To save expense in working, and waste of ground in fences, on smaller farms, single fields should correspond in number with the rotation; and should a smaller quantity of grass or green crop be wanted than a whole field, a temporary fence may be erected.

With regard to farms of considerable extent on soils of various textures, a different element from the preceding determines the number of the fields. On enclosing a farm where much stock is reared, mere economy in labouring each field is not so much an object of solicitude as the welfare of stock; and as stock thrive best on fresh pasture, and when a few of the same kind are herded together, it follows, as already pointed out, that for grazing cattle in summer each enclosure should be of small extent.

Grass Paddocks.—Although small enclosures under constant cultivation are unwholesome to grain crops, two or three small enclosures of from 1 to 5 acres in grass, near the steading, are of great service on farms on which live stock are reared. They are used by tups when out of season, by calves when weaning, by ewes in lambing, by mares and foals for a few weeks, by a stallion at grass, or as a hospital for sick and convalescent animals. Such small fields in grass are of much more value than large fields of equal land.

Access to Water.—In enclosing farms intended for live stock, access to good water should never be overlooked, though it too often is. Should a rivulet or spring of water be within reach, the fence should be so arranged as to admit the stock to it.

Fencing Pastoral Farms.—Mountain-pastures exclusively devoted to the use of live stock should be enclosed in large divisions, cattle and sheep being reared in large numbers. Mountain live stock possess active habits, and have strong instincts to search for food; and as the herbage of the mountains is somewhat scanty, stock require ample space to satisfy their wants.

Shelter Overdone.—The evils of enclosing fields very closely have been urged against enclosures altogether; and it is alleged that crops are liable to be more injured by being lodged in confined fields than in open spaces. The allegation is true; but it applies rather to an abuse in practice than against the principles of enclosure. Close fields, of whatever size, should always be kept in grass for stock; and a shed in them for shelter will greatly evade the attacks of flies.

As regards corn, a sheltered field ripens its crops earlier than an open one, which no doubt arises from the forcing influence of heat within an enclosure, which influence, however, lowers the quality of grain in comparison with that on open fields.

Waste of Ground by Fences.—When fields are very small and fences broad at the base, as in hedges, the loss of ground may be very great. This is the case in many parts of England, especially in the south-western counties, where much valuable ground is occupied by beautifully luxuriant, but greatly overgrown hedges. John Grant of Exeter stated that he ascertained by measurement that in Devonshire alone the hedges are sufficient to encompass the whole of England, being 1651 miles, subdividing only 36,976 acres.[1] The high mounds in that county supporting hedges, if extended in line, would reach from London to Edinburgh. The land in Ireland, particularly in the province of Ulster, is also much subdivided by turf-dykes, which are generally in a state unfit to confine live stock.

Economical Fencing.—It is in the best mixed-farming districts, notably in the north of England and the best-cultivated districts of Scotland, that the fencing of land has been carried out in the most economical and thorough manner, most suitable for an advanced system of farming. There farms are not only completely enclosed, but the size of the enclosures is made proportionate to the uses to which the soil is applied. Growing crops of all kinds find shelter from the vicissitudes of the weather, and protection against animals; and the live stock enjoy peace and plenty, as a recompense for confinement.

Fencing for Shelter.—In many cases it is an important object in enclosing land to afford shelter to plants and animals in inclement weather. That a fence affords shelter must be a fact cognisant to every one. Feel the warmth of a walled garden—the calm under the walls of even a ruin compared to the howling blast around—observe the forward grass, in early spring, on the S. side of a hedge, compared with that on the N. side—and listen to the subdued tone of the wind under a shed to its boisterous noise in the open air. Sensibly felt as all these instances of shelter are, they are but isolated cases.

In more extended spheres, cottages stand in a calm in the midst of a forest, come the wind from whatever quarter it may. Farm-steadings lie snug under the lee-side of a hill. Whole farms are unaffected by wind when embayed amidst encircling hills; and be the means of shelter great or small, the advantages derived from them are sensibly felt.

Shelter from Wall and Plantation.—As an instance of the benefits of shelter afforded by even a low wall to a park from the cutting effects of the sea air, we give the attached illustration (fig. 557) of a scene on the estate of Gosford, belonging to the Earl of Wemyss, in East Lothian. The wall, and the wood immediately behind it, are of the same height; but a few yards inwards the wood rises to a considerable height to some extent. Such a wall, such a belt of wood, such a plantation without a wall,

[1] *Jour. Eng. Agric. Soc.*, v. 424.

if projected on a large scale, and planted near the top of a sloping precipice or rising-ground, would shelter a large extent of country against the prevailing winds; and were such barriers placed in lines, in suitable situations, across the country, not only its local but also its general climate would be greatly ameliorated.

Instances are not awanting to prove the advantages derivable to stock and crop from shelter.

Shelter from Plantations. — The benefits derivable from plantations in improving land are far more extensive and important than from stone walls. "Previous to the division of the common moor of Methven (in Perthshire) in 1793," says Thomas Bishop, "the late venerable Lord Lynedoch and Lord

Fig. 557.—*Shelter afforded by a low wall against a cutting blast.*

Methven had each secured their lower slopes of land adjoining the moor with belts of plantation. The year following I entered Lord Methven's service, and in 1798 planted about 60 acres of the higher moor-ground, valued at 2s. per acre, for shelter to 80 or 90 acres set apart for cultivation, and let in three divisions to six individuals. The progress made in improving the land was very slow for the first 15 years, but thereafter went on rapidly, being aided by *the shelter derived from the growth of the plantations;* and the whole has now become fair land, bearing annually crops of oats, barley, peas, potatoes, and turnips; and in spring 1838, exactly 40 years from the time of putting down the said plantation, I sold 4 acres of larch and fir (average growth) standing therein for £220, which, with the value of reserved trees, and average amount per acre of thinnings sold previously, gave a return of £67 per acre."[1]

On the summit of Shotley-fell, 16 miles W. of Newcastle-upon-Tyne, M. Burnet of Shotley-bridge enclosed 400 acres of moorland with high stone walls, and cropped the ground in an easy manner for the soil. The land was thus kept in good heart, but the soil being very poor, stock advanced but little, and consequently the land would not have let for above 6d. an acre, even under the best management, and after all that had been done for it; but the central part of each field was put within a plantation, and the improvement was then surprising. The cock's-foot grass grew 3 or 4 feet high, and the young cattle throve very much better than before the land was planted.[2]

Plantations Beautifying the Country.—Besides affording shelter, plantations beautify the appearance of the country. "The plantation of Muirton in Ross-shire," observes Mr Mackenzie, "has already, in 1836, and will yet in a greater degree, improved the climate of the surrounding district, as well as afforded shelter and warmth. Already the plantations relieve and delight the eye, and spread a beauty and freshness around the scene. Muirton formerly looked a bleak and barren wild, while the opposite highly cultivated estates of Brahan and Coul were the delight of every passing traveller; but with these it may now vie both in riches and beauty."

Fencing in Upland Districts.—The upland districts throughout the kingdom are still in many cases deficient of enclosures. In many parts hill-farms have no march-fences, and the want of them is often the cause of much inconvenience to the tenants.

Shelter on Upland Farms.—The great desideratum, however, on such farms is shelter, which cannot, in such situations, be afforded by any single fence. The shelter of upland districts can hardly be accomplished but on a scale that would render it of national importance; for the attempt on a comparatively small property would confer as much benefit on the property on each side of it as on itself, so that the proprietor of a large estate would not incur the expense of sheltering it entirely. It would be desirable were proprietors of upland districts to have a mutual understanding on this subject, and plans could then be adopted which would have the effect of sheltering a great extent of country at a comparatively small cost.

PLANTING AND REARING HEDGES.

Permanent Fences.—The permanent fences of fields are usually constructed of either hedges or low dry-stone walls. In Scotland hedges are made principally of thorns, and in England of various plants—thorns, beech, hornbeam, holly, privet, myrtle. Turf walls are common field-fences in Ireland. In late years wire fences have been introduced, but from the nature of their materials they cannot be regarded as permanent in the sense of hedges and walls. Temporary fences consist of wooden palings, hurdles of iron and wood, nets, dead hedges.

We shall first direct attention to the planting of thorn hedges.

Planting Thorn Hedges.

Time for Planting.—Winter is the season for the planting of thorn hedges. It may be begun immediately after the fall of the leaf in autumn, and continued till April, when no snow or frost is on the ground, and the soil is not so wet as to be poached by working.

The young hedge will thrive the better the sooner it is planted in winter.

Preparing the Ground.—The ground should be prepared for thorn-plants. It should be bare-fallowed, limed, and manured. Thorns planted on unprepared ground are liable to be choked with weeds the first year, and be annoyed ever after.

Railway Fences.—The railways are obliged to fence their lines, and where stones are plentiful they build stone-and-lime walls. Where good soil is found, and stones scarce, they rear thorn hedges. Where both stones and good soil are

[1] *Jour. Agric.*, xi. 327.
[2] *Ibid.*, xii. 51.

awanting, they erect wire fences or wooden palings. Until the thorn fence can protect itself, a wooden paling is put up next the field.

Trench-planting.—Among the many changes which the railway system has made in the customs of this country, there is none greater than in the planting of a thorn hedge as a field-fence. For many years the bank-and-ditch system of planting prevailed. Now and henceforth the trench-planting of the thorn in the line of fence introduced by the railway engineer will be universally followed.

We will therefore describe the simple method of trench-planting.

Tools for Planting.—Before the line of fence can be planted with thorns, certain implements are required for the work. A strong garden-line at least 70 yards in length, having an iron reel at one end, and a strong iron pin at the other, is required to show, upon the ground, the exact line of the fence betwixt the stakes; and there must be a few pointed wooden pins with hooked heads to keep the line steady, whether in a straight line or curve.

A wooden rule, 6 feet in length, divided into feet and inches, having a cross-head of about 2 feet in length nailed at right angles to it, is required to measure off short distances at right angles. There must be spades and an iron tram-pick, to remove large stones, as well as a hand-pick, fig. 558, for small stones on hard ground, 18 inches long in each arm, and 3 feet long in the helve. Each man has a sharp pruning-knife to prune the thorn plants when necessary. A ditcher's shovel, fig. 559, is needed to clear out the bottom and sides of the ditches; its face is one foot broad and one foot long, with a tapering point, and helve 28 inches in length, with a cross-head. This is a useful shovel for cleaning up the bottoms of dunghills in soft ground, much better than the square-mouthed shovel.

Fig. 558.—*Hand-pick.*

Fig. 559.—*Ditcher's shovel.*

Hawthorn Plant. — The *plant* employed in the construction of a hedge is the common hawthorn (*Cratægus oxycanthus*). "On account of the stiffness of its branches," says Withering, "the sharpness of its thorns, its roots not spreading wide, and its capability of bearing the severest winters without injury, this plant is universally preferred for making hedges, whether to clip or to grow at large."[1]

Transplanting Thorns.—Thorns should never be planted in a hedge till they have been transplanted at least two years from the seed-bed, when they will have acquired a girth of stem at the root of one inch; a length in all of 3 feet, of which the root measures 1 foot, as in fig. 560, which is on a scale of 1½ inch to 1 foot, and which is in a fit state for transplantation. As thorns are usually transplanted too thick in the nursery-lines, to save room, and to draw them up sooner to tall plants, we would advise them being purchased from the nursery at that age, the year before they are to be transplanted in the fence, and laid in lines in garden mould, or deep dry soil. By this process the stems acquire a cleaner bark and greater strength, and the roots become furnished with a large number of fine fibres, which will greatly promote the growth of the young hedge, and repay the additional trouble bestowed on the plants.

But when plants are not to be so treated, the bundles, containing 200 plants each, should be immediately loosened out on their arrival from the nursery, and the plants *sheughed in* in the ground—that is, spread out thin and up-

[1] Withering's *Bot.*, iii. 561.

right in small trenches in a convenient part of the field, in dry earth heaped against them, to protect the roots from frost, and to keep them fresh until planted. The plants are taken from the *sheughs* when wanted.

Hedge - planters.—With these materials provided, workmen must be engaged.

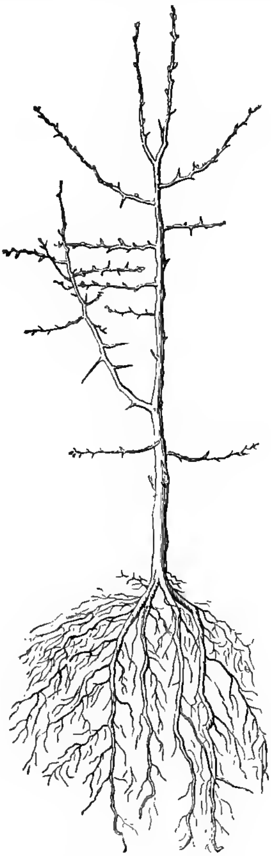


Fig. 560.—*Thorn plant.*

If a considerable extent is to be planted, the number of men required will be four —a hedger and three assistants, who have each his duty to perform, and should be kept at it without change of arrangement. When fewer hands are employed, the men must change from one portion of the work to another; and when more, one will at times be comparatively idle. The work never goes on so well, or so regularly, as when each man takes and keeps by his own particular part of the operation.

Surveying the Ground.—The ground along which the line of hedge is to be planted should be surveyed before the commencement of work, and where the surface is uniform and level the planting may proceed at once; but where hollows intervene, drain-pipes or conduits must be made below the hedge to convey away the water that might stand in them after the hedge has been planted. It is understood that the soil in the line of fence has been fallowed—that is, ploughed, harrowed, manured, and limed in summer.

Keeping the Line Straight.—If the line of fence is straight—which it should be, if natural obstacles do not interfere to prevent it—let the work of fencing begin. Should the surface be level, the line can be drawn straight with the greatest accuracy; but should elevations and hollows intervene, however small, great care is requisite to preserve the straightness of the line, because the rising parts of the ground are apt to advance upon the true line, and the hollows recede from it, especially when the inequalities are abrupt. Surveyors use the theodolite to avoid this error, but it may be avoided by using plenty of poles, to be set not far asunder from one another.

Beginning Operations. — In commencing, let the hedger, with an assistant, take the reel and cord, and, pushing its pin firmly into the ground at the end of the line of fence, run the cord out its full length, with the exception of a small piece to twist round the shank of the reel. Be sure to guide the cord exactly along the W. face of the poles and stakes at the bottom; and should any obstacle to doing so lie in the way—such as clods, stones, or dried weeds—cause them to be removed, and the ground smoothed with the spade; and with your face to the cord, draw it towards you gradually, with considerable force, until it has stretched as far as it can, and then push the shank of the reel firmly into the ground. As the least obstruction on the ground will cause the cord to deviate from the true line, lift up the stretched cord by the middle about 3 feet from the ground, keeping it close to the faces of the poles, and let it drop suddenly to the ground, when, by its elasticity, it will lie quite straight. Place a rather heavy stone here and there upon the cord, to prevent its being shifted from its position. While the cord is being adjusted, let the other two men bring forward thorn plants to a convenient spot for the work, covering up their roots with soil.

Forming the Trench.—The principal assistant with a spade makes a deep rut in front of the line, working backwards, to form a trench for the plants of 13 or 14 inches in depth, throwing the soil to his left. The second assistant follows him in the trench, working forwards, with the ditcher's shovel, and clears out the bottom of the trench; and should he come upon hard subsoil or a stone, he reduces the subsoil or removes the stone with the hand-pick. If a large stone comes in the way, it can be removed with the foot-pick.

Laying the Plants.—The third assistant now places a few of the plants upon the cast-out soil, in a line with the trench, so as to be in easy reach of the hedger when he plants them. After 3 or 4 yards of the trench have been cleared, the hedger begins by setting up a plant against the perpendicular side of the trench, working forward on one knee, which is protected with a knee-cushion, and placing some soil with his hand against the root of the plant to keep it upright. He takes another plant and treats it in the same manner, placing it at from 9 to 12 inches from the other plant, at 9 inches in inferior soil, at 12 inches asunder, in good soil.

Earthing the Plants.—The third assistant with a spade follows the hedger, and puts loose soil upon the roots of the plants, tramping the earth firmly towards them with his foot, while with his hand he keeps each plant upright. He shovels in more soil, until all the cast-out soil has been removed to fill the trench, and then the work is finished.

The work proceeds in this way day after day, until the line of fence is planted.

Old System.—It will be observed how simple is this system of running thorn hedges as compared with the laborious work of thorn-bed and bank-and-ditch and preparation of plants. Never again will the old system be resorted to; while at the same time, as long as the hedges live which were planted in the old system, they will still be treated according to that system.

Prevention from Damp.—As a safeguard against dampness in a retentive subsoil, it is advisable to make a drain at 4 feet from the line of thorns, 4 feet in depth, supplied with drain-tiles of 3 inches internal diameter.

Forming Right Angles.—A simple rule, which practical gardeners employ in drawing one line at right angles to another, is this: From the given point measure 6 feet along the line, and from the same point measure outward 8 feet; from the further end of the 6 feet measure 10 feet towards the end of the 8 feet, and the point where the 8 feet and 10 feet meet is perpendicular to the given point. This rule is directly founded upon the celebrated 47th Proposition of the 1st Book of Euclid.

Forming Curves.—In setting poles for straight lines ordinary accuracy of eye will suffice; but in setting them for curves, where geometrical ones cannot be introduced, taste is required in the planner. They can be formed only by setting up large pins in a curve, and judging of its beauty by the eye, so as the sweep shall naturally accommodate itself to the inequalities of the ground.

Curves in fields should be made conformable to the lie of the land. After large pins are set to show the general form of a long curve, or series of long curves, smaller ones should be employed to fill up the segments between the larger, and the cord stretched upon the face of all the pins will show the form of the curves, the beauty of which will be preserved by small pins with hooked heads.

If a curve on a ditch is required, the rutting of the breadth of the ditch should follow the cord in its curved position; but great care is requisite to preserve the two sides of a curved ditch parallel; for if the cross-headed wooden rule is not held as a tangent to each particular part of the curve which the ditch is to have, the breadth of the ditch will vary considerably in different places, and its form will be twisted into broad and narrow portions.

There is no error into which labourers are so apt to fall as this: they measure the breadth, without thinking of the consequences, at any angle across a curved ditch. The same error may be committed in forming a curved farm-road.

Planting along a Water-course.—Where a water-course occurs in a line of thorn fence, plant the thorns on the surface of the ground, as near as possible on each side of it, above flood-mark. The water-channel, probably dry in summer, when the fields are used only for stock, can be fenced with paling, or arched over with stones if they can be procured at a reasonable distance.

If it is desired to plant a thorn hedge on the top of a sunk fence, or along the edge of a walk by the side of a shrubbery, or to enclose a shrubbery or a clump of trees in pleasure-ground or lawn, the plants are planted in a trench as above described.

Weeds.—Where thorns are planted in connection with grassy turf, whether on the old hedge-bank system or in the trench-line method, weeds should be rigidly kept down, else they may grow

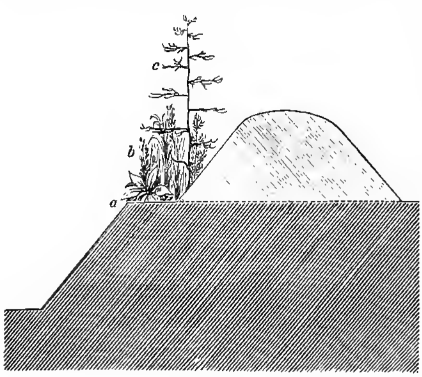


Fig. 561.—*Bad effect of weeds on thorns.*
a Scarcement. *b* Weeds choking thorn plant. *c* Thorn plant.

so as to prove detrimental to the young hedge. Fig. 561 shows clearly the bad effects of weeds on a thorn fence on a scarcement. Hence the advantage of bare-fallowing the ground which is to grow a thorn hedge.

Trees and Hedges.—If cattle are to be grazed on the fields, beeches or forest-trees should never be planted in the line of thorns, for it is impossible, even with the greatest care, to rear thorn plants, to become a good and beautiful fence, under their drip. Thorns are impatient of being overshadowed by taller trees; and trees planted on the top of a mound, betwixt double hedges, not only rob both of moisture at the roots, but pour their drip directly upon the branches of the thorns.

"To plant trees in the line of a hedge," says Lord Kames, "or within a few feet of it, ought to be absolutely prohibited as a pernicious practice. It is amazing that people should fall into this error when they ought to know that there never was a good thorn hedge with trees in it. And how should it be otherwise? When suffered to grow in the midst of a thorn hedge, the tree spreads its roots everywhere, and robs the thorns of their nourishment. Nor is this all; the tree, overshadowing the thorns, keeps the sun and air from them. At the same time, no tree takes worse with being overshadowed than a thorn."[1]

Hedgerow-trees are strongly recommended by the old writers on agriculture as being the best means of growing timber for the navy, and giving shelter to fields; and a writer on timber seems to favour the plan of planting the oak in hedgerow, as if that tree could not be sufficiently gnarled for naval purposes, and rendered thick in the bark for tan, in other exposed situations than in thorn hedges.[2]

It is not unusual to see beech mixed with thorn as a hedge; the mixture makes a pleasant-looking hedge; but beech itself is not a terror to live stock in fields. The sweet-brier (*Rosa canina*), too, is frequently mixed with the thorn, and no doubt imparts a delightful perfume to the air after a shower in summer; but it soon overcomes the thorns near it. The crab-apple (*Pyrus malus*) also displaces thorns in hedges. We have only to view the hedges in the S. counties of England to be convinced of the noxious effects of intermixing other plants with the thorn.

Thorn Hedges around Plantations.—Where thorns fence plantations, they

[1] Kames's *Gentleman Farmer*, 283.
[2] Matthew *On Naval Timber*, 359.

should be planted at a distance of at least 12 feet from the nearest tree.

Growth of the Hedge.—The young hedge should grow for four years without being touched. Thorns grow fastest in a deep sandy loam resting on a porous subsoil, and slowest on thin clay on a tilly subsoil.

Pruning.—A common practice with hedgers is to prune up the face of a young hedge the first year, and cut off the longer tops. This, however, is most injurious treatment, for it deprives the young plant of its leaves; and as leaves are the lungs of the plant, it is thereby so far choked and prevented from extending its roots and acquiring strength. After four years thorn plants will bear pruning.

Fig. 562.—*Switching-bill.*

Pruning well-grown young hedges consists of only one operation — *switching*. The first switching is cutting in prominent branches from the majority which constitute the body of the hedge, and of lopping off the leading shoots to a level line of top. This operation is performed with the switching-bill, fig. 562, which has a curved blade 9 inches long, and 1½ inch broad; a helve 2 feet 3 inches in length; and its weight altogether is about 2½ lb. It feels light in the hand, and is used with an upward stroke, slanting backwards nearly overhead.

Form of Hedge. — When a young hedge is allowed to grow at liberty for four years, and after its first switching, which is merely a trimming, it should be switched so as to assume its ultimate form. The form that is best suited for field-fences is an isosceles triangle, with a sharp apex and two equally inclining faces. This shape makes an excellent fence, as its top recedes from the animal fenced in. Fig. 563 gives an idea of this triangular form.

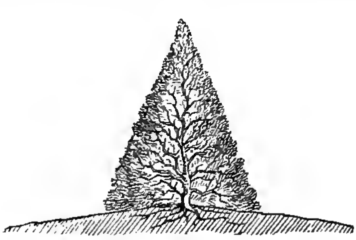


Fig. 563.—*Triangular form of thorn hedge.*

Other forms are adopted, as the curved faces and rounded head, which looks well along a public road or near a mansion-house. It is apt to be covered with a great weight of snow. There is also the natural form of the tree.

Hedges Injured by Snow.—A seasonal accident may befall a young hedge in winter—it may be smothered with snow; and on the mass of snow subsiding by consolidation, its great weight strips off many of the lateral branches, and breaks down the top shoots. There is no evading this accident, and the strongest branches of the largest hedge may be stripped off by the weight of snow.

The young plants must be pruned in spring by removal of the injured parts with a pruning-knife, but no more. No matter though this necessary pruning leave the young hedge in an unequal state — some of the plants being much crushed, whilst others have escaped injury — let it grow; and although the pruned plants cannot overtake the others at once, they will do so in time, and the hedge seem as if no accident had befallen it.

Cutting Down Hedges.—When it is contemplated to cut down or breast over any hedge, it should not be done at random in any season or year. It should not be done in the depth of winter, nor when the field is in grass or is coming into grass, but only when going out of grass; for, hedges being specially intended for fences against stock, it would be absurd to remove them when they would be of use in that respect.

Still it will scarcely be possible to avoid affecting one field or another, as it rarely happens that two adjoining fields are under the same sort of crop; and in the case of old grass-fields it is not possible to avoid it; so that the most that can be studied is to avoid cutting down the hedge as long as the field in which it grows continues in grass, whatever may be the state of the field adjoining. The compromise between two grass-fields is this—that when the hedge of the one going out of grass is cut down, thorns are furnished on the spot for a dead-hedge to fence the other that is still to be in grass.

Untrimmed Thorns.—The natural method of allowing thorn plants to grow without pruning is admirably adapted for shelter, and should be adopted in the stormy quarter of the farm; and as pruning is attended with trouble and expense where hedges thrive, they are allowed to grow up where they cannot do harm, as upon heights and in hollows. After having attained its natural height—which, in the thorn, may be 10 feet—the plants acquire thickness of stem, which will continue to increase for an indefinite number of years.

But while the plant changes its character, the stem increases in thickness, gradually forsaking the form of a hedge plant, and assuming the character of a tree—enlarging its head by the lateral expansion of the upper branches, and elevating its stem by a natural pruning of the lower branches—every year rendering itself more unfit for a fence, by presenting a row of bare stems.

Trimming Old Hedges.—In this natural tendency of hedges, the hedger should consider that the thorn plant is not in its natural state when placed in line as a fence along the side of a field; and if he desires to maintain it as a fence, he must restrain its tendency to become a tree. He has this in his power, and may even make an old hedge resume its youthful aspect by well-timed pruning, for such is the accommodating nature of the thorn plant.

Cutting Down and Breasting Over.—The only sort of pruning suitable for so strong a hedge is cutting it down. There are two modes of doing this—one by lopping the stems and some of the branches at two feet from the ground, the other by cutting off all the branches and the stems to within a few inches of the ground. The former is called *breasting over*, the latter *cutting down*.

Fig. 564.—*Breasting-knife.*

The instrument with which a hedge is breasted over is called a breasting-knife, fig. 564. It has a blade 7 inches long, 2½ inches broad; a helve 2½ feet in length, in all weighing 6 lb. It is used in the same manner as the switching-bill; but being much heavier, and employed on stronger plants, it requires greater labour to wield it.

Mode of Breasting Over.—In breasting over an old hedge with this bill, the hedger stands with his right hand to the hedge. From this position the strokes are given upwards, but near the ground at first; and, to give freedom to the hedger, he first uses the switching-bill to clear away all the small branches that grow out of and around the stem to be cut through. Without this precaution, the operating hand of the hedger might be severely lacerated by the straggling branches. The stem being thick, many strokes will be required to cut it through; and many of these will have to be given downwards, to cut away the wood in wedges. The left hand is used to rest and guide the bill.

When severed, the stems are laid upon the ground, on either or both sides of the hedge, as the thorns may afterwards be required.

Mode of Cutting Down.—In *cutting down* an old hedge, the hedger's light axe is used, fig. 565. It weighs 3 lb., and its helve is 3 feet in length. The hedger uses the axe with both hands, and directs its strokes as with the carpenter's common axe. The twigs are first removed by the switching-bill. The cutting strokes are made upwards, and the split portion is cut off by a downward blow of the axe.

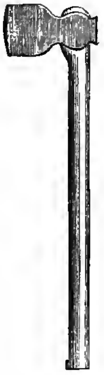


Fig. 565. *Hedger's axe.*

Breasting Bank-and-ditch Hedges.—As many of the existing farm-hedges may have been made on the old bank-and-ditch system, it is still necessary to describe the breasting, cutting down, and plashing old hedges as is done in that system. The operations of breasting and cutting down are nearly as applicable to the new system when the plants arrive at the same state of maturity.

On determining the age to breast over

a hedge, it should be noted that its stems should not be stronger than a hedger can cut through with one hand by two or three strokes of the breasting-knife.

The hedger, on commencing this operation—using the knife in his right hand, and covering his left with a hedger's leather glove—stands on the hedge-bank, near the hedge, with his face outwards, and his right hand to the hedge.

After cutting away a few branches at the end of the hedge to make room for himself to stand close to it, he commences cutting the principal stem of the plant nearest him, at about the height of his knee above the ground where it is growing. In cutting, he uses the knife by first making a firm cut upward into the stem, the knife perhaps penetrating to the heart; the next stroke is in a downward direction to meet the inner end of the first stroke, so that a wedge of the stem may be cut out. The wedge flying off, the next stroke is given in the line of the first, and it may sever the stem; but if not, another at the furthest corner of the cut, and one at the nearest, will send the knife through.

All the cuts with a view to remove the wedge-shaped pieces are comparatively light; but the upward cuts intended to sever the stem are given with force; and both sorts of strokes follow fast, until the stem is cut through: the face of the cut slopes upward. In renewing each stroke, the hedger's gloved left hand is ready, the moment the knife is brought in front of his body, to receive its back between the fingers and thumb, as a rest and a guide for the next stroke.

The cut stem will either drop down on end upon the ground behind or in front of the line of hedge, or be kept suspended by its branches. On the stem being severed, the hedger seizes its lower end with his gloved hand, and, with the assistance of the knife in the other, pulls it asunder from the hedge, and throws it endwise either on the head-ridge beyond the ditch beside him, or upon the head-ridge of the field behind the hedge-bank, whichever side may have been selected for carrying away the thorns to be made into a dead-hedge.

At the far side of the sloped cut of the stem there may be a small splinter of wood and bark, left by the last stroke of the bill, though with a dexterous hand this seldom happens; yet, to give the cut a finished appearance, the hedger cuts off the splinter neatly with his bill, held in both hands. All the lateral branches growing from the stem are cut off in the same manner as far back as the top of the hedge-bank, with an inclination corresponding to the slope of its face, so that the backmost branch preserves about the same height above the top of the hedge-bank as the stem in front does above the hedge-line.

The finished breasting is shown in fig. 566, where the sloping cuts are seen in

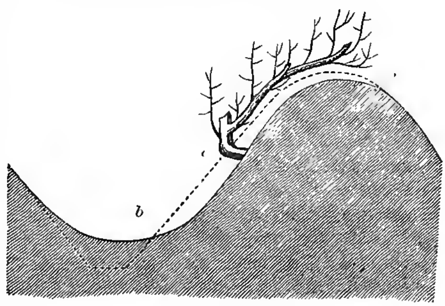


Fig. 566.—*Breasted thorn hedge on bank and ditch.*
a Top of hedge-bank. *b* Bottom of ditch.
c Main stem cut through.

the main stem upwards above the hedge-bank.

The hedger proceeds in this manner until the entire hedge is cut down. If the main stems are strong and hard, the hedger's axe should be used.

Breasting is best suited to a comparatively young hedge, every branch and stem of which will soon be covered with young twigs, which will ere long form a close structure of vigorous stems, springing from an upward-sloping base.

Cutting down an Old Hedge.—An old hedge, however, that has reached its natural height of 10 feet, should be *cut down* with the axe within a few inches of the ground. In all cases of cutting the stems of thorn plants, the cut surface slopes upwards to the back of the hedge. The cuts on the stems are not in the plane of the line of hedge, but at an angle to it; so that, when viewed in the direction the hedger is cutting, the cuts are not visible, while from the opposite direction they almost face the spectator.

Mismanagement of Hedges.—Hedges are wofully mismanaged in the cutting in many parts of the country. Without further consideration than saving the expense of a paling to guard a new-cut-down hedge, or in ignorance of the method of making a dead-hedge from the remains of an old live one, the stems of an *old* hedge are often cut over about 3½ feet high, to serve as the fence. The consequence is a thick growth of young twigs where the hedge was cut over, placed at 3½ feet above the ground upon bare stakes. To make an old hedge a valuable fence, it should be cut over near the ground, and a dead-hedge made with the part cut off to protect it.

But still worse mismanagement is in the mode of making the cuts when hedges are cut down. The bill is used to *hack down* the *stems*, instead of to *cut them off*—the branches, when severed from the hedge, being cut off clean, while the top of the stem, upon which depends the growth of the future fence, is shattered to pieces. This barbarous work is done by giving a downward instead of an upward stroke in cutting off the branches from the stems.

Fortunately for the owner of the hedge, the constitution of the plant counteracts the mischievous work of his hedger; for, hacked and split as the stems are, they push out young twigs, and conceal, though not cure, the injury they have received.

Up and Down Strokes in Cutting.—The difference in the effects of the two kinds of strokes is thus truly explained by Francis Blaikie: "A moment's reflection," he says, "will show that it is impossible for an edge-tool to pass through a piece of timber without causing a severe pressure against one or both sides of the wood, because the tool occupies *space*. The teeth of a saw drag the chips out of the cut, and *give the space* requisite for the tool to pass, but an edge-tool can only pass by pressure. . . . In cutting the stem of a hedge or young tree which is growing upright, if the blow is struck *down*, nearly the whole pressure falls on the stub or *growing stem*, which is *shattered to pieces*, while the stem cut off is left *sound;* but when the blow is struck *up*, as it should always be, the effect is reversed, the *stub* is then left *sound* and smooth, is cut *clean*, and the *stem* cut off is *shattered*."

The advantage of the proper method is, that "when this practice is adopted, the wet does not penetrate through the stub into the crown of the roots, canker is not encouraged, and the young shoots grow up strong and healthy, and able to contend against the vicissitudes of the weather."[1]

Plashing.—Hitherto the pruning and cutting have proceeded on the supposition that the hedge cut down will make a sufficient fence when it grows again. This, however, will not be the case if many of the stems are as far asunder as to leave gaps between them, even after the young twigs shall have grown up. In such a state the pruned hedge will never constitute an efficient fence without *plashing*, which consists of laying down a strong and healthy stem from one or both sides across a gap.

On cutting, where the hedger meets with a gap which cannot be filled up by young stems, he leaves a strong supple stem at the gap next him, to be plashed.

Method of Plashing.—The hedger plashes the stems in the following manner: Commencing at the end of the hedge where he began to cut, he prunes off, with the breasting-knife, all the branches from the stem he left, cuts the stem of the proper length for the gap, and then makes an upward cut in it near the ground, on the opposite side to the direction the stem is to be plashed, but no deeper than to bend it to the horizontal position, which should be near and parallel to the ground to fill up the gap from the bottom. The plashed stem is kept down by an offshoot from the stem on the other side of the gap, or by wattling it before and behind two or three stems, or by a hooked stick driven into the ground near its point, and by a wedge driven into the cut in the plashed stem, over which is placed a lump of clay to protect the stem from rain and frost.

The system of plashing is illustrated in fig. 567, where *e d* is the first plashed stem, cut nearly through at *e*, and laid along near the ground, across the gap which extends beyond *d*; *b a* is a long

[1] Blaikie *On Hedges*, 33.

stem passing across the large gap *b c*; *k* a wedge of wood inserted into the cut of the plashed stem *b* to keep it down. The stem *b a* extends beyond the immediate gap from *b* to *c*, as there are no means to fasten it down at *c*, and its end is wattled in front of the stem *a*; but could it have been fastened at *c*, it should have been cut off there. The stem *e d* originates at *e* and not at *d*, though the gap is really beyond *d*, and not between the stems *c* and *a*, because no offshoot was found on *a* to leave for a plash; and had there been, the stem *e d* would have been cut off, because the stems *e* and *a* are close enough for a fence, and then the plash would have been laid across the gap *a d* from an offshoot of *a*.

Plashing in England.—Plashing is much practised in England, where it is very neatly executed; but it seems as if good hedges were there sometimes purposely cut down to be plashed. Plashes are there laid at all angles, and twisted into all shapes, as if to prove that the thorn-plant can withstand every possible torture.

"Plashing an old hedge," says Lord Kames, "an ordinary practice in England, makes, indeed, a good interim fence, but at the long-run is destructive to the plants; and accordingly, there is scarcely to be met with a complete good hedge where plashing has been long practised. A cat is said among the vulgar to have nine lives. Is it their opinion that a thorn, like a cat, may be cut and slashed at without suffering by it? A thorn is a tree of long life. If, instead of being massacred by plashing, it were raised and dressed in the way here described, it would continue a fine hedge perhaps for 500 years."[1]

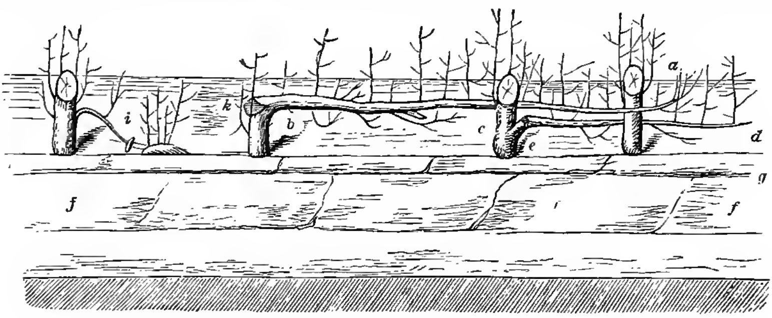


Fig. 567.—*Plashing and laying an old hedge on bank, and water-tabling a ditch.*

Scouring Ditches.—Immediately connected with pruning hedges are scouring ditches and repairing hedge-banks. A ditch which conveys a constant stream of water may have as much mud deposited in it as to require scouring before the space about the roots of the hedge is able to accommodate all the matter that should be scoured out of it. In this case, as much mud should be placed between the hedge-roots as can conveniently lie, which will serve the double purpose of easily getting rid of part of the mud, and of doing good to the hedge by thickening the soil around its roots: and the remainder should be placed on the ditch-lip on the head-ridge, to be removed at leisure for other purposes. But the more usual and better practice is, when the ditch is to be scoured, the hedge is pruned and the hedge-bank repaired.

Repairing Hedge-banks.—The propriety of combining the work of scouring ditches and repairing hedge-banks is obvious from these considerations: After weeding hedges for some years, the earth is removed much from its original position. Incessant action of the atmosphere, and of rain and snow occasionally, upon the inclined surface of the hedge-bank, sensibly co-operate with the weeding to remove the soil from the roots of a hedge. The effects of these combined causes are to leave the roots of hedges too bare; and if the deficiency is not made up, the hedge will be shaken to the roots by every wind that blows.

[1] Kames's *Gentleman Farmer*, 283.

On referring to fig. 566, it is seen that the soil is removed from the hedge-bank, and the bottom of the ditch filled up to the extent indicated below the dotted line *b c a*, from the centre of which space the root of the hedge projects at *c*. The deficiency of the soil can be supplied by *water-tabling*, and it can be best executed after the hedge has been pruned. It is begun by making a sharp notch with the spade, 3 inches deep, in the side of the ditch, about 1 foot below the root of the thorns, along *f*, fig. 567. The hedger then pares away the earth to that depth from below the thorn-roots to the notch, preserving the proper inclination of the side of the ditch. If the side of the ditch is worn away more than the required paring, earth should be rather put on than taken away from below the root of the hedge.

After the notching is done for a space, sods are raised from the best part of the bottom of the ditch, 9 inches broad, 4 inches thick, and the length of the spade. These sods are laid with the spade on their edge upon the notch, with the grass side outwards, and beaten into the bank, and their upper edge pared and made straight. The sods join more firmly when their ends are cut acute-angled, as at *f f f*, fig. 567.

The reason for putting the grass side of the sods outwards is, that the sods may adhere and grow to the bank; for if they were put on with the grass side inwards, the frost of the ensuing winter would cause them to slide down; and no apprehension of injury to the hedge from the grass of the sods need be entertained when they are set at a distance below the hedge-roots. After these sods have been laid, others, 6 inches broad, 4 inches in depth, and of the length of the spade's face, are raised and laid, to break joint, with the grass side downwards upon the upper edge of the first sods—beating them flush with the face of these, and pushing them under the thorn-roots. This is the sod *h*, fig. 567.

The reason for placing the grass side of these sods downwards is to prevent grass growing among the roots of the thorns, and they are kept in their place in winter by the sods below them.

The parings of the sides and the scouring of the bottom of the ditch are thrown upon the hedge-bank and amongst the thorn-roots. Water-tabling renovates the growth of thorns, re-establishes their hold of the bank, and encourages the springing of shoots around the incised parts of the stems and branches. It is not needed where a hedge is planted on a scarcement, as mouldering of earth from the plants is prevented by it; but the scarcement more than counterbalances the advantage by encouraging the growth of weeds.

Filling Gaps.—It is possible in the oldest hedges that gaps of such width as cannot be repaired by plashing are found, and other expedients must be adopted to fill them up, such as laying young shoots from the old stems into the gaps, or filling up the gaps with young thorn plants. The laying cannot be done until the young shoots are pretty long; but young quicks may be planted immediately after water-tabling is finished.

Planting Young Quicks.—Where young quicks are to be planted amongst old thorn-roots, the scouring from the ditch should not be put upon those places, but rather the old soil removed, and spread behind and between the old roots where are no gaps. New and fresh soil should be provided by mixing mould, decayed vegetables, and lime together in a compost, and put upon the places formerly occupied by the old soil.

The young thorn plants are prepared by pruning the roots and cutting over the stem about 9 inches from the roots; and on a bed being formed for them in the new compost earth, in the line of the old hedge, they are laid upon rotted farmyard dung, and the earth brought over the dung and plants, and beaten down; and should the weather prove dry, or likely to become so, they should be well watered. The young plants will sprout rapidly; and to preserve them from annoyance, prune away any straggling twigs from the old stems.

Laying Young Twigs.—The laying of young twigs is managed much in the same way. The old soil is removed from the gaps, and replaced by the compost. A strong twig is brought down from the stem on each side of the gap, cut short and notched, and held down amongst well-rotted dung by a hooked stick, and covered with the compost earth.

In fig. 567, the laid twig *i*, from the old stem *h*, is held down by a hooked stick. After the layer has taken root, and the young shoot growing with vigour, its connection with the old stem is severed. This plan will fill up a gap no larger than can be filled by one shoot from each side of it.

Exposing Hedge-roots.—Some farmers remove the hedge-bank behind an old thorn hedge to be used as compost. The practice, however, is injurious to the hedge, by exposing its roots, which grow chiefly in the bank, to wet and frost. If the roots of a hedge are thus left unprotected, it is possible that a few nights of severe black frost will kill every root nearest the surface. Many plants of old hedges are killed in this manner, without the cause being suspected by the farmer.

The same remarks apply to double hedge-banks.

Protecting Young Hedges.—Both young thorn plants and old cut-down hedges require protection for some years. The protection afforded to both is by a dead-hedge, stake-and-rice, wooden paling, or a wire fence.

Dead-hedge.—A dead-hedge is thus constructed: The hedger requires an assistant. The assistant, protected by gloves, cuts the severed stems of the cut-down hedge into pieces of about 3 feet in length with the cutting-bill or axe; but the thickest stems had better not be employed, branches affording a better material. He lays one cut piece above another, until a bundle is formed which he can easily lift from the ground, taking care to add small twigs to thicken its substance, to compress it with his foot, to make the pieces composing the bundle to adhere to each other, and to trim it by notching the longer twigs in with the bill to improve the appearance of the bundle. He thus makes one bundle after another.

The hedger takes his station on the line of the dead-hedge, about 12 or 15 inches from the line of the new-planted thorns. He lays one or two spadefuls of earth upon the spot from which the dead-hedge is to run, and the trench he makes should be as large as easily to contain the lower end of a bundle of thorns, as *a*, fig. 568. The mound thus laid up forms a lean for the first bundle. When the hedger is ready with the trench, his assistant hands him a bundle with a fork. The hedger receives the bundle with his gloved hands, and places its butt-end in the trench, pushing it with his foot, and making its head slope from him. A

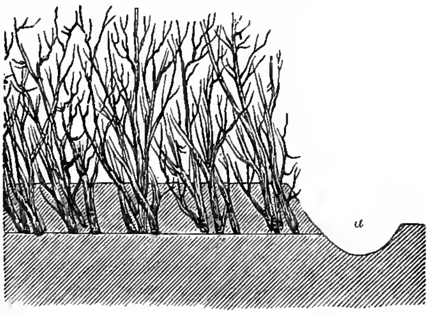


Fig. 568.—*Dead-hedge of thorns.*

tramp of earth is then raised with the spade, and placed against the butt-end of the bundle, to hold it firm.

Thus bundle after bundle is set up firmly by the hedger; and after a few yards have been set up, he cuts in any straggling sprays with the breasting-knife, and chops the top and outside of the bundles into a neat form, having perpendicular sides and a flattish top. All the thorns of a strong hedge will not be consumed in a dead-hedge of the same length.

Duration of a Dead-hedge.—A dead-hedge will last until a cut-down hedge again becomes a fence, after which it is removed for fuel.

Stake-and-rice Fence.—A stake-and-rice fence is formed of the branches of forest-trees; and where these are plentiful and thorns scarce, it is easily constructed.

Its structure is simple, as shown in fig. 569. The stakes are made from the

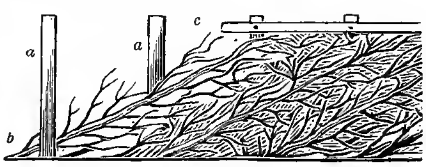


Fig. 569.—*Stake-and-rice fence.*

a a Stakes. *b* Brushwood. *c* Rail.

longer branches of the tops of trees; or, if these are not sufficient, they should be made from sawn timber, 4½ feet in length, and about 4 inches in the side. After being pointed, these are driven in line into the ground from 4 to 6 feet asunder, according to the length and strength of the branches.

The branches are set in the direction of the heaviest winds. They are set on their butt-ends upon the ground at an inclination of about 45°, and are wound alternately before and behind the stakes.

A neat and strong finish is given to stake-and-rice by nailing a single paling-rail along the top of the stakes.

Any sort of brushwood which reaches from one stake to the alternate one will answer for stake-and-rice; and if very short, the stakes can be set the closer. This fence requires fewer nails and less good wood than an ordinary paling, and is therefore cheaper; and it will stand an equal length of time, as the stakes have less strain upon them, not having the weight of materials to bear.

The branches, being warped before and behind, protect the stakes from many accidents to which those of paling are liable — such as persons climbing over them, swing-trees catching them, cattle and sheep rubbing against them.

Shelter from Stake-and-rice Fence.—Stake-and-rice forms a better fence and shelter for sheep than a paling, and should be placed on the N. and W. sides of fields, whence the strongest and coldest winds prevail. Its close structure renders it liable to lodge snow that would sink down through the rails of a paling, but not more so than a dead-hedge of thorns.

Paling.—A very common dead-fence, for protecting hedges and grass from stock in spring and summer, is the common wooden paling, fig. 570. If tall

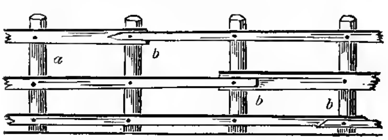


Fig. 570.—*Common wooden paling.*

a Stake. *b* Rail.
b b Broad and narrow ends of rail nailed together.

Scots fir, 8 inches in diameter, can be procured at no great distance, it is handy and economical material for the temporary fencing of thorn hedges. Trees of that size will cut up into deals, which, besides the outside slabs, will divide up the middle for rails of 3½ inches broad and 20 or 24 feet in length. The same trees, quartered, will make stakes which, if cut off at 4½ feet in length, and pointed, are fit for use. Weedings of plantations of Scots fir or larch are also useful for cutting up into paling, either entire or sawn up the middle.

A paling should be placed about 4 feet from the line of thorns, to prevent stock from injuring the hedge. Stakes should be driven by a mallet 12 inches into the ground at 5 or 6 feet asunder, and where hard a hole may be made by the foot-pick or the driver, and they will support a paling of 3 feet 3 inches in height. Two rails are sufficient to fence cattle, but 3 are required for sheep.

To strengthen the fence, the rails should be nailed on the stakes next the field, and made to break joint; so the ends of the 3 rails are not nailed upon the same stake, nor their broad ends nailed together, though thinned by the adze, but broad and narrow ends together, that the weight and strength of the rails may be equalised.

To make the paling still more secure, a stake should be driven as a stay in a sloping direction towards the thorns, and nailed to every third stake. The upper rail should be nailed near the top of the stakes, the lowest one 6 inches from the ground, and the upper edge of the middle one 20 inches above the ground.

Charring Stakes. — Charring the points of stakes no doubt incurs some expense, but it renders them more durable. Smearing them with coal-tar, and letting it dry, as far as they are driven into the ground, is perhaps as good a means of preservation.

Turf Fence.—Where turf is plentiful, it may be made to fence a young hedge. For fending off sheep and cattle, a short stake and single rail of paling are required along the top of a turf-wall.

Wire Fences.—One or other of the different kinds of wire fences, to be presently described, are now largely used in protecting young hedges.

Weeding Hedges. — The attention which hedges require in summer is confined to weeding. The operation is a very important one, not only as regards the hedges themselves, but also the condition of the fields near them. This department of farm-work is much neglected. The hedger himself can do little to the weeding of an extensive range of fences; and he is, besides, called away in summer to many other sorts of work which have no relation to his own occupation. The field-workers, who assist him in weeding, are engaged at field labour; and it is only at intervals that they can be spared from their necessary avocations.

Old Men for Weeding.—We have found it a good plan to employ old men, who are unable to undertake ordinary labour at ordinary wages, in weeding hedges by the piece; and if they are diligent, it is surprising the extent of fence they will keep clean during a summer. Old women might be employed at the same occupation; and an aged couple might employ a part of their time every day at this work, with advantage to the farm and their own pecuniary means.

Timely Weeding.—The best method of keeping the bottom of a thorn hedge close is by timeous weeding. One early summer and one mid-autumn weeding will preserve those hedges clean all the year round, and occupy less time and at less expense than one heavy weeding at the end of summer, by which time many of the plants will have shed their seed and strengthened their roots.

Tools for Weeding.—The implements are few that are required for weeding hedges. They consist of a hedge-spade, fig. 571, having a thin cutting-face of

Fig. 571.—*Hedge-spade.*

rectangular form, attached to an iron shank terminating in a socket, into which is inserted a helve two feet long with a cross-head. This spade is held horizontally in both hands, and cuts away any grassy tufts along the line of hedge.

Another implement is the common Dutch hoe, fig, 572, with a helve five feet long having a cross-head. It removes the weeds on both sides of the thorns.

A small useful implement is the hedge weed-hook, fig. 573, cut from any bush or tree, or made of iron, and which pulls out the weeds between the hedge-roots much better than the hand.

Hawthorn Seed.—The *haw* of the hawthorn is very apt to heat when put in heaps. It is frequently, notwithstanding, sent in large sugar hogsheads, and so great a proportion becomes heated that not above 1 in 20 germinates when sown. It ought to be packed in not larger quantities than bushel-hampers.

Fig. 572.—*Dutch hoe.*

When sown, it does not germinate until the second spring;

Fig. 573.—*Hedge weed-hook.*

on this account nurserymen are in the habit of decomposing its pulp by mixing the haw with sandy earth, in flat heaps not exceeding 10 inches in depth, which are frequently turned, to prevent heating.

Game, and many kinds of birds, particularly the thrush tribe, are very fond of the haw; so the hawthorn forms an excellent low stunted underwood for the protection of game. With holly, *Ilex aquifolium*, and the dog-rose, *Rosa canina*, it forms an almost impenetrable barrier against the poacher. Peasants in many countries eat the haws; and in Kamtchatka they are fermented into wine.

Hawthorn an ancient Fence.—The ancients were acquainted with the hawthorn as a *fence*. The Greeks called it *pyracantha*, or fire-thorn. It is probable that in our own country fields were fenced with thorns before Queen Elizabeth's time, and not so late as the end of the seventeenth century—as appears from a quotation by Marshall from Fitzherbert, when the latter complained, at the beginning of the sixteenth century, of landlords enclosing, and thereby shutting out their demesnes and meadows from the use of their tenants.[1]

According to Walker, the first hawthorn hedges planted in Scotland were

[1] Marshall's *Rur. Econ. Yorks.*, i. 46.

on the road leading to Inchbuckling Brae in East Lothian, and at Finlarig at the head of the Tay in Perthshire. They were planted at both places by Cromwell's soldiers.[1]

Other Hedge Plants.

Other plants than the hawthorn have been recommended to be used for fencing fields. No doubt such plants as the black-thorn, the crab-apple, the beech, the elder, and all the forest-trees that bear pruning, might form such a fence as to mark the division of one enclosure from another; but unless the plant is furnished with spines, it will prove an inefficient fence against cattle, irrespective of trespasses of evil-disposed persons.

Holly Hedges.—The holly, *Ilex aquifolium,* is the only other plant that possesses the properties of good fencing. It is durable, firm, stands pruning, is highly defensive, and verdant alike in all seasons; but being very slow of growth, it would require a long time to attain a sufficient height for a fence, and in the meantime would incur much expense in its protection.

It will therefore never become a substitute for the hawthorn for field-fencing, however beautiful a fence it forms near a dwelling-house or shrubbery.

The cock's-spur thorn, *Cratægus crus galli,* and the Virginian thorn, *C. virginiana,* have been proposed; but neither possesses properties superior to the common kind. The juniper, *Juniperus communis,* has been recommended. The tala plant, a small thorny shrub, a native of S. America, has been recommended as a good field-fence; but there is much doubt of its thriving in our climate. In Germany the hornbeam, *Carpinus betulus,* is used as a field-fence.

We have seen the common spruce, *Abies excelsa,* clipt into very neat hedges. Hindoostan possesses a great variety of plants fit for field-fences, but whether any of them would thrive in this country is uncertain. It is probable that the temperate region of the Himalaya may afford some useful hedge plant. The *Cactus* would be a formidable fence if it could be raised here.

Care of Hedges.—On contemplating the state in which hedges are usually kept, it must be admitted that the fences are not cared for as they ought to be. The low country is sufficiently, and, in many places, too densely fenced — too much ground being occupied by hedges, to the detriment of the crops growing within them.

A slight glance at the small enclosures of England will convince any one of this, though the smallest are perhaps occupied by meadows of permanent grass. In the N. of Ireland the enclosures are too small, though there the universal practice of small holdings better justifies the prevalence of small enclosures.

When the thorn fences of the country are minutely examined, they will not generally be found in a useful state. Some are allowed to grow in a rambling manner, carrying a heavy head and exposing bare stems near the ground—others are far advanced in old age, and about to decay, or covered with lichens and mosses—full of gaps, filled up with slabs, paling, or loose stones—occasionally overflown with water, which passes off of its own accord, which it can seldom do in winter before another flood overtakes it — completely overgrown with every weed that gets leave to shed its seeds for miles around—almost overcome with wild plants, which have usurped the place of the thorns—so hacked and hewed with the hatchet that the greater part is a long time of recovering the butchery, whilst the remainder have died in consequence of the rain descending on the split stems and rotting them—so overlaid with plashing, that the already half-amputated stems die in a short time—suspended by the principal root, after the earth has been washed away from it into the ditch—cut over too high, where it has put out innumerable twigs, whilst the stems below are bare—so shaken at the roots, when left exposed for want of water-tabling, the wind acting on them, by the leverage of its high stems, that after it has been cut down it dies for want of power to push out new stems. Such is the treatment which thorn hedges generally receive.

Whin Hedges.

As hedges of whin, *Ulex europæa,* are common in the upper and poorer parts of

[1] Walker's *Essays,* 53.

the country, we must say a few words on them. Whins—or furze, as the plant is named in England—are frequently sown upon the top of a turf mound constructed for the purpose, because the young plant is out of reach of danger, and requires no temporary fencing for protection, and where, generally, turf is plentiful. The plants grow well in such a situation, striking their roots down through the mound into the ground below in search of moisture.

No doubt the sharp spines of the plant attract moisture from the atmosphere as well, and the structure of the plant is well adapted for causing the rain to trickle down the branches to the roots.

Raising Whin Hedge.—In raising a whin fence, what is required is to sow the seed along the line of fence in a small rut made with the corner of the hand-hoe, and covered over with a rake. The seed may be sown upon a prepared mound, as on the prepared level of the ground. The plant grows very rapidly, and soon becomes a fence from its spiny armament.

Trimming Whin Fence.—It should be switched into the proper form of a hedge when young, to prevent the straggling form of growth which it is apt to assume. When allowed to grow at will, it attains a mature age in a few years, and then dies out, or it is hastened to its end by the frost.

It cannot withstand severe frost. It thrives best in a poor soil that has some clay in its subsoil. The whin forms a cheap fence around a plantation, and it forms a good nurse for young trees not over-thickly planted, and is well adapted as underwood to afford shelter to game.

Inglis well described the utility of the whin-plant in these words: "In returning to Wexford by another road, I was greatly struck by the gay effect produced by the furze, or, as they are called in Scotland, the whin hedges, which form the only enclosures in this district. The furze hedges are very general in Ireland, and are much preferred by the people to any other, and not without reason. In parts of the country where turf is scarce and coal dear, the furze is a ready and abundant fuel. Nor is this the only use to which it is put—the tender shoots are mashed, and given as food to the horses, and the refuse is mixed up and used as manure. There is still another use of a furze hedging—when full grown, it affords in rainy weather a shelter to live stock, which neither thorn nor any other hedge affords; for there are no droppings from a furze hedge. This is a fact of which any pedestrian may agreeably convince himself, if caught in a shower of rain in the neighbourhood of a furze enclosure."[1]

BUILDING DRY-STONE WALLS.

The low dry-stone wall is a common field-fence in Scotland, and is there named a *dyke*, to distinguish it from wall, which implies a structure of stone and lime. A dyke in Ireland means a ditch, and a ditch a turf-wall.

Badly Built Dykes.—Many dry-stone dykes in this country are constructed on erroneous principles, the stones being laid promiscuously, more with a view to make a smooth face than give a substantial hearting to the wall. The coping, too, is often disproportionately large for the body of the wall, which is not unfrequently too narrow for its height.

We suspect that many dry-stone dykes are built by ordinary masons, who, being accustomed to the use of lime-mortar, are not acquainted with the proper method of bedding loose stones in a dry dyke as firmly as they should be, and are therefore unfitted to build such a dyke. A builder of dry-stone dykes should be trained to the business; and, with skill, will build a substantial dyke, at a moderate cost, which will stand erect for many years.

Stones to be Used.—The proper form and sort of stone is essential to the building of stone dykes—flat and thin, with a rough surface by which they adhere to one another in the wall; and no material is so well adapted for this purpose as sandstone boulders of gravel deposits when split with a pick into flat pieces of the requisite thickness on being taken out of the ground, and before they become hard and dry on exposure to the air.

Dimensions of Dyke.—The usual

[1] Inglis's *Ireland*, i. 50-51.

height of a field-dyke is about 3 feet 9 inches to the under side of the cover upon which the copestones stand; and as the cover and copestones usually measure 12 inches, the dyke stands altogether 4 feet 9 inches in height.

The dyke, when finished, is measured by the rood of 36 square yards upon its face under the cover, so that every 30 yards in length of a 3 feet 9 inch dyke will be 1 rood.

The breadth of such a dyke is 2 feet at the base and 15 inches under the cover.

Double and Single Faced Dykes.—A dyke that stands by itself has two plain faces, and is called a double-faced dyke; and a dyke built against a sunk-fence is called a single-faced dyke. A double-faced 3 feet 9 inch dyke requires 1 ton of stones for 1 square yard of its face, so that 36 tons of stone are required for 1 rood of 30 yards long.

Cost of Dykes.—The expense of quarrying that quantity of stones may be about 10s. the rood; the carriage of them at a reasonable distance beyond 1 mile is also 10s.; and the building is commonly undertaken, when the stones are good, at 10s. also;—so that such a dyke costs 30s. the 30 yards, or 1s. for 1 yard in length, or £6, 9s. 6d. per cubic rood, or 3s. 7d. per cubic yard. The best way to contract for the erection of stone dykes is by the rood of 36 cubic yards, when every temptation on the part of the builder to lessen the breadth, and make the heart of the dyke hollow, is removed.

Tools for Dyke-building.—The tools of a dry-stone dyker are few and inexpensive, consisting only of a mason's hammer, a frame as a gauge for the size, and cords as guides for the straightness of the dyke. A ditcher's shovel is useful in adjusting the ground for the foundation-stones, and in putting the shivers of the stones together into heaps, to be easily removed by carts.

Dry Weather for Dyke-building.—A dyker cannot work in very wet or very cold weather, as handling rough wet stones is hurtful to bare hands. On this account, dry-stone dykes are usually built in summer.

Preparing Foundation.—The line of fence being determined on, it is marked off with a row of stakes driven firmly into the ground. The upper soil is removed to the breadth of dyke from the line of dyke to form its foundation, and is driven away immediately, not to lie in the builder's way. It may be formed into a compost with lime, near the spot, for top-dressing grass.

When the surface consists of old firm thick sward, the dyke *may* be founded upon it; but in forming foundations it should be borne in mind that dykes in *soft* earth of every kind are sure to sink to their injury—not merely curtailing height as a fence, but twisting the structure and causing a downfall.

Soil consisting of vegetable *mould* should be removed altogether, and its intrinsic worth for top-dressing or for compost will repay the trouble of removing.

Providing Stones.—After the foundation has been formed by removal of the earth, the stones are laid down on both sides *as near the foundation as practicable*, for it is of considerable importance to the builder that the stones be near his hand. When they are laid even two yards off, the builder loses time in throwing them nearer; and when they are laid on the foundation, he has to remove them before commencing work.

Large boulder-stones form good material for the foundation of stone dykes, and should be laid close to the foundation before the building-stones are brought.

In laying down the stones, the carters should be instructed to put down 18 tons on each side of 30 yards' length of the foundation; and when boulders are employed, allowance is made for them. These particulars are worth attending to, to save unnecessary trouble afterwards in removing or bringing stones, to the annoyance alike of the dyker and the farmer.

Carrying Stones.—The easiest mode of conveying large boulders is upon a sledge shod with iron. This is easier than putting them into and taking them out of a cart, the bottom and sides of which are apt to be injured. A pair of horses, yoked as in a plough, will draw a very heavy boulder upon such a sledge on ordinary ground.

Lining Carts for Stones.—When many ordinary stones are driven for buildings of any kind, the carts which are driving the stones for dykes should have an extra bottoming and lining with deals of common Scots fir, or of willow, which latter is better than any other sort of wood, being softer and less liable to split.

Two dykers, one opposite the other, are the best number for making the best work, and assisting each other with stones which one would not be able to manage.

Frame for Dykes.—The dykers begin by setting up the frame, fig. 574, at one end of the dyke, whether it commences against another fence, or at a gateway into a field, which the figure represents. The frame is made of the breadth and height of the dyke under the cover, and is set perpendicular by the plummet attached to it. A corresponding frame should be placed beyond the point which is fixed for one stretch of building, or two stakes driven into the ground, having the same inclination as the sides of the frame, to answer the purpose of a temporary frame. On undulating ground a space of ½ a rood, or 15 yards, between the frames is a sufficient stretch of building at one time. On level ground 1 rood may be taken in.

The cords are then stretched along and fastened to the outside of each frame, to

Fig. 574.—*Building a dry-stone dyke.*

guide the building of each side of the dyke straight, and to gauge its breadth. The frame is held erect and steady by a stiff rail, having a nail through one of its ends, hooked on to the top-bar of the frame, and the other end having a stone laid upon it, or pushed into the ground.

Process of Building.—When a dyke is begun at a gateway, it is with a scuncheon, and a large boulder is well adapted for its foundation-stone. If there be no boulders, a large stone should be selected and dressed for the purpose, as a protection to the end of a dyke—and especially when the scuncheon forms one side of a gateway to a field. Another boulder, or large stone, should be placed at a little distance from the first, and smaller stones used to fill up the space between them, until the building is raised to the height of the boulders. A scuncheon should be formed of in-band and out-band stones, hammer-dressed, and firmly bedded upon one another above the boulder.

Art in Building.—Great art is required in laying the small stones, and it is this in dyke-building which detects the good from the bad dyker. In good dry building, the stones are laid with a very slight inclination downwards, from the centre of the dyke, towards each face, and to break band with the stones beneath; and to support the inclination, small stones are wedged firmly under them in the heart of the dyke; whereas stones laid flat admit of no wedging to firm them, and receive none, to the risk of the dyke bulging out in both faces. The inclination causes rain which may have found its way down through the top of the dyke to be thrown off by both sides.

Thorough-bands.—The stability of a dyke is much secured by having a thorough-band stone placed across its whole breadth about half-way up the building. The building then proceeds above the thorough-bands to the top of the dyke. Thorough-band stones are often left projecting from both sides of the dyke; but the practice is objectionable, inasmuch as the projecting stones serve as stepping-stones for trespassers to climb the dyke, and are apt to lay hold of plough-tackle.

Levelling the Dyke-top. — The levelling of the top of the dyke should not be made of very small or very thin stones, these being unstable, easily broken, and in danger of slipping out from below the covers.

Covers.—The covers, if covers are to be used, are laid upon the levelling, and project an inch or two beyond each face of the dyke to protect its top, and should be 2 inches thick, without a flaw, and 2 feet in length, that their weight may keep them firm in their place, and their size cover a large space of building.

Coping. — In forming the cope, one large stone should be placed at the scuncheon to keep down the cover, and act as an abutment for resisting the wedging in of the smaller copestones. Another large copestone should be set at a short distance upon the joint of two covers to keep them secure. Thinner stones are then placed on edge between these large copestones—and where they meet, a stone is wedged in by strokes of the hammer; but *wedging* should be delayed until a considerable length of coping is finished, the better to resist the force of the wedges. The copestones should be all as nearly as possible the same height: they are usually somewhat pointed at the top or gently rounded off.

On finishing the *face* of a dyke, small stones should be firmly wedged in with the hammer, where room can be found for them, between the beds and at the ends of larger stones.

Building in Stretches. — In taking a stretch of dyke of 1 rood, the building is carried up at both ends, as well as the middle, first to ½ the height, and then to the levelling of the top, before the intermediate spaces are built in, because those primary pillars support the intermediate building; and these on their part act as wedges between the pillars.

When a few stretches of dyke are thus finished, the surplus stones, if any, should be removed, and laid where they are wanted; or a sufficiency of stones immediately brought, to allow the builders to finish one stretch before they go on with another. The *débris* of stones may be used for the roads.

Gaps in Dykes.—These are all the particulars to be attended to in building dykes for ordinary fencing; but modifications are made to serve convenient purposes.

For example, an opening under the cover of a dyke allows sheep to pass from one field into another, when the road goes round a considerable distance. When the opening is not used, it is closed up. An opening of 3½ feet wide and 3 feet high suffices.

It is convenient to have a low gap at the top of the dyke by removing the coping at a time when a passage is required for foot-passengers. By this expedient the dyke may often be saved from injury.

A gap near the top of a dyke is useful as a stile in a footpath, or at a cover, for hounds and huntsmen to pass into with ease, and at which a whipper-in may stand on the outlook for a burst.

Dykes as Fences.—Such dykes as have been described, about 3 feet 9 inches in height, will fence horses and cattle and low-ground sheep, but will not confine blackfaced or Cheviot sheep, and other expedients must be used.

Supplementing Dykes for Sheep.—For hill sheep, which would leap over ordinary dykes, some expedient must be adopted for heightening the fence. One plan sometimes used is shown in fig. 575.

This is part of an ordinary dyke with the copestones set on edge 9 inches or 12 inches higher than the ordinary coping. Upon these are placed either fillets of wood along notches formed on their top, and wedged into them, or, as was at one time common, a strong rope of straw is laid somewhat loosely over the notches, to dangle in the wind.

An expedient where a single-faced dyke is built against rising ground, having a

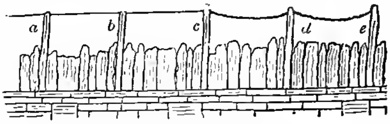


Fig. 575.—*Increasing the height of a dry-stone dyke.*
a b c d e Tall copestones.
a b c Fillets of wood on the copes.
c d e Straw-ropes on the copes.

plantation or cultivated land, is to sow seeds of whin or broom behind the dyke, and the plants in time spread over the copestones.

Where turf is tough and heathery, thick turfs, cut of the breadth of the top of the dyke, and laid firmly and neatly upon the covers, support copestones for several years.

Wire over Dykes.—Now, the more general plan is to use wire for heightening a wall-fence. Where large strong stones can be got for a cover, the wire is held by upright wrought-iron standards fixed into the covers. In some cases stakes are driven along and close to the face of the dyke, as high as to reach above the covers and to receive two or three rows of wires.

Where thinnings of plantations are abundant these may be employed, although they are less durable than the preceding plan with the wires.

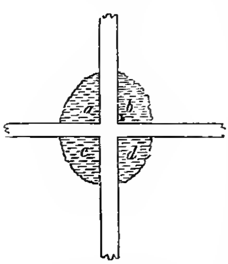


Fig. 576.—*Four watering-pools formed by two dykes crossing.*
a b c d Four watering-pools.

Joining Dykes.— When dykes run at right angles to one another, and are erected simultaneously, they should be built in connection. But where one new dyke comes against an old one, the latter should not be touched, and the new built firmly beside it.

Watering-pools.—Where two dykes cross, and the place is naturally swampy, or water easily brought to it, a watering-pool would serve four fields, and the foundation of the pool should be formed before the dykes are built, fig. 576.

Where a pond already exists, and its water is too deep for dykes to traverse, the dykes must terminate at its edge, and convert the pond into a watering-pool common to four fields.

When the pond, fig. 577, is used by only one field, it is fenced from the other three fields by hurdles or paling; and when used by more than one field, a spar-paling is placed across the pond, besides the hurdle-fences in the fields not occupied by stock.

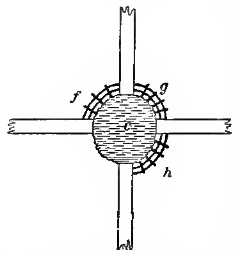


Fig. 577.—*One watering-pool common to four fields.*
c Watering-pool.
f g h Hurdle-fences in the fields not occupied by stock.

Where the ground is firm, and no water is to be obtained for a watering-*pool*, the dykes cross, and a well may be sunk in a corner of one of the fields, with a pump of such height as to supply all the fields with water by a spout in troughs. This expedient we have successfully used.

Shelter.—Where the ground is firm, and no water but shelter is wanted at the spot, the dykes should be built with a curve, to enclose a space to be planted with trees for ornament and shelter, fig. 578. The land will not be wasted, even of the finest quality; because the corners of four adjoining fields cannot be reached by the plough, while it can pass along such curves as easily as a straight fence.

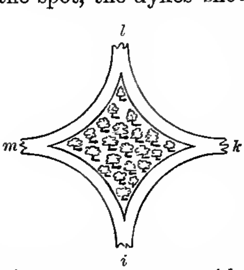


Fig. 578.—*Clump of trees within the meeting of four dykes.*
i k l m Four curved dykes.

Curves in Dykes.—In building curves in dykes, builders charge a half more per rood than for plain work. Such curves in dykes are made by the same rules as those for hedges.

Repairing Dykes.—A stone dyke is in the highest state of perfection as a fence immediately from the hands of the builders; and every day thereafter, from the effects of the elements upon the stones at all seasons, and the accidents to which they are liable by trespassers and the collision of stock, subjects them constantly to decay, making repairs inevitable every year the fields are occupied by stock.

When repairs are not extensive, the most convenient mode of supplying stones to the dyker is to lay down a cart-load here and there, and provide him with a wheel-barrow to take the stones as he wants them. When stones are thus laid down, what are not required are very often allowed to remain upon the ground for the greater part of the season, from reluctance to waste time on such an insignificant job as their removal at a busy season. It is a bad practice however. The surplus stones should be at once removed.

Utility of Dykes.—Dry-stone dykes are not nearly so picturesque objects in a landscape as thorn hedges, nor do they afford so much or so comfortable shelter to stock. They are quickly erected in a country where materials suited to them are abundant; and on completion, they impress the conviction that little trouble will be incurred by them for a number of years to come.

Sunk Fence.—A sunk fence cannot be said to be complete until a single-faced stone dyke is built against the firm ground, after the earth has been removed in front. There is no better means for supporting a bank of earth likely to slip down than to face it with a stone wall. A face dyke should be built along a farm-road which has been cut down to the level from a bank.

WIRE FIELD-FENCES.

Wire is now more largely employed than any other material in fencing land. It is cheap, durable, and easily and speedily erected.

Wire fences consist of three parts—the straining-posts, the standards or intermediate posts, and the wires.

Straining-posts.—The straining-posts are made of wood or of iron. Where wood is cheap it will be chosen, although it can bear no comparison with iron in durability.

A simple form of straining-post of wood is shown in fig. 579. It is 7 feet long, and 6 or 7 inches in diameter at

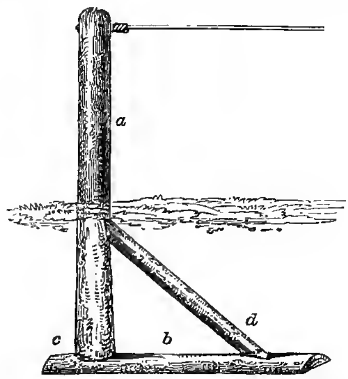


Fig. 579.—*Straining-post, with sole and stay underground.*

a Straining-post. *c* Junction of post and sole.
b Sole. *d* Strut.

the smallest, which is the upper end, and it is put into a pit 3 feet deep, fastened to a horizontal sole from 3 to 6 feet long, 3 or 4 inches thick, and 6 inches broad, which takes in near its end a strut, which is notched and nailed into the straining-post about 4 inches below the ground. The earth is firmly rammed in upon the sole and round about the strut.

Another method of securing a straining-post of wood is shown in fig. 580, where behind the bottom of the post is fastened a plank 2 feet long, 10 inches broad, and 2 inches thick; and another plank of the same dimensions is fastened in front of the post about 6 inches below the surface of the ground. The earth is then firmly rammed in until it comes to 12 inches of the surface, when another plank of similar dimensions is placed opposite to the upper plank firmly into the ground, and then three pieces of wood are tightly driven in between these two planks.

This has been considered a very secure mode of fixing a straining-post against the tension of the wires. Yet some would do away with the plank c and the pieces of wood *e*, and let the plank *d* press directly against the post. In this case the bottom of the hole should be made

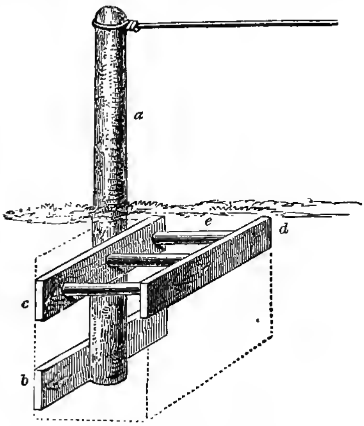


Fig. 580.—*Straining-post, with planks underground.*

a Straining-post.
b Lowest plank behind the post.
c Upper plank in front of the post.
d Plank opposite the upper plank.
e Three pieces of wood wedged in between the two planks.

just large enough to let in the post and the plank *b*.

A third method is given in fig. 581, where a similar size of post of wood is

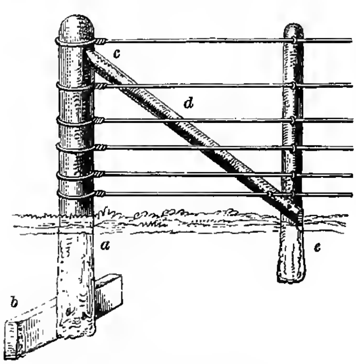


Fig. 581.—*Straining-post, with standard and stay above ground.*

a Straining-post.
b Piece of wood nailed behind its bottom.
e Standard-post.
d Strut.
c Points of connection with straining-post and standard.

placed in the pit, having a piece of wood, 2 feet long, 6 inches broad, and 2 inches thick, nailed to the back part of the bottom. A standard post is driven into the ground at 4 feet distance from the straining-post; and a strut is nailed at one end into a notch near the top of the straining-post, and at the other end to the standard post near the ground. Both the posts are fixed in the ground before the strut is nailed to them, and the strut is above ground.

Many consider it a good plan to cut the holes for straining-posts just long enough and wide enough to admit the post and its stay or support. This is a good plan when the ground is firm, but in soft ground it is better to dig out the soft earth, and have it more firmly packed around the post.

There is no more secure method of fixing a strainer than sinking it in a bed of rough concrete.

Iron Strainers.—Wrought-iron makes much more durable strainers than wood, and the former are now largely employed.

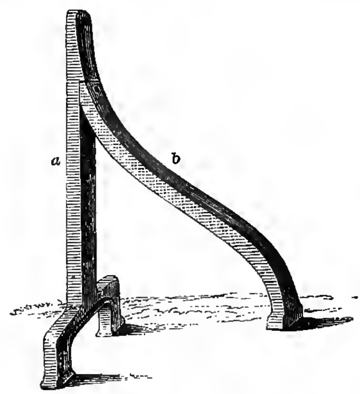


Fig. 582.—*Wrought-iron straining-post.*

a Straining-post. *b* Stay.

A form of wrought-iron straining-post long in use is shown in fig. 582.

When wooden straining-posts decay they must be removed, and in doing this the whole fence must be taken down. Iron posts obviate this inconvenience by their permanency. They are usually from 1½ to 2 inches square, according to the character of the fence and the uses expected from it. The extreme iron posts require an iron stay in addition, and both are fixed into large boulders or blocks of concrete, weighing perhaps half a ton.

Winding-pillars.—In addition to the straining-posts, it is important to have, at moderate intervals, strong wrought-iron winding-pillars, such as that shown in fig. 583, which is made by A. & J. Main & Co. By these winding-pillars it is easy to keep the wires tight, and thus ensure the permanent efficiency of the fence.

Intermediate Posts.—The intermediate posts are in most cases of larch, and the thinnings of plantations are suitable for them. For a fence of 3½ feet in height, the posts should be 5½

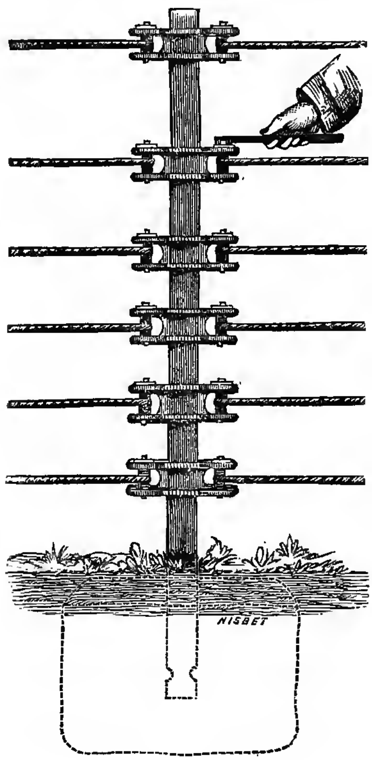


Fig. 583.—*Winding-pillar.*

feet long, with a diameter of 3½ inches at the smallest end. In ordinary fencing they may be used with the bark on.

Charring Posts.—Posts should all be charred, which is done in this manner: Lay two trees of little value parallel, about one foot or 14 inches apart, upon the ground. Between them collect chips and brushwood, which set on fire. Lay the posts directly across the flame, at the part where the surface of the ground will touch, and turn them round and round until they are charred.

They are then smeared with coal-tar while they are warm, that as much as possible of the tar may be absorbed. The smearing will be most effective upon peeled posts.

Intermediate posts have a sufficient hold of the ground at from 15 to 21 inches deep, according to the firmness or softness of the soil, and will support the wire sufficiently when set 6 feet apart, in a straight line; but in curves they are set closer, and always within the curve, to meet the strain of the wires upon the curve outside.

Iron Standards.—Iron is now largely substituted for wood in the intermediate posts or standards as well as in the strainers. The first cost is of course greater when wrought-iron standards are used, but the fence is much more durable, and will incur less trouble and expense in repairs than if wooden standards had been employed. There are numerous forms of iron standards for fences. Here we illustrate in fig. 584, *a*, *b*, *c*, *d*, and *e*, different patterns made by A. & J. Main & Co.

Varieties of Wire.—There are several varieties of wire used in fences. Formerly the *common* or ordinary iron wire of commerce was most largely used. *Annealed wire*, the common wire softened in the furnace, has been pretty extensively employed because of its pliability, but it is not so durable as most of the other kinds. *Prepared wire* is made with special care from a fine variety of iron, and forms a durable fence. *Steel* and *galvanised* wire are now also extensively used. The latter is rather more expensive than the others, but wears admirably.

Then there is the *galvanised twisted wire*, consisting usually of seven ply of small galvanised wires of different degrees of thickness, formed into one with a gentle twist. This is considerably dearer per cwt. than the single-ply wire, but it makes a very strong and durable fence.

Fence-wire is made of various thickness or weight to suit the different purposes. The length per cwt. of the single-ply wire varies from 135 to 815 yards, common lengths being from 230 to 395 yards to the cwt. Twisted galvanised wire *goes further* for its weight than the one-ply wire. The former ranges from 200 to 1000 yards per cwt., common lengths being from 260 to 465 yards per cwt.

Barb-wire.—This is a mischievous invention of the ingenious American—

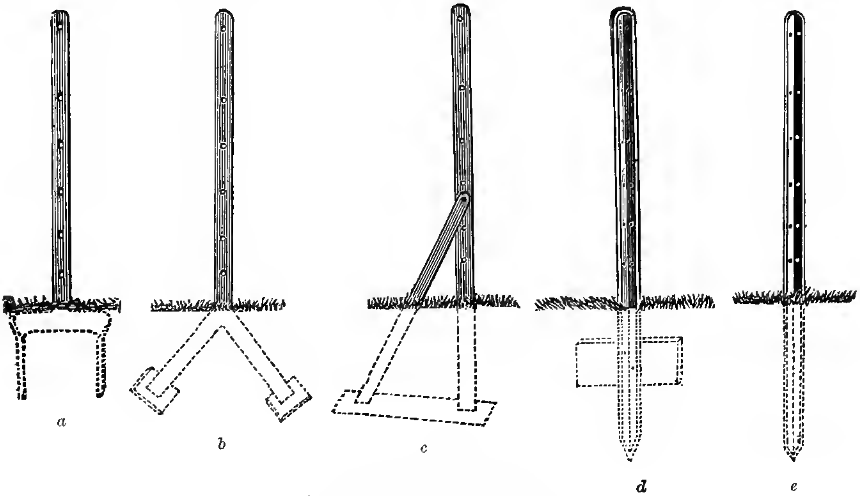


Fig. 584.—*Wrought-iron standards.*

mischievous, in that it lacerates in a painful manner men or beasts that come incautiously against it. That it is well fitted to inflict injury in this way will at once be seen by the illustration in fig. 585.

But as a fence the barb-wire is unequalled for efficiency and cheapness combined. It is dearer per cwt. than even the twisted wire, but half the number required of ordinary wires will suffice of the barb pattern. Indeed, if properly placed, and kept straight and in good repair, two barb-wires will hold in cattle or horses.

Barb-wire for Sheep.—It is not a good fence for sheep-farms, for by endeavouring to scramble through, the sheep are liable to have their fleeces much injured by the barb.

Horses.—For horses it is an effective but somewhat dangerous fence, especially

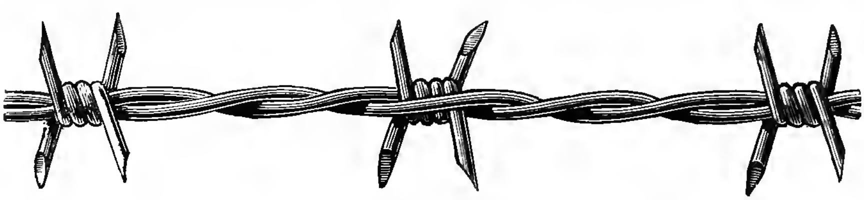


Fig. 585.—*Barb-wire.*

for high-bred animals. In England several valuable horses have died from wounds inflicted by the barb, and many owners of studs who adopted the barb-wire have removed it from their fields. The use of barb-wire by the side of public thoroughfares has very rightly been prohibited, on account of the risk of injury to man and beast.

Farm animals have a wholesome dread of barb-wire. They soon discover its existence, and the more cautious of them give it a wide berth.

In many cases a single barb-wire is introduced at the top or second from the top of an ordinary wire fence, to prevent horses from leaning and rubbing against the wire. It is quite effective as the second wire from the top, and is not so liable to cause serious injury as when it forms the top wire.

Standard for Barb-wire.—An excellent wrought-iron standard, for barb-wire,

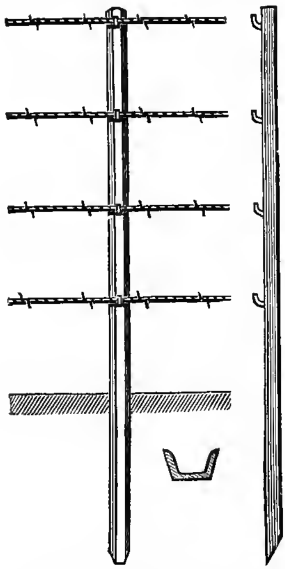


Fig. 586.—*Standard for barb-wire.*

made by A. & J. Main & Co., is shown in fig. 586.

Number of Wires.—The number of wires in each fence varies greatly. The class of stock to be confined or kept out is the chief consideration in deciding as to this. The ordinary 3 feet 6 inch fence will require 6 wires for sheep and lambs; for cattle or horses 4 or 5 wires would suffice. The top wire is usually a size or two thicker than the others, and some

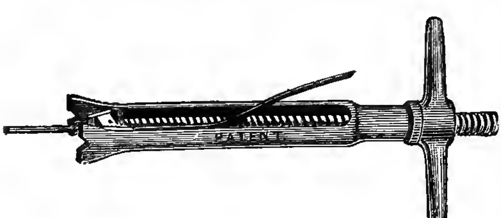


Fig. 587.—*Wire-strainer.*

have the two wires next the top of the greater strength.

Erecting Wire Fences.—The line of the fence having been decided upon, the straining-posts are first put in, and then the standards. Considerable skill and care are required in erecting wire fences, for the durability as well as the efficiency of the fence much depend upon the manner in which this work is done.

Straining Wire.—The tool used in straining or tightening wire is shown in

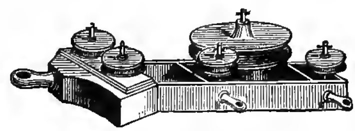


Fig. 588.—*Wire-straightener.*

fig. 587. It has a powerful screw, capable of straining 300 yards of wire, and can be applied to either wood or iron posts. The top wire is first tightened, and then the bottom one.

Straightening Wire.—If the wire is much bent, it may have to be straight-

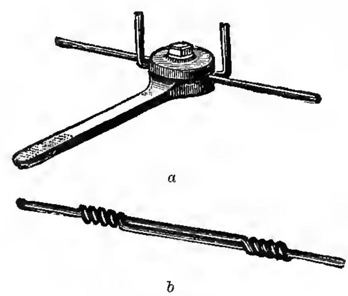


Fig. 589.—*Wire-knotting tools.*

ened before being put into the fence. A tool used for this purpose is shown in fig. 588. The wires are passed through the grooved rollers, and by this means all bends or "kinks" are straightened.

Knotting Wire.—The knotting of the wire, when it has been strained, has to be done neatly and carefully. The ends of the wires are laid inside the tongs, and then firmly secured by the bolt and cap. The two ends are set up, as in fig. 589 *a*, the twister applied, and the knot tied as in fig. 589 *b*. The ends do not require to be cut, as the twister leaves the knot complete.

Durability of Wire Fences.—The durability of wire fences is greater than might be expected. If well put up, and if good materials, they will need

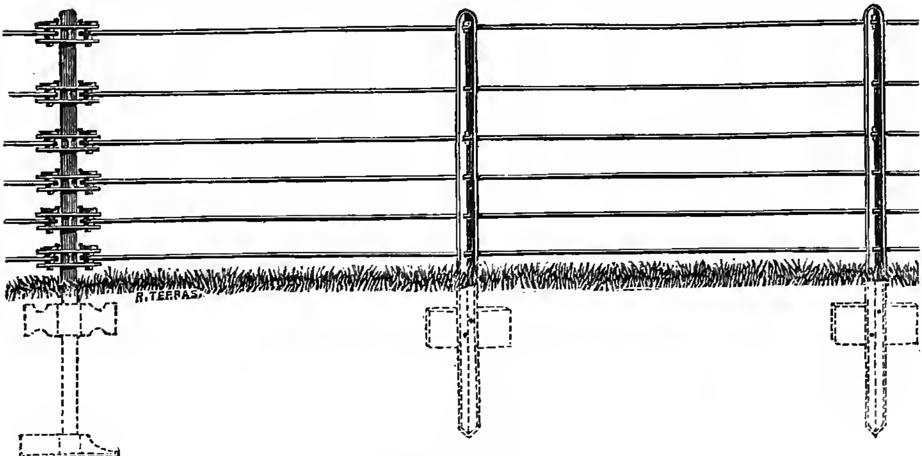


Fig. 590.—*Iron and wire fence.*

little or no repairing for ten or a dozen years. With iron strainers and iron

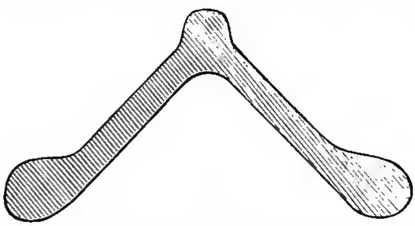


Fig. 591.—*Section of bulb-angle iron.*

standards, firmly set in the ground, it is practically a permanent fence.

No Shelter.—But while wire fences are cheap, efficient, and durable, they will never wholly supersede thorn hedges or stone dykes on farms. This for the very important reason that they afford no shelter to stock, which is so much needed on many exposed farms. They are well suited to fence plantations, to enclose deer-forests, and form march-fences; and for all these purposes, as well as for fences on pastoral and mixed-husbandry farms, they are much used.

Varieties of Wire Fences.

Much ingenuity and enterprise have

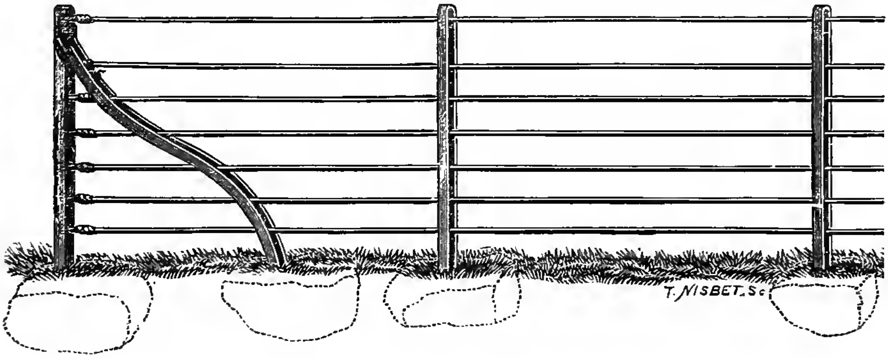


Fig. 592.—*Horse and cattle fence.*

been exercised in the designing of wire fences to suit the respective wants of the different classes of owners and occupiers of land. This will be well shown by the illustration of some of the numerous types of iron and wire fences constructed at the Clydesdale Iron Works, Glasgow, by Messrs A. & J. Main & Co.

Iron and Wire Fence.—Fig. 590 represents an excellent wire fence with iron standards, showing the winding-pillar (fig. 583). The standard used here is the "bulb-angle" pattern, which most admirably combines strength and convenience. A full-size section of the "bulb-angle" strainer is given in fig. 591.

Horse and Cattle Wire Fence.—A specially strong iron and wire fence is represented in fig. 592. The standards here are of extra strong "flanged" iron, the fence being intended for horses and cattle.

"Corrimony" Fence.—This excellent fence, designed after a fence in use in New Zealand, was first erected in this country in 1873 by Mr Thomas Ogilvy of Corrimony, Inverness, by whom the system is fully described in the *Transactions of the Highland and Agricultural Society.*[1] It is recognised as the most economical fence for sheep that has yet been introduced. This is particularly the case in hilly, woodless districts, where the expenses of carriage and erection tell heavily against ordinary fences. The materials used in the "Corrimony" fence are so light, and the facility with which they can be erected is so exceptional, that the costs are materially reduced.

The variety of wire used in this fence is bright Bessemer steel, so that it is lighter, stronger, and more durable than ordinary wire.

Construction of "Corrimony" Fence.—The chief distinguishing feature of the "Corrimony" fence is that the fixed standards are placed at a considerable distance apart, varying from 12 to 22 yards, and that in the intervening space the wires are prevented from being pushed apart by "droppers" placed at intervals of 6 feet (fig. 593). These "droppers," it will be seen, do not go into the

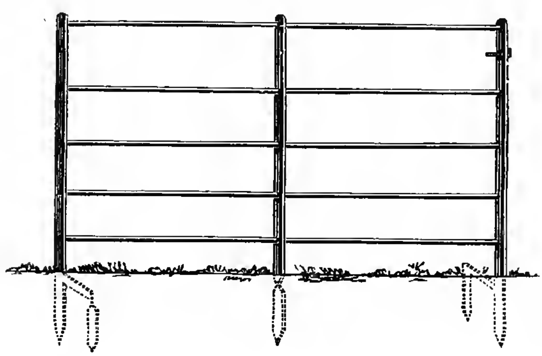


Fig. 594.—*Iron hurdle.*

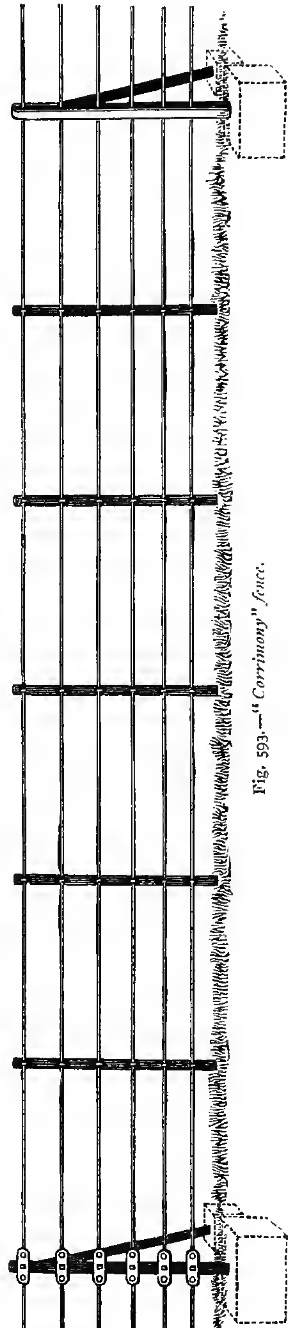


Fig. 593.—"*Corrimony" fence.*

[1] Vol. vii., 4th ser., 1875, 269.

ground, and the fence therefore possesses a certain degree of elasticity in a lateral direction between each pair of standards.

It is important for the durability of the fence that the "droppers" should be light in weight, yet strong; should take a firm hold of the wires, and expose as little surface as possible to the wind.

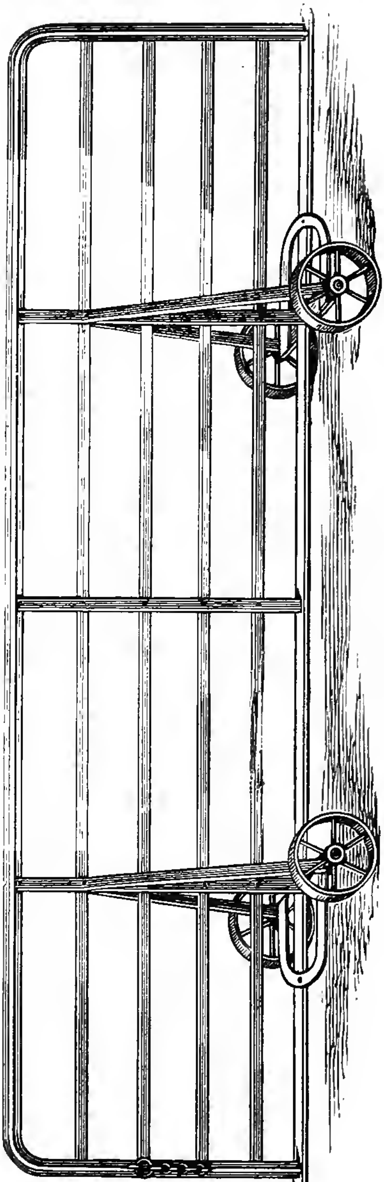


Fig. 595.—*Iron hurdle on wheels.*

Although the "Corrimony" fence is pre-eminently suited for sheep-fencing, it may also be strengthened and modified, so as to form a reliable fence for cattle or deer.

Cost of "Corrimony" Fence.—The cost for the materials for the "Corrimony" sheep-fence ranges from £35 to £50 per mile in plain condition, and if galvanised from £56 to £75 per mile. If intended also to fence light cattle, the cost would be about £10 additional.

Iron Hurdles.

For movable fences wrought-iron hurdles are convenient and durable, but rather costly at the outset. An excellent wrought-iron hurdle for sheep and cattle is shown in fig. 594. A still more convenient, but of course also more costly, iron hurdle, is that mounted on wheels, shown in fig. 595.

A convenient wicket or hand-gate for a hurdle-fence is shown in fig. 596.

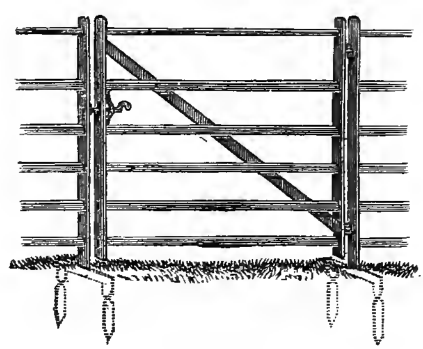


Fig. 596.—*Wicket for hurdle-fence*

Folding Hurdle.—For sheep folded on turnips or grass, a reliable hurdle which can be easily shifted and readjusted is a great desideratum. For this purpose an iron hurdle such as that shown in fig. 597 is admirably adapted.

Ornamental Wire Fencing.

For an ornamental fence combining also lightness and durability, iron and wire can hardly be excelled. Many beautiful designs of fences of this kind are now in use, notably around dwelling-houses, gardens, and terraces.

Ornamental hurdles which have the advantage of being unclimbable are shown in fig. 598.

Fig. 599 represents a light wire hurdle

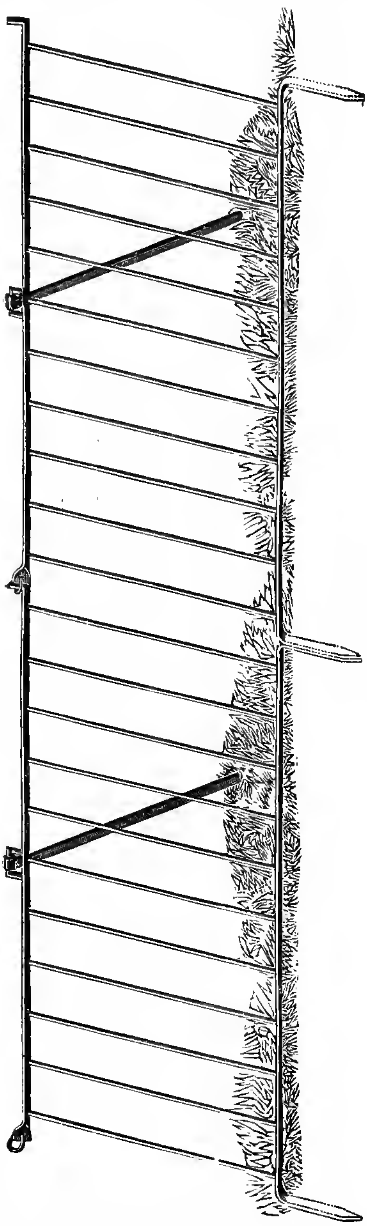


Fig. 597.—*Folding hurdle.*

suitable for borders or for the top of a wall.

A strong and attractive iron railing with wicket is shown in fig. 600.

Malleable Iron Fence.—A neat and strong iron fence is shown in fig. 601. It consists entirely of malleable iron. The bars are of bar-iron, 6 of which are employed to form a fence of ordinary height. The upper bar is horizontally,

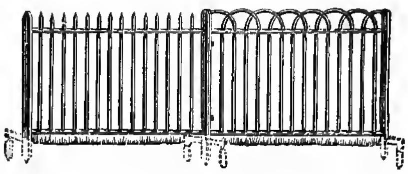


Fig. 598.—*Unclimbable hurdle.*

the 5 under bars perpendicularly placed. The bars pass through holes in the standards, and at the junction of the bars is a stronger standard, to which the ends of the bars are fastened with iron wedges split so that they cannot easily be withdrawn. The figure shows how the posts and standards are fixed in the ground in dotted lines.

FIELD-GATES.

Field-gates are a necessity on a farm. No field can be said to be complete in its fences without the gates. When well constructed, and easily opened and shut, they give an agreeable finish to the fences.

Construction.—A field-gate may be described as a rectangular frame, and a simple rectangular frame is the most liable to change of any connected structure of framework, although it is the most serviceable form. On the other hand, the triangle is the most immutable of any form, and as long as the materials remain, it will never change. To have the most immutable field-gate it ought to have the triangular form; but in practice a gate in the form of a triangle would be most unserviceable, though a combination of triangles produces the requisite figure for a serviceable gate.

If we take the most serviceable form for a gate, the rectangular, and apply a bar to it, in the position of a diagonal of the parallelogram, we immediately convert the original rectangle into two triangles, applied to each other by their hypotenuse. Such a combination gives us the true elements of a properly constructed field-gate, every other part being subordinate, and only adapted to the practical purposes of the gate as a defence or an ornament.

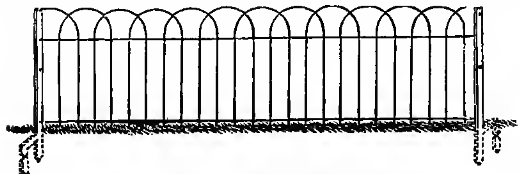


Fig. 599.—*Light ornamental hurdle.*

Thus, then, the essentials of a field-gate, whether of wood or of iron, are a rectangular frame, consisting of the heel and head posts, and a top and bottom rail; which four parts, properly connected at the angles, are rendered of an unchangeable figure by the application of one or more diagonal bars, which in no case ought to be applied short of the whole length, between any two of the opposite angles, and which convert the rectangle into two triangles.

Fig. 602 represents such a combination. In field-gates constituted entirely

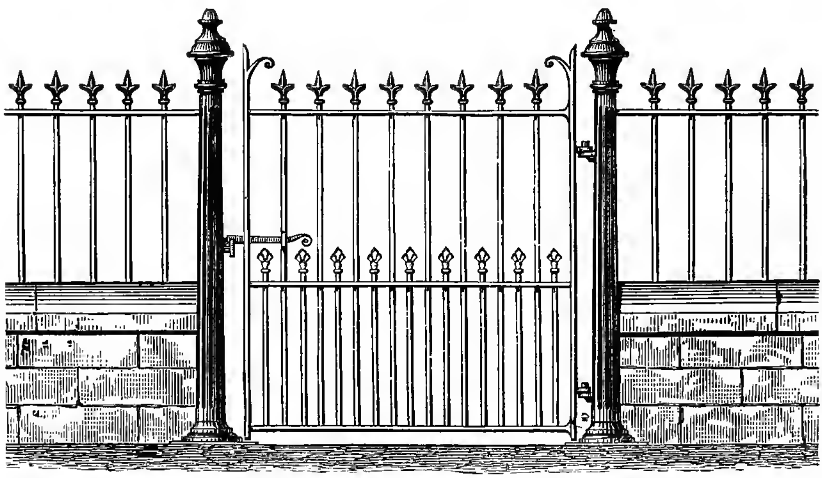


Fig. 600.—*Iron railing and wicket.*

of wood, the diagonal should invariably be applied as a strut, to rise from the foot of the heel and terminate at the top of the head post. Placed in this position, the diagonal supports the swinging end of the gate by its resistance to compression, which it is well adapted to perform by the area of its cross-section being considerable, and hence capable of resisting lateral flexure.

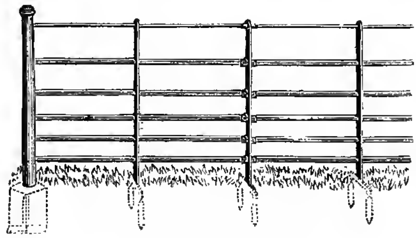


Fig. 601.—*Malleable-iron fence.*

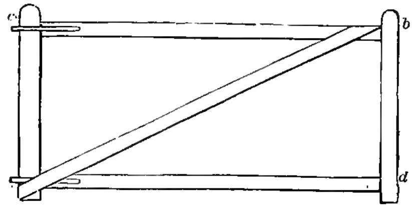


Fig. 602.—*Rectangular frame with diagonal strut.*

a c Heel-post. *b d* Head-post. *c b* Top rail. *a d* Bottom rail. *a b* Diagonal. *a c b* One triangle. *a b d* The other triangle.

The advantages of a tie are the converse of a strut. If a tie is placed from

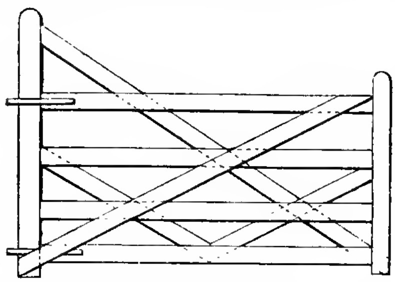


Fig. 603.—*Strong field-gate.*

the opposite angle to the strut crossing the strut in its centre—and an iron bar

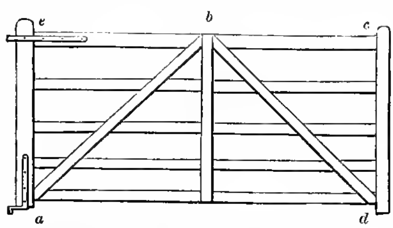


Fig. 604.—*Common wooden field-gate.*

a b Strut.
b End of strut.
c End of upper rail.
b d Tie.
c d Head-post.
a e Heel-post.
e Crook-and-band hinge.
a Heel-crook.

makes a perfect tie, the cohesion of which is such that a very small sectional area is sufficient for the purpose—the two antagonistic forces of the wooden strut and the iron tie, acting each in its own sphere, preserve within the whole structure the most perfect equilibrium.

Mr John Speir, Newton Farm, Glasgow, says: "My idea of a field-gate is as shown in fig. 603. The top and bottom bars are both heavier by nearly the double that of the centre two, the diagonals being all the same weight,

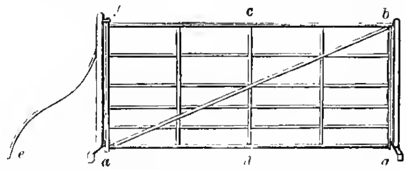


Fig. 605.—*Iron field-gate with iron posts and stay.*

b g Fore-stile.
a b Diagonal.
f b Top rail.
a g Bottom rail.
c d Upright bars.
f a Hanging-post.
e Stay.

about an inch thick, and 4 inches broad. By lengthening the heel-post and taking the diagonal from the top end, the top bar being caught at one quarter of its length is much strengthened, while the right-hand bottom corner, which is the first to fail in most gates, is also strengthened and stiffened. A gate which does not swing freely—and few field-gates do—soon gives way at that corner, so that

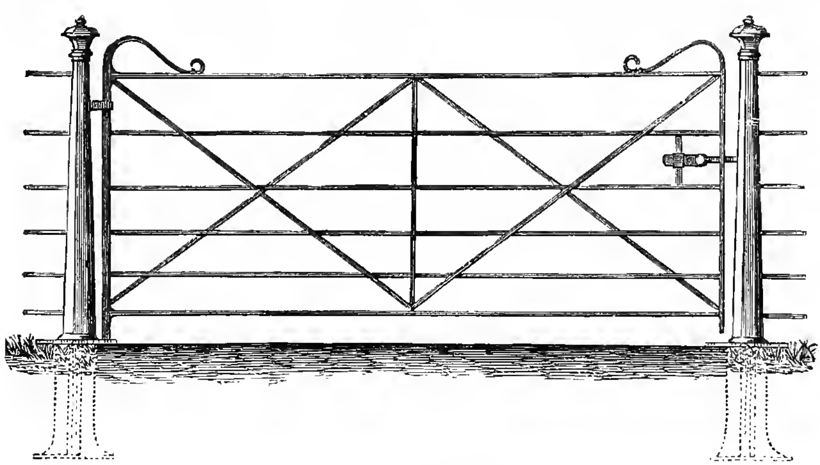


Fig. 606.—*Wrought-iron field-gate.*

any stiffening which can be given to it is of advantage. Each of the short diagonals go on different sides; and as the point of intersection of all the diagonals and bars is double, one small bolt binds them better and weakens the wood much less than three or four nails."

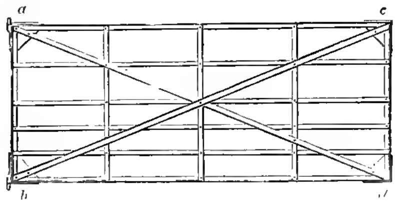


Fig. 607.—*Angle-iron field-gate.*

a b Heel-post. *a d* Antagonist diagonal.
b c Diagonal. *c d* Head-post.

Deficiency of Common Gates.—A common form of field-gate to be seen in this country is in fig. 604; and, applying the principles to it which we have been considering, we shall find it defective in several most essential particulars. It has a strut, but instead of extending across the entire diagonal, it stops short at the centre of the gate. The prolonged part of the top is liable to be broken off by any undue force being exerted upon its end, when it is converted into a lever whose fulcrum is supported at the end of the strut. It has also a tie, which is not only made of a wooden rail, but it stops short at the end of the strut, and in no part does it cross the strut so as to act with it in maintaining an equilibrium of forces.

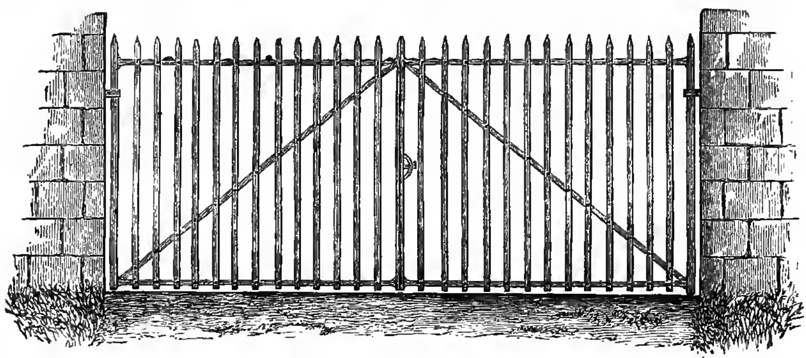


Fig. 608.—*Gate for farmyard.*

The consequence in practice is, that this form of gate is very frequently fractured at the head-post, and falls towards the ground.

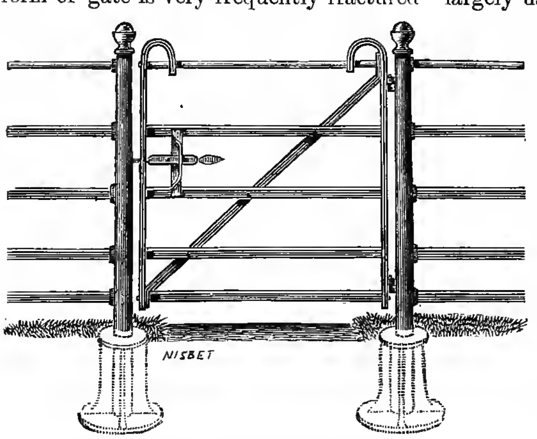


Fig. 609.—*Field-wicket.*

Iron Gates.—Iron field-gates are now largely used, but their weight is against them. Fig. 605 gives a simple form of an iron field-gate. It consists of 6 rails so arranged as to keep in lambs in the lower part of it. It is both light and strong. The fore-stile is prevented from dropping by the diagonal bar, which, on being applied with its flat side, is riveted to each of the rails; and the twisting is counteracted by the top and bottom rails being welded flatways to the fore and hind stiles with strong solid knees. The upright bars retain each of the rails in its proper place.

The gate-frame is 9 feet long, and 3 feet 9 inches in height. The gate can be hung upon wooden posts; but the iron posts, as shown in the figure, correspond better with the appearance of the gate. They are made of malleable iron, and are fastened into large stones with double bats; and the hanging-post is additionally supported by a stay.

This form of gate would be strengthened by the introduction of a tie stretching from the top of the hanging-post to the bottom of the fore-stile across the centre of the diagonal.

A strong and yet moderately light field-gate of wrought-iron, made by A. & J. Main & Co., is shown in fig. 606.

Angle-iron Gate.—Angle iron, so extensively used in boiler-making, ship-building, and other purposes, has also been employed in the construction of field-gates. Fig. 607 is a gate made of it. The external frame is composed of four bars of angle iron; and, to give security to the joinings at the four angles of the trusses, the ends of the bars are riveted upon cast-iron corner-plates, those of the heel-post being formed of strong projecting pivots, by which the gate is hinged. The diagonal is contrary to the general rule, for it is apparently a strut; but being of angle iron, it possesses the stiffness of wood to resist lateral strains.

To render the bracing complete, the antagonist diagonal is applied as a tie. The upright bars are riveted to the horizontal ones, as well as to the diagonals; so that the frame is rendered unchangeable in figure by any force that might be applied to the head-post. Any number of interior bars may be added to suit the objects of the gate; those in the figure will retain lambs.

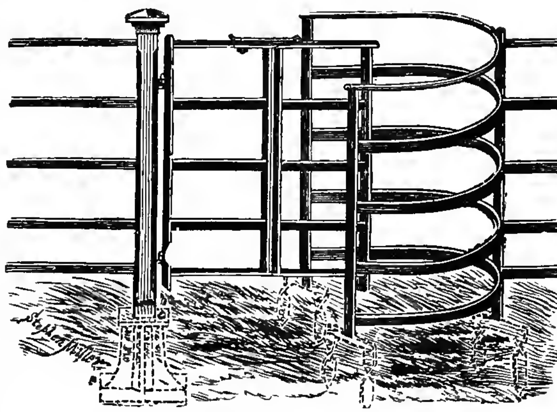
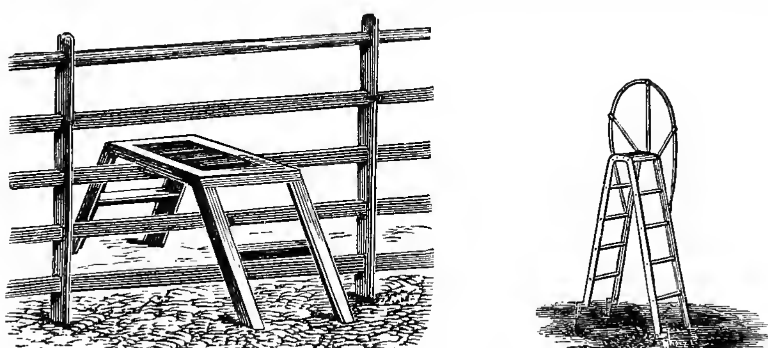


Fig. 610.—*Turnstile.*



a *b*

Fig. 611.—*Fence steps.*

Gate for Farmyard.—A suitable gate for a farmyard is shown in fig. 608 (A. & J. Main & Co.) It is made of flat iron uprights, with angle-iron diagonals, and it may be hung on stone or wood.

Wickets.—Small gates or wickets for foot-passengers may be made either of wood or iron. A strong iron wicket, made by A. & J. Main & Co., is shown in fig. 609. A convenient form of turnstile, made to fold and open when required, to allow a barrow or an animal to pass through, is represented in fig. 610.

Fence Steps.—These are used sometimes instead of wickets or turnstiles. In fig. 611, *a* and *b*, different forms of wrought-iron fence steps are shown.

Hanging Field-gates.—An effective method of hanging a field-gate is by crook-and-band hinges at the upper rail, and a heel-crook at the bottom of the heel-post, fig. 604. Both the band-hinge and the heel-crook ought to be double-tailed, to embrace both sides of the heel-post and of the upper rail. The upper crook keeps the gate close to the upper part of the hanging-post, while the heel-crook, resting on and working in a hole made in a hard stone, supports the entire weight of the gate.

A gate-post, of whatever kind, which has to support the entire weight of a gate, requires to be very securely fixed into the ground; but when the gate is supported by a heel-crook, the post may be more slender.

Fastening Field-gates.—A simple mode of fastening field-gates to the head-posts is to hook on a small linked chain from the stile-head of the gate to a hook in the receiving-post. No animal is able to unloosen this simple sort of fastening. Horses soon learn to unfasten almost every other sort.

Painting Gates.—Field-gates ought to be painted before being put to use, and all the mortise-joints of wooden gates soaked with white or red lead when being made. Moreover, they ought to receive a new coat of paint every year, as without it they will rot in a comparatively short time. Iron gates must of necessity be painted, to keep them from rusting. Coal-tar does not look well as a paint, and is apt to blacken the hands and clothes after exposure for a time to the air.

Many compositions are presented to public notice as suitable for painting outside work, but there is nothing better than white-lead oil-paint.

Field-gates painted white have a lively appearance amongst the dark-green foliage of thorn hedges, and are easily discerned.

Wire Gates.—Wire is an unsuitable material for the construction of field-gates. It is too flimsy to bear the constant use of opening and shutting, and the pressure of animals.

Gate-posts.—Large stones set on end form appropriate gate-posts in connection with stone dykes; but pillars built even with large stones and lime for supporting gates are short-lived on a farm.

Posts of wood are most largely used, but many are of iron.

Preserving Gate-posts.—Wooden gate-posts require some treatment to prevent them from rapid decay through exposure to changes of weather. The ends sunk in the ground may be charred and tarred as described for fence-posts, and the portion above ground may be regularly painted. Another plan is to creasote the sunken ends of the posts, as is done with hop-poles (Divisional vol. iv. p. 331).

DRAINING LAND.

The part which drainage plays in agriculture can hardly be overestimated. Drainage, natural or artificial, is essential alike for pastoral and arable farming. Upon ill-drained land good farming of any sort is an impossibility. As in other matters relating to agriculture, there has in recent years been much progress in the art of draining, and we are specially indebted to Professor M'Cracken for his assistance in preparing an entirely new chapter on this subject.

Antiquity of Land Drainage.—The art of land drainage in the British Isles is probably much more ancient than is generally supposed. In the early numbers of the *Journal of the Royal Agricultural Society of England*, evidence from many sources—unearthed and collated chiefly by the enthusiasm of Pusey—may be found to prove that in a more or less methodical fashion a system of drainage was practised in the counties of Essex, Norfolk, Suffolk, and Hertford, at a very early period of the seventeenth century.

Early Methods.—Some of the earliest written accounts of the treatment of the heavy clay-lands of these counties describe these ditches or "thorows" (hence has been derived our term "thorough-drainage") as being cut from 2 to 2½ feet in depth. Some material was deposited which by its decay might leave a channel for the water to flow through.

"Essex" System.—A quantity of such materials as hedge-cuttings, brushwood, twisted hop-bines, straw, or stubble was deposited in the bottom of the ditch, and the earth firmly replaced on the top of them. These by their porosity allowed a passage for the water, and subsequently by their decay a larger channel was formed, through which it might flow still more freely.

This method of drainage, under the name of the "Essex" system, long confined to the S.E. counties of England, at length, in the early part of the present century, began to be tried and appreciated by agriculturists in other parts of the kingdom.

"Deanston" System.—It was in Scotland that the full benefits to be derived from methodical drainage appears to have been at first most fully realised and taken advantage of; and to the Perthshire farmer, Smith of Deanston, who by practical experiment and shrewd observation elaborated what came to be known as the "Deanston" system, do we owe, more than to any single individual, the awakening of a general interest in the subject, and the discussion of its merits, which ended in the unanimous verdict that thorough drainage must, *in nearly all cases*, take the first place amongst improvements as the precursor of profitable farming.

The *Transactions of the Highland and Agricultural Society of Scotland*, and the *Journal of the Royal Agricultural Society of England*—the latter first issued in 1840—served to keep the farming community abreast of the times by publishing the experience and opinions of those who were practically engaged in carrying out drainage operations.

Parkes's System.—Conspicuous amongst those who were led to devote their time and ability to the study of the subject was Josiah Parkes, whose wider knowledge enabled him to carry his researches more deeply into the philosophy of drainage than Smith had attempted to do. These two champions of drainage, whilst at one as to the benefits accruing from a thorough or parallel system, differed widely in their views as to many important details.

Their conflicting opinions are, perhaps, best expressed in the words of the greatest living authority on this subject, namely, Mr Bailey Denton.

Characteristics of "Deanston" System.—"The characteristic views of Smith were—

"1. Frequent drains, at intervals of from 10 to 24 feet.

"2. Shallow depth—not exceeding 30 inches—designed for the single purpose of freeing that depth of soil from stagnant and injurious water.

"3. Parallel drains at regular distances, carried throughout the whole field, without reference to the wet and dry appearance of portions of the field, in order to provide frequent opportunities for the water rising from below and falling on the surface to pass freely and completely off.

"4. Direction of the minor drains down the steep, and that of the mains along the bottom of the chief hollow; tributary mains being provided for the lesser hollows.

"The reason assigned for the minor drains following the line of steepest descent was that the stratification generally lies in sheets at an angle to the surface.

"5. As to material—stones preferred to tiles and pipes."

Characteristics of Parkes's System.—"The characteristic views of Parkes, at that time, were—

"1. Less frequent drains, at intervals varying from 21 to 50 feet, with preference for wide intervals.

"2. Deeper drains, at a minimum depth of 4 feet, designed with the two-fold object of not only freeing the active soil from stagnant and injurious water, but of converting the water falling on the surface into an agent for fertilising; no drainage being deemed sufficient that did not both remove the water falling on the surface, and keep down the subterranean water at a depth exceeding the power of capillary attraction to elevate it too near the surface.

"3. Parallel arrangement of drains, as advocated by Smith of Deanston.

"4. Advantage of increased depth, as compensating for increased width between the drains.

"5. Pipes of an inch bore the best known conduit for the parallel drains.

"6. The cost of draining uniform clays should not exceed £3 per acre."

Conflicting Opinions.—It was inevitable that, with respect to an art as yet in its infancy, and practised under such diverse conditions of soil and climate, many antagonistic opinions should be held as to the best and cheapest methods of carrying it out. That this was especially so in the case of drainage was only to be expected, when we remember that the solution of many of its problems could only be arrived at after years of trial. The controversy carried on between the out-and-out followers of these two prominent leaders, led to the subject being still more thoroughly thrashed out, and to the acquisition by the public of much valuable information, which might not otherwise have been forthcoming.

But it is to be deplored that Smith should have clung so tenaciously to his idea of removing only the *surface* water, and that by such unsatisfactory conduits as 2 to 2½ feet trenches filled only by loose stones; whilst the uncompromising attitude taken up by Parkes in favour of extreme depth, and, for the sake of cheapness, distances apart which experience has proved too great to be compatible with efficiency, did incalculable injury to the cause he had so much at heart.

The leading principle, however, advocated by Parkes, that of keeping down the water-level in the soil, by drawing off the "subterranean" water, went far towards placing the aims of drainage engineers upon a proper basis.

Loans for Draining.—One result of the early drainage agitation, of which it would be impossible to overestimate the importance, was the application of public money, and that of private companies, to the execution of this improvement.

"The first effort made to apply collective capital to the improvement of landed property, was that made in the year 1843 by the Yorkshire Land Drainage Company."[1]

Subsequently, at intervals, the Legislature passed various enactments, such as the "Public Moneys Drainage Act," the "Private Moneys Drainage Act," and the Acts of the great loan companies—the General Land Drainage and Improvement Company, the Lands Improvement Company, and the Land Loan and Enfranchisement Company.

The object of these and similar enactments was to provide money wherewith to carry out drainage and other improvements; the funds thus advanced being secured by an annual rent-charge on the land, sufficient to repay principal with interest in a given time, usually twenty to thirty years.

Of enactments which have tended still further to extend the area of drained land in the kingdom, perhaps the most notable are the Settled Land Act of 1882, and the Agricultural Holdings Act of 1883. The former of these empowered tenants for life to sell part of their interest in their property in order that they might invest the proceeds in the improvement of the remainder. The latter gives to the ordinary tenant-farmer security for whatever money he may expend judiciously in the drainage of his land; or, if the work be done at the expense of the landlord, it limits the rate of interest which may be charged to five per cent per annum.

Extension of Drainage.—Money to any required amount being now obtainable on reasonable terms, and most of the obstacles to land improvement having been swept away, it may be predicted that as soon as the return of agricultural prosperity shall have become assured, a fresh start will be made towards the drainage of the vast area which is still but half-productive owing to the want of this necessary improvement.

Object of Drainage.—The great object of under-drainage is to draw off constantly the surplus water, so that it may never be permitted to remain stagnant in the soil.

[1] Bailey Denton, *Royal Agric. Soc. Eng. Journal*, Part i. 1868.

Soils Retaining Water.—All productive soils have the power of retaining in their interstices a greater or less quantity of water. The degree in which they possess this power depends upon the fineness of the state of division in which their particles occur. Thus, a dense clay can absorb and retain more water than a loam, and a loam than a sandy soil. Whatever the texture of the soil, if it be in a wholesome state, the water contained in it will be in a state of motion and not absolutely stationary.

Evaporation and Loss of Heat.—When an undrained soil on an impervious subsoil becomes saturated from any cause, the water in it is practically stagnant, being removed simply by surface evaporation. So long as evaporation continues, the land is being robbed of its heat, the water-vapour carrying it off in a latent state. So great is this loss of heat that, as has been pointed out by Sir Lyon Playfair in the *Encyclopædia of Agriculture*, 219 tons of coal would be required to evaporate an average annual rainfall of 30 inches from one acre of undrained land, "so as to allow the free use of the sun's rays for the legitimate purpose of growing and maturing the crops cultivated upon it."

However intense the heat of the sun's rays may be, it is impossible for it to be transmitted downwards into a water-logged soil; for though the surface film of water becomes warmer, it becomes at the same time lighter, and must consequently remain uppermost. On the other hand, when the temperature of the air falls below that of the soil, a refrigerating process commences by which the lower layers of soil are rendered colder. The water on the surface which has been chilled becomes heavier than that beneath, and consequently sinks, the process of convection going on until the temperature of the soil has been reduced to that of the air.

Evaporation lessened by Drainage.—When such a soil has been thoroughly drained, this state of affairs is completely altered, as will be seen on perusal of the following experiment conducted by Mr Charnock at Holmfield, recorded in vol. x. of *The Journal of the Royal Agricultural Society of England.*

	Rainfall in inches.	Evaporation from soil saturated, in inches.	Evaporation from drained soil, in inches.
1842 . .	26.11	30.02	21.56
1843 . .	24.49	31.19	20.11
1844 . .	19.00	37.85	15.40
1845 . .	28.18	31.09	23.26
1846 .	25.24	33.28	18.38
÷ 5	123.02	163.43	98.71
Mean	24.60	32.68	19.74

This experiment shows that from the undrained soil the evaporation exceeded the rainfall by 8 inches, whilst from the same soil, with the same rainfall, the evaporation was reduced by drainage to 5 inches less than the rainfall, a difference of 13 inches of water carried off by the drains, which would otherwise have been evaporated from the surface. The excess of evaporation over rainfall was due, in this instance, to the "soakage" of water from contiguous slopes.

Drainage and Soil Temperature.—When the surplus water is thus quickly drawn of from beneath, the waste of heat by evaporation is reduced to a minimum. A fresh supply of water finds its way into the soil after every rainfall, and, as the temperature of the rain in spring and summer is usually several degrees, occasionally 10° or 12°, above that of the soil, the latter gains an increment of heat by every shower. An accession of heat at this time is of special value, as hastening the germination of the seeds which have been sown, and helping forward vegetation generally.

Drainage accelerating Harvest.—

To the warming of the soil in this manner by the free circulation of rain-water and air early in the season, and to the fact that the growth-producing influence of the sun's rays is no longer squandered in the needless evaporation of superfluous water, but is permitted to perform its proper work, may be ascribed, in a great measure, the result that the drainage of large areas in certain districts, notably the Lothians of Scotland, has been known to mature the crops for harvest about a fortnight earlier than was previously the rule. Since the temperature of drained land is in summer occasionally raised above undrained land to the extent of 3°, often 2°, and still more frequently 1.5°, it follows that the advantage derived from drainage is in many cases as if the land had been transported 100 or 150 miles S.

Rain-water Evaporated.—The proportion of the rainfall which is evaporated from the surface of the land is much greater than is generally supposed.

Mr Charles Greaves, M. Inst. C.E.,[1] found, by fixing an open tank in a quiet part of a flowing stream, that the loss by evaporation from an exposed water surface amounted to 77.77 per cent of the total rainfall on an average of 14 years. In three of those years the evaporation exceeded the rainfall.

Undrained clay-land offers very nearly similar conditions, and from such land the loss by evaporation is greatest. Soils of opener texture, and those which are well drained, lose much less from this cause, and drained land loses comparatively little. It may be taken, however, that on an average about two-thirds of the rain which falls in the course of the year is evaporated, while only about one-third finds its way down into the soil, so as to be out of reach of evaporation.

The following table, prepared by Mr Rodgers Field, gives results by various observers; but it should be stated that only in the case of the Rothamsted observations were perfectly natural conditions preserved:—

		Dalton.	Evans.	Lawes and Gilbert.	Greaves.	Dickinson.	Evans.	Bailey Denton.	Greaves.
		Soil.	Soil.	Rather Heavy Loam.	Soil.	Gravel, Sand, and Soil.	Chalk.	Chalk, Gravel, and Clay.	Sand.
		3 Years.	7 Years.	5 Years.	14 Years.	18 Years.	7 Years.	1 Year.	14 Years.
		inches.	inches.	inches.	inches.	inches.	inches.	inches.	inches.
Winter. October to March.	Rain	14.2	11.9	13.4	13.6	13.8	11.9	7.8	13.6
	Percolation	5.8	4.6	7.7	7.2	8.6	6.9	3.3	12.4
	Evaporation	8.4	7.3	5.7	6.4	5.2	5.0	4.5	1.2
Summer. April to September.	Rain	19.4	14.6	14.5	12.1	12.8	14.6	11.5	12.1
	Percolation	2.6	1.2	2.6	2.5	0.5	3.0	0.8	9.1
	Evaporation	16.8	13.4	11.9	9.6	12.3	11.6	10.7	3.0
Entire Year.	Rain	33.6	26.5	27.9	25.7	26.6	26.5	19.3	25.7
	Percolation	8.4	5.8	10.3	9.7	9.1	9.9	4.1	21.5
	Evaporation	25.2	20.7	17.6	16.0	17.5	16.6	15.2	4.2

Growing plants, during their seasons of most active growth, give off large quantities of water from their leaves, results obtained by Sir J. B. Lawes and Dr Gilbert showing that crops of grain and pulse transpired water at the rate of 250 300 parts by weight to one part of dry matter elaborated by them; thus a crop producing 2 tons of dry matter will

[1] *Proceedings of the Inst. of Civil Engineers*, vol. xlv. Part III.

have transpired 500 to 600 tons of water, equivalent to about 6 to 7 inches of rainfall per acre.

Fertility from Rain-water.—The rain which falls upon the land brings with it in solution certain fertilising materials. These, as the water passes downward to the drains, may be taken up by the soil and the roots of growing crops, and form a valuable source of plant-food.

Salt from Rain-water.—Practically all the common salt required by the crops of the British Isles is supplied from this source. The quantity of common salt thus deposited is greatest on the west coast, whence the prevailing winds carry it from the Atlantic Ocean. But even inland, and towards the east coast, the quantity is considerable.

"The amount of chlorine annually contributed by the rain to the land at Rothamsted has amounted to 14.92 lb. per acre on an average of six years; this amount is equal to 24.59 lb. of pure common salt, an amount of chlorides greater than that which is contained in most farm crops." [1]

At the Royal Agricultural College, Cirencester, the average quantity of salt in the rainfall has been ascertained by Professor Kinch and his predecessors to be about 45 lb. per acre per annum.

Nitrogen and Sulphuric Acid from Rain-water.—Again, it has been found that at Rothamsted a year's rainfall brings with it about 4½ lb. of nitrogen, in the form of ammonia, nitric acid, and organic matters; and 18½ lb. of sulphuric acid, the quantity of the latter being "about sufficient for the wants of cereal crops, though unequal to the requirements of turnips." [2]

These materials pass away largely in the drainage-water from land not occupied by crops; but as the bulk of the nitrogen, the most valuable constituent of plant-food, is brought down during the summer months, when little or no water flows away from a drained soil, it is nearly all obtainable by the roots of farm crops.

Carbonic Acid and Oxygen.—Besides the substances referred to, which are directly of manurial value, rain-water contains varying quantities of carbonic acid and oxygen, which it has dissolved in its passage through the atmosphere.

The former of these exerts upon many of the constituents of soils, particularly upon the compounds of lime and potash, a powerful solvent action, supplying them to the roots of crops in an available state, and at the same time breaking down the soil-particles to a still finer state of division.

The oxygen which occurs in rain-water in a condensed form acts upon the organic matter and upon the iron in the soil, amongst other benefits preventing that unwholesome acidity which results from the imperfect decomposition of organic matter in undrained or water-logged soils, and supplying the products of decomposition to the roots of crops in a state fit for assimilation. The oxygen combines with the lower compounds of iron, or ferrous compounds, transforming them into the higher, or ferric compounds, which yield up their oxygen readily to organic substances. The iron each time it comes into contact with fresh air is *re*-oxydised, thus assuming the *rôle* of a purveyor of oxygen.

Ventilation of the Soil.—A further result of successful drainage, of no less consequence than those already described, is the thorough ventilation of the soil. From the fact that all superfluous water is drawn off from beneath, the soil derives an enhanced power of absorbing a fresh supply of both water and air. Rain-water passes down *through* it instead of flowing off on the surface, and in doing so it, piston-like, draws after it atmospheric air. Every shower thus aerates the soil afresh, and secures that constant process of oxidation which is so necessary to keep it in a state of fertility. Those forms of iron and organic matter which are injurious to plant-life cannot therefore continue to exist to a dangerous extent where the drainage is perfect.

The *subsoil* also is subjected to the action of the air, and, particularly when periodically stirred by the "subsoiler," its condition, both as to texture and composition, becomes ameliorated.

Drainage and Nitrification.—The researches of Warington and others

[1] Article by Sir J. B. Lawes, Dr J. H. Gilbert, and Mr R. Warington, *Royal Agric. Soc. Eng. Journal*, 1883.

[2] *Ibid.*

have shown that the nitrogen contained in organic matter must be acted upon by nitrifying organisms before it is assimilable by plants. These organisms, or bacteria, occur chiefly in the surface-soil, the depth to which their action extends depending upon the depth to which the soil is thoroughly aerated.

"Nitrification only takes place in a moist soil sufficiently porous to admit air."[1]

Drainage, therefore, enables nitrifying organisms to carry on their beneficial action to a greater depth, and thus gradually but surely adds to the depth of feeding-ground whence the roots of plants may obtain supplies of food.

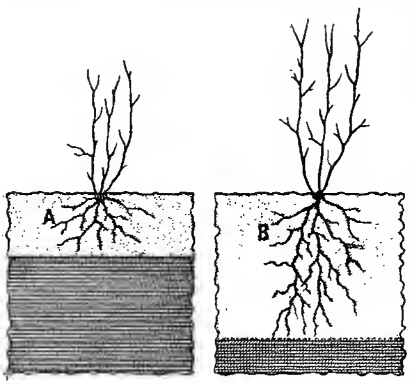


Fig. 612.—*Water-table in drained and undrained land.*

a The roots of a plant in a wet and undrained soil. *b* The roots of a plant in a drained soil, the water-level being lowered by drainage.

Lowering Water-level.—Roots cannot carry on their functions in a soil which is always saturated with water to the exclusion of air, and they decay and die as soon as they reach the permanent water-level, or "water-table." See fig. 612.

Drainage mitigating Drought.—Plants which have been enabled to send their roots deeply into the soil, in consequence of the water-table having been lowered, have at their command, in the deeper layers of soil, out of reach of evaporation, a sufficient supply of moisture to tide them over periods of protracted drought. Consequently the crops growing on a drained field may be little the worse for drought, whilst those on land of a similar description, but undrained, may be completely burnt up for want of water.

Drainage increasing Produce.—As a natural consequence of an enlarged feeding-ground, and the deeper rooting power which it confers, all crops assume a more robust habit; and a larger yield, together with a greatly improved quality and uniformity of produce, may be looked for with confidence.

Appended is a table constructed by J. Thomson, Hangingside, Linlithgowshire, which presents the produce from one imperial acre of inferior and of good land, before and after being thorough-drained; and the result is, that the produce declined from both in the second rotation, though less from the good than the inferior soil. Still the inferior soil gave a return of more than 25 per cent of corn and 70 per cent of grass, which percentages are highly remunerative, and as highly incentive to further improvements:—

Kinds of Crops.	From Inferior Land.			From Good Land.		
	Before being Drained.	After being Drained.		Before being Drained	After being Drained.	
		In the 1st Rotation.	In the 2d Rotation.		In the 1st Rotation.	In the 2d Rotation.
	bush. pks.	bush. pks.	bush. pks.	bush. pks.	bush. pks.	bush. pks.
Barley	23 3	33 1	29 1¼	27 3	38 0	36 2
Oats	35 2¾	47 2¼	44 1½	38 0	52 1¼	50 0
	£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.
Grass, value per acre	1 3 9	2 11 6	1 19 8	1 11 8½	3 19 3	3 11 4

[1] *The Chemistry of the Farm,* by R. Warington, F.C.S. Fourth ed., 21.

Wet Clay-land. — On heavy clay-lands in a wet state the list of crops which a farmer may grow is very limited, as few crops can make headway under such adverse conditions. In wet seasons the land cannot be worked for many months during the autumn, winter, and spring, for it is well known that to work clay-land when wet may injure it to an extent from which it may not recover for years, and the consequence is that such land has frequently to remain unoccupied, as a bare fallow, during the ensuing summer.

Drained Clay-land.—After drainage, however, the rainfall is carried off more rapidly, and the land gets quickly into a condition in which it may be safely worked. The texture of the clay is also changed, so that it becomes more friable, and approaches more nearly to the nature of a loam. Part of the ploughing may now be done in the autumn and at intervals during the winter, and, when spring arrives, the tillage may be completed in time for the sowing of a root crop.

Drainage and Root Cultivation.—The growth of root crops, particularly turnips and swedes, has in this way been immensely extended. Drainage also in many cases enables the farmer to feed off roots in the field upon the heavier loam soils, where previously the land was too wet and heavy to admit of this cheap and desirable method of consuming them.

Drainage and Autumn-sown Crops.—Autumn-sown wheat, oats, rye, beans, and tares, suffer less damage from the severity of the winter, and, particularly on marls and chalk soils, a smaller proportion of the plants is thrown out of the ground by the frost. A similar advantage is secured for the clover root, which yields a thicker and stronger plant.

Drainage facilitating Tillage.—As a result of the land drying more quickly after it has been drained, the periods during which it may be worked with propriety are lengthened, and a corresponding saving in both manual and horse labour is affected. In some instances three horses may do the work on 100 acres, where previously four were required; thus a saving of the keep of one horse, and half the wages of a man, amounting together to, say, £50 per annum, would reduce the labour bill of the farm by 10s. per acre.

Drainage improving Pasture.—On all pasture-lands a perpetual struggle for supremacy goes on amongst the numerous species of plants which constitute the herbage. So long as the land is wet, those of the coarser and inferior class—rushes, sedges, tussock-grass, and others—have an undue advantage and preponderate. By drainage the balance is strongly turned in favour of the finer and more valuable kinds, and a complete change takes place in the relative proportions of the different plants.

Drainage conducive to Health.—When the drainage of land hitherto wet has been carried out over a wide area, the health of the whole neighbourhood, both as regards the population and the farm live stock, is greatly improved. Rheumatic affections and diseases of the respiratory organs become much less prevalent. In the mitigation of one disease alone, the dreaded liver-rot of sheep, which after seasons of extreme rainfall carries off its millions of valuable animals, the benefit conferred by drainage is incalculable. The liver-fluke, which causes this terrible malady, as is well known, can only complete its curious life-history where the ground is saturated.

The health of the crops of the farm, as well as that of the live stock, is much benefited. The seed germinates quickly, instead of lying rotting in the wet places, as part of it did prior to drainage; the plants assume a sturdier growth and healthier hue, and they are much less susceptible of the attacks of fungus enemies.

Insect Attacks.—Insect pests, likewise, do less harm on drained than on undrained land, for on the former the crops grow more quickly past the stage at which they are most liable to be attacked.

Drainage and Economical Manuring.—It is generally accepted as an axiom that lime and manures of all kinds are in a great measure wasted if applied to wet land, and not until drainage has been carried out can they exercise anything approaching a full and remunerative effect.

Natural Drainage.—There are, certainly, many districts in England where the natural character of the earth's crust renders draining unnecessary, or even impossible, over large tracts of country. These conditions are perhaps best seen in the Oolite and Chalk formations, also where the mountain limestone and trap rocks approach the surface. The shattered and shingly nature of many of the Oolitic beds, the porous and absorbent character of the Chalk, and the cracked and fissured state in which the mountain limestone and trap rocks occur, may often be found to drain the higher grounds and slopes of the districts which they occupy in a more efficacious manner than could be attainable by any artificial means.

But the valleys in those districts are frequently saturated by the water which percolates from the higher grounds, and require to be drained before they can be satisfactorily cultivated.

Drainage and Irrigation. — Thus, where irrigation is practised, drainage is regarded as the first step, and an indispensable one, towards the preparation of the land for that purpose.

Causes of Wetness in Land.—The wetness of land may be due to the impervious nature of the soil and subsoil preventing the downward escape of the water which falls as rain upon its surface, or overflows upon it from higher grounds; or it may be caused by water which has filtered through neighbouring lands at a higher level, and discharged into it, either from springs, or in a diffused manner from water-bearing strata. See fig. 613.

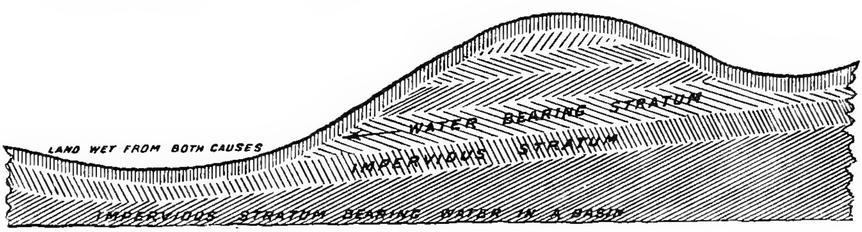


Fig. 613.—*Cause of wetness in land.*

First Step in Drainage.—The cause or causes to which land owes its wetness must be fully considered before the work of drainage is commenced, so that the method employed may meet all the requirements of the case.

On many farms the *whole* of the land does not require drainage, owing to a portion of the soil resting on a porous subsoil. Where this is so, the expense will be correspondingly reduced. But yet, if a porous subsoil becomes damp in winter by receiving water from a distance, it requires draining as well as an impervious one, though at less cost.

Determining Necessity for Drainage.—It is by no means difficult to determine whether land is in want of drainage. With a little experience any one can readily detect the parts of a field on which the crops are most affected. The plants exhibit a lack of vigour, having a withered and sickly appearance, and a bleached or yellowish colour; and the freshly turned furrow-slices show a glazed surface. On bare land the moisture may be easily seen. In spring, when the air is keen, dark-coloured patches may be observed on the slopes or in the hollows, contracting or disappearing in dry weather, and extending after rain. These palpable hints that the subsoil is in a state of super-saturation cannot be mistaken.

When the land has been down some time in permanent pasture the species of plants growing upon it, as well as their appearance, will indicate whether or not it is sufficiently dry. On wet land, several of the sedges, popularly known as "blue-grass" or "carnation-grass," are more or less abundant, particularly in the furrows and in hollows. Rushes also soon put in an appearance, along with several of the coarser and more unpalatable grasses, such as tussock-grass (*Aira cæspitosa*). Amongst many others, the following are a few of the plants which indicate undue wetness:

black grass (*Alopecurus agrestis*), floating foxtail (*Alopecurus genicalatus*), quaking grass (*Briza media*), horse-knot (*Centaurea nigra*), self-heal (*Prunella vulgaris*), marsh thistle (*Carduus palustris*), bog-rush (*Juncus Bufonius*), marsh cudweed (*Gnaphalium uliginosum*), marsh orchis (*Orchis latifolia*), spotted orchis (*Orchis maculata*).

Time for Drainage.—Most of the drainage done in this country is carried out in the autumn and winter. As much of it as possible should be done in the autumn. On arable lands the stubble of whichever of the grain crops has been grown alone, without clover or grass seeds, gives the most fitting opportunity. The land is usually drier at this season than at any other, and the soil to be removed is therefore lighter. It will also bear the treading and cartage of the pipes with least injury.

On heavy clay-land it may sometimes be necessary to wait until the soil has been softened by rain, but in most cases the soil will cut freely. Harvest being over, labour is usually plentiful. The work can also be done at this time without injury to any growing crop.

On grass as well as tillage land, similar reasons for autumn drainage hold good. The grazing season is over, so that there is no waste of herbage; and live stock may be all excluded from the fields where the work is in progress, so that there need be no risk of their injuring either themselves or the drains by falling into the open trenches.

Autumn-made drains possess, further, the advantage of being somewhat in working order before the growing season of the following spring has commenced.

Special causes occasionally lead to drainage being done at times which would ordinarily be considered injudicious, as, for example, strikes or slackness in trade in mining districts, throwing men out of employment and locally reducing the cost of labour.

Skilled Labour.—It is, nevertheless, generally better to employ skilled men at fair wages than unskilled men even at a low rate, as the former will require less supervision, and, what is of vital importance, they will be able to make a truer bed for the pipes.

If unskilled labourers are to be employed, they should be accompanied by one or more skilled hands, to take out the bottom of the drain and form the bed for the pipes.

Outfalls.—Before commencing the actual work of drainage, it is desirable that the water-courses into which it is intended the drains shall discharge should be examined, so that any shortcoming in their carrying capacity may be rectified, and any risk of flooding provided against. Where the soil is of a character which admits of the free percolation of the water, such as sand, or free loam, or marl consisting largely of lime, the outfalls will require to be more capacious than where the soil is of a more impervious nature.

This is well shown by the following figures from an account of the Hinxworth experiments by Mr Bailey Denton:—

	Rainfall.	Discharge from Drains in "Free" and "Mixed" Soils.	Discharge from Drains in "Clays."
	Gallons per acre.	Gallons per acre.	Gallons per acre.
October	1200	211	Nil
November	1229	484	11
December	901	678	188
January	1702	1337	1026
February	155	744	323
March	598	262	107
April	1085	293	206
May	547	148	110

Outfalls from Hollows.—Bogs and marshes occur in many parts of the country, which present great difficulties to the drainage engineer, on account of the entire absence of any natural outfall, the area to be drained lying in a basin, saved from being perpetually under water only by evaporation and slow filtration through the surrounding lands. Under such circumstances it may be necessary to incur considerable expenditure in making deep open cuttings; but subterranean channels may occasionally be resorted to with greater economy.

Subterranean Outfalls.—In one instance, on the river Wansbeck in Northumberland, where a basin of this kind had to be dealt with, a shaft, 20 feet in depth, was sunk at the lowest point, and from the bottom of the shaft a tunnel of 4 feet in diameter, and 600 yards in length, was driven through the intervening ridge to the bank of the river. The mains of four to five hundred acres discharged into the shaft. The land so drained was improved to the extent of 15s. to 25s. per acre, so that, although the shaft and tunnel alone cost about £1000, the result proved to be highly remunerative.

Outfalls in Limestone Districts.—In many of the limestone districts, particularly those on the mountain limestone, the "pot-holes," or "swallow-holes," and the cracks in the rock, are frequently made use of, the drainage-water being discharged into them. They furnish cheap and convenient outfalls, but the water is almost certain to find its way again to the surface at lower levels.

Where no extraordinary difficulties have to be encountered, the scouring, and, if more fall be required, the straightening, of the natural water-courses will be found to provide an ample outfall.

Falls in Outlets.—There should be a decided fall from the outlet of the drain, whether natural or artificial. Cresy states that, in the case of drains, the falls should not be less than 8 feet in the mile, or one foot in 220 yards. In large deep rivers the fall is sufficient at one foot in the mile, and in small rivers two feet.

Scouring Outlets.—The open ditch which receives the drain-water should be kept scoured deep enough for a considerable distance; and it is better to deepen it at the lower end than to increase its width, when the ground is level. A frequent charge of neglect against farmers is that of allowing open ditches almost to fill up before they are scoured out; and the ready excuse for the neglect is, that scouring ditches to any extent necessitates considerable labour and expense; and no doubt it does when they are allowed to fill up. But were ditches scoured as they require it—every year, if necessary for the wellbeing of stock, fences, and drains—little expense would be incurred at one time.

It would be better to face the expense of converting an open ditch into a covered drain at once than to neglect the scouring of it when necessary.

Should the fall from the outlet towards a river be too small, a covered drain should be carried parallel as far down by the side of the river as to secure a sufficient fall. Rather incur the expense of carrying the drain under a mill-course, mill-dam, or rivulet, by means of masonry or a cast-iron pipe, than allow back-water to impede an outlet-drain.

The volume of water flowing from the outlets of drains increases as the barometer falls; and this increase is observed more in clay than in light soils.

Examining Soil for Drainage.—The nature of the soil and subsoil of the land

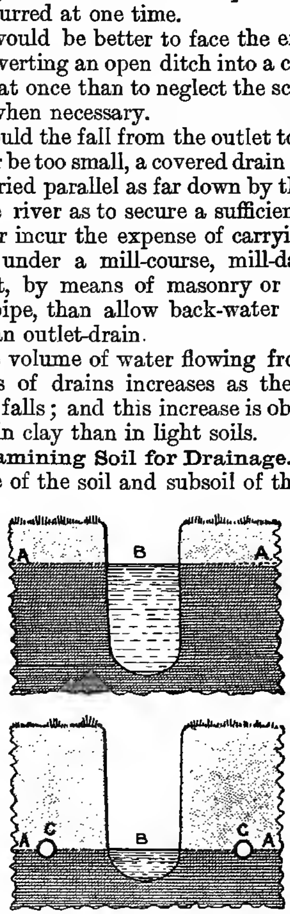


Fig. 614.—*Water-level test-holes.*

1. Undrained land. 2. Drained land.

a a Water-table, beneath which the soil is saturated.
b Water in test-holes, standing at same level as water-table.
c c Sections of drain-pipes.

to be drained must now be ascertained, and the causes of wetness investigated.

The cutting of *test-holes* at intervals over the fields gives the best means of arriving at a satisfactory conclusion on these points. The height at which the water stands in the test-holes will indicate the height of the water-table in the soil, which, in an undulating field, will vary considerably in different parts. Before drainage the water will rise in the test-holes after rain, and fall during dry weather, reaching, probably, in the winter months almost to the surface. See fig. 614.

From the knowledge gained by a study of the test-holes, the best depth at which to drain will be determined. If the drainage be thorough, after it has been completed the water-table will seldom rise above the pipes, the water being drawn off as soon as it reaches their level.

Draining Springs.—Should springs be discovered in any part of the field, it will be found advantageous to remove their water by special drains, distinct from the regular system, and at a greater depth, so that none of the spring-water may be permitted to diffuse itself through the soil.

Drainage varying with Soil.—When the soil varies in different parts of a field, the drainage should vary accordingly, and it is only experience and careful observation which will enable the superintendent of the work to carry out the whole economically and to the best advantage.

Depth of Drains.

The question of depth has probably given rise to more controversy than any other point in connection with drainage. A minimum of 4 feet was formerly rigorously enforced in all cases in which public money was devoted to this improvement. This rule led to much imperfect work, not because the depth was too great, as is thought by many, but on account of the reluctance of landowners to incur the expense of sufficient frequency. In order to keep down the cost to what was regarded as a standard amount, the drains were cut too far apart, with the natural result that the land between them was imperfectly dried, and, to complete the work, it was found necessary to spend almost as much more in making new drains between the original ones.

The tendency in recent times has been in the direction of extreme shallowness, 2 feet and even less, with consequences even more unsatisfactory.

No particular depth will have the best effect under all circumstances.

Depth to vary with the Soil.—In coming to a decision upon this point, due consideration must be given to the character of the soil and subsoil as observed in the test-holes; to the depth of soil it is desired to convert into a wholesome feeding-ground for plant-roots; and to the security of the pipes against injury from roots, silting, and tillage operations. Any depth in excess of these requirements may be considered waste.

Depth for Free Soils.—In free soils the depth must be sufficient to prevent any *direct* flow of the surface-water through small channels into the pipes, without its being completely filtered in its descent. Should it find its way directly to the pipes, it will carry with it quantities of the finer particles of soil, and much of the manurial matters which are applied, thus robbing the land of its fertility, and stopping up the drain with sediment.

Depth for Clay Soils.—In clay soils a similar danger arises; for the stiffer the clay the more thoroughly does it become traversed in all directions by cracks in times of drought. These cracks often extend to great depths; and, when a heavy rainfall, such as a thunder-shower, occurs, the water washes down the open crevices to the drain, in which it deposits a fine adhesive mud, necessitating the expense of frequent cleaning.

Depth for Peaty Soils.—When the land is of a peaty nature it is desirable, whenever possible, to cut down right through the peat and lay the pipes on the bed of firm clay or sand which usually underlies it. Even when the bed of peat is 6 or 7 feet in depth, it will be found better to do this than to lay the pipes in it, as they will inevitably sink and derange the whole drainage-system.

In the case of a field which had been drained twice previously, with pipes laid in the peat, the writer has been compelled to take up all the old drains and lay them afresh on a bed of firm sand at a depth of 5 to 6 feet.

Depth for Porous Soil.—In the case of a porous soil on a bed of clay, when the depth would not exceed 5 feet, a similar course of treatment is to be recommended. Much greater distances between drains will thus be admissible, and the cost may be actually less than it would be were a shallower system adopted.

The test-holes will sometimes reveal a porous water-bearing stratum in the subsoil; and when this is observed, both efficiency and economy demand—unless the depth at which it occurs be quite prohibitive—that the drains should be made deep enough to tap it, and so prevent the water rising into the higher layers of soil.

Root Depth.—In good land it is probable that about 2½ feet of soil will be required by the roots of ordinary crops. Under exceptional circumstances roots may be traced to three times this depth; and an instance is recorded, in vol. x. *Royal Agricultural Society of England's Journal*, p. 622, of mangel having "completely choked" drain-pipes at a depth of 4 feet.

Speaking generally, however, a drain may be considered safe from the obstruction of all roots, excepting those of trees, at 2½ feet.

Minimum and Common Depth of Drains.—This depth of 2½ feet should be regarded as the irreducible minimum at which it will pay to carry out drainage works; and it is rarely prudent to risk anything less than 3 feet. Practice has established a common depth, where there are no exceptional circumstances, of 3 to 4 feet.

Deep Drains and Capillary Attraction.—It should not be forgotten that the water enters the pipes from beneath, as the water-table or plane of saturation rises to their level; consequently it is the deepest drain that first begins to carry water after heavy rains, and in the autumn; and the deeper the drain the greater is its power of neutralising the capillary attraction of the soil.

Should an entire field be of uniform character, all the drains may be cut to the same depth, with the exception of the mains.

Depth of Main Drains.—Main drains should be not less than 6 inches deeper than the minor or tributary drains.

Graduating Depth in Flat Land.—When the surface of the land is almost dead level it is sometimes necessary to graduate the depth, particularly of the mains, by making them deeper at the outlet than the source, so as to secure a sufficient fall.

Distance between Drains.

The width of the intervals between the minor drains, like the depth, must be settled by a careful consideration of the information which has been gained by a study of the test-holes, and, as in the case of the depth, the distances apart should vary according to the nature of the soil and the causes of wetness.

It is probable that more failures have arisen from too wide intervals being adopted in order to lessen the cost, than from all other errors combined.

Nature of the Land and Depth of Drains.—Within certain limits, the distance to which a drain will dry the land on each side of it efficiently will depend upon the texture of the soil and the depth at which the pipes are laid. The more porous the soil the greater will be the area affected, and the more impervious the soil the less the area dried.

An Established Rule.—Experience has formulated a rule with regard to this which may be taken as a tolerably correct guide under ordinary conditions,—namely, that in porous soils a drain will dry an extent, on each side of it, equal to from five to six times its depth; in medium soils, four to five times its depth; and in clays, from two to three times its depth. Thus, 4-foot drains might be cut 40 to 60 feet apart in the first case; 24 to 32 feet in the second; and 16 to 24 feet in the third.

Drains in Furrows.—The practice of making the drains, whenever practicable, in the furrows, in fields with high-backed ridges, has now become almost universal; and in such cases the distance apart will be largely regulated by the width of the ridges. Besides saving a certain amount in the depth to be cut, it has been found in practice that drains so laid do their work better than those cut without regard to the ridges.

Preliminary Surveying.

Before beginning the actual work of drainage, the land which is to be laid dry should be carefully surveyed, and a definite system decided upon.

Course of Main Drain.—The main

drain should, as far as attainable, occupy the lowest part of the field, having its outfall at the lowest point. When there is any uncertainty as to the proper outfall, this should not be determined by the eye only, but the levelling instrument should be resorted to.

Outfalls.—As every outfall is a source of danger, being liable to be blocked up by weeds, mud, or by the interference of rats and other vermin, the number of outfalls cannot be too far reduced, and if the whole of the water can be discharged by one outlet so much the better.

Sub-mains.—When the surface of the field is undulating, a sub-main should branch into each hollow, with pipes intermediate in size between those of the mains and those of the minor drains. Any necessity for making the minor drains of a greater length than two chains may be obviated by providing sub-mains. In practice this is found to be advisable.

Fall for Mains.—Sufficient fall must be secured for the main to enable it to discharge rapidly the accumulated water of the minor drains.

Inclination of Mains.—"One of the most frequent errors made in systematic arrangement, arising more from inadvertency than from reflection, is the setting out of main drains in the courses of the lowest ground, without respect to the rate of inclination at which the ground on either side falls towards the hollow. Thus it will often be observed that a 3-inch pipe, laid at an inclination of 1 in 400 will constitute the main for 6 or 8 acres of comparatively porous land (capable of rapid percolation) of which the lateral 2-inch pipe drains may be laid at an inclination of 1 in 100. Now, if we calculate the relative capacity and power of discharge of the pipes under these circumstances, we shall find the mean velocity of the 3-inch main will be 13.60 inches per second, while that of the 2-inch minor will be 24.60 inches, and that of the main will discharge 3.40 cubic feet per minute if full, while the minor drain will discharge 2.65 cubic feet per minute if full, so that two minor drains will more than fill the main drain, although the discharge from the main may be accelerated by the pressure of water in the minor drains."[1]

It is desirable to allow a space of at least 10 yards between all mains and hedges or growing trees.

Direction of Main Drains.—The direction which the minor drains ought to take leaves little room for doubt unless the land be very level. The only position in which they can be relied upon to work properly is in the direction of the greatest slope. Instances may occasionally be seen of drains running obliquely across a declivity, and these may carry the water some distance, but whenever they pass through a porous layer of soil, the water escapes from them, and oozes out to the surface further down the slope. A drain placed across an incline cannot dry the land it passes through; for, though the water can readily enter the pipes, it can as readily find its way out again.

"The line of the greatest fall is the only line in which a drain is relatively lower than the land on either side of it."[2] It is only by availing ourselves of the laws of *gravity* that we can remove the water by drainage.

"In many subsoils there are thin partings, or layers of porous materials, interposed between the strata, which, although not of sufficient capacity to give rise to actual springs, yet exude sufficient water to indicate their presence. These partings occasionally crop out, and give rise to those damp spots which are to be seen diversifying the surface of fields, when the drying breezes of spring have begun to act upon them. In fig. 615 the light lines indicate such partings. Now it will be evident, in draining such land, that if the drains be disposed in a direction transverse or oblique to

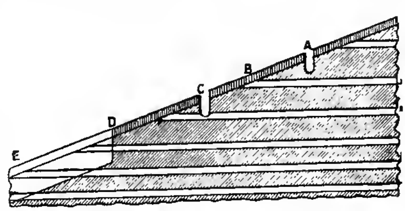


Fig. 615.—*Inclination of drains and strata.*

[1] Bailey Denton. [2] *Ency. of Agric.*

the slope, it will often happen that the drains, no matter how skilfully planned, will not reach these partings at all, as at A. In this case the water will continue to flow on in its accustomed channel and discharge its waters at B. But, again, even though it does reach these partings as at C, a considerable portion of water will escape from the drain itself, and flow to the *lower level* of its own point of discharge at D. Whereas a drain cut in the line of slope, as from D to E, intersects all these partings, and furnishes an outlet to them at *a lower level* than their old ones."[1]

Junction of Minor and Main Drains.—The direction of the minor drains will therefore be nearly or altogether at right angles to the main or sub-main; but they should, nevertheless, deliver their contents at an acute angle. This is achieved by curving their lower extremities, for a few feet, in the direction in which the water in the main is flowing, so that the discharge of the minors may not impede the passage of the water in the mains.

Minor drains should in no case enter the opposite sides of the main at the same point, but a few feet of space should always intervene, so that the flow of the water in the main may not be checked by the meeting of two opposing currents.

The proper position for the outfall, mains, sub-mains, and minors having been determined, the next point demanding consideration is the conduit for the water.

Drainage Materials.

An immense variety of devices has been resorted to at different periods in the history of drainage, and under different circumstances as to soil and locality, and although the cylindrical pipe is now used exclusively by scientific drainers, it may be interesting to refer to several of the forms which, though now considered obsolete, might be advantageously adopted in some parts of our colonies where suitable pipes are difficult to procure.

Old English Drain.—Fig. 616 represents a drain, at one time common in the south-eastern counties of England and elsewhere, partially filled with brushwood, faggots, poles, straw, twisted hop-bines, and even horns, the soil being

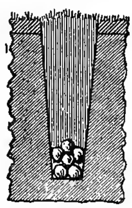


Fig. 616.

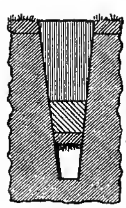


Fig. 617.

Fig. 620.—*Surface-turf cut to shape.*

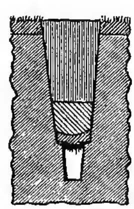


Fig. 618.

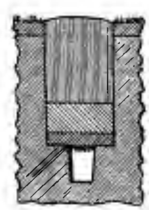


Fig. 619.

returned to its original place on the top of these.

Wedge-and-Shoulder Drains.—Figs. 617, 618, and 619 are forms of what were known as "wedge-and-shoulder" drains. These were used in many parts of England where the soil was found to be firm enough to give durable turfs. The surface-turf (fig. 620), was placed first in the drain, grass downwards, in such a position as to secure a sufficient channel for the water beneath it. The rest of the soil was then firmly returned above it.

We have examined drains, both in Northumberland and in Leicestershire, constructed on the plan of fig. 617, and still in fair working order, although cut over fifty years ago.

In one form of this drain, turfs of peat, cut to the proper shape and dried, were largely used. They were chiefly prepared in the Fen-lands, and exported to the surrounding districts.

Plug Drains.—Fig. 621 shows what was termed "plug" draining. It resembled somewhat the wedge-and-shoulder drain when finished. The trench was cut and bottomed neatly, then a string of wooden blocks moulded to the desired

[1] *Ency. of Agric.*

shape, and joined together by iron bands, was laid on the bottom, and, when the clay had been firmly beaten over this, it was drawn forward by means of a chain

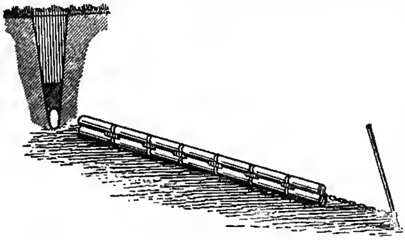


Fig. 621.

and lever, and the operation repeated for another length. A great objection to this kind of drain was that the walls of the channel were rendered too solid and impervious by the process of stamping the clay tightly over the block cores.

Stone Drains.—Figs. 622, 623, 624, 625, and 626, are all forms of stone drains which have been used more or less extensively in many localities. Fig. 622 is the method adopted and advocated by Smith of Deanston. The trenches were 5 to 6 inches wide at the bottom in the minors, and filled about 15 inches deep with stones, which were either gathered off the land, or quarried and broken so as to pass through a 3-inch ring. The cost of such drains varied, according to the labour of quarrying and carting, from 8d. to 1s. per rod.

In figs. 623, 624, 625, 626, the conduits were formed of flat stones or flags, and the last three, when well laid and on a firm bottom, have proved practi-

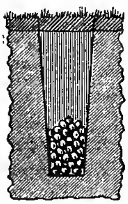


Fig. 622.

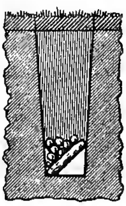


Fig. 623.

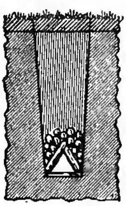


Fig. 624.

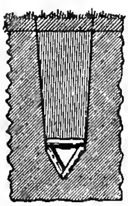


Fig. 625.

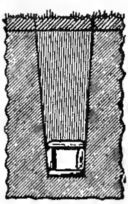


Fig. 626.

cally indestructible. Great lengths of mains, constructed after the fashion of fig. 626, may be found in many districts, in as good order as on the day they were completed.

Peat Drains.—Fig. 627 represents a drain in which the conduit is of peat, figs. 628 and 629, cut into shape by a

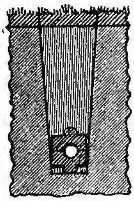


Fig. 627.

Figs. 628, 629.

special tool, fig. 630, and dried. These are useful in soft bogs which cannot be bottomed, as they are not liable to sink.

Tile Drains.—Fig. 631 illustrates the earliest form of tile used for drainage. It had broad flanges on which it rested on the bottom of the drain; and through the top a number of holes were pierced to admit the water.

Fig. 632 is a drain made with bricks which have had a groove scooped out on one side. Fig. 633 shows the manner in which these were laid, the junctions of the bricks in the upper row being over the centres of those in the lower row. We have seen large quantities of these taken from drains cut over fifty years ago in Cheshire.

Fig. 630.

Fig. 634 represents the "horse-shoe" tile, the best of the early forms. These were laid either on the clay, when sufficiently firm, or on flat "soles" of tile or wood. When pantiles were used as soles the ends of the horse-shoe tiles were set over their centres, so that the joints of the soles and of the tiles should not coincide. Horse-shoe tiles were usually placed on wooden boards when the soil was of peat, as this prevented their sinking out of position better than when tile soles were used.

When a larger water-carrying capacity was required, combinations of several horse-shoe tiles were formed, as in figs. 635 and 636.

One of the earliest forms of cylindrical pipes, fig. 637, was a rude sort of socket pipe, one end being widened while the pipe was in a plastic condition, by a wooden plug, whilst the other end, to fit into the next pipe, was pared thin with a knife.

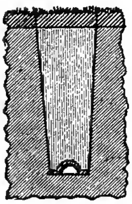


Fig. 631.

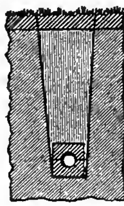


Fig. 632.

Fig. 633.

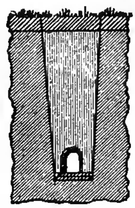


Fig. 634.

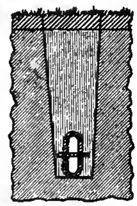


Fig. 635.

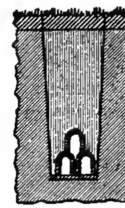


Fig. 636.

The plain cylinder, fig. 638, soon followed, fitted, where a rounded bed cannot be cut for it, with moulded double sole, fig. 639. Pipes with egg-shaped section, fig. 640, have been recommended; but,

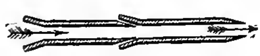


Fig. 637.—*Longitudinal Sections.*

although theoretically correct, they are troublesome to lay, and consequently they are rarely used.

Fig. 641 shows a drain with cylindrical pipe.

Advantages of Cylindrical Pipe.—Plain cylindrical pipes are found in practice to possess overwhelming advantages over every other kind of conduit. Possessing, weight for weight, the greatest strength, they are less liable to breakage than horse-shoe tiles. They are light and convenient to load and cart, and easy to lay in the drain, whilst their capacity for carrying water is greater, relatively to their weight and bulk, than any other form.

Figs. 638, 639, 640.

Collared Pipes.—Collared pipes, fig. 642, *a* and *b*, are used occasionally, when the risk of displacement is great. The forms represented in fig. 642 *a* may be cemented and made water-tight, should it be found necessary to lay the main near trees or hedges; in fig. 642 *b* the ends of the pipes, A, A, are simply fitted loosely into the tile collar, B. Recourse is but rarely had to the latter of these.

Selecting Pipes.—The selection of the pipes to be used requires as much discrimination as would be exercised in the choice of bricks for building purposes. The materials used in their manufacture require the same care in selection, exposure to the atmospheric action, removal or crushing of small stones, mixing, and moulding.

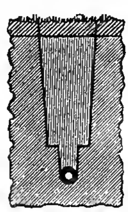


Fig. 641.

If the proportion of sand in the raw material be large, the bricks will be too porous, lacking in durability, and liable to breakage in handling. Should it be pure stiff clay, the pipes are liable to shrink unduly, and twist and crack, and an excessive number of "wasters" will result in the kiln. A large percentage of lime is also fatal to durability, particularly if the pipes be exposed to frost before they are laid. The manner and

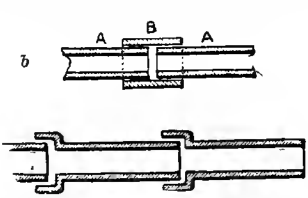


Fig. 642.—*Longitudinal sections of collared pipes,* A *and* B.

degree of burning are also important factors in the manufacture of a good article. The smaller sizes of pipes are usually cut into 14 to 15 inch lengths, and these will shrink in burning to 12 or 13 inches; the shrinkage being, roughly, about one inch to the foot—more with stiff clay, and less with the freer loams.

The length of the pipes should be taken into account in comparing the price-lists of different manufacturers. The pipes should be of suitable material, well made, and burned by skilled workmen; the product when finished being straight, smooth, especially in the interior, so as to offer no rough surfaces likely to accumulate sediment, and, when struck together, they should give out a clear metallic sound. If hard and firm in texture, they will break with a sharp clean fracture.

It was at one time thought that porous pipes were to be preferred, the idea being that the water entered largely through the walls of the pipes. This notion has been long since exploded, the quantity penetrating the pipe itself having been proved to be quite infinitesimal, practically the whole of it entering at the junctions of the pipes.

Cost of Pipes.—The prices at which drain-pipes may be procured vary somewhat in different districts, depending upon the cost of coal and labour.

Calibre of Pipes in inches.	Cost per 1000. In close proximity to Coal-fields.		Cost per 1000. Distant from Coal-field.		Average Weight per 1000.
	Morpeth, Northumberland.	Heaton Mersey, Lancashire.	Gloucestershire.	Banffshire.	
	£ s. d.	£ s. d.	£ s. d.	£ s d.	tons. cwts.
2	1 1 0	1 2 0	1 5 0	1 9 0	1 1
2½	1 6 0	1 8 0	1 15 0	1 19 0	1 5
3	1 15 0	2 5 0	2 5 0	2 10 0	1 16
4	2 5 0	3 5 0	3 0 0	3 15 0	2 7
5	...	5 5 0	4 5 0	5 5 0	3 5
6	6 5 0	6 10 0	7 10 0	8 15 0	5 0

The above table shows a marked want of regularity in the grading of prices, according to the respective sizes of the pipes, at different tile-yards.

On estates possessing tile-sheds and machinery the pipes may be turned out readily at one-third less than the prices charged by those who manufacture them for sale.

Size of Pipes to be used.—The selection of the pipes having been determined, as to quality and form, the points still left for consideration are the sizes of pipes to be used, and the relative numbers of each size.

Conditions regulating Size of Pipes.—The size or calibre of the pipes used will depend upon—(1) The Character of the Soil and Subsoil; (2) Rate of Fall; (3) Rainfall; and (4) The Depth of the Drains.

1. *Character of Soil and Subsoil.*—The more porous these are the more rapidly will the rain-water find its way to the drain-level, and the greater, consequently, should be the capacity of the pipes, so that they may remove it with sufficient rapidity.

2. *The Gradient, or Rate of Fall, at which the Pipes are laid.*—The greater the fall, the greater will be the velocity of the water in the pipes, and the greater, therefore, will be their power of discharging rapidly a given volume of water. The following table will best illustrate this fact:—

[Table.

Fall in 100 ft.	2-inch Drain-pipe, Sectional Area 3.1416 sq. in.		3-inch Drain-pips, Sectional Area 7.0686 sq. in.		4-inch Drain-pipe, Sectional Area 12.566 sq. in.		8-inch Drain-pipe, Sectional Area 50.264 sq. in.	
	Velocity per second in feet.	Discharge in gallons in 24 hours.	Velocity per second in feet.	Discharge in gallons in 24 hours.	Velocity per second in feet.	Discharge in gallons in 24 hours.	Velocity per second in feet.	Discharge in gallons in 24 hours.
ft. in.								
0 3	0.79	10,575	0.90	24,687	1.08	43,698	1.23	277,488
0 6	1.16	15,528	1.33	36,482	1.50	60,691	1.65	372,240
0 9	1.50	20,080	1.66	45,534	1.83	74,043	2.01	453,456
1 0	1.71	22,891	1.94	53,215	2.13	86,181	2.33	525,648
1 6	2.16	28,915	2.43	66,655	2.61	105,603	2.85	642,960
2 0	2.53	33,868	2.83	77,628	3.00	121,382	3.30	744,480
2 6	2.83	37,884	3.16	86,680	3.36	135,948	3.70	844,720
3 0	3.11	41,632	3.47	95,183	3.68	148,896	4.05	913,679
3 6	3.36	44,979	3.74	102,589	3.96	160,225	4.37	971,659
4 0	3.59	48,058	3.99	109,447	4.24	171,554	4.67	1,055,551
4 6	3.80	50,869	4.23	116,030	4.50	182,073	4.95	1,116,719
5 0	4.02	53,814	4.46	122,339	4.75	192,189	5.22	1,177,631
5 6	4.22	56,491	4.68	128,373	4.97	201,090	5.47	1,234,031
6 0	4.40	58,901	4.89	134,134	5.20	210,396	5.71	1,288,175
6 6	4.58	61,310	5.08	139,346	5.41	218,893	5.95	1,343,839
7 0	4.74	63,452	5.27	144,557	5.61	226,985	6.17	1,391,951
7 6	4.91	65,728	5.46	150,069	5.81	235,077	6.39	1,441,583
8 0	5.07	67,870	5.64	154,707	6.01	243,169	6.60	1,488,959
8 6	5.23	70,012	5.82	159,644	6.19	250,452	6.80	1,534,099
9 0	5.38	72,020	5.99	164,313	6.37	257,735	7.00	1,579,199
9 6	5.53	74,028	6.16	168,070	6.54	264,603	7.20	1,624,319
10 0	5.67	75,902	6.32	173,359	6.71	271,499	7.38	1,664,927

3. *The Rainfall.*—Were the rainfall distributed evenly throughout the year, every day having a proportionate allowance, pipes of exceedingly small calibre would be sufficient for the removal of any superfluous water; indeed very little water would reach them. But provision must be made, not for the *average*, but for the *maximum* rainfall. "Spates" or floods occur in all districts of this country, and the capacity of the pipes must be sufficient to enable them to remove the water in such exceptional cases, and thus prevent it injuring the surface of the land and growing crops by forming large ponds in the fields. It is probably during winter thaws, when the accumulated snowfall of many days is rapidly melted by a strong W. or S.W. wind, that the carrying capacity of a system of drains is put to the severest test.

In Great Britain an inch of rain in a day is considered a very heavy fall. But in many parts of the Highlands of Scotland, 3 inches not unfrequently fall in one day.[1] In December 1863, there fell at Portree, in Skye, 12½ inches in thirteen hours; and on the same day 5.2 inches fell at Drishaig, near Ben Cruachan. At Leathwaite, in Cumberland, 6.62 inches fell on the 27th November 1848, and in a number of instances this enormous fall has been rivalled since that date.

Strain on Drain-pipes.—As an example of the strain to which the water-carrying capacity of drain-pipes may be put in extreme cases, let us suppose a square field, with sides of ten chains in length, and an area of ten acres; let it be drained by 2-inch pipes, the average fall being 1 in 100, and the minor drains placed 33 feet apart. Should this field during winter, when evaporation is least active, be already saturated by continued wet weather, and a fall of rain occur, or a snow-cover melt, equal to 2 inches of rainfall per day, this would amount to about 44,800 gallons per acre, or 448,000 gallons on the ten acres, in twenty-four hours. Now, each of the drains, of which there would be twenty in all, would, if in perfect order, remove 22,890 gallons in

[1] Buchan's *Meteorology*.

the same time, or collectively 457,800 gallons. In such a case, therefore, the drains would be filled to the limit of their capacity, with practically no margin.

To contain the whole of this water, the main would require to be 8 inches in diameter at its lowest end.

It is true that evaporation would account for a certain proportion of the water; but, in the case above described, the quantity so removed would be inconsiderable, and, if the land were of a porous nature, it would have little time to come into operation. The evaporation would, in fact, be at least balanced by the unavoidable inaccuracies in the adjustment of the pipes, and the sediment which would be certain to accumulate in some of them after they had been laid for a few years.

4. *The Depth of the Drains.*—After a heavy rainfall, shallow drains, when once the water-table has reached their own level, are called upon to remove the water more suddenly than those that are deeper; as the greater the depth through which the water has to filter, the longer will it be in reaching the drain-level. Consequently, for deep drains pipes of a somewhat smaller size may be used than for shallow drains, as the former will receive their supply more gradually.

There are other circumstances which would influence the size of pipes required, though in a less degree than those already enumerated, the more important being:—

The presence of water from higher grounds, either from springs or from water-bearing strata in the subsoil, which would add to the volume of water to be removed, and make it necessary to employ pipes of a larger size than would be otherwise necessary.

The distance of the drains apart; for, when placed wide apart, each drain has a larger area to dry, and more water to remove, than if they had been in closer proximity to each other.

The length of the drains. Thus, the lower end of a long drain, say one exceeding ten chains in length, contains most water, and ought to be laid with larger pipes than those used near its source.

Small Pipes Objectionable.—About forty years ago, when pipe-drainage was in its infancy, large numbers of 1-inch pipes were used for the minor drains. Parkes stoutly defended the practice, and joined issue with Smith, who as strongly condemned it, ridiculing the pipes as "pencil-cases." Experience has demonstrated that Smith was right in judging them too small, for in addition to their lack of capacity to remove the water with sufficient rapidity in emergencies, they have been found extremely liable to get out of order. A slight displacement, which might not seriously affect the work of 2- or 3-inch pipes, may be fatal to such a small conduit as is formed by 1-inch pipes.

Prevailing Sizes.—One and a half-inch pipes were also much used; but at the present time none are employed of less than 2-inch calibre, and many drainers look upon 2½-inch as the minimum allowable.

Proportions of Different-sized Pipes.—No definite rule can be given as to the relative numbers of the different sizes of pipes, but, in the drainage of areas of from ten to twenty acres in extent, with soil of medium texture, it may be given as an approximate rule, deduced from the examination of a large number of records, that about 5 per cent of 4-inch, 4 per cent of 6-inch, and 2 per cent of 8-inch pipes will be required, the remaining 89 per cent or thereby being 2- or 2½-inch.

Pipes for Mains.—Respecting the size of the main pipes, it may be estimated that a 4-inch main will remove the accumulated water of five acres of retentive soil, or four acres of porous soil; a 6-inch main that of eight acres of retentive, or six acres of porous soil; and an 8-inch main that of eighteen acres of retentive, or twelve acres of porous soil.

The recent tendency to increase the size of the pipes used in minor drains, renders it necessary that the size of the main pipes should likewise be increased in a corresponding degree.

Number of Pipes per Acre.—The number of pipes which will be required per acre for the minor drains may be readily calculated when the length of the pipes and the distance between the drains are known. For example, with pipes one foot in length, and drains 18 feet apart: divide 43,560, the area of an acre in square feet, by 18, the distance between the drains in feet, giving 2420 as the number of pipes required per acre.

In the following table will be found the respective numbers of pipes of 12, 13, 14, and 15 inches in length, at distances from 15 to 42 feet, which must be provided for the drainage of one acre of land:—

Distance between the Drains.	Rods (5½ yds.) per acre.	12-inch Pipes.	13-inch Pipes.	14-inch Pipes.	15-inch Pipes.
Feet.					
15	176	2904	2680	2489	2323
18	146	2420	2234	2074	1936
21	125	2074	1915	1778	1659
24	110	1815	1676	1555	1452
27	97	1613	1489	1383	1290
30	88	1452	1340	1244	1161
33	80	1320	1219	1131	1056
36	72	1210	1117	1037	968
39	67	1117	1031	957	893
42	62	1037	958	888	829

Custom in Executing Drainage.

The execution of drainage works may be undertaken by the landowner, either by himself or with the aid of some of the great land improvement companies; or it may be carried out by the tenant, with the assistance of the landlord, or at his own expense, in the expectation of recouping himself in the improvement of his crops, and by compensation under the Agricultural Holdings Act (1883) at the end of his tenancy.

On some estates the pipes are provided by the landlord, and all the labour by the tenant; but this rule often leads to unsatisfactory results, as many tenants are inclined to carry out their part of the agreement in a temporary fashion, in order to save expense.

The cartage of the pipes is almost invariably done by the tenant.

Drainage by Contract.

In some districts it is customary to carry out all extensive drainage by contract, under the supervision of a competent superintendent.

Specifications. — Contracts of this kind may be made somewhat on the lines indicated by the following specification:—

Specifications for Cutting and Filling Drains on .... Estate.

.... *Farm.*

18...

The minor drains are to be cut in parallel straight lines directly up the natural slope of the land or otherwise, in such direction and at such distances apart as may from time to time be pointed out, to be ... feet deep, at the distances apart generally of ... feet, as shall be directed. The drains are to be cut as narrow at the bottom as practicable, allowing space for the thickness of the pipe. The sides must be dressed clean, and the bottoms to have clean and uniform inclinations. Extra cutting must be given through rising ground or irregularities of the surface.

The main drains are, in all cases, to be 6 inches deeper than the minor drains.

None of the drains to be filled till inspected by Mr ...., who will superintend the work, and all the material, excepting stones, is to be returned to the drains as equally as possible.

In soft clay or peaty ground, where a firm bottom cannot be obtained, precautions must be used, by cutting an extra depth and laying turf with the green side up in the bottom, or boarding upon which the pipes are to be placed, or such other method as may be directed.

The work is to be carried on by first cutting or preparing a thorough outfall to the main drains. This outfall to be a foot below the mouth of the main drains.

All the drains must be filled, keeping the bottom of the drains clear of mud or loose soil as the work proceeds.

The contractor is to perform all boring and blasting of stones, and pay the cost of the whole work, excepting the pipes, which are to be furnished by the employer, laid down as conveniently as may be, and excepting also the laying of the pipes, which is to be done by a man appointed and paid by the employer.

The whole work must be completed to the satisfaction of Mr ...., or any competent party the employer may appoint to inspect the same.

Estimates to be given in per imperial chain of 22 yards.

...-inch cylindrical pipes to be used in the minor drains, and ...-inch main pipes, and the work to be finished by ....

Men for Drainage Work.—In making a contract, only strong, active, and *skilful* men should be engaged; for, though men able to do a hard day's work may be found anywhere, yet if deficient in skill and experience, dissatisfaction at their work will arise. Unskilled men willingly engage at low rates; but it is wise to give such rates to skilful men as will enable them to earn good wages.

Superintending Drainage Work.—Another point, besides contracting for the cutting, is securing a careful superintendent to measure the drains and lay the tiles. No man's wages are better earned in efficacious draining than those of a skilful superintendent. Without careful supervision common evils in drainage work are these: In bad weather in winter, great length of drains are cut and left open for an indefinite time, without pipes, and in the interval rain or snow falls, and brings down parts of the sides into the bottom; the spade-work is roughly and unevenly executed, whereas it should be neat and correct in every size of drain; drains are made to pass by the side of comparatively small boulders, instead of these being removed, and the drains carried forward in a straight line; the most clayey or sandy part of the earth from the bottom of the drain is placed upon its edge, where its weight brings down the upper soil into the drain: the pipes are laid down in a careless manner, instead of being conveniently placed for the person who lays them; pipes are laid in without regard to their continuous contact or straightness in line; and, to reach the climax of negligence in the whole process, a long time elapses, even in wet weather, before the earth is returned above the pipes. Where a careful superintendent is employed, these evils are avoided.

When drains are executed by the landlord, strict superintendence is the only safeguard for their efficient execution. When the tenant undertakes the drainage, he is desirous to save the expense of superintendence, and trusts to the contractor to undertake every part of the work, as the farm-steward cannot be spared to superintend draining.

When the same men cut the drains and lay the pipes, which is too much the practice, they find damp weather more favourable for cutting hard ground than for pipe-laying, and they go on cutting, day after day, as if they had nothing else to do, thereby exposing a long stretch of drain to the weather, which brings down much of its sides. Should the rain continue, the workmen can neither bottom out the drain nor lay the pipes, and the matter becomes daily worse. Should sudden frost follow, it crumbles down still more of the earth from both sides, and on rain or snow coming, the bottom is converted into sludge that cannot be taken out until it becomes firm, or until dry weather induces the men to lay the pipes; they then go on laying them as if certain the dry weather will continue, without thinking that they have the earth to return into the drain; but by the time they have finished pipe-laying, they find the earth too hard with frost to be returned to the drain, so the laid pipes are exposed to whatever change of weather may occur.

When left to their own will, workmen on piece-work naturally execute the part of the work most conducive to their own interest, and most pleasant to their own feelings, irrespective of ultimate consequences to the work.

On the other hand, a superintendent would have laid the pipes and returned the earth while the drain was in a fresh state. A superintendent is not required to see a sufficiency of work done every day, for there is little fear of men on piece-work working less than will secure them good wages. What is to be apprehended is regarding the work as to its *quality* and *efficiency*, and to secure these superintendence is absolutely required.

Draining, being a hidden work—and when executed, its excellence cannot again be reviewed—its execution calls for the strictest supervision.

Execution of Drainage.

Having secured a satisfactory outfall, and the general system of drainage to be adopted having been decided upon, the course of the main may be marked out in such a manner as will provide sufficient fall, usually up the lowest part of the area to be drained, and the cartage of the pipes may be taken in hand. It is better to haul the pipes and lay them in convenient lots along the course of the proposed drains, than to cart them across the freshly filled trenches as the work goes on.

Cutting is always commenced at the lower end of the main, which should be opened throughout its entire length before proceeding with the minor drains.

Fig. 643.

The top-spit may be removed by the ordinary digging spade, fig. 643.

Drainage Plough.—On tillage land the drains are often marked out, and the surface-soil turned back by the common plough; whilst on grass land a turf of 8 or 9 inches in depth may, with a saving in cost, be removed by the draining-plough shown in fig. 644, as made by Hornbsy & Sons, Grantham.

Width of Drain.—On land which is free from stones, the narrower the trenches are made the better, provided there is room enough for laying the pipes. The trench may be divided into three horizontal divisions (fig. 645) according to the method of cutting: the top-spit of a 3½-foot drain being, say, 14 or 15 inches wide and 8 or 9 inches deep, and removed by the digging-spade or plough; the shaft of the trench, say, 24 inches deep, and contracting to 10 inches in width, cut by the long-bladed draining spade or "clay-cutter," figs. 646, 647, and 648; and the bottom division of the trench, just wide enough to admit the pipe, and 9 inches in depth, cut partly by the clay-cutter and finished by a scoop of the same size as the pipe itself.

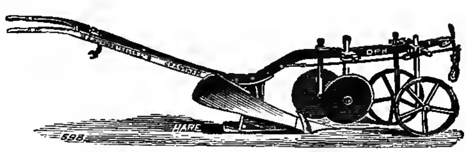


Fig. 644.—*Draining-plough.*

Scoops of different patterns are shown in figs. 649, 650, and 651.

In the Fen districts of England, where the soil is of an extremely homogeneous and easy-cutting nature, the trenches are made but little wider at the top than at the bottom, and a skilful man may be seen, in the draining competitions occasionally held there, cutting a 4-feet drain, clean and true, hardly 6 inches wide at the surface.

Drains in Hard Gravelly Soil.—In many districts it is found impossible to use the ordinary draining tools, owing to the presence of coarse gravel or numbers of stones in the soil; and it becomes necessary to have recourse to the pick and narrow shovel, with a hammer to break the larger stones. Under such circumstances the trench is made wide enough to allow a man to work in it, the bottom being finished by the square pattern shovel, fig. 652, so as to obtain a plane surface whereon to lay the pipes, which are, in this instance, of the double-soled form.

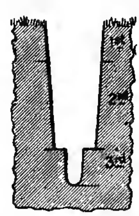


Fig. 645.—*Divisions of trench.*

Removing and Avoiding Boulders.—It is desirable that the drains should run in straight lines, and to effect this it may be necessary to remove the smaller boulders, either by blasting or breaking with the hammer; but when large boulders lie in the track, the cost of removal would be too great, and the drains must be led round them, avoiding any abrupt curves.

Drains falling in.—In proceeding with the cutting of very deep mains, whenever a tendency to fall in is indicated, short thick planks should be provided, and placed against the loose parts of both sides of the drain in a perpendicular or horizontal position, according to the form of the loose earth, and there kept firm by short props between the planks at both sides of the drain, as in fig. 653, where *a a* are the sides of the drain, *d d* planks placed perpendicularly against them, and kept in their places by the short prop *c*; or placed horizontally at *f*, and its opposite neighbour is so placed, and both kept in their position by the props *e e*. When there is no tendency of the earth to fall in, the drain may be dug at once to half its depth. It is convenient in a deep cut of 9 or 12 feet to take off the upper half of a new division of the drain before digging to the bottom the preceding division, in order to have a stage from which to hand down the pipes for the bottom.

Fig. 646. — *Clay-cutter, hollow or circular pattern.*

Blade 20 inches long, 5 inches wide at top, 3 inches wide at bottom.

Fig. 647. — *Clay-cutter, socket pattern.*

Same dimensions as fig. 646 (Richardson & Co.)

Placing the Dug-out Soil.—The soil which is dug out of the drain should be laid at such a distance from the edge that none of it will crumble into the open trench, and so spoil the evenness of the bottom before the pipes are laid; and in such a manner that its different layers may be returned over the pipes in the same relative position they originally occupied, thus retaining the best soil on the surface.

Fig. 648.—*Cast-steel clay spade.*

Size—13 inches by 6 inches.

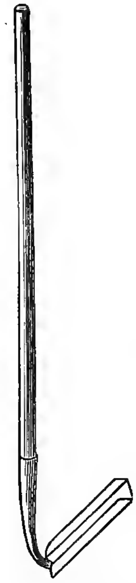


Fig. 649.—*Drain-scoop to pull, square pattern.*

Inspecting Drain-work. — During the progress of the work, and before each length of pipes is laid, the superintendent should inspect the open trenches to ascertain whether they have been cut

Fig 650.—*Drain-scoop to pull.*

Size—15 inches by 3 inches, 6 feet handles.

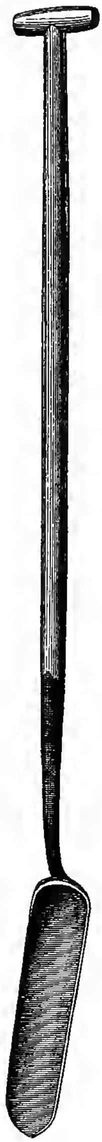


Fig. 651.—*Drain-scoop to push.*

Size—15 inches by $3\frac{1}{2}$ inches, 3 feet 9 inch crutch handles.

and dressed in accordance with the terms of the contract.

The *depth* he can test most conveniently by means of a light drain-gauge (fig. 654), a rod of 4 to 5 feet in length, shod with iron at the lower end, marked with feet and inches, and fitted with a moveable cross-piece, which may be adjusted to the minimum depth of the drain. With this he can readily measure whether the drain is at all points of the specified depth.

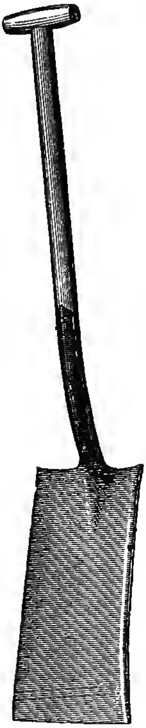


Fig. 652.—*Drain shovel, square pattern.*

The rounded groove in the bottom made by the scoop should be smooth and free from loose earth and small stones; and it is essential that the fall, or inclination, should be perfectly uniform, for any depression in the course of the pipes is likely to cause a deposition of sediment, fig. 655).

Testing Levelness of Drains.—There are various ways of determining whether the bed for the pipes be perfectly true. An old and clumsy one, resorted to by many workmen, is that of pouring water into the trench, and noting the parts in which it stands as depressions which require further attention. But the method is inapplicable to cases where the bottom of the trench is of a porous nature, and it is in all cases liable to damage the bed prepared for the pipes.

Challoner's level[1] has also been used to some extent. It is made of boards, and fitted with a plummet, as shown in fig. 656. The board forming the base is 12 feet in length. With a drain 96 yards long, and having a total fall of 2 feet, or ¼ inch in each yard, attach a board along the whole length (4 yards)

[1] *Royal Agric. Soc. of Eng. Jour.*, No. xxv., (1850), 115.

of the level, so that it shall be one inch lower than the level at one end, and nothing at the other. When the level,

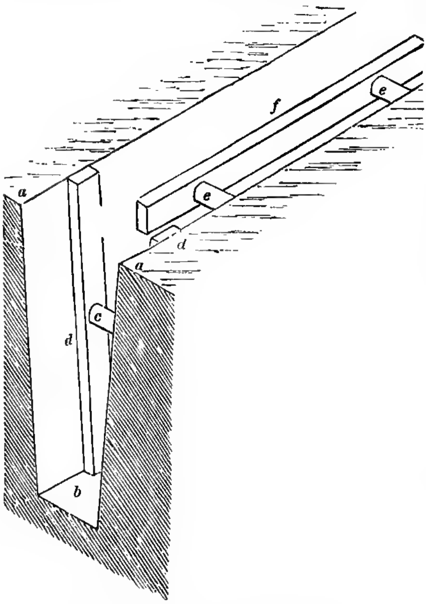


Fig. 653.—*Positions of planks and props in a deep drain to prevent earth falling in.*

thus adjusted, is placed on any part of the bottom of the drain, the plummet should hang perpendicularly, if the fall be uniform throughout the 96 yards. This contrivance, being clumsy to move about, and ill adapted to long stretches of drain, is now but seldom employed.

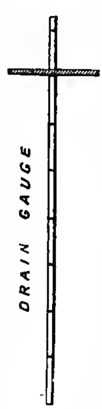


Fig. 654.

The uniform fall of a drain may be most accurately determined by the use of three levelling-staves, or "boning-rods" (fig. 657), two of them, say, 24 feet in length, and one with an adjustable cross head. Their use will be best explained by the diagram (fig. 658). A, B, are two of the levelling-staves, fixed perpendicularly at the extremities of the length to be tested, the lower end of each resting on the bottom of the trench. The superintendent places himself in such a position that he can bring his eye into a line, D, D, with the upper edges of the cross-heads of the

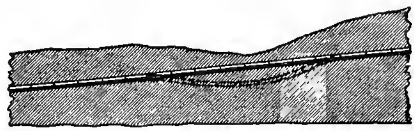


Fig. 655.—*Showing the line of pipes truly laid with regular fall, and pipes improperly laid on uneven bottom.*

staves A and B. The staff, C, with its cross-head adjusted to the same height as those of A and B, is then placed, as shown, at as many points as necessary

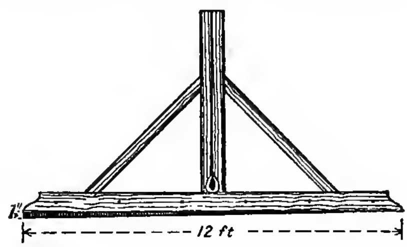


Fig. 656.—*Challoner's level. Giving a fall of ¼ inch to the yard.*

along the drain. If at all points the cross-head of the staff, C, is exactly in the line of vision, D, D, then the fall of the bottom of the drain is perfectly uniform. If at any part the staff, C, falls below the line of vision, D, D, the bottom has been too much scooped out, and must be made up: and if, on the other hand, it rises above the line of vision, the bottom requires to be deepened.

When the cross-heads of the respective staves are painted in contrasting colours, as black, white, and red, they are more easily distinguishable in use.

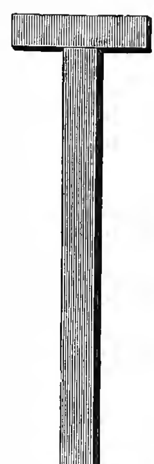


Fig. 657. — *Levelling-staff, or boning-rod, for testing the uniform fall in drains.*

By marking the levelling-staff, B, with feet and inches in a bold and distinct manner, and adjusting a spirit-level to that at A, the exact amount of fall between the two staves may be conveniently ascertained.

American Method.—Fig. 659 gives an illustration of a method of regulating the fall of the bottom of the drain, described by Judge French as used by him in America. A B is a surface view of the open trench, at either end of which a post is driven. Between the posts, when

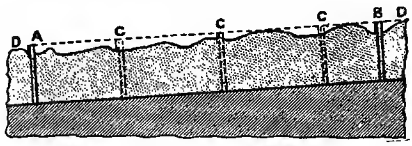


Fig. 658.—*Showing use of levelling-staff.*

the trench has been cut all but the last spit, a line, C D, is stretched as tightly as possible, about 7 feet above the proposed line of the bottom. The cord is supported at regular distances by the squares, E, E, E, the cross-pieces of which project over the open trench, and prevent sagging. These squares are driven in the bank of the drain, so that the upper surface of each cross-piece is in the line C D. Having thus fixed the line properly, the workman scoops out the bottom of the trench, F G, making it parallel to the line C D, testing, as he proceeds, with a 7-foot measuring rod, H.

This method has the advantage that it may be carried out by one man, and it requires no greater skill than that of the ordinary workman.

Cost of Cutting Drains.

The cost of cutting drains varies greatly in different localities, fluctuating most in the vicinity of large mining and manufacturing centres, and remaining more stationary in purely agricultural districts.

The chief factors which determine the price are the nature of the soil and the depth of the drain. The deeper the drain, the greater is not only the actual cost, but also the cost per cubic yard of

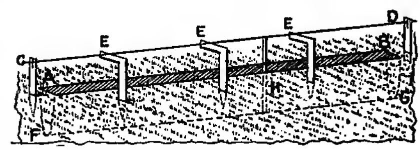


Fig. 659.

soil removed, which may vary from 3d. to 6d. per cubic yard.

Quantity of Earth Removed.—The accompanying table gives the quantities of soil, or "spoil," according to the depth and average width of the trench:—

TABLE SHOWING NUMBER OF CUBIC YARDS OF EARTH IN EACH ROD, 5½ YARDS IN LENGTH, IN DRAINS OR DITCHES OF VARIOUS DIMENSIONS.

DEPTH.	MEAN WIDTH.											
In.	7 In.	8 In.	9 In.	10 In.	11 In.	12 In.	13 In.	14 In.	15 In.	16 In.	17 In.	18 In.
30	0.89	1.02	1.146	1.27	1.40	1.53	1.655	1.78	1.91	2.04	2.164	2.29
33	0.98	1.12	1.26	1.40	1.54	1.68	1.82	1.96	2.10	2.24	2.38	2.52
36	1.07	1.22	1.375	1.53	1.68	1.83	1.986	2.14	2.29	2.244	2.60	2.75
39	1.16	1.324	1.49	1.655	1.82	1.986	2.15	2.32	2.48	2.65	2.81	2.08
42	1.25	1.426	1.604	1.78	1.96	2.14	2.32	2.495	2.674	2.85	3.03	3.21
45	1.34	1.53	1.72	1.91	2.10	2.29	2.48	2.67	2.865	3.055	3.246	3.438
48	1.426	1.63	1.833	2.04	2.24	2.444	2.65	2.85	3.056	3.26	3.46	3.667
51	1.515	1.73	1.95	2.164	2.38	2.60	2.81	3.03	3.25	3.46	3.68	3.896
54	1.604	1.83	2.06	2.29	2.52	2.75	2.98	3.20	3.44	3.666	3.895	4.125
57	1.69	1.935	2.18	2.42	2.66	2.90	3.14	3.38	3.63	3.87	4.11	4.354
60	1.78	2.036	2.29	2.546	2.80	3.056	3.31	3.564	3.82	4.074	4.33	4.584

Examples of Cost.—While it is impossible to give any definite figures respecting the cost of cutting, the following, which are the average of a large number of price-lists, may serve as examples:—

For 3-feet drains, with 2½-inch pipes.	Easy cutting loam . .	4½d. to 5d. per rod.
	Strong loam . . .	5½d. " 7d. "
	Clay	7d. " 8d. "
	Strong clay, with stones	8d. " 9½d. "
	Very stony clay . . .	9½d. " 11d. "

3½-feet drains may cost, in each case,	1d.	to 1¼d. per rod more than for 3-feet drains.	
4 " " " "	2d.	to 2½d.	" " " "
2½ " " " "	1½d.	to 2d. per rod *less*	" " "
2 " " " "	2d.	to 2½d.	" " " "

Six-feet drains in peat may cost from 1s. 4d. per rod; but if the sides require to be timbered to prevent them falling in, a much greater expense may be incurred—occasionally for 6- or 9-inch pipes as much as 4s. or 5s. per rod. For larger pipes and mains, it is a convenient rule to add one farthing per rod for every additional inch in the diameter of the pipes.

Laying the Pipes.

The laying of the pipes should proceed, step for step, with the opening of the drains, and long stretches of open trench ought never to be permitted. It is much better that the pipe-laying should be done by the superintendent himself, or by a skilful man under his direct control, and paid by the day, than to have it done by piece-work by the contractor.

The whole efficiency of the drainage depends upon this portion of the work being done with care and skill. It is desirable, also, that the pipe-layer should cover the pipes with sufficient earth to prevent their displacement, when the bulk of the material which has been removed from the trench is being returned to it by the ordinary drainers, otherwise they are likely to be displaced in the filling in.

Pipe-laying Iron. — In all cases where it is not necessary to lay the pipes by the hand, this may be best done by

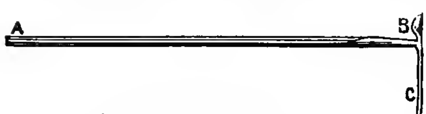


Fig. 660.—*Pipe-laying iron.*

the implement represented in fig. 660. This is known as the pipe-laying iron. It is fitted with a light handle, A, 5 or 6 feet in length, and at one end of the iron or steel head there is a small scoop, B, the other end being a round bar, about 9 or 10 inches in length, and curved at the extremity. With this the workman can easily, standing on the bank of the trench, pick up the pipes which have been placed at a convenient distance from the edge, and deposit them in their proper place in the bottom. The scoop enables him to level any small irregularities of the pipe-bed, and to remove whatever pebbles or crumbs of soil may have fallen upon it; whilst the curved point of the rod, C, allows him to turn the pipe round until it has been firmly bedded, close to the one which has been previously laid.

Still many find it quite satisfactory to lay the pipe by the hand and fix it firmly in position by the foot.

Faulty Pipes not to be used.—All faulty or damaged pipes should be discarded, and only those used which are perfect; for, as the strength of a chain is that of its weakest link, so also the capacity of a drain is that of its most faulty pipe.

Junction Pipes.—Ready-made junction pipes may be obtained from the pipe-maker; but the connections between the minor drains and the mains are usually made on the spot, by chipping a hole in the main pipe and sloping off the end of the minor pipe, so as to fit, with a small hand-pick.

Junctions should be adjusted as accurately as possible, with the pipes firmly placed and covered before the pipe-layer leaves them. If there are any openings left, soil may find its way in, and vermin, particularly water-rats, frequently fill up the pipes with earth from their burrows.

Important Details.—When the pipe-layer finishes a length, he should never leave the end of the last pipe open, but plug it firmly with straw, hay, or some filtering material which may admit the water only after it has been freed from silt.

Pipe-laying, like drain-cutting, is always commenced at the lowest point, and continued upwards.

Every length, as it is laid, should be filled in on the same day, as a heavy fall of rain, while the pipes are uncovered, may almost choke the drain with sediment before it is completed.

When the liability to displacement of the pipes is unusually great, it may be desirable to push a round bar of wood up the pipes to steady them, and withdraw it when they have been firmly packed with soil.

Outfall Pipes.—The last pipe at the outfall of the main should be at least 3 feet in length, of cast-iron, and fitted with a vertical flap-grating, to exclude all vermin. It should be fixed in masonry, and have, if possible, a clear fall of 1 foot under its orifice.

Filling Drains.

The refilling of the drains is usually done with a long-handled draw-hack. The most expeditious method, however, is to employ the ordinary plough to throw in the greater portion of the earth, and gather in the residue with a spade or shovel.

The soil can never be returned to the trench in so firm a condition as it was before being dug out, consequently there is always a quantity left over, to spread on the surface. The top of the drain should have the soil heaped over it at first, so that there may be no depression when it has settled down. On grass land, the sods should be closely fitted in their original position, and left 6 to 9 inches above the general level of the field; and it is desirable that they should be heavily rolled as soon as possible.

The ordinary drainers most commonly lay the sods as part of their work; but, to secure a more careful finish, it is probably better to have them laid by experienced workmen receiving day wages.

Drains Chart.—While the work of draining a field is being completed, the exact position of both mains and minors should be entered in a plan of the farm, the outfalls being distinctly marked. This may save much trouble and expense should any of the drains get out of order, or if additional drains be found necessary.

Cost of Draining per Acre.—The total expense of draining a farm must depend chiefly upon the depth and frequency of the drains. Appended is a rough estimate, in accordance with data previously given, of the cost per acre of draining a field of, say, fifteen acres in extent, of medium loam soil, with 3½-feet drains, at 24 feet distances apart, using pipes of 14 inches in length.

	£	s.	d.
1385 2½-inch pipes at 28s. per 1000 .	£1	18	9
774 " 50s. " .	0	3	10
626 " 125s. "	0	7	9
318 " 170s. " .	0	5	3
Cost of 1555 pipes	£2	15	7
110 rods of cutting, at 7d. per rod . .	3	4	2
Cost of cutting and pipes .	£5	19	9
To which may be added—			
Cartage, say	0	10	0
Pipe-laying, at ½d. per rod .	0	4	7
Plan of drains, say	0	0	6
Total cost, without reckoning levelling, superintendence, or sodding on grass land . .	£6	14	10

The expense will be greater on heavy land, and correspondingly less on light land. A considerable saving may be effected in the cost of the pipes when they are made on the estate.

The interest payable by the tenant, in the example given above, under the Agricultural Holdings Act (1883), at five per cent, would amount to 6s. 9d. per acre per annum.

Draining-machines.

Many attempts have been made to reduce the cost of drainage by the use of draining-machines. Various forms of machines have been invented from time to time with this object; but no device has hitherto succeeded on soils which do not possess a homogeneous and easy-cutting texture, and the difficulty of accurately graduating the inclination of the bottom of the drain, when the surface of the field is uneven, has been found almost insurmountable.

"Mole"-draining.—An implement, by means of which considerable areas were at one time pipe-drained, was constructed like the ordinary "mole"-plough. It was worked either by steam-power or by horse-power, through the medium of a windlass placed on the headland. The pipes, forty to fifty at a time, were strung upon a rope or chain attached to the "mole," and drawn into the channel formed by it. Openings were made along the course of the drain, to give facilities for drawing a fresh set of pipes into each length.

Whilst this method, under favourable conditions, answered tolerably well with the inch, or inch and a half, pipes at one time so generally used, it is not adapted to the laying of the larger sizes now universally employed.

Keeping Drains in Order.

On many estates even more care and expenditure are required to keep the existing drains in good working order than to carry out new drainage works. In discussing this department of the subject it will be convenient to consider *seriatim* the causes of derangement, and, with respect to each of these, the most approved methods of prevention and cure.

Causes of Obstruction.—These are:

1. Obstruction of the pipes by silt or compounds of iron.

2. Obstruction of the pipes by roots of trees.

3. Displacement of the pipes.

Silt and Compounds of Iron.

1. The blocking up of the pipes by silt may be due to careless pipe-laying, the pipes being imperfectly fitted to each other, leaving too wide openings through which soil may be carried by the water entering the pipes; imperfectly fitted junctions, which allow water-rats or other vermin to find access to the channel; want of depth, allowing the water to enter the pipes loaded with fine soil in suspension, owing to want of sufficient filtration. Much of the mischief is sometimes accomplished before the work is completed, where a length of pipes has been subjected to a fall of rain after being laid and before being covered up.

Obstruction by Iron Compounds.—This causes much trouble in reclaimed peat-bogs, and peaty soils generally. For the following explanation of the chemical changes which result in the deposition of iron compounds in drains we are indebted to Professor Kinch of the Royal Agricultural College: "I take it that the iron is dissolved in water as ferrous carbonate—by virtue of the carbonic acid in the water—and, in the case of peaty and boggy water, as various organic salts of iron, and that the ferruginous water on aeration in the drain has its iron compounds, which are mainly ferrous compounds, oxidised and converted into ferric oxide, which is deposited in a more or less hydrated state—ferric hydrate—generally round some root or other foreign matter as a nucleus. Sometimes iron pyrites (insoluble) may be oxidised to sulphate of iron (soluble), and this deposit ferric oxide when in contact with calcium carbonate and air."

The less soluble compounds being precipitated, occur as a thick, ochrey, reddish-brown substance in the pipes or at the outlet.

Preventive Measures.—To obviate the obstruction of drains by any of the materials named, several preventive measures may be taken.

Cesspools.—Cesspools may be constructed along the course of the drains, at regular intervals, varying in frequency according to the danger of obstruction. These cesspools are sometimes of wood, and barrels are occasionally used for this purpose, but it is much more satisfactory

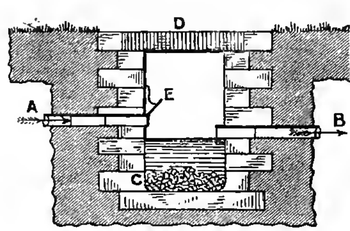


Fig. 661.—*Drain cesspool.*

to have them built of stone or brick and hydraulic lime. They may be either round or square in form, and 2½ to 3 feet in diameter, and 2 feet to 3 feet deeper than the lowest outflow pipe (fig. 661).

All cesspools of this kind should be periodically inspected, when the sediment which has accumulated in them should be removed.

It is desirable also to make a cesspool under the mouth of the last pipe at the outfall, in order to prevent the sediment becoming heaped up in such a manner as to impede the outflow of the water.

Flushing.—Periodic flushing of drains liable to become blocked by ferruginous deposits is likewise an effective method of freeing them from such obstructions. This may be accomplished by stopping up the drain at its outlet until it has become completely filled with water, and then allowing the water to rush out, carrying the deposit along with it. In some cases, where circumstances are favourable, the higher extremity of a drain may, by means of a branch drain, be connected with a stream or pond, whence a strong flow of water, for flushing purposes, may be turned on at will. The pipes of the connecting drain should be as large as, or a little larger than, those of the drain it is intended to flush, and the end pipe at the stream should be guarded by a small sluice or flap-valve.

Symptoms of Blocking.—The first indication that a drain has become blocked is usually a dark-coloured patch on the surface, caused by the saturation of the soil. On the level, the wetness will become apparent directly over the obstruction, and extend for some distance up the course of the drain; but on the slope of a declivity the water may not find its way to the surface until it has reached a considerably lower level than the point at which the pipes are blocked.

Clearing Choked Pipes.—The commonest method of clearing out pipes which have become choked up is to cut an opening into the drain below the point of obstruction, and another above it, the two openings being 12 to 25 yards apart; a strong wire, No. 1 or No. 2 gauge, is then pushed up the pipes, from the lower to the higher, and a swab of sacking or other suitable material having been attached to the upper end of the wire, the whole of the intermediate conduit may often be swept clear without further trouble, by hauling the swab down through it. Irregularities in the pipes, however, not infrequently obstruct the passage of the wire or the swab, and cause it to stick fast, thus entailing a considerable amount of trouble, and the cutting of fresh openings into the drain, before the work is completed.

Clearing-rods.—Clearing-rods, by means of which the clearing of drains may be effected more conveniently than by the wire, are now much used. The accompanying diagram shows the method of using one form of clearing-rods, manufactured by Messrs Reid & Co. of Aberdeen (fig. 662). The first rod to be inserted has a pointed "cleaner," or a screw, to pierce the obstructing material, and this is thrust forward into the drain,

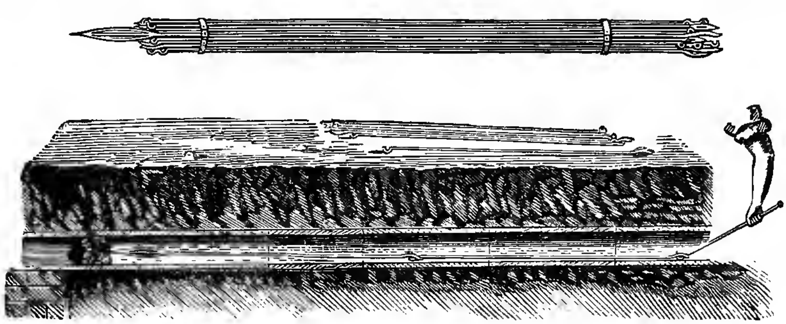


Fig. 662.—*Drain-clearing rods.*

by hooking on rod after rod, until the required length has been attained.

All the rods being of the same length, the exact position of the obstruction may be readily determined by counting those left unused, should it be found necessary to open the drain.

Reopening Drains.—It occasionally happens that drains get so completely blocked by a hard deposit of sand or iron ochre, or by a gluey deposit of fine clay, that the swab constantly jams in the pipes, so that it becomes impossible to draw it through. In dealing with such cases it is often necessary to take up the entire drain, clean out the pipes, and relay them, the expense of the operation amounting perhaps to one-half more than the original cost.

Endless-chain System of Clearing.—A system of cleaning by which the cost may be greatly reduced has done good service for some years on the Crewe estates, and may be found useful in other localities. It was devised by William Evans, a foreman drainer.

Openings into the drain are made, as shown, fig. 663, at intervals of 18 yards along its course, this distance being found the most convenient when the windlass, fig. 664, is worked by one man. A few pipes are taken out, and a small hole is dug under the mouth of the last pipe to receive the mud. The

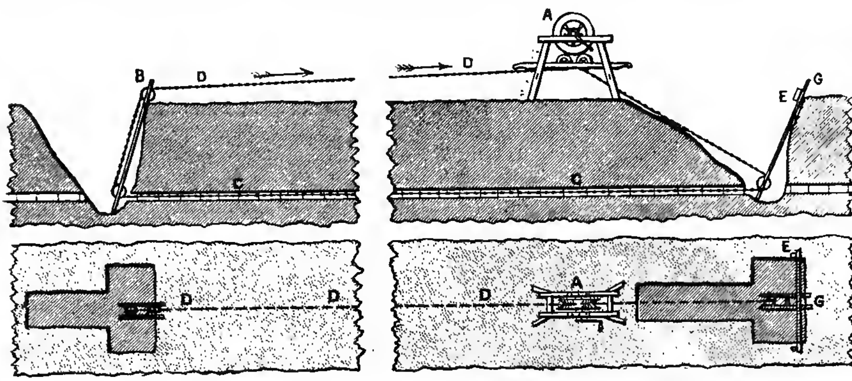


Fig. 663.—*Section and plan of drain in process of being cleaned, showing arrangements.*

a Windlass.
b Upright for lower opening, having two runners.
c c Drain pipes. *d d* Chain.
e Cross-bar, fitted with spikes, used for securing upright.
g Upright for higher opening, having one runner.

upright, fig. 665, is then placed so that the lower runner is opposite the mouth of the pipe; and a stout chain, which has been drawn through the drain by means of a rod or wire, is taken round

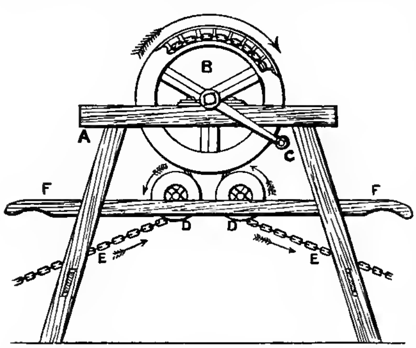


Fig. 664.—*Windlass for chain cleaning drains.*

a Wooden frame.
b The windlass, of cast-iron, and fitted with catches.
c The handle for turning the windlass.
d d Runners, also of cast-iron.
e The chain.
f Handles for carrying the machine; on grass land the machine may be inverted, and wheeled on the windlass.

the runners at the bottom and the top of the upright, and thence to the windlass, which is placed close to the higher opening. The chain then passes from the windlass to a runner at the lower extremity of an upright fixed in position in the higher opening.

One of the workmen then turns the handle of the windlass, and the endless chain passes rapidly down the drain-pipes, removing the sediment in its course.

As the chain does its work gradually, there is no danger of it becoming jammed. When the deposit has become hard or dry, a few pailfuls of water, poured into the higher opening, will greatly facilitate the operation. The chain may be made thicker by attaching short lengths of similar chain to it; and the work may be completed by sweeping out the pipes by swabs attached to the chain.

The cost of cleaning by this method need not amount to more than two-thirds the original cost of the drain.

Obstruction of the Pipes by the Roots of Trees.

2. The trees whose roots give rise to the greatest amount of trouble are the ash, the alder, and the different varieties of poplar and willow. The roots of the trees named, and occasionally of other species, penetrate the junctions of the pipes in search of moisture, ultimately pressing the pipes apart and filling up

the conduit by a dense sponge-like brush of rootlets, often many yards in length. The interstices between the rootlets become packed with sand and mud, and the block is complete.

The stoppage of drains by roots sometimes occurs at almost incredible distances, occasionally as much as 60 or 70 yards from the trees to which the offending roots belong.

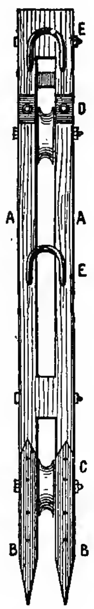


Fig. 665.—*Upright for lower end of drain, with runners.*

a a Wooden frame.
b b Iron spikes for fixing it in the ground.
c d Lower and upper runners, fixed by movable clump to the wooden frame.[1]
e e Handles.

[1] The upright for the upper end of the drain requires only the *lower* runner.

Means of Prevention. — To prevent mischief arising from this cause, it is desirable, wherever possible, to cut down all trees within 15 or 20 yards of the main at the time the drainage is done. When it is necessary to have the main taken past trees which cannot be removed, socket pipes may be employed, and danger averted by cementing the junctions. If ordinary pipes are used, gravel is sometimes placed round them, and gas-tar, which is found to be very obnoxious to roots, poured over it.

Another preventive measure, which has proved efficacious in some districts, is that of packing the pipes firmly in screened cinders. If the pipes be first laid, and the cinders merely placed over them, the roots are liable to enter the pipes from beneath: it is therefore necessary to place a layer of cinders, a few inches in thickness, on the bottom of the trench, and, having laid the pipes, to pack them tightly with cinders at the sides and on the top (fig. 666).

Remedy.—There is only one cure for the obstruction of drains by roots—namely, to take up the pipes, remove the roots, and relay.

With shallow drains the roots of several of our farm crops have been known to enter the drain-pipes and interfere with the passage of the water.

Derangement of Drains by Displacement of the Pipes.

3. This (see fig. 667) may be due to the sinking of the pipes in a soft oozy subsoil, such as peat or fine clay; when the best preventive is to lay the pipes on boards or sods. Occasionally the bed on which the pipes lie is washed away, as where the drain passes through a very porous layer or "pocket," by a quantity of water escaping from the conduit.

Fig. 666.—*Section of drain with pipes laid in cinders.*

Dislocation of drains over large areas is frequently brought about in salt districts by subsidence of the ground, caused by pumping brine from beneath, and in coal-mining localities by the pitfalls which are continually taking place.

Derangement which results from displacement of the pipes can only be rectified by taking up the pipes and relaying them.

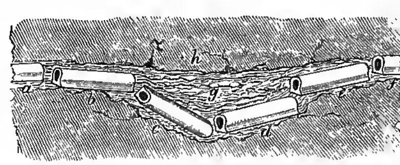


Fig. 667.—*Displacement of pipes in a drain.*

Re-draining Land.

Re-draining of land should as a rule be accompanied by the taking up of all the pipes of the original drains. So long as any of the old drains are left, the field will be subject to patches of wetness after every heavy rainfall, the old pipes conveying the water to the points at which they are blocked, and then allowing it to escape and saturate the surrounding soil.

Nevertheless it is a common practice in some parts of the country, when a field requires re-draining, to run a few drains across the old drains, tapping these where they seem most defective.