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By

T. Wibberley, N.D.A., N.D.D.

Of Queen's University, Belfast

Author of "Continuous Cropping, or Farming on
Factory Lines for Large Farmers,"

"War Time Farming," etc.

THIRD EDITION

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CO-OPERATIVE MOVEMENT
AND THE FOREMOST AGRICULTURAL THINKER IN EUROPE
TO WHOM THE AUTHOR IS DEEPLY GRATEFUL
FOR HIS GENEROUS HELP
AND THE GREAT FACILITIES WHICH HE PLACED AT
THE AUTHOR'S DISPOSAL
TOWARDS THE ELUCIDATION
OF THE MANY PROBLEMS
OF CONTINUOUS CROPPING

I wish to place on record my sincerest thanks to my old teacher, Professor Crowther, of Leeds University, for the undertaking of several analyses, and the cheerful help he has always extended to me in connexion with several investigations, and also to the many agricultural experts and farmers who have helped me with much valuable criticism and practical suggestions, and last, but by no means least, to my wife, who has practically written every word of the book from my dictation, compiled most of the tables, and who, realising my difficulty in doing the actual writing myself, made a study of shorthand and typewriting, with the sole object of making me into "a writer"!

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INTRODUCTION

A FEW years ago the catch phrase, "Three acres and a cow," formed the main plank in the platform of a band of social reformers. The idea contained in such a phrase may be all very well in theory, but the practical man who cannot do better than feed a cow on three acres of land had better give up farming, and take up some occupation requiring less skill and energy.

This latter statement applies specially to the smallholder, who, with the advantage of being able to concentrate his resources on a small area of land, may reasonably be expected to produce more per acre than a farmer whose operations are concerned with an extensive area.

The smallholder whose land is situated near a good market town where fruit-growing and market gardening are possible is already obtaining treble the revenue from his land than the large farmer in the same district obtains. This kind of intensive cultivation, though, is not possible in districts with a scattered population or where railway and market facilities are lacking. The small farmer under these conditions is compelled to produce more or less the same kind of soil products—milk, butter, beef and bacon—as do his larger contemporaries.

The trouble is that the farmer, large or small, has not realised to what extent these agricultural products are capable of being produced where an intensive system of cropping is followed.

The object of this book is to give the small farmer a

lead in the direction indicated. That is to say, instead of centering himself with feeding one cow on three acres of land, he should aim at keeping a cow, or its equivalent, on every acre.

Is this possible? Certainly—assuming an intensive system of cropping is followed and land of average fertility is being dealt with. .

So much, then, for the general idea. As to the size of holding, one of twenty acres will be a convenient standard to work by. As will be seen later, the necessary modification for the cropping and management of a larger or smaller holding than this will be only a matter of elementary arithmetic.

On this holding the main object will be the production of milk, for, next to intensive market gardening, milk production, wherever at all possible, is the ideal system for the small farmer.

Milk for direct consumption is practically the only farm product which, so far, has not had to contend with foreign competition. For the last twenty years, owing to the increasing population of these islands and the higher standard of living which has been adopted, the demand for milk has increased and is still increasing by leaps and bounds. Furthermore, from the smallholder's standpoint, the steady inflow of ready cash resulting from the sale of milk or milk products is of great importance.

Again, milk production is not subject to the many fluctuations which are experienced in other kinds of farming. Still further, the big dairy farmer has to depend upon hired help for the milking and attendance of his dairy cows, and the best servants procurable in these days will seldom give the same attention to the animals under their charge as will the man, or the wife, son, or daughter of the man, who owns the cattle. In this connection, dairy farming often finds lucrative

and constant employment for the members of the smallholder's family.

Even where milk selling for direct consumption is not possible, dairy farming from the smallholder's standpoint is very profitable. The demand for milk products—butter, cheese, and animals largely raised with the assistance of skimmed or butter-milk, that is, calves and pigs—is increasing and is likely to continue to increase.

From every standpoint, then, dairy farming, properly undertaken, is very profitable for the small farmer.

Let it be understood that in speaking of profitable farming, something more is meant than is usually conveyed by such a phrase.

One cannot regard a small farm as profitable when the owner can only just manage to feed and clothe himself and family and keep clear of debt, or even in addition save a few pounds in the year.

Farming, large or small, before it can be termed profitable should at the very least yield a revenue capable not only of providing the necessities of life for those engaged on the farm, but be profitable enough to yield a reasonable cash wage for every man, woman, and child employed in it, and still leave a surplus as net profit. How such is possible, by intensive cultivation, is the main object before the writer's mind in writing this book.

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CONTINUOUS CROPPING

CHAPTER I

THE NORFOLK *v.* A CONTINUOUS-CROPPING ROTATION

ONE of the greatest arguments against farming on the ordinary lines is that at least 80 per cent of the cropping and the cultural operations are confined to spring-time. Spring-time over a large area of these countries might well be described as the rainy season. From, say, February 1st to May 1st, for one day on which a farmer can work on any except the lightest soils, there are often three or four days, due to heavy rainfall, of enforced idleness. In fact, the ordinary farmer, working on the Norfolk system, or some modification of it, pretty well spends his spring-time between trying to till and "tapping the glass."

THE NORFOLK ROTATION

The Norfolk system, with its modifications, consists chiefly of corn and root growing.

Extensive corn growing in the sixties was all very well when wheat was at a consistent price of 60s. and 70s. per quarter, farm wages not more than one-half what they are now, and casual labour abundant. Climate and labour difficulties were then no bar. With the then remunerative prices for all farm pro-

duce and low wages, a farmer could afford to have his workmen and horses idle half the time, and even afford to lose a few crops.

Things have changed, however, and we must change with them. In fact, we *have* changed—changed from tillage to grass-growing. To-day only the very light land and inferior land—in other words, land which will not grow good grass—is now under the plough.

THE WAR AND WHEAT PRICES

Whilst war prices exist, corn growing is undoubtedly a profitable undertaking, but who is to say what the price of corn will be a few years hence? Wheat in a few years after the war may be cheaper than it was before. The clearing and breaking-up of additional vast areas in America, the Colonies, and other corn-growing areas, the great development in agricultural motors and other machinery greatly facilitating this work, the opening of railways in these areas, all indicate cheap corn after the war.

But, while the foreign farmer may beat us as far as corn growing is concerned, he cannot beat us in live stock or in live-stock products, if we farm on progressive lines.

The United Kingdom is the stockyard of the world. Of live-stock products milk is the chief, and it is the only farm product in connection with which so far the foreign farmer has not been able to compete with us. Milk products, butter, cheese, and cream, he does produce, but he cannot produce any one of them either better or cheaper than we, if we set about our farming in a better manner.

Now, with all this farmers will more or less agree, and have shown their agreement, in late years, by more or less turning their attention to dairy farming, or stock raising, as opposed to tillage.

The unfortunate part is that they have been quite content to produce milk, beef, etc., from the natural forage, grass, whereas the whole gist of the continuous cropping argument is that by substituting what we call artificial forage crops, in place of grass, we could produce double and treble the amount of milk, beef, and bacon, etc., than is possible to raise under a grass-growing régime.

This means a revival of arable farming, but on lines suitable to the labour and climate conditions.

It should not be understood that we are arguing entirely against corn growing. This is to a certain extent necessary for a continuous-cropping system of farming, especially where continuous cropping is followed on a large scale ; but with corn as with other crops, more intensive and less risky methods than those which at present obtain are necessary.* In fact, the continuous cropping system in certain districts would make an extension of corn growing possible. We are arguing against the whole hoggers, who favour corn growing and roots on a very much extended area, and this, even with the assistance of a certain amount of Protection, is not possible and would not be profitable.

THE HISTORY OF THE NORFOLK SYSTEM

The Norfolk system was devised nearly two hundred years ago by Lord Townshend. At that time the system pretty well revived agriculture, but, to repeat, things have changed ; amongst them probably the climate itself.

When, for instance, does one nowadays see the old-fashioned winter of frost and snow except on a Christmas card ?

Again, the annual rainfall in the Norfolk area is

* See Book II, *Continuous Cropping*, or, Farming on Factory Lines, for large farmers. In preparation.

about 24 inches, whereas in the other parts of these countries it is as follows :

England generally	33.4"
England, excluding the eastern counties or "Norfolk area"	36"
Ireland	40"
Scotland	45"
Wales	46.9"

It is self-evident that a system devised for a district with a comparatively low rainfall is not likely to succeed in a district where the annual rainfall may be from 36 inches to 50 ; most of the rain falling in spring-time and harvest, just the time a farmer does not want it.

Continuous-cropping farming is common-sense farming. Under this system from 70 to 80 per cent. of the tillage operations are done in the summer and autumn, *when the rain, instead of being a great hindrance, is a great help to tillage operations.* As to the remaining 20 or 30 per cent., this is done in the spring, the time of the year we have frequently referred to as unsuitable for tillage operations because of rainy weather !

A LITTLE ELEMENTARY BOTANY

Here we come to a very interesting point. Tillage work in spring under the continuous-cropping system is not quite the same thing as under the ordinary system. In the first place the spring tillage is very much less under the former system than under the latter, but of still more importance, whatever spring cultivation or crop sowing must be done in connection with continuous cropping is done on land dried by the growing of the preceding crop.

The leaves of the plant are the lungs of the plant, and perform similar functions in a plant as the lungs perform in a human being or other animal.

One of the chief operations of the lungs in a human being is the expulsion of moisture from the system. If one breathes for a few seconds on to a pane of glass, the glass immediately becomes damp. Precisely the same effect may be obtained by placing a cabbage under a glass globe for a few minutes in the sunshine.

A plant really obtains its nourishment from the soil by absorbing through its roots, plant food dissolved in the soil water. The moisture is expelled through the breathing pores of the leaves and green stems, leaving behind the plant food for the building up of vegetable tissue.

Now, it has been found that for every pound of dry matter assimilated by a plant, 250 lb. of water are expelled by the leaves. In rape, for instance, there is 14 per cent. of dry matter. Hence in a 25-ton crop per statute acre there will be $3\frac{1}{2}$ tons of dry matter.

Since 250 parts of water are required for the elaboration of one part of dry matter, it follows that for the production of $3\frac{1}{2}$ tons of dry matter, 875 tons of water are required.

One inch of rainfall per acre is practically equal to 100 tons of water. Therefore, by growing during the "winter" half-year 25 tons of rape, *we rid the land by leaf evaporation of nearly 9 inches of rainfall.*

The root action of the rape also facilitates drainage, and between this and leaf evaporation one would be quite safe in saying that by cropping a field with rape we rid the land of about the equivalent of 12 inches of rainfall.

It is scarcely necessary to point out, further, how ridding the land, prior to the spring tillage operations, of this amount of moisture, facilitates soil cultivation and crop saving in a wet spring.

So marked is this drying effect of winter crops that in the districts of low rainfall if the crop is not con-

sumed by the end of March the land is so dry that the tilling may have to be delayed. This is a matter which requires individual attention on the part of each farmer, and a study of the average monthly rainfall in his district will be a great help.

One would imagine that this drying effect might militate against the succeeding summer crops. Such, however, is not the case if a little judgment is used. The root action of the winter crops breaks up the soil particles in a most marked manner ; hence a finer tilth is procurable on the cropped, as compared with the uncropped, portion. In other words, quicker tillage is possible, and the repeated turnings over of the soil with consequent drying in a dry spring are avoided.

The quick tillage helps to conserve soil moisture, as does also the finer tilth. The finer the soil particles, the more retentive of moisture is the soil.

A CONTINUOUS CROPPING ROTATION

We may now set down what may be considered as a standard rotation on our twenty-acre holding, and later indicate how the rotation may be modified to suit any abnormal conditions. The rotation is as follows :

First year.—Tares for soiling.

Second year.—Tares for hay, followed by winter forage crops.

Third year.—Roots consisting of mangolds and potatoes.

Fourth year.—Tares for hay with seeds.

Fifth year.—Seeds for soiling.

On a twenty-acre holding cropped on the above lines there would be four acres in each break of the rotation.

As will be noted, pasture land has been entirely eliminated, and in its stead four acres of vetches and four acres of seeds as summer soiling have been substituted.

There is a very sound economic reason for this. It

requires two acres of good, and three acres of inferior, pasture, for the summer feeding of a dairy cow, whereas one acre of land properly cropped with forage crops will provide enough green food to feed at least three cows throughout the summer.

In cropping eight acres of land with summer fodder crops, we are, therefore, providing for the feeding of our twenty cows and leaving a surplus over. It is always well to allow a surplus in farming calculations. Dry or unfavourable seasons may reduce the crop yields, and if a surplus is available it is always possible to turn it into extra fodder for winter feeding.

Of course, in recommending the entire elimination of pasture land and the substitution of forage crops, one quite expects to be told that it cannot be done. This phrase is the greatest possible hindrance to agricultural advancement. Were the writer, as a successful farmer, asked by a would-be successful farmer for some sound and brief advice, the querist would probably be told to compile a list of all the things that he was told could *not* be done in farming practice—and then go and do them !

PASTURE v. FORAGE CROPS

On this matter of pasture *versus* forage crops for the small farmer, anyone familiar with the growing of such crops cannot otherwise regard pasture land, on the small farm at least, than as being little better than waste land.

The three factors of production to the farmer are land, labour, and capital, and when land is in pasture, excluding derelict land, the minimum is being produced from each factor. In this connection it is well to remember that in such countries as Denmark, Belgium, and Holland forage cropping in place of pasture is the order of the day.

As to what is possible on our own soil in this direction I am greatly indebted to Captain Sir John Keane, of County Waterford, Ireland (who farms his land on the continuous-cropping system), for the following information :

This gentleman broke up some wild mountainy land and sowed on it tares for summer soiling. As the results of very carefully kept accounts he found in the summer of 1914 that bullocks fed entirely upon this forage crop increased in live weight, over a period of approximately six weeks from June 1st to July 8th, at the rate of 3 lb. per bullock per day.

Continuing his investigations during the summer of 1915, he ascertained that seventeen and a half statute acres of green oats and vetches produced 14,686 daily rations of green food. This is equal to 840 rations per acre, which, again, is equal to the rations for twenty-eight head of cattle for one month.

Simple as these facts may appear, they contain the nucleus of great economic changes. Many economists and agriculturists labour under the delusion that prime grazing land is essential for the production of summer beef ; but even our primest grazing land will not provide more food per acre than is necessary for one beast, whilst with secondary land, two and three acres are often required for summer pasture. Whilst on even the best grazing land a live-weight increase of 9 stone per beast in six weeks is unheard of.

Farmers who have been in the habit of grazing cattle in summer may imagine that some pasturage is essential for the sake of giving the cattle exercise. In the Continental countries previously referred to, however, no such allowance is made ; cattle are *always* either tethered or kept indoors.

Even under our ordinary farming conditions cattle are usually confined in the house during the winter

months without any ill-effects resulting. It is also necessary to bear in mind that during the winter period indoor cattle are fed on much less laxative food than the green soiling crops, which it is intended to use in summer. The farmer may, therefore, disabuse his mind of the idea that outdoor exercise such as is provided under the pasturing system is essential. Under the summer soiling system, however, as will be seen in future chapters, outdoor exercise for the animals is not precluded.

THE WINTER FOOD SUPPLY

For the winter feeding of the farm stock we shall have available the crops produced in the second year's break, consisting of 4 acres of tare hay, followed by 4 acres of winter forage crops ("winter greens"), 4 acres of roots (say, 2 acres of mangolds and 2 acres of potatoes), grown in the third year's break, together with 4 acres of tare hay and 4 acres of seeds hay or ensilage grown in the fourth year's break. We may tabulate our supply of winter food as follows:—

Break	Crop	Area Acres	Yield Per Acre Tons	Total Fodder Tons	Total Forage Tons
2nd year	Tares hay ..	4	3½	14	—
	Winter greens	4	25	—	100
3rd year	Mangolds ..	2	30	—	60
	Potatoes ..	2	12	—	24
4th year	Tares ..	4	3½	14	—
	Seeds hay ..	4	2	8	—
Totals ..		12	producing ..	36	184

CO-OPERATION NECESSARY FOR ECONOMICAL PRODUCTION

As will be seen later when we come to discuss continuous-cropping rations, the above amount of food would be more than is necessary for the feeding of our

twenty cows, or their equivalent, during the winter period.

It will be necessary later to discuss in detail the cultivation and management of each of the crops mentioned in the rotation. Before doing so, however, it is necessary to point out that the methods here recommended for the handling and growing of the various crops are not of necessity the most economical or the most up-to-date for the large farmer.

The reason for this is very simple. These articles are written primarily for the small man on the land, and in these circumstances there is little use in recommending a method of soil cultivation or crop harvesting which calls for the use of equipment entirely beyond the means of the smallholder.

Later it may be found that by the adoption of co-operative principles implements at present beyond their power of purchase may be made available to our small farmers. For the time being, we must deal with things as they are, not as they may be when those who rule, or misrule, the agricultural destinies of these countries awaken from their lethargy.

We are assuming, then, that on our twenty-acre holding as manual labourers there are a man and a boy, and a woman to help in the dairy work; and as horse labour, a horse and a pony, or, better still, two strong cobs.

CHAPTER II

SOME OF THE IMPLEMENTS YOU NEED AND HOW TO USE THEM

As will be shown later, the tares intended for summer soiling—that is, fed green to the farm stock—once we have got our rotation in operation, will follow the seeds rye grass and clover grown in the fifth year's break. This latter crop, it will be remembered, is intended to provide a portion of the green food for the summer months.

The different parts of a plough.

The last cutting of the previous rye grass crop will take place during September and early October, and as the different sections during this last cutting are cleared, preparations will immediately be made for sowing the tares.

On our holding the seed ley will have to be ploughed.

PLOUGHS AND PLOUGHING

On this matter of ploughing a few words are very necessary. The small farmer would be well advised to turn a deaf ear to anyone who recommends him to buy a swing plough. He should purchase a modern wheel-plough fitted with a skim coulter, a digging board, and a tail knife or breaker. Since he will also later require a plough for the opening and closing of drills, he will find it economical to buy a wheel plough to which a second, or moulding, board can be attached, and also a potato-digging body.

For two strong cobs a plough should not exceed more than $1\frac{3}{4}$ cwt. in weight.

Too much attention cannot be given by the farmer to the purchase of his plough, since it will be the most-used implement on his holding. The great point about a wheel-plough is that anybody can use one, whereas the old-fashioned swing-plough requires very expert handling.

From the examination of a plough it will be seen that the draught can either be shifted to the left or right, or raised or lowered. When working normally the draught hake should be set in the centre and the chain put to its lowest point. It is in the opening and finishing up of the land that the draught point requires altering for various purposes.

The wheels of the plough are intended to regulate the depth and width of the furrow. The big (furrow) wheel regulates the width and the small (land) wheel the depth, although the big wheel also regulates the depth to a certain extent. The skim coulter is also adjustable and can be raised or lowered as desired.

Some ploughs have also a knife coulter in addition to the skim coulter, but in latter years a sharp shin piece

has been put at the front of the breast, which does away with the need for a knife coulter.

The tail knife at the end of the mould board is intended to split the furrow slice and thus help in the breaking up of the soil. This also can be moved up and down as desired.

The first thing to do in commencing to plough a field is to mark out the headlands on which the horses turn when ploughing. This operation simply consists of ploughing a shallow furrow about 3 inches deep all round the field which is to be ploughed. This furrow should be turned outwards towards the fence and should run about 4 yards from the fence and parallel to it.

The skilled ploughman will be able to gauge the 4 yards distance with his eye; but the amateur will find it a great assistance to place sticks at different points 4 yards from the fence along the headland.

Having marked out the headlands, we can commence the ploughing proper.

The land is ploughed in "setts," "sections," or "lands," as they are variously called. These, as a rule, are from 11 to 22 yards wide, but in the case of winter crops the narrower "setts" are preferable.

"OPENING OUT"

In commencing to plough the land we have to do what is called "opening out"—that is, two furrows must be ploughed and thrown together. This is called making the crown, or middle piece. It is the marking out of the headlands, the making of the crown piece, and the finishing up of the last furrow between two setts that are the ticklish jobs, though by setting the plough in a proper manner it really is quite simple even for a beginner.

There are different ways of setting the plough, but the simplest of all is as follows :

First the big wheel is fixed so that it just touches the ground when the plough is resting on a level surface. The big wheel should also be moved outwards until there is a width of about 10 inches between the wheel and the coulter or skin piece when viewed from the front. The small or land wheel should be raised so that it is about 5 inches from the ground when the plough is held level.

The plough set for opening out. Note the position of the skim coulter and the wheels.

SETTING THE PLOUGH

The next point to attend to is the draught. For the opening of the first furrow—and for marking out the headland—this should be set in the dead centre and the draught chain raised to about midway in the muzzle. Then the skim coulter is dropped until it is about an inch above the share and slightly inclined backwards.

On those ploughs with a knife coulter a skim coulter may be dispensed with both for opening out and marking the headlands, the knife coulter being set with a slight angle backwards a little above and behind the share's point. With this "set" on the plough all that need be done in marking out the headlands is to tilt

the plough over to the left hand, so that the little wheel runs on the ground, and drive the horses straight.

It will be understood that the horses should be driven so that the sticks or guiding rods can be clearly seen by the ploughman, the sticks being kept at an equal distance between the two horses which are yoked abreast.

In marking out the first furrow of the "crown piece," proceed exactly in the same manner as when marking out the headlands, using the guide sticks also.

Having reached the top of the field, the horses are turned to the right hand, and the second furrow thrown against the first. In making this second furrow a little adjustment of the hake may be necessary.

Some ploughmen prefer, when ploughing the second or "turn-back furrow," as it is called, to have the right-hand horse walking in the furrow just made. Under such conditions the hake should be shifted over to the furrow side of the plough, otherwise the plough will turn the first furrow back again into its old place. If, however, the right-hand horse walks to the left and just against the first furrow slice, the plough will be found to run steadier and probably without any further adjustment of the draught.

It may be here explained that by shifting the draught hake to the left of the ploughed ground the plough will run more to the right, and *vice versa*. Thus, if the second furrow does not quite touch the first, the hake should be moved slightly to the left, and if the second furrow overlaps the first, then the hake should be moved a little to the right.

Once the first two furrows, or crown piece, are made it is plain sailing. The big wheel then runs in the furrow so as just to touch the side of it, and may be either moved in or out according to the width of furrow desired. The little wheel runs on the unploughed land and may also be raised or lowered.

Generally speaking, if the plough is set in the manner described no further adjustment is necessary except perhaps to raise the little wheel an inch if deeper ploughing is desirable. It may also be mentioned that a wheel-plough is intended to run slightly tilted to the ploughman's left hand.

The finish of the last two furrows between two lands calls for a little further adjustment of the plough. In ploughing the last furrow but one, both wheels should

The first stages in ploughing a field.

be dropped about 2 inches so that this furrow is ploughed a little shallower than the general ploughing. Then for the last furrow there will be what is called a shoulder, or "whip sod," to steady the plough in turning over the last furrow. This whip sod should also be ploughed up in scouring the furrows.

All the "lands" having been ploughed, there still remains the headland.

To finish ploughing the headland the ploughman reverses his team and plough so as to throw a second furrow against the headland furrow, travelling all around the headlands to do so. In this manner he continues travelling round and round until all the headlands are ploughed.

SOWING AND SEEDING

The next job to be tackled is the sowing and covering of the seed, and this is a matter which calls for a little consideration.

If the land is fairly heavy, the seed may be broadcasted on the newly ploughed land before harrowing, although, if the ploughing is not fairly well packed, that is, if fissures are left between the furrows, it may be necessary to harrow the land slightly so as to close up the fissures and prevent the seed from getting under the sod and being sown too deeply.

This operation, where needed, having been performed, the seed should be broadcasted. Then follow several harrowings until the seed is completely buried and a fairly fine seed-bed obtained.

On light land it is really better to harrow the land down fine before sowing, then to broadcast the seed and cover with the harrow. The object of this latter method is to make a firm seed-bed, and further to assist in this direction light land should be rolled immediately after sowing. In some cases it is an advantage to roll both before and after.

TO ROLL OR NOT TO ROLL

It is not always possible to roll even light land at the time of sowing the tare crop—late autumn or early winter—as the ground is sometimes not dry enough.

Now, if land is rolled in the sowing of any crop when the soil is not sufficiently dry, harm is done instead of good. The surface soil is made pasty and when dry weather does come, the top surface of the soil bakes and forms a crust, very unsuitable for plant development.

As a guide to the suitability, or otherwise, of the land for rolling, remember that land is fit for rolling if the soil does not stick to the roller.

THE CORN DRILL AND THE SEED FIDDLE

If the smallholder can obtain the use of a corn drill for the sowing of the crops he should certainly do so. A crop sown with the drill requires less seed, is more evenly distributed, and more evenly covered in than

The spring-tined harrow, shown here, is a necessity for the economical tilling of the land.

when broadcasted by hand or by the seed fiddle, which latter implement, apart from the sowing of tares, every smallholder should purchase.

When the corn is to be drilled in, it is necessary on any class of soil to harrow down the ploughed land to a fine seed-bed before drilling. In connection with the covering in of broadcasted seed on land which has been harrowed down, and, perhaps, rolled also, it should be understood that there is only one type of harrow that will do this satisfactorily. That is the spring-tined harrow, one of the finest inventions of the present generation.

Many smallholders may have noticed that the average big farmer has at least three different types of harrows, a heavy drag harrow, a medium, and a light or finishing harrow. All these types were essential before the advent of the spring-tine; but in such an implement we have a harrow which will work deep or shallow, heavy or light, at the will of the operator. In fact, the implement will turn up the land deep enough to be called a cultivator and run light enough for harrowing moss-grown pastures.

THE SPRING-TINED HARROW AND HOW TO USE IT

The spring-tined harrow consists of a rectangular angle-iron framework, with three round cross-bars running from one side to the other. On these bars, the tines, teeth, or pegs, as they are variously termed, are fitted. The tines instead of being straight, as in the case of an ordinary harrow, are made elliptical, or in plainer language, are shaped like the figure 9. They are made of steel and from their shape are "springy."

The harrow is fitted with a lever and the further this is pulled back the deeper the tines enter the surface, and the deeper the work is done. On the other hand, when the lever is pushed forward the draught and the depth of the harrow are reduced.

In either covering in seed, or in harrowing down ploughed land, the tines in the first operation are put fairly deep, and in every subsequent harrowing the depth of the tines is reduced. In the final harrowing, the tines may only be an inch or less deep in the soil.

For this final refining of the seed-bed ("tickling" is the very appropriate name Irish farmers have for it), it is also a good idea so to hitch the harrow that it runs "slant-dicular" or diagonally.

In buying a harrow for a two-horse team, an eleven-tined implement about 3 ft. 9 in. or 4 ft. wide is

plenty big enough. In fact, some people say that for two light horses, or deep work, nine tines are enough ; but it is better to get the bigger implement, as it is quite easy to remove two tines if for some jobs the draught is too heavy.

There are also spring-tined harrows with second auxiliary springs, or helpers, as they are called, fitted to the tines. These double-spring harrows are a few shillings dearer, but well worth the extra cost.

Another thing which makes the spring-tined harrow an acceptable implement for the small man is its comparative cheapness. A harrow of the size indicated above can be obtained for about £2 10s. or £3.

When we come to discuss the cultivation of other crops we shall see how essential a spring-tined harrow is for the economical tilling of the land.

CHAPTER III

THE SOWING AND MANURING OF TARES; OTHER USEFUL IMPLEMENTS

It is now proposed to describe the seeding and manuring of tares, which form the first break in the suggested rotation.

The quantity and proportions of vetch and cereal seed sown for a tare crop must be varied according to circumstances. According to the land and climatic conditions, the "brairding" or planting capacity of both types of seed varies. Generally speaking, the milder the climate and the lighter the soil, the greater the "brairding" capacity of the crops.

The right proportion of seed can only be determined by each farmer by experiment and observation. The mistake commonly made is to *sow too much vetch and too little cereal*, and as a result the former crowds out the latter. Again, when the vetches predominate, they lodge and become rotten at the bottom, making it difficult to cut and save the crop.

A USEFUL TARE MIXTURE

This error has been made so frequently in South English counties, where the intention has been to grow the tares for hay, that a farming axiom is heard which refers to the impossibility of a man making more than one good tare hay crop in his life,

A good tare mixture for soiling for average land and medium climate is :—

4 st. of 14 lb. of winter wheat or winter barley	} Per statute acre.
4 st. of 14 lb. of winter oats	
5 to 6 st. of 14 lb. of winter tares	

This is sown in autumn, and in the following spring the portion of the tare crop which it is intended first to graze, then mow, then graze or mow a second time, it is necessary, after the first grazing, to sow an additional bushel of Italian or Western Wolths rye grass.

It is very important in sowing tares to get an even distribution of the seed. The method usually followed to obtain this object is to weigh out sufficient for a statute acre, mark out the acre and sow. This is easily accomplished when dealing with a rectangular field, but in case of a field irregular in shape the striping out into acres is not easily accomplished.

Here is a simpler plan :

Divide the number of square yards in an acre by the width to be sown and then divide the quotient obtained by some convenient part of the quantity of seed to be sown to an acre. For instance, suppose we wish to sow 16 st. of 14 lb. to a statute acre. To find the linear distance on which to sow, say, a stone, we divide 4840 (number of square yards in an acre) by 2 (width to be sown), and divide the quotient by 16.

Example: $4840 \div 2 = 2420 \div 16 = 151$ yards = distance to sow 1 st. 2 yards wide, at a time.

A corn drill, as a general rule, is fitted with an attachment to regulate the sowing of various seeds. This attachment is not often reliable, however, especially when the machine has become a little worn. Further, this attachment has been made, and the

indicator fitted, for the sowing of only one variety of seed at a time, such as wheat and barley. With a mixture of seeds it is, therefore, necessary to calculate the quantity of seed in the above manner.

This table will be found useful in this connection :

SEED SOWING TABLE

Quantity in seed per st. acre	Width sown in yds.	Quantity of seed to sow	Linear yds.
14 st. of 14 lb.	2	14 lb. on	172
" "	3	"	116
15 st. "	2	"	161
" "	3	"	107
16 st. "	2	"	151
" "	3	"	101
17 st. "	2	"	142
" "	3	"	95
18 st. "	2	"	134
" "	3	"	89
19 st. "	2	"	127
" "	3	"	85
20 st. "	2	"	121
" "	3	"	81
3 lb.	2	4 oz. on	201
" "	3	"	134
4 lb.	2	"	151
" "	3	"	101
5 lb.	2	"	121
" "	3	"	81
6 lb.	2	"	100
" "	3	"	67
7 lb.	2	"	86
" "	3	"	58

When broadcasting, either by hand or with the seed fiddle, a convenient width to sow is 3 yards. With this latter method a more even distribution is obtained by allowing each sowing to overlap the previous one.

It should also be borne in mind that slightly more seed—from 2 st. to 3 st.—is required when broadcasting than when the crop is sown with a corn drill.

THE MANURING OF TARES

As to the manuring of the crop, for either fodder or forage crops, especially when winter-sown, there is nothing better than farmyard manure; but at the time of the year when the tare crop is sown as a rule the supply of manure on an average farm is at its minimum. When farmyard manure is available it should be spread and ploughed in at the rate of from 15 to 20 tons per statute acre.

Fortunately very satisfactory tare crops can be grown with artificials, and of these a complete mixture is generally the best for the purpose. By a complete mixture is meant one containing the three dominant ingredients of plant food—nitrogen, potash, and phosphate. A suitable general mixture would be :—

- 2 cwt. to 3 cwt. of superphosphate or basic slag,
- 2 cwt. to 3 cwt. of kainit,
- 1 cwt. to $1\frac{1}{2}$ cwt. of sulphate of ammonia or nitrate of soda per statute acre.

On the general question of artificial manures, it may be here stated that at the outset, until we get the system of continuous cropping well established on our smallholding, we shall have to use artificials very liberally. This is due to the fact that at present the ratio of animals to acres is very low, being, in fact, about the equivalent of one full-grown beast to every 3 or 4 acres.

Later, when we have our holding up to the equivalent of the cow per acre stage, we shall require very little artificial fertiliser indeed.

After the first crop of tares used for soiling we proceed to grow a second crop of tares for hay or, in a wet season, ensilage. This will be sown on the soiling

tare stubble, usually in early October or at the latter end of October or early in November in southern districts.

The cultivation of the land will in all essential details be the same as for the preceding crop. That is, the tare stubble will be ploughed, the seed sown and covered in with the spring-tooth harrow, or, if a seed drill is used, the land will be harrowed down to a fine seed-bed, and the seed sown with a corn drill.

THE DISC HARROW AND TRIPLE CULTIVATOR

Where a good disc harrow and a triple cultivator are available there is no need to plough for the second crop of tares, except in the case of very stiff land. With these two implements all the cultivation necessary for a statute acre of this crop can be done with a three-horse team or a small agricultural motor in about four to six hours.

“TIPS” IN CULTIVATION

As a general rule the triple cultivator should be put on the land first, and then followed in the same direction with the disc harrow. Next work the two implements in the opposite direction, so as to cross-cut, rolling first, if the land is dry enough. Then follow again with the disc harrow, giving this time an overlap or double stroke of the disc. This means that the second discing should be done in “setts,” the operator travelling round and round as in ploughing, so that the right-hand set of discs runs over the land cut by the left-hand set of discs in the preceding stroke.

Sometimes it is better to disc harrow the tare stubble before putting on the triple cultivator. It all depends on the condition of the land. If the soil is fairly dry the cultivator should precede the disc, so as to break the top crust and allow the disc to enter the soil. If the land contains a certain amount of moisture, in condition

known to farmers as "between wet and dry," the disc harrow should precede the cultivator. Sometimes after cultivating a piece of land it is necessary to allow the land to dry a little before it is fit for discing. On the other hand, if the land is dry, one implement should immediately follow the other, so as to retain the moisture. It is all a matter of judgment, and to obtain the maximum amount of good for the minimum use of these implements is a matter of skill for each individual farmer.

One great advantage resulting from the use of quick-working implements like the foregoing is the conservation of soil moisture. This makes itself very apparent especially after a dry autumn or summer. If a farmer commences the tilling with the plough and harrow of, say, 4 acres of land, the operation would take him about eight days. Now suppose during dry-weather conditions he ploughs the whole 4 acres first, then by the time the ploughing of the last acre is accomplished, the first acre is baked quite hard, and needs a tremendous amount of extra labour to produce a fine tilth. Then by the time the tillage of No. 1 acre is completed, No. 4 is baked. On the other hand, by tilling with the disc and triple cultivator, all the work can be completed in sixteen hours, or, say, two days.

Again, under dry conditions the triple cultivator is passed over the whole 4 acres first. This just breaks the top crust sufficiently to form a soil mulch, which acts like a blanket, and prevents excessive loss of moisture. Having made a mulch over the whole 4 acres, then the complete cultivation and sowing of each individual acre should be proceeded with. On the other hand, if the soil is moist when its cultivation is undertaken, it would be better to till the whole 4 acres simultaneously, so that there would be an interval for drying between each cultural operation.

Of course the above remarks are primarily intended for the man who is continuous-cropping on a fairly extensive scale. On a twenty-acre holding the cultivation and sowing will *always* be done on small areas of about an acre at a time. Still, in these circumstances the conservation of soil moisture and judgment in the tilling of the land are all-important.

CO-OPERATION AND MANURING AND SEEDING THE TARE HAY CROP

To talk of using such implements as the disc harrow, triple cultivator, and motor tractor on a small farm may appear to some people ridiculous, but there are many examples of expensive machinery being used on small farms in these countries where co-operative methods have been adopted.

As to the manuring of the tare hay crop, the intention is to consume the preceding soiling crop on the land or, if any portion of the crop is house fed, to cart the manure resulting from its consumption back on the land. Wherever this system is followed no further manure will be required for the tare hay crop. If it is not possible to manure the land in this manner, then the same system of manuring should be followed as has already been recommended for the growing of tares for soiling.

Where tares are intended to be cut for hay, it is generally advisable slightly to reduce the amount of vetch seed and increase the other seeds say:—

5 st. of 14 lb. of vetch	
4 to 5 st. of 14 lb. of winter oats	Per
4 to 5 st. of 14 lb. of wheat or winter	statute
beardless barley	acre.

Rye should be substituted for barley in northern districts and on heavy land.

CHAPTER IV

THE A TO Z OF HAYSAVING AND HAYMAKING

SOWN at the times stated the tare hay crop should be ready for cutting in early June. A certain amount of judgment is required as to the exact stage of growth that should be reached before cutting. If it is cut too early the vetch wilts and falls into dust. If it is cut too late it becomes fibrous, and the stock will not readily eat it.

The right time to cut is when the vetch seed are just forming in the pods at the top of the stem. When the top vetch pods have reached this stage the bottom ones will be fairly well formed ; and the grain in the ears of the barley, oats, or wheat will be in the milky stage. If this stage of ripeness has not been quite reached, the crop is bulky and fine weather obtains, then it is better to take advantage of the latter and proceed with the haying.

The psychological point in connection with a vetch hay crop is the saving or harvesting of the crop. It is doubtful whether there is any farm operation about which so little is understood by both practical and scientific men as the saving of a hay crop. Practically all text-books are absolutely silent on the subject, and whilst there are many practical farmers who understand the saving of hay, they do not understand the underlying principle, but work on judgment based on long years of experience. Any attempt to obtain technical information from such men on the subject is rarely successful.

All they know is that they make good hay—they just have the knack of doing it, just as, long before dairy bacteriology was thought of, there were many farmers' wives who had the knack of making good butter, or cheese, without knowing exactly how they did it.

As a general rule, there is more bad hay made annually than good. Even where the best of hay is made, in ninety-five out of one hundred cases far too much labour is spent on the work.

THE WRONG WAY

Haymaking to-day is, or at least should be, quite a different thing from what it was twenty years ago. Machinery and the advancement of science make the difference. Yet I have watched neighbouring farmers in County Meath and other grass countries where hay is the only crop harvested, and where one would naturally expect the most up-to-date method to obtain, but instead the method followed is practically the same as when Young made his famous tour through Ireland over 150 years ago.

First the crop is mown, and then allowed to lie in the swathe for four or five days in fine weather and maybe two or three weeks if the weather is broken. Then, be it soon or late, when the top layer of the swathe is nicely dried, and assuming that the sun is shining, or there is a good drying wind, the swathes are tossed about—on a small scale by hand and on a large scale by a hay-kicker.

This tossing is done two or three times, the idea being to get the stuff absolutely dry. Next it is put into small lap cocks, as they are called. These lap cocks are simply bundles of half-dried grass, roughly thrown together. Were they made neat and topped off, so as to throw off the rain, they would be of some utility, but made as they are they are worse than useless.

If at this stage it rains, the lap cocks are soaked through, and on the approach of dry weather are again spread out (of course by hand) and when they are dry are thrown together again. If the farmer is lucky from a weather standpoint, the lap cocks are next swept together and put into larger cocks or wynds, roughly pyramidical in shape, and containing from 5 to 10 cwt.

In this stage they are allowed to stand generally for a month or two, when they are finally carted home.

A more troublesome method of haysaving could not be devised. Now, all this trouble is gone to with the sole object of preventing the hay from heating in the stack.

As the best farmers, both scientific and practical, know, a certain amount of heating is necessary for the making of good hay. It is when one comes to ask for specific information as to the right amount of heat that one meets the "stone wall." The "water jump" is reached when information is sought as to how to prevent overheating, or how to induce heat. A considerable amount of space has been spent on this matter, but it is all important with regard to the saving of ordinary hay, and particularly the saving of tare hay.

The writer has received a good deal of credit for having realised the economic value of tare hay. In this connection little credit is due. It has long been known that such fodder is highly nutritious. The trouble of saving the crop was the main reason why it was not previously grown on a larger scale. This trouble was due to (1) the sowing of unsuitable tare mixtures for haymaking purposes, and (2) the non-recognition of the utility of modern machinery for the purpose. Perhaps the lack of more precise knowledge of the principles underlying haymaking also played a part in the neglect.

AND THE RIGHT WAY

Instead of leaving the crop to lie in the swathe several days after cutting, the swathe turner should be brought into use and kept in use shortly after the crop is cut. Given bright sunshine or a fair breeze, the plan followed is to save the vetch crop in sections. Thus, about 4 to 6 acres, or so much as a swathe turner can turn over in about three hours' time, comprise a section.

MORE USEFUL IMPLEMENTS

As soon after cutting as the dew has dried off the top of the swathe, the swathe turner commences operations. The swathes are turned towards the sun, or, if there be any wind, in the direction the wind is blowing. By the time the last swathe of the section has been turned the first portion will have dried considerably, and we start to turn the whole thing again.

As a general rule, in good weather, we give the crop three turnings in the first day and two more in the early part of the second day, in the afternoon of which the crop is gathered in. This gathering-in consists of throwing the swathes together with the swathe turner and forming windrows. Next a slide rake is used to run the windrows into heaps, and from the heaps so gathered, pikes, cocks, or wynds, as they are variously called, are made.

These are pyramid shape and vary in weight from 10 to 15 cwt. They are topped off and raked down so as to turn the rain. In these pikes the hay is allowed to remain for a week or fortnight, and sometimes much longer, if to get them carted doesn't fit in with the general work. Once in the pikes we feel fairly safe. In these pikes the stuff, of course, heats, but if there is no moisture in the stuff when they are made, no harm, but in fact good, results from the heating.

It is at the gathering-in stage and at the first carting and stacking that great judgment is required. This judgment is a matter of experience, but as a guide as to when the gathering-in stage has been reached, a fairly reliable test is as follows: Take a straw-band twister, and, with the help of an assistant, twist a piece of the stuff into a *very* tight rope band. If juice or moisture sufficient to damp the hand holding the rope cannot be squeezed out of the stuff by this plan it is fit to gather in.

To revert to the actual haymaking. Up to this point we have gone along by saving hay on paper (a very easy thing to do), and by assuming good weather conditions, but the general lesson to be learned from the foregoing is that we have let the very ancient axiom "Make hay whilst the sun shines" go by the board.

AIR-DRYING HAY

To-day, with that marvellous invention the swathe turner, we make hay whether the sun shines or not, realising that the constant turning to and fro will dry the hay in a manner which can only be appreciated to its full value when tried. Even in the absence of both wind and sun constant turning will dry a crop.

It should not be imagined, though, that an old hay kicker or tedder can be used for this constant turning work, especially for a tare crop. Those old tools batter the crop, knock out the seed, break the fibre, and if after tedding it should rain, the stuff gets as wet as wet rags. The swathe turner preserves the swathes intact so that they can turn a considerable amount of rain.

In buying a swathe turner, the small farmer should certainly buy a combined implement, that is a machine which can be used as a swathe turner, a side tedder, and a side delivery rake—three implements in

one, at a cost of not much more than an ordinary swathe turner or horse rake.

Sometimes, if the weather is exceptionally good and other work permits, we make a short circuit and cart the stuff direct from the windrow into the stack, gathering it into heaps with the little hay slide—a most admirable little tool costing only about 40s.

Again, it may happen that just before we reach the gathering-in stage the weather may show signs of rain. In these circumstances smaller pikes of about 1 cwt. or so are made, topped, and raked off so as to turn rain.

Then, assume rain does fall. Later, when the outside has dried off and the ground has dried, the bottoms of these pikes or quills are exposed to sun and wind. This is done with the hand forks. Later, these are run together, again with the slide rake, into the larger cocks previously mentioned.

Suppose, after getting a considerable amount cut, continuous wet weather follows. Well, for the first few days no great harm will result, as, when in the undisturbed swathe, hay can stand a considerable amount of rain. Later, however, especially in catchy weather—the sort described by the Kerryman as “raining with showers in between”—the underside of the swathe begins to ferment, and, later, turns mouldy.

Now, every farmer must have observed that a dairymaid always hangs up her utensils in the fresh air, to keep them sweet. Fresh air is a great sweetener, preventing the growth of the micro-organisms which cause ferments.

So, taking a tip from the dairymaid, the right thing to do with a fermenting hay crop is to expose it to the fresh air, no matter what the weather is like, unless it is actually raining.

This I have done successfully in very damp weather—in between the showers—and, of course, a quick-

working implement like a swathe turner makes it possible.

As to the matter of carting and stacking, there is this point to remember: One object of making the big pikes of hay is to enable a man to use a hay bogie, as it is called. This implement is a low cart mounted on two wheels and fitted at the front with a winding barrel and racket.

Attached to the barrel are two ropes, which are passed round the pikes, and are coupled at the back of the pikes. This done, the platform of the bogie tips up, and, by working the racket, the entire pike is hauled on to the bogie. When the pike reaches a point a little past the axle the platform drops back into its place and is carted to the hay shed or stack.

This, of course, means very quick work, since it saves the trouble of pulling the pike to pieces and lifting it by hand on to a cart or wagon.

These hay bogies are common enough in Scotland and Ireland, but practically unknown in England, except in the remote north.

Apart from their utility in carting in the corn or hay, they are very useful things on a continuous-cropping farm. Creel sides can be fitted and the bogies used for carting fodder crops to cattle when these are fed in a house or out on pasture. They are, however, unfit for taking live pigs and sheep to market.

They can be used for practically all kinds of carting work about the farm, but in winter time it is necessary to get an extra pair of wheels, 3 feet in diameter, as the small ones used in summer skid and make the draught heavy on wet land.

The bogies as a whole are light, the wheels are about 6 inches wide, and hence, fodder-crop carting in wet weather can be undertaken without cutting up the

land. The price is within the reach of the smallholder, being about £7. The extra wheels are £3 more. The creel sides can be made at home.

SOME HINTS ABOUT STACKING

Now, as to the matter of stacking. It is an advantage for hay of any kind to heat a little in the stack, "sweating," as it is called. True, if the heating is too great the stuff becomes mow burnt, or may even take fire. But there is a good deal less risk of the latter contingency than is generally supposed. Some farmers on the appearance of a little heat, get into a panic, and begin doing the very thing they shouldn't do, pulling the stack to pieces.

Now, the heating of a stack is primarily caused through the action of small organisms, or bacteria, as they are called, and possibly also by the live cell tissue of the hay itself. At all events, heating from this cause takes place up to a certain point; after that, the organisms are killed by the heat, and further heating results from the chemical combinations or substances in the hay and the oxygen of the air.

It should also be noted that these bacteria require a certain amount of moisture present in order to work or bring about heating. Forearmed with the above knowledge, we can control the amount of heat in a stack. Many farmers who follow the practice of hay sweating know from long experience how much heat is desirable. Their method is largely guesswork, and wherever in farmwork we can dispense with guesswork the better.

Thermometers are cheap enough and should always be used in stack building. If in building a stack, put a long iron pipe in the centre and build round it, the thermometer can be placed into this, and by the assistance of a bit of graduated cord the heat at any part of

the stack can be determined. A good maximum temperature to get the stack to is 120 deg. F., which means that if a piece of iron be thrust into the stack and left there about ten minutes, the iron on being withdrawn is so hot that it cannot be borne in the hand.

Slight heating will, of course, take place in the pikes, and when this is on the decline (judged by the use of an iron bar), I commence to cart. If heating in a pike takes place due to moisture, that is damp heating, the pikes should be spread out, dried a little more and re-made before stacking, otherwise they won't fire but turn mouldy. Re-heating also takes place in the stack—very slowly at first, and rapidly later. The following are the chief points to be remembered in connection therewith. First, the slower the stack is built the greater the heat will become.

The reason for this is that the stuff is loose and a great amount of air is present.

Well tramping the stack also minimises the after-heating. Hence, with very dry hay slow carting seems to be indicated. In practice, though, one likes to put a bit of a hustle into hay carting, so that, except in the case of the small farmer, master of his own time and work, slow stack building does not appear to be very feasible.

When slow stack building is necessary the best way of carrying it out is to build two stacks at the same time, working alternate days on each. Where this is not possible, and the hay has got so dry that the after-heating cannot be very great, I often cut a load of green stuff, just letting the outside moisture dry off, and put a bit of this in the stack whilst building—about 1 cwt. to every load of hay.

Now, the ideal way of stacking vetch hay is to bring in the stuff dry, but slightly green, and stack it. That is, as the farmer puts it, "let it heat from its own

moisture." There is, however, danger of overheating on this system unless precautions are taken, and the necessary precautions are to sprinkle salt through the fairly green stuff when stacking. I use about 14 lb. of common agricultural salt to every ton of stuff, sprinkling the salt every time a fresh load is put on the stack.

Salt is an antiseptic, and therefore prevents the bacteria from working too rapidly and the temperature rising too high. I might mention that whilst a useful temperature to obtain in the stack is 120 deg. F. there is no danger if the heat rises to 140 when salt has been used, although if preventable the stack should not pass 120 deg. F.

If, however, during the process of hay-stacking the heat shows a tendency to rise past 120 deg. F., the ordinary farmer begins to get alarmed, and to pull the stack to pieces and rebuild. This is a very wrong thing to do, as it means allowing more air to enter the stack, and will later cause greater heat.

The right thing to do is to ram on more stuff at once, which has the effect of crushing out the air, and thus preventing the temperature from rising. In addition, salt should, of course, be used perhaps a little more liberally than one stone to the ton.

When a stack is completed, and suppose the temperature reaches, say, 140 deg. F. (which should not happen if judgment and salt are used in the making of the stack), it is, of course, impossible to lower the temperature by putting on more stuff. The best thing to do then is to make a strong brine of salt and water, using as much salt as the water will dissolve, and pouring the brine along the centre ridge of the stack.

Made in the way indicated, carted slightly green, with salt used in the stacking, vetch hay makes excellent feeding. It comes out of the stack with a

greenish tinge and with the most beautiful smell. The salt also makes the fodder very appetising to cattle.

To give some idea of the feeding value of such food, I append two analyses, No. 1 being made by the Irish Department of Agriculture, and No. 2 by Professor Crowther of the University of Leeds.

	No. 1.	No. 2.
Albuminoids ..	13·38	9·27 per cent.
Oil	1·58	2·12 „
Carbohydrates	42·11	40·4 „
Fibre	23·15	30·0 „

It may also be mentioned here that No. 2 sample was made from tares farther advanced in ripeness than No. 1.

CHAPTER V

THE WIBBERLEY WAY OF MAKING ENSILAGE

THERE is still the matter of ensilage made from tares which must be dealt with. Continuous rain soon spoils a heavy crop of tares, but continuous rain need not hinder continuous cropping. The system is practically weather-proof, and in our erratic climate any system of tillage that isn't, isn't worth a thought.

There are two chief systems of silage-making at present, the silo and the stack system. The type of silo which is most useful is the American stave silo. As this system is altogether too costly for the small farmer, however, and, in the writer's opinion, only really needed in exceptional circumstances by the larger farmer, the matter is not here dealt with. On the other hand, stack silage is a practical proposition for a large or small farmer, so that this system is fully dealt with.

Hitherto it was thought very necessary in making a stack of ensilage to fix up a most elaborate apparatus for compressing the stack. There was an arrangement of ropes, winches, and struts, by means of which pressure was applied. Such apparatus on the plan followed by the writer is not in the least needed.

Before describing the new system, it may be necessary to explain that there are two kinds of ensilage, sweet ensilage and sour ensilage. A more descriptive name for the latter variety is muck, for whilst undoubtedly it has a feeding value, the smell is

horrible. Dairy cows cannot be fed on it without their milk being tainted. Even without the cows actually eating the stuff, if sour silage is brought anywhere in the neighbourhood of milk, the milk is tainted.

SOUR SILAGE

The sour silage is made by keeping the temperature low, so that fermentation is slow and very complete. Now just as in the method of hay-stacking described in the preceding pages, the temperature can be controlled by excluding air.

In the making of sour silage, the greenstuff is put together very quickly, and as soon as the stack is built, or the silo pit is full, weight is immediately applied to it. In making sweet silage, the stack-making or silo-filling is done slowly; generally, carting is done on alternate days. This admits a large amount of air, and causes the temperature to rise.

It is generally stated that sour silage is made at a temperature not exceeding 120 deg. F., and sweet silage at from 140 to 160 deg. F. It is also stated that if the temperature passes 140 deg., the silage is brown, and if the temperature becomes higher than 160 deg., the stuff is burnt. All this may be true when silage is made in the ordinary way, but on the system here described it is different. The writer has frequently brought the temperature of silage up to 160 and even 175 deg. without either browning or burning. The essential differences between the two methods are:

1. Under the ordinary system, the stuff is carted wet and green.

2. The temperature is regulated by increasing or decreasing the speed of putting the stuff together.

Under the plan followed by the writer the stuff is partly dried, and the temperature regulated partly by the rate of stacking; but more so by the use of salt.

When the tares or grass are partially dried, say, just at the stage when in ordinary haymaking a farmer would begin to turn over the swathes, carting commences. The silage stack is built in the field where the stuff is grown to minimise the labour of carting at a busy time of the year. The stack is circular, so as to minimise waste on the outer edges.

First, a layer of rubbish is placed on the ground to form a bottom. Then carting proper commences. As the stack is being built, an allowance of salt—1 stone to the ton—is scattered over the stuff.

The stack is built together at the rate of about 20 to 30 tons per day. If the gang is sufficiently large to bring more than this quantity in a day, then a second stack should be built simultaneously.

Of course, the first half-dozen loads are dumped in the centre. After that the stuff is lifted on to the stack by hand in the case of the small farmer, and with the assistance of a horse-fork or elevator where ensilage is being made on a big scale. It may here be mentioned that these latter implements have made stack silage possible where before, when it had all to be done by hand, the labour was both slow and heavy.

If, during the process of building, the temperature reaches about 140 deg., the rate of carting is increased. Generally speaking, when salt is used in the manner indicated, no great rise of temperature takes place until the stack is completed. More often it will be found necessary, in order to start the heat, to bring a load or two of fresh greenstuff and spread it through the partially dried stuff.

When the stack is nearing completion and there is any danger of the heat passing, say, 160 deg. F., a barrel of brine may be used in the manner referred to in connection with haymaking.

The stack is finished off about 4 feet higher in the

centre than on the outside. In a few days' time it will have sunk nearly level ; then a layer of rubbish is placed on top and a trench dug all around the base of the stack.

If this stack is built on a piece of grass land the sods are cut all around the verge of the stack, and placed grass side down to act as a coping. The rest of the soil from the trench is placed on the top of the stack to the depth of about 9 inches or 12 inches. As the stack settles down, cracks will appear in this layer of soil ; These are closed up with a hand rake, the back of a spade being used to smooth off.

Once the stack is finished, it does not seem to matter, as far as my experience goes, to what temperature the stack rises. The highest stack temperature recorded by the writer is 175 deg. F. This temperature occurred in a small stack which was purposely allowed to attain this heat, no attempt whatever being made to lower the temperature. The stuff turned out beautifully. Anyway, if a man does not care to take the risk, the temperature is easily reduced by pouring one or two barrels of brine down the centre of the stack.

The chief advantage of letting the material for ensilage become partially dried is that the labour of carting and stacking is considerably reduced. With such a method, also, very little loss results at the outer edge, especially if, as should be done, the sides are well raked and handplucked whilst building, or the outer verge for a height of 2 or 3 yards trimmed off with a sharp hay-knife. As compared with other methods, little or no moisture exudes from the stack, either whilst building or after.

AN ECONOMICAL COVERING

There is a considerable amount of labour expended in covering the stack with soil, but economy in this direction is not difficult to effect. In the first place, as

regards the small farmer, the covering of the stack with soil can be dispensed with by simply building a hay-stack on top of the silage stack, placing a layer of rubbish between the ensilage and the hay.

Again, where stack silage is fairly intensively followed, and a sufficient quantity of hay may not be available for making these super-stacks, the lifting of the soil on top of the stack can be done with the assistance of the horse-fork, a wooden bok being hitched on to the rope and used to elevate the earth. Also the labour of hand-digging the soil can be dispensed with by running a horse-drawn cultivator or disc harrow several times around the stack to loosen the soil.

Silage made on this plan is sweet, nutritious, and, above all, is succulent, so that the big farmer at least, who is almost at his wits' ends to find a good substitute for roots, might well follow this system with a view to providing green, succulent food for winter use.

The possibility of being able to convert the tare crop into ensilage in the manner described serves us with another example of how continuous cropping fits in with adverse climatic conditions.

CONQUERING THE CLIMATE

In practice we make vetch ensilage when the weather is not good enough to make hay. More labour is required to make ensilage even in the new way than is required to convert the crop into hay, assuming good or even fair weather conditions to obtain. The very weather conditions, however, which compel us to undertake the extra labour of silage-making, make the tilling of the tare stubble for the winter-green crops to follow all the easier.

Rain in spring-time often hangs up tillage operations for a week at a time ; but rain in the months of June and July only facilitates tillage work.

CHAPTER VI

ALL ABOUT "WINTER GREENS"—CONSERVATION OF SOIL MOISTURE

As already indicated, "winter greens" follow the second tare crop. The term "winter greens" is used in a general sense, to indicate any kind of green crops—e.g. thousand-headed kale, marrow-stem kale, Labrador kale, giant rape, hardy green turnips, etc., for use during the winter months.

A great thing to be remembered in the growing of winter greens, especially in a dry summer, is the conservation of soil moisture. Reference has already been made to the necessity for quick cultivation to attain this object. As well as being quick, the tillage should be thorough, as the finer the particles of soil the more moisture the land will retain, and the more it is able to draw from the sub-soil by capillary attraction.

Again, close packing of the soil by heavy rolling assists capillary action, but it should be borne in mind that moisture dries off a perfectly smooth surface much more quickly than it does from a rough one.

A practical demonstration of this may be made by pouring equal quantities of water on two boards, one smooth-planed and the other left rough-sawn. It will be observed that the surface of the latter is damp long after that of the former is perfectly dry. Therefore, after rolling, especially in districts of low rainfall or light soils, the top surface of the land should be

roughened by harrowing. This forms what is known as a soil mulch, which acts like a blanket and prevents undue evaporation of water.

A very effective soil mulch can also be made by carting on the surface of the land well-broken farm-yard manure and spreading it about by harrowing instead of ploughing it in. The manure carting can be done as circumstances favour, either before the seed is sown, or after, or even when the seed has got into the rough leaf. In the latter case, however, harrowing is not possible, as the young plants will be torn out, and the manure must therefore be spread by hand.

Even when every precaution has been taken to conserve the soil moisture it will happen that at the time these winter-green crops are being sown during the months of June and July, the land may be very dry. There is little use in sowing winter-green crops under such conditions—a fact well known to most farmers.

What is generally done is to prepare the soil and, immediately there is any sign of rain, to commence to sow the seed. This, however, is a mistake, unless there is considerable rainfall. What should be done is, immediately it commences to rain, get on the already prepared land with the harrows and keep the surface soil stirred whilst the rain is falling, so as to work the moisture in. Of course, this can be overdone; but it will be understood that as soon as ever the land shows any signs of pastiness, the harrowing should cease, and the sowing be proceeded with.

As to the actual cultivation of the land, this can usually be done by the disc harrow and the triplex cultivator, without ploughing at all. Deep cultivation, say, more than 5 inches, for these crops is not essential.

CHEAP WINTER FOOD

The fact that the tilling of winter-green crops can be accomplished with quick-working tools is of the greatest practical and economic importance. Last year the writer ascertained that the cost of tilling and completely preparing a 9-acre field for a crop of winter greens was only 13s. 6d. per acre; horse and manual labour being charged at the rate of 3s. per day.

This means that the complete cultivation of the crop is no more than the singling and weeding of a root crop, which these winter greens are intended largely to replace.

A smallholder who, unfortunately, is not a member of a co-operative implement society must perforce use the ordinary plough and harrow for the cultivation of the winter-green crops. In this case, however, the same principle of quick cultivation must be followed in order to conserve the soil moisture.

It is advisable, under the latter circumstances, to harvest the preceding crop of tares, and cultivate the land in sections so as to have as short a time as possible between taking out one crop and putting in the next.

THE SOWING OF "WINTER GREENS"

We now come to the sowing of the winter greens, the cultivation for all the different varieties of which, after tares, is practically the same. First of all, before giving details of sowing and manuring, it is necessary to deal with the different characteristics of each crop.

MARROW-STEM KALE

Marrow-stem kale, a crop of recent introduction, is a hybrid between kohl-rabi and kale; but instead of growing like the former a bulb, it grows a thick fleshy

stem, surrounded with leaves similar to those of the kale plant. Both stems and leaves are very nutritious. There are two varieties of marrow-stem kale, the green and the purple leaf. If there is any difference, the former seems to be more vigorous in growth than the latter.

The outstanding feature of this crop is its drought-resisting properties. Hence preference should be given to it in districts with an annual rainfall of, say, less than 25 inches, or where the rainfall is even heavier, but the soil porous. At the same time it should be understood that in districts of *heavy* rainfall and heavy soil, marrow-stem kale grows most luxuriantly.

In its early stage, unlike hardy green turnips and giant rape, the growth of marrow-stem kale is not very vigorous, and hence it has not the same capacity for smothering weeds. Therefore it would appear to be more suited to grow in rows, to permit of horse hoeing, than for broadcasting. On this question, however, I shall have something to say later.

Marrow-stem kale is not as soon ready for consumption after sowing as giant rape. If both are sown, say, at the end of June, the rape is ready for cutting by the first of October, whereas the marrow-stem kale may not be ready until December, or even the following February. If, therefore, the crop is required for autumn or early winter consumption, it should be sown earlier than June. It can be sown as early as March, not, of course, after a tare crop, which would not be off the land in time, but as a main crop, in much the same way as ordinary cabbages. When sown, say, in March or April, the crop will be ready for use in late August or early September. It may then be either grazed or cut, and, if the land is rich or well manured, will give a second very useful crop in late March or early April.

OTHER KINDS OF KALE

Other kinds of kale useful for continuous cropping are the thousand-headed and that which gardeners know as Labrador kale. The latter is a very hardy variety of curly kale, which, on account of the rapid second and third growth it will make after being cut (assuming the land to be well manured), has become known in certain parts of Ireland as "Cut-and-come again cabbage."

These varieties of kale do not withstand the drought as well as marrow-stem kale, but they withstand frost better than any other variety of winter greens. They are also slower in growth, and hence are not as suitable for either early feeding or broadcasting as giant rape or hardy green turnips. They are better suited to clayey land than to light land.

Both may be sown in early spring for autumn and early winter feeding, and, as indicated, will give a second crop and even a third if the land is well manured. On this latter point it may be here remarked that all these so-called annual plants of the cruciferous or cabbage tribe are really biennial in habit—that is, will give a second and sometimes a third crop, provided a fair amount of the parent stem is allowed to remain in the ground at the time of the first grazing or mowing, and the land is well manured.

GIANT RAPE

With the possible exception of white mustard, giant rape is the quickest growing of all the cruciferous fodder crops. With well-tilled, well-manured land, in a moist summer the writer has often grown it 4 feet high in the space of twelve weeks, getting a yield of from thirty to

forty tons per statute acre. Growing so quickly, this crop, as well as hardy green turnips, completely smothers out every weed, except charlock, and leaves the land in a beautifully clean condition. Like the different types of kale mentioned above, it is more nutritious than either mangolds or turnips, whilst its manurial value is two and a half times greater than either mangolds or turnips. All kinds of stock are very fond of the crop.

When intended for autumn or early winter use giant rape should not be sown later than, say, the 15th of July, and if it can be got in by the 15th of June, assuming that the soil and weather conditions are favourable, all the better. As with most of these crops, the best results can only be obtained by liberal manuring. But once we have got our smallholding up to the "cow-to-the-acre" standard the supply of plenty of farmyard manure to these and other crops will present no difficulty. The crop requires a fair amount of moisture, and in districts of a rainfall of 30 inches and over, preference should be given to giant rape over other crops.

HARDY GREEN TURNIPS

Hardy green turnips when broadcasted have in their manner of growth all the appearance of a hybrid between white turnips and giant rape; that is, the crop grows a bulb like a turnip and will grow a top of dense foliage from 3 to 4 feet high, like rape. Like rape, too, when sown under suitable conditions, it is very quick growing and requires a fair amount of moisture. It will not stand frost or dry weather as well as rape or the different varieties of kale. On this question of moisture it may be remarked in passing that, once the plants are well established, there is not much danger of

their suffering from drought, unless in exceptionally dry years. Even in districts of low rainfall there is, in fact, generally in late autumn, winter and early spring more moisture than the average farmer wants.

WHITE MUSTARD, RYE AND RAPE

White mustard is an extremely rapid-growing cruciferous plant, though more useful for grazing with sheep than for feeding to other kinds of stock. It is also only of use for autumn consumption, because, having a hollow stem, even a mild frost completely kills it.

For late sowing a mixed crop of rye and rape is very useful. Sown by the end of July, under favourable conditions it will give a magnificent feeding in the following March. A useful mixture is about 8 or 9 stone (of 14 lb.) of rye per statute acre, and $2\frac{1}{2}$ to 3 lb. of giant rape. It is an advantage with this crop to sow the rye about ten days before the rape, in order to minimise the possibility of the quick-growing rape smothering the rye. Rye can also be sown alone, put in by September 1st to provide green feeding in the following April. When sown alone 16 stone of seed per statute acre is required.

MAIZE

In the South of England and in districts of low rainfall, especially where dairying is carried on and a good bulk of green feeding is required in late summer and autumn, a fair portion of the tare stubble could be sown with maize for green soil when the pastures fail. This crop could be put down in early June to provide autumn feeding, and by the latter season it will often reach the height of 6 to 7 feet. It requires to be very liberally manured. Unlike the preceding crops, it is not

suitable for broadcasting ; it should be sown in rows, the seed being dropped in every alternate furrow, as the land is being ploughed, at the rate of about two and a half bushels per acre. The White Horse Tooth variety is a very good one. It must be remembered, though, that maize does not do well in Ireland and Scotland, but does extremely well in the south and south-eastern counties of England.

CHAPTER VII

THE MANURING OF WINTER GREENS

THE dominant manurial ingredient for such quick-growing and dense foliage crops of winter greens as are necessary to the continuous-cropping system is nitrogen. This, whilst being the dearest fertilising element the farmer has to buy, is most plentifully supplied by nature if one troubles to get it.

Four-fifths of the atmosphere consist of nitrogen, and the farmer who carries on his occupation on scientific lines can obtain some of this nitrogen free for his soil.

Like most things easily obtained, however, atmospheric nitrogen is least valued. Instead of a farmer drawing on nature for a supply of free nitrogen, he prefers to buy it in the form of nitrate of soda or sulphate of ammonia, in which manures it exists to the extent of $15\frac{1}{2}$ and 20 per cent. respectively.

NITROGEN FIXERS

Now, there are certain farm plants, called legumes, which possess the extraordinary power of taking nitrogen from the air, utilising a certain amount for their own use, and storing up the balance in the soil for succeeding crops. To these legumes belong such crops as clover, beans, peas, and vetches.

A study of the standard rotation will show that in our five years' cropping we have the land occupied for four years with nitrogen fixers. That is, four

leguminous crops precede the winter-green crops, which stand so much in need of nitrogen.

This feature (there are plenty more to be dealt with later) is one of the most important of the continuous-cropping system.

Further, farmyard manure is very rich in nitrogen, and, since it will be a convenient time to apply at least a portion of our farmyard manure when sowing the winter greens, we shall after a time be able to get along without much nitrogenous, or, other kinds of artificial fertilisers.

This statement, however, requires a little qualification. Whilst our leguminous crops, by the time we come to sow the winter greens, will have stored up a large amount of nitrogen, this fertilising ingredient may not be immediately available for the plant in its very early stages.

An early and a rapid growth with winter greens is all important, and to ensure this it is generally very advisable to sow, either with or immediately after sowing winter-green seed, about $1\frac{1}{2}$ cwt. of nitrate of soda per acre, especially on light soils or in dry weather.

As to the application of farmyard manure, this must be varied according to circumstances. Generally speaking, the wisest course to follow is to get on with the tillage of the land and the sowing of the crop as quickly as possible after the tares are removed, to conserve as far as possible soil moisture. Then when the crop has got into the rough leaf, the manure may be carted on and spread at leisure.

This spreading of manure on the surface on light land and in dry districts is a great help in conserving soil moisture.

Another advantage of spreading manure after, instead of before, tilling the land is that by the former method the quick-working disc harrow and cultivator

can be used, whereas it is difficult to operate these implements after farmyard manure has been freshly spread.

On heavy land it may be an advantage to cart and plough in farmyard manure, so as to leave the soil light, but by the time we have got into stride with our rotation there will be plenty of humus in the soil to effect this object.

There does exist amongst farmers an idea that the "sun draws the virtue out of manure" if the latter is allowed to lie on the surface, an idea which contains as much truth as another axiom, now nearly obsolete, that good butter could only be obtained by churning at a certain phase of the moon.

Most farmers in commencing continuous cropping will probably wish to introduce a winter-green crop in place of roots on land under corn last year which may or may not have been growing a crop of vetches during the winter for soiling in spring and early summer.

MANURING VETCH STUBBLE

If such an oat stubble has been uncropped during the winter farmyard manure should be applied at the rate of from 20 to 25 tons per statute acre, together with from 1 to 2 cwt. of nitrate of soda when the seed is sown. The same manuring may be followed if a winter tare crop has been cut for hay, or if the crop has been cut and carted off the land. If, however, the plan of consuming the fodder crop on the land has been followed, then a less quantity of dung, say, about half, would suffice, and the same amount of artificials.

In case dung is not available for the crop (although every attempt should be made to provide a certain amount), about 4 cwt. superphosphate or, on land

subject to finger-and-toe or deficient in lime, 5 cwt. of a good grade basic slag should be used along with at least 2 cwt. nitrate of soda per statute acre.

Slag or superphosphate when used, especially the former, should if possible be applied some time before sowing the seed, so that it may become soluble or available for the crop in its early stages.

CHAPTER VIII

THE SOWING OF WINTER GREENS

THE broadcasted quantities of seed required for the various types of winter greens are as follows :

Marrow-stem, thousand-headed and other forms of Kale.—5 to 6 lb. per st. acre.

Giant Rape.—4 to 5 lb. per st. acre.

Hardy Green Turnips.—4 to 5 lb. per st. acre.

White Mustard.—14 to 16 lb. per st. acre.

Giant Essex Rye and Rape mixed.—8 to 9 stone rye, 2 to 3 lb. rape per st. acre.

Giant Essex Rye alone.—16 stones per st. acre.

The greatest care is necessary in putting in the seed to ensure an even distribution. The quantities stated, too, should not be exceeded. *The thick seeding of these crops results in a weak, sickly growth*, which at the first may look quite healthy, but, later, turns from a green to a purplish colour, and is easily killed by draught or a mild frost.

It is better to err on the thin side. These crops all make a very rapid growth, and in about a week's time after sowing, if the braird is not thick enough, one can always go and scatter a few pounds more seed.

On this matter of seeding, the writer has often been asked the question, "If the land is not well tilled, would it not be better to put on a little more seed?" The answer is a very emphatic "No." With winter greens, as with all other kinds of farm crops, the man

who cannot see his way to make a good seed-bed before sowing, had better look out for some occupation requiring less skill than does farming.

Once a good tilth has been secured, the seed may be broadcasted with the handy little implement, the Cahoon seed sower, or seed fiddle, previously referred to. This seeder, however, is apt to throw out more seed to one side than the other. This can be avoided if the direction of the wheel which broadcasts the seed, is reversed at every "bout" up and down the field. In going down the field, the operator will turn the wheel from him, and towards him on the return stroke. By this means a very uniform seeding is obtained.

THE MATTER OF MOISTURE AGAIN

Once more it is necessary to emphasise how essential moisture is for the growing of winter greens, especially in the early stage. Presuming that all the precautions referred to have been taken, there are very few places in this country where a sufficient quantity of moisture cannot be obtained in the months of June and July, when the crops are sown. Even in a country like Essex, which has one of the lowest rainfalls, there are generally 2 inches of rainfall in each of these months.

If, however, after all the precautions, a seed-bed is dry, then the farmer had better wait for rain before sowing. A crop sown on July 1st under damp soil conditions will be further advanced by the month of October, than one sown a month earlier when the soil is dry. Further, a rapid growth is essential for the smothering of weeds, and one of the features of these crops is that, when properly grown, the laborious processes of thinning, weeding, hand and horse hoeing, are dispensed with. This means, of course, reducing the cost of producing the crop by at least one half.

Now we come to the great question: To drill or to

broadcast ? The writer has conducted many experiments to find out which is the better, and after about ten years' experience, certainly thinks that broadcasting is the better way. In the first place the labour is less, and secondly, although a crop sown in rows may seem to be heavier in yield than one broadcasted, this is not really so. That can be proved if the drilled and broadcasted crops are weighed and the difference taken.

Again, a broadcasted crop properly grown may seem to be a little dirtier than a drilled crop in its earlier stages ; but eventually the land is cleaner from broadcasting than from drilling. The statement may sound exaggerated, but, nevertheless, once a continuous-cropping rotation has been properly established, weeding may be dispensed with.

WHEN IT PAYS TO DRILL

In the case, however, of a farmer who has commenced the growth of winter greens, where there has been an idle interim between the growth of winter greens and the previous crop, it may be better for the first year to grow the crop in rows. Under these circumstances, the seed may be sown with an ordinary corn drill, or turnip sower ; but a far better way is to broadcast the crop, and, if the weeds seem to be getting ahead of the crop, a cultivator can be run through the young braird, thus leaving the crop in rows.

By this method of sowing, the farmer has two strings to his bow. If the crop grows well at the beginning, there will be no necessity for putting it into rows. When grown in rows, these need only be about 16-20 inches apart. Growing in rows is also necessary when the system of inter-cropping of continuous

crops is followed. That is, each crop is sown whilst the preceding crop is on the land. This is, however, of more importance for the large farmer, and is fully dealt with elsewhere.*

A close study of the rotation previously referred to, will show that the land is practically never idle. Immediately one crop is out, another is put in, and, under these conditions, drilling or growing in rows is not at all necessary for the cleaning of the land. It should be understood that even when the crop is grown in drills or rows singling out is not at all necessary. In fact, with such a crop as marrow-stem kale it is a decided disadvantage to thin the plants, as the stems grow too thick, either for easy cutting or for stock consumption. Especially is this the case where the crop has to be consumed by sheep.

COVERING IN THE SEED

The seed of all winter-green crops, except rye, should only be lightly covered with soil. The best plan of covering in is, when the necessary good tilth has been obtained, to give one run up and down the field with the spring-tooth harrow, working 2 or 3 inches deep. This will leave shallow furrows about 7 inches apart, into which a lot of the seed will roll.

Next, broadcast the seed and roll the land in the opposite direction to that in which the spring-tooth harrow was worked. Another run with the spring-tooth harrow set so as just to roughen the surface, and following in the same direction as the roller, will complete the covering in.

This final harrowing leaves a roughened surface, and reduces the evaporation of soil moisture.

Everybody has noticed how on light land and in dry

* See footnote, page 17.

weather the ordinary turnips always "strike" first near the head lands, where the land is firm. On such land it is, therefore, a good plan to roll the land, both *before* the spring-tooth harrowing and the putting in of the seeds, as well as after these two operations.

In the case of rye sown alone or in conjunction with rape, the rye can either be put in with the corn drill or broadcasted, and well harrowed in with the spring-tooth harrow. As before, the latter implement should be used both before and after broadcasting.

The second harrowing when rye is being sown will, of course, be much deeper than when such small seed as rape and kale are being put in. When rye and rape are to be grown together, there should be an interval of about ten days between the sowings, so that the latter will not smother the former.

Reference has already been made to the necessity of each farmer varying the kinds, and the area sown of the different types of winter greens, according to his soil, climate and rainfall. My own general plan is as follows :

All land ready for seeding by :

June 15th, sown with marrow-stem or other kale.

July 1st, sown with giant rape.

July 15th, sown with hardy green turnips.

August 1st, sown with rye and rape mixed.

August 15th, sown with rye alone.

This, in practice, means that whatever portion of the vetch crop may be soiled or ensiled by June 8th is sown with marrow-stem kale. Of the remaining area, at least half will be cut, saved, and carted by June 20th, so that a good area of rape is got in.

If the vetch haying is completed by about July 4th, the field is finished with hardy greens, rye and rape, or rye alone, these two latter crops being in the nature

of extra strings to the bow, if weather conditions or other causes result in deferred sowings.

By sowing on July 1st we can count on having the rape ready for consumption by October 1st, and the kale, if sown on June 15th, by November 1st.

In practice, we commence to use the rape on the first-mentioned date, and continue until the crop is finished.

The area sown generally lasts until about November 30th. Then, as long as frost and weather permit, we continue with the marrow-stem kale. In most seasons, we can continue using the kale until about Christmas time. After that, frost, or very wet weather, stops further feeding until about February.

During this month we finish up the marrow-stem kale, and start on the hardy greens. By the time this latter crop is finished at the end of March, there will be a fair second growth of the giant rape, which was previously fed in October. This gives very nice grazing for April.

During late December and January, and on any very wet days or frosty weather, which may occur during the winter season, mangolds are fed in place of winter greens, 2 acres of the winter-green break (on our 20-acre farm) being sown with this crop.

IN COLD DISTRICTS

In districts where the winter is fairly severe, it might be better to sow hardy green turnips early and the rape later, that is, sow the hardy greens before July 1st, and the rape before July 15th. The rape, being the hardier, stands the winter better than the hardy greens, which latter can be used twice, that is, be mown or grazed off in October, and allowed to grow a second crop by the end of the following March.

Where the hardy green crop is cut, care should be taken to leave an inch or two of the stem above the bulb, as it is from this stem that the second growth springs. In like manner, when fed off the grazing should be stopped before the stems have been eaten too low.

It may also be mentioned that any of the varieties of kale, also the rye, and mixed rye and rape will, if consumed in late autumn or early winter, reach a second growth by the following spring, assuming that the land is rich enough and well manured.

CONTINUOUS CROPS FOR SPRING CALVERS AND WINTER DAIRYING

Another point, which has often been raised by small farmers in a creamery district, is that the cows usually do not calve until spring-time, and, under these conditions, the question is asked, is it better to defer sowing so as not to have the winter-green crops ready for consumption before calving time?

Sowing should not under any conditions be deferred. If the crops are ready before calving time, then one can arrange to have more of the cows calving in winter instead of spring.

The business of a dairy farmer is not to *keep* a cow, but to see to it that the cow keeps him. It is bad enough to have the land idle all winter, without having the cows on the pension list also.

A cow calving in winter will always give about 100 gallons per annum more milk than one calving in the spring. Furthermore, even in-calf cows that have gone dry before winter need feeding.

A cow is no cleverer than a man, and, therefore, cannot make something out of nothing. That is, she cannot keep her condition and produce a good healthy calf on a diet of bad hay, or straw, and cold water.

This semi-starvation of in-calf cows is a very serious matter. Apart from producing a weak calf, a cow which comes to calving time in a semi-starved condition cannot be expected to give her maximum milk yield. Much of the more liberal feeding which she receives when she commences milking goes to build up the condition she has lost through the semi-starvation period. In other words, she puts the fat on to her ribs instead of into the milk pail.

FEED EVERYTHING WELL

Of course, one often hears of the ancient heresy about a cow being liable to abortion and "getting a blast" if she comes to the calving time full of flesh. There is a very big difference, though, between being full of flesh and being full of fresh air.

Dairy cows should at all times be kept in good condition without being over-fat. Further, the condition of a cow has nothing to do with abortion or udder blast.

Again, if there are no cows in "profit" during winter, the small farmer will have young dry stock, which need feeding. This class of beast also, in the hands of a small farmer and often in the hands of the large one, too, seldom gets sufficient feeding during the winter months. More false economy, for if there is one thing more than another that requires liberal winter treatment, it is young stock.

Anything that does not pay for feeding, certainly won't pay for starving. A beast when well fed from birth is just as valuable at two years old as one semi-starved through winter will be at three years old, and, no matter how successfully a beast may be starved, it is bound to eat more in three years than a well-fed one in two,

These are things which small farmers need to ponder over seriously. In most places it is a delight to see the fine sappy condition of young stock in the Fall after the season's grazing, and a misery to see them in the following spring after the winter on a meagre diet. Too often one can see them in spring-time staggering around bare pastures, looking for a thistle to lean against, or turning over a stone to see if there is a worm under it!!

Therefore, not only is it necessary to have cows in milk in winter, when milk is dear, but it is necessary to feed in-calf, or dry cows, and the other stock on the farm more liberally.

It might also be mentioned that there is no danger of the forward winter greens running into flower in autumn or getting stalky before spring-time. If there is a tendency for these crops to flower, let the stock walk over the crop and nip it back a bit. This is an important point to be kept in mind, especially in a mild spring and where the area sown is considerable.

CHAPTER IX

THE CONTINUOUS-CROPPING WAY OF GROWING POTATOES

It has been shown how the "winter-green crops" used under my system not only dry the land and make it fit for spring cultivation, but the root action of these crops breaks up the soil in a remarkable manner. So much is this the case that, where roots follow "winter greens," the labour of cultivation of the former is reduced by one-half, as compared with what would be necessary on similar land left uncropped throughout the winter.

Again, the reader will remember the reference which has been made to "winter greens" as a weed-smothering crop. This is most pronounced in the crop following the "winter greens," which, in accordance with our rotation, will be roots and potatoes.

The average yield of potatoes per acre in these countries is from 5 to 6 tons, and without the least doubt by adopting up-to-date methods it is easily possible to double the yield of this crop.

Of the 4 acres of winter-green stubbles allowed for on any typical twenty-acre holding, it would be advisable to plant, say, 2 acres with potatoes, and the balance with mangolds.

The cultivation of both mangolds and potatoes is precisely the same. As the land is cleared from winter greens it should be ploughed at once, then well cultivated and harrowed down to a fine seed-bed. Too often the mistake is made of planting the crop in a rough seed-bed and depending upon the after cultivation to

get a fine tilth. But this is never so satisfactory, and it is much better even if it means delaying the planting to obtain a good tilth first.

Under the ordinary system of potato growing, drills are made about 27 inches apart, and the potatoes planted about 12 inches apart ; the seed is not usually sprouted, and spraying, except in certain districts, is not carried out. By such a method, only one crop of potatoes is obtained in the season, and that a low yield crop.

Now the up-to-date method, and a much better one, is to make the drills at the start 36 inches apart. In these drills early or second early varieties of potatoes should be planted a good 15 inches apart.

The seed should be well sprouted before planting. Having such a large amount of freedom these sprouted potatoes will attain a far more rapid growth than when planted unsprouted and in the usual size of drills.

DOUBLE CROPPING OF POTATOES

Of course, the date of planting the crop will vary in different districts. On early land (the ideal land is light loam near the seaboard) the potatoes should be put in by mid-March, the winter-green crops being cleared much earlier than usual with this object. In less favourable districts, however, it may be the middle of April before the "earlies" can be put in. In any event, when the crop has been moulded a second time, about late May or early June, the second crop of a late variety of sprouted potato should be planted in between the rows of the first or second "earlies."

The easiest way to plant this second crop is by running a grubber or Hunter hoe up and down the drills after the second moulding of the first-planted crop. The Hunter hoe should have the scuffling feet

reversed, so as to pull some loose mould into the middle of the drills or rows.

It is advisable that the late-grown tubers, as well as being planted in the exact middle of the drills, should also be put down in a triangular fashion—that is, equidistant between the already growing plants.

Of course, it must be understood that whilst the first-planted crop is in the ground, the late one will not make much headway as regards the development of foliage ; but it will make a good stout root growth, and when the first-sown crop is dug will grow remarkably fast.

As with the planting, so with the digging of the early planted crops, the date will vary, according to the district and the soil. If planted at the latest by the middle of April they should easily be ready for lifting by the first of July ; and at the same time as the early crop is being dug the late one is moulded. These will also be ready for the second moulding before the middle of August, and, when the operation is well advanced, the planting of curly greens, such as broccoli and kale, may be commenced, the plants being put down in the exact spots occupied by the recently dug early potatoes.

By this means, what practically amounts to a double crop of potatoes is obtained in the year, as well as a crop of “ greens.”

The greens will command a very good price in the following February and March, or, lacking a suitable market, will give very valuable feeding for the live stock on the farm at that period.

DETAILS OF SPROUTING

The whole success of the system of inter-cropping of potatoes depends upon the proper sprouting of the tubers before planting.

A certain amount of fresh seed should be obtained every season, with the sole object of growing seed for the following year. These potatoes should be dug before the tops have withered and the tubers left exposed to the air as soon as they are dug.

This exposure results in the potatoes turning green, and as every potato planter has known for years—and scientific investigators are just beginning to find out—green seed is always more virile and more productive than seed completely ripened. This green seed can be stored in a loft or in potato boxes.

As regards boxes, the kind recommended by the Irish Board of Agriculture is very suitable. There is, of course, no need to procure boxes to hold all the seed potatoes. A certain number can be sprouted in boxes, and the balance sprouted on the floor or on shelves; the boxes being used to convey the seed to the field. The main object of sprouting is to preserve the strongest shoot in the potato, which of necessity is the first one, as it will give by far the most vigorous foliage and much better-developed tubers than those resulting from the growth of the secondary shoots.

With the ordinary method of storing potatoes, after the turn of the year the tubers will sprout in the pit. Then when the potatoes come to be turned in the early spring the delicate white shoots are injured or knocked off completely.

Another thing to remember is that heat, darkness, and absence of air favour the rapid growth of sprouts, whilst cold, light, and air retard growth. In other words, if the potatoes are stored in a warm, dark place the shoots grow quickly and spindly, whereas if light and air are admitted, the tubers being kept in a moderate temperature, the shoots are short and sturdy.

WHERE TO SPROUT POTATOES

In practice, with the early varieties of potatoes it is well to let the shoots make a growth of about 1 inch, covering them up with straw for that purpose, and keeping them in a fairly warm temperature, say, in a loft over cattle, until this size of shoot is obtained. Then every day the windows and doors of the loft should be opened, and the straw removed so as to expose the shoots to the light. The shoots will then

Here is the type of sprouting-rack used on Mr. Wibberley's farm.

turn green, get very strong, and stand a lot of knocking about.

In the case of early potatoes, where the hardening-up process is being carried out in early spring, it may be desirable to cover them up with straw at night to ward off any danger from frost.

Now, in the case of the late varieties, the trouble will be to keep the potatoes from making too great a growth of sprout by the time they are planted. From the foregoing it will be deduced that the plan to be followed with "lates" is to store them in a cold place, and, except in very frosty weather, to admit light and air throughout the entire winter and spring.

This can be best accomplished by sprouting some in boxes, and the balance, in the case of the "earlies," on the floor of a loft, where they may be spread 4 or 5 inches deep, and the "lates" on cheaply-constructed shelves, which can be erected in any convenient house and removed when not required for potato sprouting.

These shelves should be about $2\frac{1}{2}$ feet wide, with about 11 inches between every two shelves. They may be continued to any convenient height, say, about 8 feet. All that one requires are four or six uprights about 8 feet long and 3 inches by 3. These may be joined together by 1×2 -inch laths, upon which light scantlings are laid across to form the shelves.

Where 120 sprouting-boxes, or sufficient to plant a statute acre, will cost 35s. to 45s., a pound's worth of timber will make sufficient shelves to plant three acres of potatoes.

Another advantage is that the shelves can be taken down in the summer, leaving the room available for other purposes.

MANURING THE POTATO CROP

The method of manuring the potato crop will depend upon whether the previous winter-green crop is fed entirely or partially on the land, or is cut, carted home, and consumed indoors.

It is scarcely necessary to point out what great economy of labour is effected by feeding the crop on the land. In practice I find that this can be done in the months of October and November, and again from about the middle of February until the middle of April, although in these periods there are times when, through the heavy fall of snow or very wet weather, other feeding (roots or ensilage) has to be resorted to in the former case, and the crop carted or roots also used in the latter. Farmers with no experience of eating crops off the

land with cattle at the time mentioned would imagine that excessive poaching or puddling of the land takes place. Such is not the case, however. The land, due to the water evaporation from the leaves, is actually drier than uncropped land. Land, too, containing the large amount of humus which accumulates in the soil where continuous cropping is followed, does not suffer as much from trampling as does land devoid of this substance. Again, it should be understood that where live-stock (other than sheep) do eat off these crops, they are only allowed on the land for an hour or two during the day.

In practice there will generally be one portion of the land from the winter-green crop cut off and carted home, and another portion will be eaten on the land. Under these conditions the manuring of the winter-green stubbles will vary.

Generally speaking, heavy manuring of potatoes with dung is not advisable. Heavy manuring with farmyard manure results in a heavy crop of tops very susceptible to blight, and an inferior crop of tubers. In more technical language farmyard manure is too rich in nitrogen and too deficient in potash and phosphates to grow a heavy and sound crop of potatoes.

ARTIFICIAL MANURES

Where the green crop has been cut and carted home a dressing of from 15 to 20 tons of farmyard manure per statute acre supplemented by a dressing of 4 cwt. of superphosphate and 1 cwt. of muriate or sulphate of potash per statute acre is recommended. If the land is very poor, either a little extra farmyard manure or 1 cwt. of sulphate of ammonia per statute acre may be added to the above artificials.

On boggy or peaty land sulphate of ammonia or any

nitrogenous manure should not be used. Such land is already rich enough in nitrogen. True, a large amount of the nitrogen in such soil may be unavailable for plant foods but will be liberated by substituting 5 or 6 cwt. of basic slag in place of the 4 cwt. of superphosphate.

Again, on light, sandy, or gravelly land an equivalent amount of phosphates in the form of bone-ash or steamed bone flour may be substituted for the superphosphates.

Where a green crop has been consumed on the land, the only manure required will be the artificial dressing mentioned above, although on poor land a little farmyard manure may be given as well. The above recommendations are primarily intended for the late crop of potatoes.

In the case of the "earlies," a little nitrogenous manure may be used, as this crop requires a little push in its early stages. For the early crop, therefore, from 1 to 2 cwt. of nitrate of soda per statute acre may be used. As a matter of fact I only give 1 cwt. of nitrate of soda per statute acre, and if later in the season the crop is cut down by frost or harsh winds, then I give another cwt. of nitrate to help it to recover.

The farmyard manure may be either spread on the land and ploughed in, or placed at the bottom of the drills before planting. Where inter-cropping or double-cropping of potatoes is followed all the farmyard manure is to be placed under the first-planted crop. The later variety or the inter-crop will get benefit from this dung in the remoulding.

As to the artificials, I give half of the phosphates and the potassics to the earlies, sowing it on top of the dung in the drills. The remaining half spread along the alleys of the drills and work in with soil just previous to planting the late varieties.

THE AFTER CULTIVATION OF POTATOES

As previously mentioned, the nitrogenous fertilisers are all given to the early crop.

About a fortnight after planting and covering the early crop, the tops of the drills should be levelled. This can be done with a chain harrow turned on its back or a few thorns threaded into a framework roughly made like a gate. A plant will always take the shortest cut to the daylight, and the object of this levelling is to ensure the haulms coming through in the middle of the drills instead of through the sides.

A few days later, when the tops are peeping over the land, the drills may be partly remoulded so as to cover in the tops and keep them from the frost. This, of course, is done by first running the drill-grubber up the drills and then following with the moulding plough. The operation may be repeated in about a fortnight's time.

Later still, as soon as ever the tops have got fairly well advanced and show any indication of straggling over the drills, the operations of grubbing and moulding should be repeated, a final moulding being carried out just before the planting of the second crop.

Constant grubbing and stirring of the soil is the very best thing in the world both for a potato and a root crop. Even if there are no weeds to be seen, one may say that thorough after-cultivation of these crops is as good as an extra dose of manure. The stirring of the soil draws up the moisture from below, helps to work in the moisture which falls on the land, keeps the land loose and friable, and so allows the tubers to develop.

It is specially necessary to keep the soil well tilled under the inter-cropping system in the early part of the season, because later, when the second crop of potatoes

has been remoulded, and the inter-cropping of greens broccoli and curly kale—has commenced, further horse labour is not possible.

THE DIGGING OF THE CROP

As to the method of digging the crop, this can either be done by the digging plough or by hand. If it is possible to do so, it is best, for the smallholder at least, to dig the earlies by hand. The crop will be lifted a small portion at a time, and whilst hand digging may seem laborious and costly, it is well worth while because of the more complete tilling of the soil which results.

Where the area of potatoes grown on this double-cropping plan is considerable hand digging may not be

The wheel plough recommended by Mr. Wibberley, with ridging and digging attachments.

possible. The ordinary digger, too, cannot be used, since this implement cannot be worked without the horses trampling on the late varieties. In this connection it will be remembered that, when discussing ploughing, the smallholder was recommended to buy a wheel-plough which could be converted into a ridging plough, and also into a potato-digging plough.

It is to be hoped the small farmer will pay sufficient attention to recommendations regarding implements. His capital may be very limited, and

hence the combined implement wherever possible should be purchased. Whether a man is handling land on a small or large scale labour-saving implements are of the greatest importance.

"Neither wise men nor fools can work without tools." Some of the latter do try, but they always wind up in the workhouse.

Now for the spraying of the crop. It is surprising how few smallholders in England ever spray their potato crop. In Ireland nowadays the spraying of potatoes is universal.

THE VALUE OF SPRAYING AND SPROUTING

This spraying of the potato crop by the Irish farmer is largely due to the splendid work done in this connection by the Irish Department of Agriculture. There are many features of the Irish Department's work deserving of criticism, but it is not so as regards the spraying and sprouting of potatoes.

Throughout the length and breadth of Ireland it has been proved very conclusively that by sprouting about 2 tons increased yield per statute acre can be obtained, and a similar increase obtained by spraying. This latter has proved to be the case in dry years when potato disease has not been prevalent, for not only does spraying prevent blight, but it gives renewed vigour to the crop, keeping the tops green and growing long after the tops of the unsprayed portion are completely dead.

A FOOLISH ARGUMENT

The writer has heard the criticism advanced both in England and Ireland that whilst spraying and sprouting increase the potato crop in a most marked manner, the crops following the tubers are better on the unsprayed and unsprouted portion of the field than those on the

sprayed and sprouted. There are times when on hearing this type of criticism advanced, one almost despairs of agriculture. A man advancing such a criticism knows as much about the principles underlying agricultural practice or science as a billy goat does of the science of eugenics.

If on two plots of land receiving the same amount of manure one plot gives a yield of 5 tons of potatoes to the statute acre, and double the yield is obtained from the second plot through the adoption of a better system of potato growing, such as sprouting and spraying, it is only reasonable to expect that the plot giving the double yield has taken more out of the land than the low-yielding crop. But 5 or 6 tons of an extra yield of potatoes would surely put a man in a position to buy a little extra manure to restore the balance of the fertility which had been taken from the land by the extra yield.

DETAILS OF SPRAYING

There are two spraying mixtures generally recommended for potatoes, the Bordeaux mixture and the Burgundy mixture.

The former mixture is made in the following proportions: 2 lb. of sulphate of copper (commonly called bluestone) and 1 lb. of unslaked lime to every 10 gallons of water. The Burgundy mixture consists of 2 lb. of sulphate of copper and $2\frac{1}{2}$ lb. of washing-soda to every 10 gallons of water.

Personally I much prefer the Burgundy mixture; it sticks on the leaves far better than the other, it is much easier to prepare, and the nozzles of the spraying machine are not so likely to become clogged by its use.

HOW TO MAKE BURGUNDY MIXTURE

The actual method of preparing the mixture is as follows: Get two paraffin barrels (which are of 40 gallons capacity), fill one three-parts full of water, then put 8 lb. of bluestone in a bag and hang it in the water, moving it about until it is dissolved.

In the second barrel put 10 gallons of water and dissolve into it, in the same manner as the bluestone, 10 lb. of common washing-soda. When both substances are dissolved, pour the washing-soda into the bluestone solution and mix the two together.

The stuff must next be tested. This is generally done by getting a small piece of blue litmus paper and dipping it in the solution. If the paper turns red, or even has a reddish tinge, dissolve another half-pound of washing-soda and pour it into the liquid already mixed.

This little test is very important. The object of mixing the washing-soda with the bluestone is to neutralise the latter, and if the blue litmus paper turns even a little red, it shows that the bluestone has not been sufficiently neutralised. If the stuff is used in this state it will burn the potatoes.

A second test must be made after putting in the little extra washing-soda in the mixture, when it will probably be found that the paper remains blue. If it does not, still more washing-soda solution should be added to the mixture. A little book of litmus paper can be obtained from any chemist for 2d.

SPRAYING HAS ITS LIMITS

Spraying is most important for the late crop of potatoes, which is more subject to blight than the early one. It should be borne in mind, however, that spraying is a preventive and not a cure for potato blight.

It is therefore necessary to spray the crop before the disease makes its appearance. Two sprayings at least should be given, the first one as soon as ever the potato tops are about 6 inches high, and the second about three or four weeks later.

In practice it will be found that the most convenient time to spray is immediately after the first and second moulding of the crop. It will scarcely be necessary to spray the earlies, as they will be dug, in most years, before the blight has made its appearance, and, further, they won't be stored, but sold as soon as dug.

The spraying mixture is applied with a small knapsack spraying machine, which costs about 36s. From 80 to 100 gallons of the mixture are required per statute acre.

THE STORING OF POTATOES

Now as to the pitting of potatoes. It is something of a paradox to say so, but in pitting potatoes never put them in a pit; that is to say, make the clamp, or pile as it is sometimes called, on the level surface of the land.

Very, very often a pit of from 9 inches to 12 inches deep is dug and into this the potatoes are put and then built up into the form of a pyramid like a clamp of mangolds. This system means that there will be about 9 or 12 inches deep of potatoes below the surface of the land, and in anything like a wet winter the potatoes are bound to become damp. Therefore, start the pit on the level land and on the highest piece of land in the field, or wherever else the potatoes are pitted.

CLAMPING POTATOES

Make the pit about 3 feet 6 inches or 4 feet wide at the bottom, and let it taper off to a point, using the big

potatoes to build up the sides and putting the small stuff in the middle.

Very often a farmer thinks his potatoes have completely missed disease. He pits them, but then when he comes to turn them over in two or three months' time he finds half of them rotten. To minimise this risk always have a bit of air-slaked, dusty lime to hand, and in putting the potatoes into the clamp dust them well with this. This keeps them nice and dry, and if by any chance a few diseased ones do get into the pit,

Never clamp potatoes until they are ripe, that is, until the skin is quite firm and will not rub off.

the lime prevents the disease from spreading to the surrounding tubers.

Another thing that causes potatoes to rot in the clamp is digging and pitting them when they are not properly ripe. Potatoes should never be dug until the haulms have completely withered and the haulms can be pulled out of the land without any potatoes sticking to the roots.

Another test is to rub the potatoes between the thumb and finger. Only when the skin does not rub off under the thumb are they ripe enough for digging and pitting.

HOW TO AVOID ROTTING

Still another cause of potatoes going bad in the clamp is their not being sufficiently ventilated in pitting. As a result of this the tubers sweat, and sweating in a potato pit means disaster.

To avoid this, having built up the potato pit in a pyramid shape, lay on the top some nice straight straw just as though thatching a rick. Then put about 6 inches of earth on top of the straw, and lay a plank along the crest of the pit. The plank can be left along the ridge for about a week, then taken off and the crest also covered with soil. In doing this a wad of straw should be inserted about every 4 feet along the crest to act as a ventilator, and only on the approach of frost should these wads be removed and a shovelful of soil put in their place.

Of course, the soil for earthing up the pit should be dug from a trench all round the clamp, so that when wet weather does come this trench keeps the clamp fine and dry.

Now, as well as putting straw underneath the soil next to the potatoes, a layer of thatch should be put on outside the soil. The object of this is to turn off the bulk of the rain and prevent it from soaking through the soil.

This outside thatch is a thing that isn't very often done, but it is about the best "cinch" I have met for keeping potatoes dry, and it is absolutely essential where the soil is fairly light and porous, as on such a soil the water easily soaks through.

TURNING THE POTATOES

About late January or early February the potatoes ought to be turned to prevent them from shooting, and to give them a little drying in case any water has got in.

Then the newly-formed pit is built up in the manner explained above.

Better still than re-pitting is to bring the potatoes home and put them into a house. They can then be graded and picked over during any wet weather which may prevent outside work.

Of course, where the potatoes are to be sold in February or so, there is no need for re-pitting. They can be graded and picked, bagged, and sent direct to market.

Some farmers prefer to take the small potatoes from the general bulk at the first pitting, and this is quite a good plan to follow wherever there are sufficient hands to do the work ; the small and bad potatoes can then be used for pig feeding. Generally though, where potatoes are grown to a large extent, there is a great hurry to get them all pitted immediately they have been dug, especially during dry weather conditions.

As well as taking out small potatoes, some farmers also pick out the potatoes intended for seeding next year—that is, the potatoes about the size of a hen's egg. For seed the writer prefers to have a small portion of the land dug while the potatoes are in their green state, putting them direct into boxes on shelves, and letting them "green," green potatoes being so much better for seed.

One mistake very often made, and a very serious one indeed, is to use potato haulms for covering up the pits. Now, if by any chance the tops have been blighted, the rain washes the spores of the disease from the haulms down to the potatoes ; as a result, half the potatoes go rotten. Potato haulms should never be used for this job. Neither should they be used for bedding, no matter how hard up a farmer may be for litter. They should be gathered together, put into a heap, and burnt on the field.

THE THIRD INTER-CROPPING

The type of cabbage crop to be put in immediately after the second crop of potatoes is moulded must be decided by each smallholder for himself.

In the neighbourhood of markets, savoys, broccoli, or curly kale may be planted, and sold in the following February and March. When the cabbages are intended for cattle feeding thousand-headed kale or marrow-stem kale could be planted. Whichever type of crop is used, the plants should be sown in the bed by early April, so as to have them good and strong by July.

The plants will have to be dibbled in, as before-mentioned, in the exact spot occupied by the early potatoes. Moist weather should, of course, be chosen for the job.

Always before transplanting any plant of the cabbage tribe, it is a good thing to dip the roots of the plant in a strong solution of liquid manure. When dibbling in, too, care should be taken that the tap root does not get bent or turned up in the hole. This is best avoided by making the hole fairly deep, then putting in the root of the plant and, after packing the soil firmly round it, pulling up the plant for about 1 inch, which has the effect of straightening out the tap-root.

In a hurried season, or where the area is considerable and transplanting is not possible, rape or hardy greens may be sown as an inter-crop. Immediately the second moulding of the potatoes is done, run along the "alleys" and sow in a thin line about 2 lb. of the seed per statute acre. The easiest way to do this is, use a single row Planet junior seed drill, or if this implement is not available then put the seed in a glass jar fitted with a cork through which a large goose quill is inserted. The seed will trickle through the goose quill very evenly, and in a nice straight line.

CHAPTER X

THE CONTINUOUS-CROPPING WAY OF GROWING MANGOLDS

ABOUT one or two acres of the winter-green stubble should be planted with roots as a stand-by for feeding in winter, in very wet or frosty weather, when it would not be either suitable or convenient to use winter greens.

As regards the kind of roots to plant, mangolds are to be preferred to turnips. They do far better after the winter greens, and, unlike turnips, which are of the brassica tribe, they are not susceptible to "finger-and-toe." Further, mangolds lend themselves to more intensive cultivation, giving a far greater yield than turnips.

The cultivation for mangolds should be deep and thorough. Plough the land well, then cultivate, harrow, and work it down fine; also cross-plough and repeat the other operations if necessary. As a rule, though, after winter greens cross-ploughing will not be necessary.

The strip where the mangolds are to be sown will be the last to be cleared of the winter greens; hence quick cultivation is very necessary, especially in a dry spring. In this connection a disc harrow along with a good cultivator would help a tremendous lot. So much so that, except on very heavy land, if the winter-green stubble is tackled in damp weather (and generally in spring there is a sufficiency of damp weather) ploughing will not be necessary.

THE DISC AND THE CULTIVATOR

Where these two implements are available, two or three cuts, first with the cultivator, then with the disc harrow, in opposite directions, along with a final refining with a spring-tooth harrow is all that is needed. It is true these implements are dear ; nevertheless they are easily procurable by smallholders if co-operative methods are put into practice.

Having got the land thoroughly fine, drills should be opened about 28 inches wide, and manure carted into them. Then the artificials should be spread on top of the farmyard manure and the drills split so as to cover in the fertilisers.

If this stage can be reached, that is the mangolds ready for sowing, about the third week in April, then the crop can be grown from seed, and sown in the usual manner on the drills. In practice, though, it is more likely to get into the first or second week of May before the mangold break is ready for planting. Anticipating this, it is better to put in mangold plants rather than sow seed for the crop.

A USEFUL METHOD OF TRANSPLANTING MANGOLDS

The plants should be grown in a frame, the seed being put down about the 1st of March. Then about a month later, or as soon as the young plants have become fairly strong, they should be hardened off by removing the top frame, only covering them up in the early stages of the hardening-off process at night-time.

The mangolds are dibbled in in exactly the same way as the cabbage, but the greatest care should be taken with them to see that the tap-root is straightened out when planting, for otherwise the plant will fail. The root should also be dipped in liquid manure.

As soon as the plants are in, unless the land is too wet, the drills should be rolled with an ordinary iron

one-horse roller. This firms the land and presses the plants down in the manure.

Now this method of transplanting mangolds is very important. For three years running the writer has had an increased yield of ten tons to the statute acre from mangold plants put down in the first and second weeks of May compared with seed sown at the same time.

Many farmers would imagine that mangold planting is not likely to be successful. They base their opinion on the fact that often in thinning out mangolds, where they have come across a gap, they have transplanted a mangold, and it has either died off or made very little growth. It is quite easy to understand why such should be the case. A mangold plant put down at thinning-out time, say, the end of May or early June, seldom gets sufficient moisture at that time of the year. Further, it should be remembered that the plant is put down between two other mangolds, each of which has already got a hold of the ground, and in consequence grows ahead and smothers the transplanted mangold.

When, however, mangolds are transplanted all together they all have an equal chance, and, in addition, the transplanting process is done earlier in the year, and always during damp weather.

As in the putting down of the cabbage plants after potatoes, wait for damp weather for putting in the mangolds.

I have been so pleased with my success in connection with this new method of growing mangolds that I now transplant nearly all I grow. Not only am I able to do this when other work is hung up, but later I can push on with the early hay harvest, and I don't need to stop this important work for the sake of thinning out the mangolds.

Only yellow globe or tankard mangolds should be

transplanted. Long reds have a tendency to bolt. Give the mangolds plenty of room and on a 28-inch drill, leave them 15 inches apart. Another modification which I have adopted in mangold growing when seed is sown is to sow every alternate drill with the long red and yellow globe varieties. This results in the mangolds having more "breathing room." The "long reds" grow upright and the "yellow globes" nearer the ground. Experiments in this direction have shown that an increased yield of 5 tons to the acre can be obtained from the mixed crop over and above that obtained from similar plots, one all "long reds" and the other all "yellow globes."

So much then for the planting of the mangolds. There are still, however, the questions of manuring and after cultivation—the latter an all-important point in the case of the mangold crop—and, finally, the lifting and storing of the roots to be considered.

Since under the continuous-cropping system the winter greens on the mangold portion of the land will be consumed late in spring, the former will be usually eaten on the land, but in addition to the manure resulting from consuming the crop where grown, an additional 10 to 20 tons of dung per statute acre can be applied.

As regards artificials, mangolds are very peculiar in their requirements in this respect. Having been produced or bred from a seaside weed, the mangold requires a good deal of salt. A good artificial mixture for mangolds consists of 4 to 6 cwt. of salt and $1\frac{1}{2}$ cwt. of nitrate of soda per statute acre.

LIQUID MANURING FOR MANGOLDS

Later on in the season liquid manure can also be given to the mangolds. This should not be given in dry weather unless the liquid is very dilute, but it may be

given in damp weather undiluted. Strong liquid manure applied during dry weather is liable to burn the plants. If liquid manure is not available an additional cwt. of nitrate of soda may be applied at the grower's discretion when the plants have got a firm hold of the ground.

If it is not possible to give as much farmyard manure as the quantity mentioned above, the crop should receive an additional 4 cwt. of superphosphate per statute acre as well as the quantities of salt and nitrate stated.

Sulphate of ammonia or nitrolim can be used in place of nitrate of soda, but the full 2 cwt. of both of these manures should be applied, mixed with the superphosphate and salt, on top of the farmyard manure before the drills are closed.

Then almost as important as the planting and manuring of mangolds is their after-cultivation. There is no crop that pays so well for proper after-cultivation as does the mangold crop. The land after the winter greens will be clean, but for all that, the crop should be hand-hoed twice and a grubber run between the drills three or four times during the growing period.

Nevertheless, the work is straightforward enough, and provided it is faithfully carried out one can safely depend on obtaining a fine crop.

LIFTING AND STORING MANGOLDS

Mangolds should be lifted in good time in the autumn, say, by about the middle of October; for, although a certain amount of growth may take place after this date, there is always the chance of a sharp frost, to which mangolds are very susceptible, coming along and doing no end of damage.

This is one of the many curses of the root-crop which I have often described as the "root of all evil."

It is all very well to grow a few roots as a stand-by for rainy or frosty weather when winter greens cannot be used, but to grow a crop like mangolds on a large area when a night's frost may reduce the value of the crop by one half, or even totally destroy it, is simply courting disaster.

Of course, in parts of England where a man can realise from 25s. to 30s. a ton for mangolds, it is worth while taking a little risk. It should be remembered, however, that as feeding on the farm for either milk or beef production mangolds are not worth more than 10s. per ton.

Why, then (is the natural question that arises), if the feeding value is so low, do mangolds command such a good price? The answer is that the man who pays a high price for mangolds is the town dairyman, and he buys the crop as a virtue of necessity. In other words, the high price is obtainable on the same principle that if a man had the Lakes of Killarney at the gates of Purgatory, he could sell water at a guinea a pint!

But to return to the lifting of the mangolds. They should be pulled from the ground, the dirt scraped off with the *back* of a knife and the tops cut, or, better, screwed off, about an inch of leaf being left above the crown of the root. On no account should the bulb itself, either at the top or bottom, be cut with the knife, as this causes the roots to bleed.

When lifted, the roots should be thrown into small heaps, and, unless the crop is being carted as it is pulled, these heaps should be covered every night with the tops so as to keep the frost from them.

In case a night's frost does come before lifting is completed, the mangolds should be left severely alone until the frost has left the roots. Mangolds lifted whilst frosted will be sure to rot in the clamp. The first sharp frost will, however, cause the leaves to fall

around the bulb and this protects them to a certain extent from serious damage.

PITTING OR CLAMPING

The best way to store mangolds is in a clamp on a piece of dry, level land. No hole should be dug, as is often done when potatoes are stored, but the roots simply laid on the level surface. At the base the clamp should be about 5 feet wide, the sides being built up and gradually inclined inwards. The finished clamp will then be shaped like a triangle.

In forming the clamp the long mangolds should, of course, be used for building up the sides and ends, the small ones being thrown into the middle of the clamp.

The best method of building the mangold clamp.

When built, about 6 inches of loose straw should be thrown over the clamp and later a layer of straight straw put on this and made secure by twine and pegs in the same way as a haystack is thatched.

It is only in the colder districts where the frosts are very severe that any additional covering would be necessary. In such districts a thin layer, say, 3 or 4 inches of earth, can be placed over the thatched straw.

CHAPTER XI

VETCHES AND "SEEDS" SAINFOIN

THE time of sowing this crop will vary according to the details of the previous cropping. On the part under mangolds we can sow the crop immediately the mangolds are carted, or at any time during winter or early spring when the land is fit to handle.

Little is needed in the way of cultivation. It is only necessary to plough the mangold leaves under, broadcast the seed, and cover in with the harrow. When a corn drill is procurable this will, of course, be used instead of broadcasting.

The portion of the root break under potatoes will be sown in spring, at least where kale or broccoli has been sown as a third inter-crop. By spring-time is meant any time in spring after the land has been cleared and is fit to handle.

In all farm practice it is a mistake to be tied to particular dates; a mellow condition of the soil at sowing time should be the determining factor.

If kale or broccoli has not been sown as an inter-crop then the vetches should be sown in autumn immediately the potatoes are dug.

Ploughing after potatoes is not necessary for the sowing of mixed vetches; the land can be cultivated sufficiently with the ordinary cultivator and the seed covered in with the spring-tooth harrow or drilled in.

The question arises as to whether it is not better to plough after potatoes for a vetch and corn crop when

the land is dirty. The answer is that land which has first grown a winter-green crop and then a drilled crop like potatoes ought to be as clean as a whistle, and if it isn't, the man responsible for foul land cropped on these conditions is not likely to benefit from any advice.

The autumn-sown vetches, where such are got in, should be grazed down in spring, say, in late April or early May, and on this land as well as the spring-sown portion grasses and clovers should be sown after the grazing. These are broadcasted, and can be covered in with the chain-harrow and roller.

When grazed down in spring the vetch crop will not be ready for haying or ensiling until about mid-July, that is, about a month later than the seeds-hay and the vetch crop sown in the second year's "break."

This, in practice, will be found a very useful feature, as by dividing out the work of haying over two months we shall be better able to get the work done—an even distribution of horse and manual labour is everything on a farm.

No manure will be required for the vetch crop sown after the root break. The land will be rich enough.

The seeds sown with the vetch crop will give very nice feeding in the late autumn of the same year as sown. Sometimes they may be fit to cut, but it is better to graze them and give them a good chance to thicken out and fill up the bottom. The tramping of the animals and the animal droppings will help a lot in this direction.

THE FIFTH YEAR'S BREAK. *Seeds*

The seeds grown in the fifth year of the rotation are primarily intended to provide green soiling during the summer ; but no hard and fast rule can be laid down. It often happens that when a man has laid

aside a field of seeds (chiefly rye grass and clover) that portion of the field may become dead ripe before he could consume it, and then he is compelled to cut it for hay.

The haying of a portion of the crop can be undertaken if desired, but, generally speaking, it will be found in practice that the best thing to do is to soil the whole lot. On the portion left for soiling a lot of the liquid manure produced during the winter should be applied whenever weather conditions permit.

There is nothing that will push on seeds or any green forage crop like liquid manure, and rye grass sown under the conditions which we have mentioned and top-dressed with liquid manure should give at least *three good cuttings*, and sometimes four, of soiling during the year.

In practice, this will mean that we shall commence to cut the rye grass for soiling about the 1st of May, and plan out the cutting of the plot so that the 4 acres will last the cattle about six or eight weeks. Then, as a patch of the rye grass ground is cleared, we can put on more liquid manure, and by the end of the six or eight weeks' period the part cut first will be ready again, and so on during the summer and autumn.

A useful seeds and sainfoin mixture is as follows :—

Italian Rye grass,	14 lbs.	} Statute acre.
Perennial	10 „	
Red clover	2 „	
Alsike	2 „	
Sainfoin	10 „	

CHAPTER XII

MODIFIED CONTINUOUS-CROPPING ROTATIONS

So far we have dealt with the case of the small twenty-acre farmer who devotes his entire farm to producing fodder and forage to be afterwards converted into milk and milk products, chiefly, and who buys the necessary litter and, as will be seen later, a certain amount of concentrated food in exchange for his potato crop. But there is also the case of the man having a larger holding, say, up to 40 or 50 acres, to be dealt with.

Such a man, whilst also engaging in dairy farming chiefly, could not aim at carrying 40 or 50 dairy cows on his holding. There are many reasons for this, the chief one being shortage of capital to buy the necessary stock.

This reason is sufficient in itself, but others may also be mentioned. On most farms housing accommodation is not available for such a head of dairy stock, neither would there be sufficient labour on the average small farm to milk and tend such a herd.

These difficulties may not in the future be insuperable ; but at present, except in very exceptional cases, they are.

THE FIFTY-ACRE MAN

For this reason the "big smallholder," the forty or fifty acre man, will find it more practical to modify his rotation so as to be in a position to grow his own litter, sell, where suitable markets exist, a portion of his grain

and other crops, and pay more attention to the raising and feeding of dry stock, for which suitable housing accommodation, if needed, is more easily obtainable than is the case where milking cows are concerned.

Even the twenty-acre man need not aim at keeping nothing but milking cows. As previously indicated, calf-rearing, the feeding of a few yearlings and in-calf heifers to replenish his dairy herd, should receive attention. This, however, will be fully dealt with when we come to discuss the stocking of the farm.

For convenience of reference our standard rotation (hereafter referred to as Rotation A), intended for the twenty-acre farmer who is going to concentrate on tillage dairy farming, is here restated :—

First year's "break" : 4 acres.—Tares for summer soiling.

Second year's "break" : 4 acres.—Tares for hay followed by 4 acres winter greens.

Third year's "break" : 2 acres mangolds, 2 acres potatoes.

Fourth year's "break" : 4 acres.—Tares for hay with seeds, the latter for autumn cutting.

Fifth year's "break" : 4 acres.—Seeds for soiling.

This makes a total area cropped of 20 acres. No litter or corn for horse feeding is provided, the intention being to buy litter, corn, and other foodstuffs, the money obtained from the sale of potatoes helping in this direction.

THE THIRTY-ACRE FARM

On a holding of 30 acres, or thereabouts, in extent, the rotation might be extended one year, making a six instead of a five year rotation, as in Rotation A, there being also five instead of four acres in each "break." The first "break" of the rotation will be lea corn.

The winter variety of oats or wheat should be sown on the lea in the autumn, instead of spring-sown varieties. The harvest in consequence will be about three weeks earlier, and an earlier harvest means in average years better weather conditions for saving, and in every year longer days, lighter dewfall, and a better opportunity for the sowing of the succeeding crop of tares than is experienced when the oat-crop is spring-sown.

Rotation B 1 will therefore be :—

First year.—Autumn-sown lea corn.

Second year.—As in Standard Rotation A.

Third year. " " "

Fourth year. " " "

Fifth year. " " "

Sixth year. " " "

Rotation B 1 will provide more than sufficient litter for the stock, corn for the feeding of horses and other stock, including pigs and poultry. There have been times when maize was so cheap that it would have been more economical for the smallholder to sell the oats and buy maize and other foodstuffs to replace them. It is very doubtful, however, whether we shall see such times again for a few years. In short, as a general principle, the small farmer should aim at consuming all he grows.

KEEP THE MONEY AT HOME

The main object of the big farmer who sells corn is to buy foreign feeding-stuffs containing a substance called albuminoids, in which corn and all ordinary farm crops are by comparison very deficient, but with a food supply of vetch hay and winter greens on the farm, it is no longer necessary to buy albuminous foods for the sake of making balanced rations.

Don't run away with the idea that there need be any

slavish adherence to this or any other rotation. Each smallholder must be guided by local circumstances of soil and markets. For instance, on light soils in early districts, a crop of early potatoes sown on the lea might well be substituted in place of the lea oats. In money value one acre of early potatoes is often worth from two to three acres of corn.

If in the rotation a lea potato crop is decided upon (Rotation B 2) it can either be a single crop of earlies or a double crop of earlies and lates, obtained by inter-cropping as previously described. In practice, though, it will generally be found that inter-cropping with potatoes twice in the rotation is not practicable. It would mean too big a rush of work in spring and summer, and the great thing to be aimed at in farming, either on a small or large scale, is an even distribution of both horse and manual labour throughout the year.

LEA POTATOES A FINE THING

Those who have not previously tried it will shrink from the task of breaking up lea land for a potato or other drilled crop. No difficulty in this direction need, however, be feared provided a good disc-harrow is available. With this implement I have often broken up old lea land not previously tilled in the memory of man.

Before ploughing give the lea surface a cut in opposite directions with the disc. This cuts the surface into little squares. Then plough, using the skim coulter so as to bury the turves.

In the spring give another overlap cut with the disc in the same direction as the land was ploughed, a run with the cultivator and a final refining with the spring-tooth harrow. The land after these various operations on average soil will then be ready for drilling.

MORE ALL-WEATHER FARMING

The discing and ploughing of the lea can be done in wet weather, without any danger of puddling the land, such as would happen if the cultivation of stubble land was undertaken under such conditions.

If a single crop of early potatoes is grown, the succeeding crop of vetch and cereals can follow immediately and in sections as the tubers are lifted. The tare crop, by the way, provides very useful soiling in autumn, but if intended for this purpose it should be cut before the corn shows any tendency to shoot, otherwise it won't grow again. If cut, it must also, unless the land is very rich, be manured, but far better than either cutting or manuring is to graze off the crop in sections with the assistance of the movable fence.

A SOILING CROP AFTER POTATOES

In the early potato-growing districts of Ayrshire this system of sowing a soiling crop after early potatoes is quite a feature. Sometimes tares are sown, often rye grass, and in some cases common barley. In prolonged autumns I have seen the barley harvested as an ordinary farm crop and give quite an average yield. In this district, however, the land is annually planted with early potatoes followed by a soiling crop.

OTHER MODIFICATIONS

In Rotation B 1 peas may follow lea corn. In the South of England where the crop commands a good price, but as the growing and marketing of this crop is confined more or less to restricted areas, where the culture of the crop is well understood, there is no need to go into details here. The same remark applies to the growing of flax or linseed for linen fibre. When either peas or flax follow lea corn, some cover crop should be put down with the latter for use in spring.

A FORTY-ACRE FARM

On a forty-acre farm, where circumstances are suitable, Rotations B 1 or B 2 may be followed, each "break" of the rotation being extended, so that it consists approximately of $6\frac{1}{2}$ instead of 5 acres. The circumstances, though, in which such an extension is practicable will be exceptional, because of the labour, housing, and capital difficulties previously referred to. True, the labour difficulty will not be great if lea corn is grown in the first year, but it will be considerable if instead of lea corn we grow potatoes.

THE LABOUR REQUIRED

On this question of labour it may be remarked that the cropping of a thirty-acre farm on the lines recommended in Rotation B 2, where lea potatoes are grown, the feeding of the crops to the stock and the tending of the stock can be managed comfortably by one man, provided he has a grown youth and a woman to help with the milking, calf and pig feeding, and casual labour to help in the planting and picking of potatoes, and at harvesting.

If oats are grown instead of potatoes in the first year, then the same labour can handle 40 acres cropped on this plan. This assumes, though, that in both cases the milk is sold in bulk. If retailed, or if it has to be carted a long way to a station or milk depot, another boy or girl is required. Also only about 20 or 24 cows are in milk, the rest of the stock being dry stock and pigs.

The matter of the available labour supply needs very serious consideration in the planning out of the rotation. For instance, the carrying out of Rotation A on a twenty-acre holding will require nearly as much labour as Rotation B 1 carried out on 30 acres of land, if in the former case practically all the food is fed to milking

cows, and in the latter more attention is given to the raising and feeding of dry stock. Of course the gross revenue per acre will be higher under Rotation A than under Rotation B 1, and for this reason, wherever labour, market, capital, and housing facilities exist, Rotation A, the purely tillage dairy farming rotation, should be followed even on a holding of 50 acres in extent.

AN ALTERNATIVE ROTATION

An alternative rotation (Rotation C) for either a forty or fifty acre holding would be :—

First year.—Summer-sown winter pasture.

Second year.—Autumn-sown corn.

Third year.—Tares for soiling. Sown autumn 2nd “year.”

Fourth year.—Tares for hay followed by winter greens.

Fifth year.—Potatoes and mangolds.

Sixth year.—Tares for hay with seeds, and sainfoin.

Seventh year.—Seeds and sainfoin for soiling.

Eighth year.—Seeds and sainfoin for pasture.

This rotation is really an extension of Rotation B 1, and is primarily intended for the small farmer who, lacking sufficient labour to till all his holding, or who cannot see his way for labour and other reasons to milk, say, more than twenty dairy cows, is compelled to keep more dry stock.

The chief features of the rotation as compared with the preceding ones are :—

(1) Winter pasture provides succulent food for a large portion of the winter, early spring, and following summer, in fact up to the time when the land is tilled for autumn-corn. The consumption on the land of the winter pasture would leave the soil in a very

good condition for the growing of the succeeding grain crop.

(2) The winter pasture, with the seeds and sainfoin pasture in the eighth year, provides more outside room for the stock, and this room, if practically all the crops are home fed, as they should be, will be wanted on most holdings. This again means the carrying of a greater proportion of dry stock (which can be wintered out) than in the previous rotation.

THE ADVANTAGE OF PASTURING

The seeds and sainfoin pasture will be grazed in summer and on it will be fed a large amount of the soiling crops grown in the third and fourth years' breaks. Needless to say this feeding on the pasture will make the land very fertile, being in practice the same as though the land were heavily top-dressed with manure.

Wherever this system of soiling on pasture is followed, the grass-harrow should be run over the land at least once a week to spread the droppings. Then as soon as there is a good bite on the winter pasture, say, by August 1st, if sown in June, the grazing and soiling should be alternated week by week between the winter pasture and the seeds and sainfoin pasture.

In wet weather during winter the cattle should not be allowed on the winter pasture at all, but kept on the seeds and sainfoin pasture. A little poaching of this does not matter, but should, nevertheless, be avoided as much as possible by feeding the stock in a movable shed during very wet weather.

CHAPTER XIII

CONTINUOUS CROPPING FOR MOUNTAIN FARMS

It will be seen that the system of continuous cropping permits of very varied rotations being introduced, and with the examples given the small farmer with his wits about him will have no great difficulty in framing his rotation to suit the particular conditions of soil, market, labour, and, above all, climate under which he is working.

There are, however, a very large number of small farmers in these countries, notably along the Pennine Chain, in Devon, Cornwall, Wales, Kerry, in short in hilly districts generally, whose case calls for special consideration.

As a rule each of these farmers has a small amount of level arable land in the valleys (where the home-stead is generally built), and the rest of the farm is on steep mountain-sides. In such districts the land in the valley is cultivated, whilst the rest of the land is left in a state of nature, growing very poor pasture and grazing very inferior stock, generally sheep and young cattle. On such pasture a sheep takes four or five years to mature, and then certainly yields very toothsome mutton, but not enough of it to provide a dinner for half a dozen hungry men.

The young cattle are poorer still. Good two-year-old bullocks after a year's grazing on these poor mountain pastures turn into "yearlings." Spring-dropped calves, pail and hand-fed during the summer

and in nice condition by autumn, are turned out to winter on these mountain stretches. In the following spring they are often of less value than in the previous autumn—miserable-looking creatures surely, which I have heard described as being so thin that it takes two of them to cast a shadow !

Realising the extreme poverty of their mountain pastures, these mountain farmers keep a very inferior class of stock, under the opinion that better-bred stock could not be fed on their farms.

This opinion is perfectly sound when the farmer is depending on the mountain pasture alone, but it is certainly absolutely wrong when we come to consider how tremendously the feeding capacity of this land can be improved by a suitable system of tillage.

OLD-FASHIONED TILLAGE IMPOSSIBLE—

True, tillage of these mountain lands on the old lines is entirely out of the question, at least on anything like an extended scale. Such tillage means an impossible amount of work in carting crops home and manure back ; means a big rush of work in spring for cultivation and in autumn for harvest, and here we are up against climatic and labour difficulties. These difficulties have proved to be too great even for the lowland farmer, hence the tremendous decrease in the area under the plough in the last generation or so ; but bad as is the climate for tillage on the lowland, it is infinitely worse in the hill districts, due to the heavier rainfall.

A study of a rainfall chart will show that whilst there may be an annual rainfall of thirty inches on the lowland, on a neighbouring hill, only a few miles distant, the annual rainfall may be sixty inches, or even higher.

Apart from rainfall, as previously stated, the crop and manure carting involved in the ordinary system of tillage makes the system prohibitive. Between bad roads, or the entire lack of them, and steep inclines a horse can't haul half an ordinary load either up or down the hill.

In laying out a suitable rotation for the tilling of hill land, therefore, it is imperative to dispense, as far as possible, with carting ; to grow crops which will not be at the mercy of the elements ; crops, too, the sowing of which can be undertaken at a time of the year when rainfall doesn't hang up the whole of the tillage work, but helps on tillage operations.

BUT WIBBERLEY TILLAGE VERY POSSIBLE

A splendid rotation, Rotation D, for such conditions is :—

First year.—Summer-sown winter pasture.

Second year.—Summer-sown "winter greens."

Third year.—Autumn-sown vetches and grass seeds, hayed in June.

Fourth and fifth years.—Seeds, part hayed, rest grazed.

In the first year of this rotation, the lea-land can be ploughed and tilled practically any time in summer. Then it can be sown in May, June, and July (the time of sowing like the whole rotation is very elastic) with the seeds for the winter pasture. This will give succulent feeding for sheep and dry stock for a good portion of the winter, spring, and up to the end of May.

Then during June, if need be, when the winter pasture has been grazed bare in sections, the different sections can be sown with winter greens. Preference

should be given to the hardier varieties of winter greens, such as thousand-headed, marrow-stem, and Labrador kales, and rye.

The "winter greens" will give feeding at the same time as the winter pasture; in fact, these crops form a second winter pasture. In addition the "winter-green" pasture is intended to provide summer feeding as well. All the varieties of kales mentioned, and the rye will continue to give a second, third, and fourth growth, if they are kept from flowering by constant grazing. In other words, these crops are not really annuals, as the text-books say, or rather they can be converted into biennials by simply keeping them from flowering.

During the third summer, as the different sections of the "winter-green pasture" have been finally grazed down, the land can be re-tilled and sown with mixed vetches and grass seeds. On these hill lands the sowing of this crop should be completed, say, by mid-August, so that the land is nicely covered in by late September or late October. It should then be eaten down fairly bare before the winter sets in.

EARLY SOWING ESSENTIAL

The early sowing of the tares and the subsequent grazing down of the crop in hill districts is very important. The object is to get a good root growth established before winter sets in. If the sowing is delayed until, say, October or early November, the weak growth resulting is not able to withstand the winter.

A second advantage of early sowing is that the grass seeds are given a good chance to become established.

In passing, it may be mentioned that the temperature on an elevated land is much lower than near the sea level. The decline in temperature is about one

degree Fahrenheit for every 270 feet rise above sea level.

A mistake I have often seen made is to leave an early-sown tare crop ungrazed in late autumn, with the view of having the spring feeding all the earlier. When this has been tried, the invariable result is that the soft growth of tares has been cut down by winter frost or snow and not only the top killed but the root also.

When grass seeds are sown with a late summer tare crop the amount of vetches must be reduced somewhat, otherwise the grass seeds may be smothered. A suitable mixture will be :—

5 st. winter vetches	per statute acre.		
2 st. winter wheat	„	„	
2 st. winter oats	„	„	
2 st. winter rye	„	„	

with grass seed mixture.

The vetch mixture and grass seeds can be sown at the same time, the former, as previously described, like an ordinary corn crop, and the latter more shallow under the final stroke of the harrow, just before rolling.

The intention is to convert the vetches into hay during the month of June or early July, to provide dry food for feeding to the stock in winter time along with the winter greens. A certain amount of dry fodder must, of course, be fed with the greens to prevent excessive purging, and, again, dry fodder will be needed as a standby during very frosty weather or when the ground is covered with snow.

SILAGE MAKING

There is, of course, more snow on the higher elevation than on the lower. The snow also remains longer. As an extra precaution and to provide laxative food

during a period of frost or snow, therefore, it is essential to convert a portion of either the vetches or seeds into the sweet silage (previously described). In fact it is a very good plan, and renders silage-making all the easier, to mix seeds, hay, and vetches together in the stack, but since they will not be growing in the same field in the same year the labour of carting may make this recommendation difficult if not impracticable.

Again, I have recently found that a portion of kale or rape can be mixed through longer fodder in the making of silage on the new plan. It is very useful to know this, as often a farmer obtains a bigger bulk of these crops than can be conveniently consumed. So far I have only mixed one load of kale to every three loads of vetches or seeds, but am in hopes of yet being able to make sweet silage from the former crops alone.

In using rape or kale mixed with long fodder for the making of silage, it is a distinct advantage to get the latter partly dried to absorb the excessive moisture in the former. It is not possible, however, to dry either rape or kale even partly. I did try this one year, and the resultant silage had such a frightful smell that no one could go near it without a respirator on.

GRASS SEEDS MIXTURE

As already indicated, part of this in its first year of growth can be hayed or ensiled if necessary, and the rest grazed ; or, if enough fodder is obtained from the vetch, the seeds can be grazed in the first year.

Under any conditions, in their second year—the fifth in the rotation—the seeds should be grazed, and they may even be grazed a third or fourth year, provided a grass-seed mixture of three or four years' duration has been sown originally. The only conditions under which

a small farmer should leave the seed mixture down for more than two years, however, is where his area is considerable and he has in addition other mountain land calling for reclamation. Two years is generally long enough for the small farmer to leave his land in grass.

Hill land, after being put through a continuous-cropping rotation, can, of course, be kept in grass for a fairly long period, but the cost of doing so and the comparatively poor returns obtained should decide the small farmer to keep on at the tillage. Let there be no resting on the oars. The best grass that ever grew will not bring in the same return as forage-crop growing.

It is, of course, intended to consume all the crops on the land where they are grown. Even the hay or ensilage which is saved should be fed on the land. In suitable weather the latter food can be given to the stock whilst grazing the winter pasturage and in bad weather will be fed in a movable shed erected in the field, and the manure resulting afterwards carted out and spread.

The growing crops will, of course, be folded off, by use of a movable fence in case of cattle and by netting where sheep are fed.

THE WALKING MANURE CART

Naturally, eating the crops on the land means tremendous labour economy, for not only is all the trouble of carting crops avoided, but, in addition, with the exception of the little manure which accumulates in the sheds and which only has to be carted a few yards, manure carting is also avoided. In short, the stock consuming the crops where grown means using the stock as walking manure carts.

Again, with the exception of a little vetch and some-

times seeds hay, all harvesting is dispensed with, or rather the stock does the harvesting, converting the crops into milk, mutton, beef, and pork.

Another point is that the tillage is spread out over seven of the best months of the year—in late spring, summer, and autumn, *when the rain is the greatest help instead of the greatest hindrance to tillage operations*. The plenteousness of the rain in hill districts has already been referred to, and it is in such districts that the intensive growing of forage crops can be developed to the maximum, and where tillage operations *in virtue of the summer rainfall* are reduced to the minimum.

In addition to all these labour economies, the actual labour involved in the tilling of mountain land, in accordance with the rotation given, is so little as to be almost incredible. By taking advantage of the rainfall, the vigorous root action of the crops grown, each helping to break up the land for the succeeding crop, the natural inclination or “fall” of the mountain land and modern implements, we need only plough once in the entire rotation. The ploughing is done in breaking up the grass root for winter pasture. After that, the rest of the tillage can be done with a disc-harrow, a cultivator, the spring-toothed harrow, and sometimes a light finishing or chain-harrow.

A ONE-WAY PLOUGH

As regards ploughing to begin with. This, on a steep hillside, should be done with a one-way plough; not the ordinary type of one-way plough which has one plough-body in the soil and the other standing on its head in the air, because the great weight of this type of plough, its cumbersomeness and general top-heaviness prevent its being used under these conditions.

No, the right kind of one-way plough for a hillside is the swing-under type. With one of these implements there is nothing to do, when the end of a furrow is reached, but lift up the stilts, touch a lever with the toe, and the plough-breast and share swings from one side of the plough to the other. Of course, all the furrows will be thrown downhill, but the fact that this is so renders the work easier, and, in addition, the sods are packed tighter together.

For the subsequent cultivations, always carried out when the soil is moist, in summer and autumn, the implements previously mentioned will suffice.

After ploughing, the first implement to be used is the disc-harrow. Now if the incline is fairly slight, this implement can be worked at right angles to the incline, but if at all steep, the top section of the disc does very little work due to the canted position of the implement.

DISC-HARROWING STEEP LAND. SOME USEFUL HINTS

The best way of working the disc-harrow on a hill is to go up idle and come down with the disc set to the lowest depth. In ascending the hill, the disc should be clear of the hill, which means getting a disc with an easily operated transport attachment.

In most makes of disc-harrows, the transport arrangement is a separate concern altogether, and is only used for travelling along a road and often requires the help of two or three men to mount the machine on the transport. There is a disc made, though, the Howard, on which the transport wheels are slung behind, and in that position keep the disc steady when at work.

To take the discs out of the ground all that need be done is to pull a cotter-pin out which supports a lever, and move the horses onward. Automatically the harrow mounts the transport wheels. To put the discs

into action, a pull on the lever and the putting back of the cotter-pin is all that need be done.

It should also be seen that the disc purchased has a swivel wheel front, and in working a hill, lift the front of the machine fairly high, so as to make the discs cut deeper.

Another advantage of working up and down the hill is that two horses have no difficulty in working a big three-horse disc. Travelling on the wheels going up the hill, it is very light draught, and coming down the hill, of course, reduces the pull. The over-lap stroke mentioned in a previous chapter should also be used in working the disc.

After discing, the land may or may not require the cultivator. That will depend on the nature of the soil. This implement, like the disc, can be used up or down or across according to the slope of the land.

Next, level and harrow the land fine with the spring-tooth, broadcast the seed, cover in winter-green seed with the grass-harrow, and bigger seed, vetch, etc., with the spring-tooth.

The land should also be rolled. Rolling, of course, must be done across, as on a steep hillside nothing short of an elephant could pull a roller against the hill. There are some hillsides, indeed, where a roller can't be used even crossways with safety. In this case the land can be firmed with a plank-leveller, which any handy-man can make for himself, planks or old railway sleepers being used for the purpose. A temporary firming of the land is sufficient, since as soon as there is a bite on the land, sheep or young cattle can be allowed out to graze, and in grazing will firm the land.

CHEAP AND QUICK TILLAGE

This whole operation of cultivating an acre of mountain land is done in a day by a man and a team

of horses. Another man will in the day mix, spread the artificials, and sow the seed, and if, as in the second year, the crop is winter greens, we have from 20 to 25 tons per statute acre of luscious green feeding, *at less than the cost of thinning out an acre of turnips.*

In like manner, the cultivation, sowing and manuring of an acre of tares, as in the third year, will scarcely exceed in cost the single operation of ploughing an acre of stubble in preparation for roots.

A LABOUR-SAVING SYSTEM

Now, if steep mountain land be tilled on the ordinary system, which means leaving the land idle for a long winter period, when the maximum rainfall occurs a lot of the soil gets washed down the hillside, and one may often see mountain farmers who follow this system carting the soil from the bottom to the top of a field ; —playing at draughts with the land, I call it.

All this frightful labour is avoided by the continuous-cropping system, because the land is always covered with a crop in winter and need only be idle for a couple of weeks in summer, between the sowings. Hence, just as happens when the land is in grass, washing of the soil is avoided, the growing crop binding the soil together and preventing this.

Other advantages equally applicable to any of the rotations mentioned are :—

1. The land is practically never idle from start to finish of the rotation, and the large amount of fodder grown enables two or three times the number of stock to be fed.

2. More stock means more manure, which increases the humus or vegetable matter in the soil. The fact also that at every cultivation a fairly dense stubble is turned in also helps in this direction. This constant turning in of humus has a marked effect on the physical

and chemical properties of the soil, and also on soil temperature, a very important point indeed.

3. Having the land carrying a crop in winter prevents the nitrogen and other fertilising elements from being washed out, as happens under the ordinary system. The heavier the rainfall, the greater the loss in this direction.

4. The growing of such leguminous crops as vetches and clover so often in the rotation stores up a large amount of free nitrogen from the air.

FEWER BOUGHT FOODS NECESSARY

Again, the growing of such albuminous foods as vetches and winter greens reduces the necessity for buying so much albuminoids in the form of foreign cakes and meals (cotton, soya, palm-nut cake, and meal, etc.) for the compounding of balanced rations. Such foreign foodstuffs are essential with the ordinary farm crops, since balanced rations cannot otherwise be compounded.

To go back once more to the question of labour ; equipped with the necessary implements and three horses, two men, and a youth to help in the folding and tending of the stock, can till 100 acres of a mountain farm in accordance with the rotation mentioned on page 117, provided all the crops are consumed where grown and only dry stock is kept.

CHAPTER XIV

WINTER PASTURES

THE writer has tried many types of winter pasture, but does not feel at present able to make anything approaching a definite statement as to which is best. As with many other features of continuous cropping, there is a lot still to be learnt on this point. Again, circumstances alter cases—the winter pasturage suitable to one set of conditions does not best suit others.

For sheep feeding, Giant Essex rye with a little scarlet or crimson clover answers very well. This may be sown in April, May, or June, the seeding being about 12 st. of rye and 2 to 3 st. of vetch, or 10 lb. of scarlet clover per statute acre.

The vetch and rye mixture is sown like an ordinary corn crop, but when crimson clover is sown, the rye is put in first, and, under the last stroke of a light harrow, the crimson clover is broadcasted. In either case the land is well rolled after, the roller being followed with the grass-harrow, to roughen the surface, prevent "baking," and to conserve moisture.

Sown at the time mentioned in a moist district, the crop will be ready for its first grazing with sheep or young cattle, or even pigs, about six or eight weeks later.

On the lowland and in southern districts, 3 or 4 st. of winter barley can be used in place of an equal quantity of rye.

RYE AND RAPE PASTURE

Another very good winter pasture can be made by sowing 9 st. of Giant Essex rye and 3 lb. of giant rape per statute acre. Here the rye will be put down in late May and about a fortnight later, when it has appeared above ground, the rape broadcasted, and covered in with the light harrow and roller, damp weather being chosen for the sowing of the rape. In cold, wet districts the rape prevents the rye from getting lodged in winter, and also protects it from frost.

As before and under the conditions previously mentioned, a certain amount of winter barley can be substituted in place of rye. Marrow-stem or thousand-headed kale may also replace part of the rape.

A winter pasture can likewise be formed with rape alone sown about mid-June, but for this crop on lea, the land should be ploughed early in spring or in winter if possible, and worked down to a fine tilth before the seed is sown. In fact, a good tilth for any summer-sown winter pasture is very desirable, and is best obtained by disc-harrowing the grass-land both before ploughing and after.

Where rape is sown alone, it can be broadcasted, but if it is intended to graze the crop with pigs, it is better to sow the crop in rows about a foot apart. This can be done by putting in the seed with a seed-barrow and stopping the requisite amount of holes to ensure the seed dropping out in rows 12 inches apart ; or the seed can be first broadcasted and, when the crop is in rough leaf, the cultivator run through, leaving it in rows, or the Planet junior single row drill can be used.

One advantage of sowing in rows is that whilst grazing, pigs will not unduly trample the land. They will always walk in the rows and eat from each side,

'cutely stepping clear over the crop in passing from row to row. Again, growing in rows permits of the running of the cultivator through the crop after each grazing, which has the effect of freshening up the soil and preventing the growth of weeds.

A winter pasture of rape alone is suited to either sheep, cattle, or pigs. Even dairy cows for a large part of the winter, late autumn, and early spring will greatly appreciate an hour or so on the rape, and their owner will appreciate it too, when he finds how such green feeding increases the milk flow, and, other experiments notwithstanding, influences also the quality of the milk.

CHAPTER XV

FORAGE CROPS FOR PIGS

BRIEFLY, without having made any precise experiments, the writer considers that 6 or 7 lb. of rape is as good value for pig feeding as 4 lb. of potatoes, which in turn is equal to 1 lb. of Indian meal, or 6 lb. of separated milk. A ton of rape can, of course, be produced at less than one-tenth the cost of potatoes. The great point, however, is that we can have the rape in summer and autumn, when potatoes are not available. Further, the labour of attending forty pigs grazing is not as great as that necessary for feeding four inside a house, since all the cooking, cleaning out, and manure carting is done away with.

I once kept an account of feeding twelve pigs in the old style and found that, charging potatoes at £2 per ton, Indian meal at the then cost price of £6 15s. per ton, and separated milk at 1d. per gallon, it cost 52s. 6d. to produce a hundredweight of pork which sold at 47s. 6d. per cwt. The pigs, in other words, "died in debt," like many others have done fed in the same way.

Other farmers then—about eight years ago—realised that pigs fed on the old style did not pay, and hence much of the present pig shortage.

The method I follow now with summer pigs is to turn them out when about ten weeks old, generally about mid-May, on a winter pasture, the pasture

having been previously grazed with sheep or young stock in March and April.

Whilst they are on the forage crop, meal and separated milk are given to the pigs, starting with a daily allowance of 1 lb. of meal and $\frac{1}{2}$ gallon of milk per pig, and increasing as follows :—

Scale of feeding 10–12-weeks-old pigs whilst grazing forage crops

		Meal		Separated Milk
1st period of 4 weeks..		1 lb.	..	$\frac{1}{2}$ gallon.
2nd	„	2 lb.	..	$\frac{3}{4}$ „
3rd	„	3 lb.	..	1 „
4th	2 weeks..	4 lb.	..	1 „
5th	„	6 lb.	..	1 „

In this way each pig consumes during the entire grazing period of sixteen weeks $2\frac{3}{4}$ cwt. of meal and 91 gallons of milk. The meal consists of ground oats or rye, or, if purchased food, equal parts of Indian meal and pollard.

Putting the home-grown meal at 1s. per stone, and the separated milk at 1d. per gallon,* the cost of the trough food will be £1 10s. 5d., and in the sixteen-week period the pigs will increase about $1\frac{1}{4}$ cwt. live weight, yielding 70 per cent. or 7 st. of dressed carcase, which at, say, 84s. cwt. is worth 70s. 6d. Thus the value of the grazing is about £2 per pig.

The meal is not cooked but fed raw, being simply mixed with the milk, well stirred up and allowed to soak a few hours before feeding.

Separated milk is all important in the successful raising of pigs, but where it is unprocurable either some vetches, lucerne, sainfoin, or clover should be cut, carted, and fed in the fold, or a little of each of these should be sown with the rape.

* Separated milk is not so cheap in Great Britain as in Ireland, but a corresponding calculation can easily be made,

The other kinds of winter forage pasture mentioned all contain either clover or vetch, and these crops supply the essential albuminoids which, in the absence of separated milk, the dietary would otherwise lack.

Depending on the weight of the crop grown, it will require four acres to summer feed thirty pigs in this manner, but food from the same plots, as already indicated, would be available in spring, autumn, and a good part of the winter for other stock.

A NETT PROFIT OF £15 PER ACRE

The value of the food produced from the winter pasture, consumed by stock other than pigs, would more than cover the entire cost of growing the winter pasture, so that from the pigs alone a clear profit of £15 per statute acre is obtained, the value of the pig manure produced being put against the attendance.

The thirty pigs would not be given the run of the whole four acres, but be folded on about an acre at a time, and the fold changed every fortnight. By the time the fourth acre was eaten down, the first acre folded would be ready again.

In practice I find it a very good plan to alternate the folding of pigs with sheep and young stock. Weanling calves do remarkably well on a forage pasture, especially rape, or rape and vetches mixed, whilst the value of this feeding for sheep is already well known.

In the folding of pigs, ordinary strong wire-netting is used, but one strand of barbed wire should be run inside the netting, and about 6 inches from the floor, to keep the pigs from trying to get under the netting. Further, the pigs should be rung to prevent rooting. They should also be provided with a rough shelter from the sun, and accustomed to a little green feeding before being turned out on the crop.

CHAPTER XVI

CAPITAL AND CONTINUOUS CROPPING

THE great bar to an immediate adoption of continuous cropping or any intensive system of tillage by the small farmer, and often the big farmer, is the lack of capital.

Even where capital is limited, however, the small farmer can do much by making an economical use of what he has. For instance, if a farmer could annually invest in his holding the large amount he at present annually spends in the purchase of feeding stuffs his capital would very soon increase. This is possible by raising cheap home-grown food, especially of an albuminous nature, like many continuous crops are, and thus dispensing to a large extent with the present very heavy cake bills.

Again, one often hears of smallholders in England paying heavy prices for farmyard manure, up to 8s. per ton by the time it is on the land. Now, a crop of, say, giant rape, can be grown at a cost of from 2s. 6d. to 3s. per ton, and after being consumed on the farm by stock its manurial value per ton will be—according to the Leeds University Table on Manurial Values—4s. 3d. per ton.

A twenty-ton crop of rape can easily be grown to the acre. This, consumed, will certainly fertilise the land as well as twenty tons of farmyard manure, which even at 5s. per ton will cost £5 per acre, whereas the cost of producing twenty tons of giant rape at the outside will

only be £3. We mustn't forget, too, that we have a crop worth at least as much as 10s. per ton, or £10 per acre, as food, apart from its manurial value.

ECONOMICAL USE OF CAPITAL

In like manner the manurial value of green vetches is 5s. 8d. per ton, and twelve to sixteen tons per statute acre can be raised worth as food £8 to £10 per acre and costing about £4 per acre to produce.

Further, in the table referred to, it is assumed that the food is consumed indoors, and the manure stored in a heap, the further assumption being that one-half the nitrogen and one-fourth of the phosphate are lost in storage. But by consuming the crop on the land there would be practically no loss of these two ingredients, and hence the manurial value of giant rape and kales would be approximately 7s. and green vetches 9s. per ton of food consumed respectively.

Again, whilst the ultimate aim of our smallholder should, as has been frequently stated, be dairying, there are few at the outset who could purchase sufficient dairy cows to consume all the crops, grown under the system recommended, on a holding. The question arises would not one kind of stock require as great a capital outlay as another?

The answer is a very emphatic "No."

The general recommendation made throughout these pages is first to convert the three sources of production—land, labour, and capital—into crops, and afterwards convert the crops into live stock and live-stock products, and subsequently into cash. Bearing this in mind, we can take a concrete case of the validity of the previous statement.

Suppose a small farmer had, say, £80 for the purchase of stock, which stock he required for the purpose

of eating his crops. In normal times he could purchase five two-year-old bullocks for this amount at £16 per head which a year later he could sell at £22 a head, leaving a gross profit of £30. For the same amount he could buy (in normal times) 20 weaned calves at £4 per head, which, if well fed, would certainly sell for £10 a head in twelve months, or £200 in all, leaving a gross profit of £120.

The twenty calves would certainly consume more food than the five bullocks, but certainly not three times as much, whereas the gross profit from the calves is four times greater than from the bullocks. That is to say, young dry stock for the smallholder is more profitable than old dry stock, for the very obvious reason that in the case of the former more attention and labour are required which the small farmer and his family invest in the stock by attending to them.

Again, if a small farmer has a surplus of milk, along with a patch of summer fodder crop to consume, then instead of buying a bullock or weaned calves, his best investment would be three or four young sows, which in early autumn with their litters would be worth three or four times what they cost.

CONTINUOUS CROPPING AND DAIRYING MEANS CONTINUOUS CASH

In like manner, instead of paying high prices for calving cows for the dairy herd at which he is ultimately aiming, the small farmer should raise instead of buy dairy cows. Once a dairy herd has been started, then there is a regular supply of cash coming in, and it is this feature, together with the facilities which dairying offers for the conversion of the family labour into cash, which makes tillage dairy farming ideal for the small man on the land.

One more point. As a temporary expedient until capital is available to carry out continuous cropping and dairy farming to its fullest extent, more attention can be given to the ready-money crops, like potatoes, than would be the case under a full fodder-cropping system.

It is not to be assumed that at any time it is recommended to carry twenty in-milk dairy cows on a twenty-acre farm. This, except in very exceptional circumstances, is impossible, because of the lack of sufficient houses. A portion of the stock must be dry, which in many districts will scarcely require houses, except such as can be provided by the erection of cheap movable sheds, fully described in another section.

Also, it will always be necessary to have a certain amount of young stock coming in to replace those in the herd. At present it would probably pay best for the small dairy farmer to sell out his dairy cows at their third calf. At that time they will bring their best price. An exception to this recommendation should be made in the case of an exceptional milker, say, over 700 gallons per annum, which should be retained for breeding purposes to ensure keeping a heavy milking strain in the herd.

With the mountain farmer and others remote from a town, or creamery or other market for his milk, he has no alternative but to keep a large proportion of dry stock, and, as before recommended, young dry stock and also sheep, a breeding flock for preference.

Whilst it is not recommended to keep twenty dairy cows on twenty acres of land, to repeat, the ultimate aim should be to keep *the equivalent of a cow to the acre*, at least to the acre tilled, and the further aim of the smallholder should be to till every acre.

In Ireland the equivalent of a full-grown beast or dairy cow is spoken of as a "Collop." There are

different standard "collops" in use, but generally speaking the following may be taken as typical :—

1 dairy cow	..	..	..	.. equals 1 collop
1 horse	..	..	..	.. " 1 "
1 beast (2-3 year old)	..	..	..	.. " 1 "
3 beasts ($1\frac{1}{2}$ -2 year old)	..	..	..	.. " 2 "
2 " ($1-1\frac{1}{2}$ year old)	..	..	..	.. " 1 "
3 " ($\frac{1}{2}$ -1 year old)	..	..	..	.. " 1 "
4 " (under $\frac{1}{2}$ year old)	..	..	..	.. " 1 "
4-5 hoggets (according to breed)	..	..	..	.. " 1 "
3-4 ewes, with lambs (according to breed)	..	..	..	.. " 1 "

On the typical twenty-acre tillage farm, taken as our example throughout this book, in actual practice (having reference to the matter of providing sufficient housing accommodation) the actual stock kept might be as follows :—

2 strong cobs, or 1 horse and 1 cob, say,	equal	2 collop
10 dairy cows		10 "
3 in-calf heifers (2-3 year old)		3 "
3 in-calf heifers (1-2 year old)		2 "
4 calves from $\frac{1}{2}$ -1 year old)		1 "
8 calves (under $\frac{1}{2}$ year)		2 "
Total		20

This would give a total head of thirty stock.

From the ten dairy cows we might reasonably expect eight calves, of which, with ordinary luck, there would be three heifer calves.

The bull calves could be sold as veal or weaners before they were six months old. The heifers would be kept on and at about a year and nine months, if well fed, put to the bull to calve down at about two and a half years old. This would permit of the selling out of about three dairy cows per annum, the heifers replacing them, or if there were sufficient housing room, the size of the dairy herd could be increased, and the number of young dry stock diminished.

To take another example of stock farming, say, in a mountain farm of forty acres, where no suitable market for milk existed and having five acres of second year's grass, as in Rotation B, we could stock something like the following :—

2 horses and 1 cob	..	..	..	equal 3 collop.
8 dairy cows	..	..	..	„ 8 „
2 in-calf heifers (2-3 year old)	..	..	..	„ 2 „
3 beasts (from 1½-2 year old)	..	say	..	„ 2 „
12 „ (from ½-1 year old)	..	..	..	„ 4 „
12 „ (under ½ year old)	..	..	..	„ 3 „
35 breeding ewes and 1 ram	..	say	..	„ 9 „
20 hoggets	..	..	..	„ 4 „
Total				— 35

This represents 1 “collop” per acre of tilled land, leaving five acres of grass for summer pasture, and allowing for a few pigs to be kept, which are not included in the above estimate.

The dairy cows would supply the house with butter and milk and leave sufficient for feeding, with the addition of meal, the twelve calves, as well as allowing a little milk for pig raising. On such a farm the raising of calves and pig feeding with milk and forage crops should be an important feature.

Also in hilly districts it is not recommended to keep cattle over two years old, except a heifer or so to replenish the dairy herd, but to sell them before they reach that age. This means selling as forward stores, instead of attempting beef production, which would not be very practical in exposed districts. The stores, in fact all the cattle, except the calves, will be wintered out of doors, but provided with movable sheds as shelter in very severe weather.

Stores wintered out are better for grass or stall finishing than indoor-fed stock.

IN- AND OUT-FEEDING

Many is the argument the writer has had on this point with both scientific and practical men, their argument against out-feeding being that "heat means meat."

This is true enough in theory, but in practice "outside feeding means health" and a keen appetite, both of which mean thriving. Further, the loss of food in cold weather is less than theory would indicate. A beast kept out of doors will grow a coat on it like a Shetland pony and does not suffer as much in consequence as the sleek-coated, in-fed animal.

With out-fed animals there is no cooking, pulping and general "finicking" of the food to persuade the animal to eat it. In short, there is no more labour in feeding 100 cattle outside than 25 indoors. Add to this the economy of being able to eat the food where grown and to produce the manure where wanted.

It will also be noticed that in the examples of stocking given, the stock is varied. It is, as with cropping, a very safe policy not to have too many eggs in one basket. Sudden fluctuations in the market value of any particular kind of stock are less liable to result in financial loss on a varied stock farm than on one where only one or two classes of stock are kept.

SHEEP ON THE MOUNTAIN FARMS

As to the sheep on a mountain farm, probably flying flocks will be best, rather than sticking to the same stock year after year. For instance, ewes could be bought in the autumn and put early to the ram, say, about late September or October. The lambs would then be dropped in late February and March. With the land cropped on the plan recommended there would be abundance of green food. The lambs

would be sold early, and the ewes cleared out in the autumn fat.

The hoggets could also go out in October. On the other hand, there being no sheep on the land in winter would permit of buying a few young store cattle in the autumn and selling in the spring-time.

There is good money to be made at the business, for when the grass makes an appearance in spring, stores invariably make a far better price per cwt. than in the autumn, when due to the small amount of arable land in the country, many farmers have to sell, lacking food to winter their cattle on.

This buying for resale, though, needs a man with an eye for a likely beast, and his head screwed on tight to his shoulders, and if, as in the writer's case, the buying has to be done in an Irish fair, he also needs a tongue sharp enough to clip a thorn fence.

As a final word, in stocking land, the small farmer should always buy young in preference to more matured stock—something he can increase in capital value by putting both his crops and his labour into, something that, as it is commonly phrased, “will grow into money.”

CHAPTER XVII

MANURES AND THE MANURING OF CONTINUOUS CROPS

ONCE we have toned up the fertility of the soil by the continual home consumption of continuous crops, the expenditure on artificials will be very light, but in the initial stages we have to depend very much on artificials for the production of these crops. In other words, the policy recommended is to turn artificial manures into fodder and forage crops, and then, by consuming these, largely increase the available supply of natural manure. Some farmers seek to improve their land by buying a large amount of feeding stuffs, but all the writer's experience goes to show that £1 spent on artificials from the standpoint of increased soil fertility is worth as much as £8 spent on feeding stuffs.

THE SCIENTIFIC PRINCIPLES OF MANURING

There are four essentials of plant life—phosphates, potash, nitrogen, and lime. Completely abstract from any soil any one of these four constituents, and it will be found absolutely impossible to grow any plant in it. That is to say, assuming a soil to be devoid of phosphates then the heaviest possible dressings imaginable of potash, nitrogen, and lime will not make the soil capable of maintaining vigorous plant life.

Yet, whilst all crops require phosphates, potash, nitrogen, and lime, they do not require them in the same proportion. Pasture land, for instance, responds

very freely to an application of phosphatic manure, and seldom requires much nitrogen. Again, the most important ingredient in a potato manure is potash, while turnips require, as a general rule, very little potash, but must have a liberal supply of phosphates.

Just one step further, and we have the principle of manuring on the tip of the fingers. A saying, as true as it is old, states that "one man's meat is another man's poison." Exactly the same applies to plant nutrition.

Pork steak is very nourishing, but feed a dyspeptic on pork for a week, and at the end of it, he won't want any more food—a coffin will better supply his needs. In the same way, if a boggy pasture be deficient in phosphates and assuming the pasture to be of a very acid nature—that is to say, short of lime—a dressing of superphosphates which consists essentially of phosphates, will not increase the yield of pasture, but will decrease it; whilst on the other hand, basic slag which again consists essentially of phosphates, would on such land produce marvellous results.

The explanation is, that the phosphates of slag exist in a different chemical condition from those contained in superphosphate, and the former manure contains a certain amount of lime which helps to neutralise the acidity of soils.

This brings us to a consideration of the second part of the subject.

Let it, before we go further, be clearly understood that the value of artificial manures depends entirely upon the amount of phosphates, potash, and nitrogen they contain. Some artificial manures, such as superphosphates, contain phosphates alone; others like muriate of potash contain potash alone. Nitrate of soda and sulphate of ammonia only contain nitrogen, while slag contains phosphates and lime,

Again, there are artificial manures which contain two of the ingredients. For instance, phosphatic guano and bone meal contain both phosphates and nitrogen, whilst Peruvian guano and many compound manures contain all three ingredients, and are spoken of as complete manures ; that is to say, they contain, if properly blended, the three ingredients of farmyard manure, and, like farmyard manure, can be continually used, if necessary, on land in conjunction with lime, without the slightest fear of permanently exhausting the soil, if a suitable rotation of crops is adopted.

In order that farmers may have a perfectly clear idea of the composition of artificial manures, a matter which every farmer should know as well as he does the days in the week, we will now give a table setting out the approximate percentage of fertilising ingredients in the chief artificial manures.

PHOSPHATIC MANURES—	Phosphates	Percentage Contents.		Lime
		Potash	Nitrogen	
Superphosphate . . .	26-35	—	—	—
Basic Slag . . .	24-42	—	—	20-40
Bone Ash . . .	80	—	—	—
Bone Meal . . .	50	—	2-3	—
Rock Phosphate . . .	50-70	—	—	—
Phosphatic Guano . . .	50	—	2-3	—
POTASSIC MANURES—				
Kainit . . .	—	12	—	—
Muriate of Potash . . .	—	50	—	—
Sulphate of Potash . . .	—	48	—	—
Potash Manure Salt . . .	—	20-30	—	—
NITROGENOUS MANURES—				
Nitrate of Soda . . .	—	—	15.5	—
Sulphate of Ammonia . . .	—	—	20	—
Nitrolim . . .	—	—	16-20	50

In addition to the above we have Peruvian Guano and compound manures. The former, through its comparative cost, has largely gone out of use except

in gardens. As previously stated it contains nitrogen, potash, and phosphates, as do also, generally speaking, special or compound manures.

Regarding these latter manures, they are simply mixtures of the raw ingredients mentioned in the above table. As a rule they are sold at a price far exceeding their value, and the practical farmer, speaking generally, would be well advised to have nothing to do with them but to blend his own manures according to the kind of land he wishes to manure and the kind of crop he wishes to grow.

We can also classify manures according to whether they are acid, alkaline, or neutral, that is, neither acid nor alkaline. This classification is of importance, especially as regards the phosphatic manures, because, as previously indicated, acid manures on an acid soil, i.e. one deficient in lime, will give poor results, and in extreme cases will do more harm than good. On the other hand, acid manures on an alkaline soil, i.e. one containing lime, will invariably give a more economical return than alkaline manures.

Regarding this, one cannot, however, dogmatise, as the writer amongst others has obtained extremely good results by applying such an alkaline manure as basic slag on pure limestone or chalk pasture. Nevertheless the principle of alkaline manures on acid soils should always be followed and also the contrary, acid manures on alkaline soils, except when experiments prove that alkaline manures in the latter case are more profitable.

As to the neutral manures they will give good results on either type of soils, but, with the exception of rock phosphate, better results on alkaline than on acid soils. In short, if a soil is acid, that is, deficient in lime, *the best thing to do is to lime it and make it alkaline.*

Table classifying manures into :—

ACID	ALKALINE	NEUTRAL
*Superphosphates	Basic Slag	*Nitrate of Soda
*Dissolved Bones	Nitrolim	Kainit
*Dissolved Guano		*Muriate of Potash
Sulphate of Ammonia		*Sulphate of Potash
		Potash Salts
		Bone Meal
		Rock Phosphate

In the above table the manures indicated by * are soluble manures, that is, quick-acting. The rest are less soluble and slow-acting. Nitrate of soda is extremely quick-acting and should on any class of soil or crop be used when it is necessary for any reason for an early bite of green food, or when attacked by pests, or in very dry weather.

Sulphate of ammonia is much less soluble than nitrate, therefore slower-acting and more suitable for autumn application than the latter. Nitrolim occupies a position intermediate between the two. This manure should never be applied direct to a growing crop, as it has a tendency to burn the foliage. It should be worked into the land during cultivation.

The solubility or otherwise of a manure is of great importance, as, in districts of heavy rainfall, a soluble manure applied in autumn will result in loss. This loss will be most marked in mountainous districts or soils of free drainage. For this reason in such districts, other things being equal, preference in the use of phosphatic manures should be given to bone meal, basic slag, or ground rock phosphate. The last is the cheapest form of phosphate, and will only give good results in districts of fairly heavy rainfall, especially if the soil be fairly acid, e.g. peaty or moory soil short of lime.

THE TEST FOR LIME

From the foregoing it may be gathered, that in planning out a manurial system it is highly important first to ascertain whether the land is deficient in lime. In order to do this, samples of soil should be taken from different parts of the field, about one sample per acre, well mixed together and rubbed fine.

Then taking about a handful of the thoroughly mixed samples, spread it out on a deep plate. Next completely cover the soil with spirits of salts (commercial hydrochloric acid) and stir with a stick. If any effervescence or "fizzing" takes place, even to a slight extent, the farmer will be safe in saying that the land contains lime. If there is no effervescence, then the soil is lacking in this ingredient.

Several tests should be made from the mixed samples, as one or two may not be very decisive. The samples may be taken to the depth of 7 inches, and the best means of taking them is to use a wide-bore augur. With this bore a hole into the soil and through a board, which is laid on the surface of the land. Whilst the augur is being bored into the ground, the soil is deposited on the board. Another good method and still simpler is to drive a piece of iron pipe, about $1\frac{1}{2}$ -inch bore, into the soil to a depth of about 7 inches. The pipe on being withdrawn will contain a core of soil, typical of the surface soil from top to bottom.

Throughout the book standard manurial formulas, suitable for the different crops, have been given, but with the additional information given above the intelligent farmer can often get far better and more economical results,

CHAPTER XVIII

MANURING CONTINUOUS CROPS IN MOUNTAINOUS DISTRICTS

In order to demonstrate the different modifications which may be introduced in the manuring of a continuous rotation, we will deal fully with the manuring of Rotation D, recommended for continuous cropping in mountainous districts. Under such conditions, the land is usually very poor, and farmyard manure generally unavailable, or if available, presents the difficulty of carting. At the outset we are entirely dependent on the use of artificials.

The standard rotation referred to is as follows :—

First year.—Summer-sown winter pasture.

Second year.—Summer-sown winter greens.

Third year.—Autumn-sown vetches and grass seeds hayed in June of following year.

Fourth year.—Seeds hayed or pastured.

Fifth year.—Seeds pastured.

MANURING THE WINTER PASTURE

Now in the very first year of this rotation (the statement is equally applicable to other rotations) it is necessary to be very liberal in the use of artificials, the object being the growth of a good supply of food to be converted into manure, partly through the consumption of the crop on the land, and partly resulting from the root and stubble of the crop. *The*

more liberal we are in the first year's manuring the less we shall need to spend in subsequent years.

The manuring must also be varied according to the different types of winter pasture sown. The most suitable type for average mountain conditions will be a rye pasture, with a little scarlet clover or vetches. These two latter crops belong to the order of legumes, and have the remarkable power of absorbing nitrogen from the atmosphere for their own sustenance and for the benefit of succeeding crops.

The standard manurial dressing for such a pasture will be :—

3 cwt. of 35 % superphosphate	} per statute acre.
3 cwt. of kainit	
1 cwt. of sulphate of ammonia	

MODIFICATIONS

If the land is deficient in lime, the application of from 1 ton of ground or any other form of lime per acre should also be applied, and worked into the soil after ploughing.

If lime is not easily procurable, about 4-5 cwt. of good basic slag should be applied in place of superphosphate. Even though the slag supplies a certain amount of lime, however, it would pay to give $\frac{1}{2}$ ton of lime in addition.

Now, if the annual rainfall is over 40 inches, or if less than this, and the land is loose by nature, then 3 to 4 cwt. of bone ash or bone meal should be used in preference to either slag or superphosphate. If bone meal is used, containing, say, 2 per cent. nitrogen, 4 cwt. will supply to the soil about 9 lbs. of nitrogen, or as much as will be contained in three stones of sulphate of ammonia, so that the dressing of this manure may be reduced by this amount.

At the time of writing kainit, of course, is not procurable, but as a general rule most soils, especially heavy soils, contain a sufficiency of potash for a few years, but the potash is inert or locked up. The application, however, of the slag or lime will generally liberate a sufficiency for present needs.

If the soil is fairly retentive, or a good seed-bed has not been obtained, or the sowing is late, or for any reason it is desirable to push on the crop in its early stages, nitrate of soda, about $1\frac{1}{2}$ cwt., may be substituted for the sulphate of ammonia.

Even on poor land, the manures recommended may be depended upon to give a good growth, but if the land is very poor, then the quantities of the different ingredients applied may well be increased.

MANURING WINTER-RAPE PASTURE

In case a rape pasture or rape in conjunction with a certain amount of rye is sown as a winter pasture, then kainit, except on very light soils, may be omitted.

The whole success of growing a good clean crop of rape depends upon a good start. This in turn depends upon fine tillage, and a good supply of quick-acting nitrogenous manures. For this reason, preference should be given to nitrate instead of sulphate, and about 2 cwt of this manure used per acre, although 1 cwt. of nitrate and 1 cwt. of sulphate will be better for heavy-rainfall districts. The other phosphatic manures must also be used in slightly heavier dressings than for the rye pasture, say, about an extra cwt. per statute acre. Lime must also be applied where the land is deficient in this ingredient.

The winter-pasture crop will all be consumed on the land, leaving it in fine condition for the succeeding crop of winter greens. It should also be mentioned

that if a rye pasture is sown, the winter greens following will be rape, kale, etc.

If rape be sown first, it will not do to sow rape a second time, as there may be a danger of finger-and-toe disease. Therefore a good portion of rye with scarlet clover or a little vetch may follow the rape. Kales may also follow rape. These, belonging to the same order as rape, are also subject to "finger-and-toe," but in the writer's experience by varying the different types of cruciferous crops—rape, kales, hardy greens—after each other, he has never had a case of finger-and-toe. This may be due to the fact that the spores which cause the disease are in a resting stage in winter.

The winter-green crop will not require very much manure, about 2 cwt. of a suitable phosphate and 1 cwt. of a nitrogenous manure per statute acre being generally ample.

The winter greens also will be eaten where grown, and in this way a magnificent crop of tares can then be obtained, without any further manuring. Again, after the tares, seeds hay will not require manuring, whilst the seeds for soiling and folding in the fifth year will do quite well with whatever farmyard manure has accumulated. In fact this will be the most convenient time to apply the farmyard manure to the crop.

Roughly, the cost of the manure and lime in the first year's break will be about £2 15s. and in the second year £1 per statute acre, giving a total expenditure on manures of about £3 15s. per acre during the five years of the rotation, or an annual expenditure of about 12s. 6d. per annum per acre, which must be considered low in comparison with the amount of food produced.

CHAPTER XIX

FOOD AND THE FEEDING OF CONTINUOUS CROPS

No farmer, be he large or small, can hope to get the best results from the feeding of his stock, who has not at least a working knowledge of the scientific principles involved in foods and feeding. Standard rations may be given, but, like standard manurial formulas, they can more often than not be improved upon by the man who has a brain and will use it.

All food can be divided into the digestible and indigestible portion. From the feeder's standpoint we need only concern ourselves with the former. This digestible portion becomes "dissolved" in the animal's stomach, absorbed into the blood stream, goes to repair the different parts of the body, and supplies the animal with heat and energy. This portion is spoken of as the MAINTENANCE DIETARY of the food.

All the digestible part over and above that required for maintenance is utilised for the production of various animal products. This is called the PRODUCTIVE DIETARY and in the case of a dairy cow goes to form milk and help in the building up of the unborn calf, whilst in bullocks, pigs, and store sheep it goes to produce beef, pork, and mutton respectively, and also wool in the sheep. This is the case also with ewes, in which the productive dietary helps in the building up of the unborn lambs, and the milk for the lambs when born.

MAINTENANCE AND PRODUCTION

The fact that a large portion of the food supplied to an animal goes to maintenance, in other words simply serves to keep the animal living, whilst the surplus goes to produce increase of weight, milk, etc., is all important.

For instance, a bullock weighing 10 cwt. wants about 1 st. of meadow hay and 3 st. of swedes per day, practically half a daily ration, as a maintenance diet. *It is the food over and above this quantity which is available for the putting on of flesh.* Therefore the shorter the fattening period can be made without of course risking over-feeding, the less dead loss there is as regards the maintenance dietary.

In the case of pigs, sheep, and dairy cows, this loss from under-feeding is more pronounced. Hence the folly of a large number of farmers, in Ireland especially, of keeping dairy cows dry all winter—cows which are dairy cows in summer and pensioners in winter.

THE REAL NUTRIENTS OF FOOD

We can further subdivide the digestible portion of food into three parts, known respectively as (1) albuminoids or as this part is sometimes called protein, (2) fat or oil, and (3) carbohydrates. Each of these food ingredients has a definite function to perform in the animal body.

Just as a man who sets about building a wall wants a certain amount of brick or stone, lime and sand, so does a beast in the building up of its body or in the manufacture of such products as milk or wool require each of the particular food ingredients mentioned above for the purpose.

We can carry the analogy still further. The brick-layer or stonemason will require brick or stone, lime and sand in certain proportions. If, for instance, he has

sufficient lime and sand for the making of the requisite amount of mortar for 20 rods of a wall, and only sufficient stone or bricks for 10 rods, then the wall-building must cease when the 10 rods is erected, until a further supply of building material is obtained. In like manner a beast must have the proteins, oils, and carbohydrates in certain proportions for its proper nourishment.

Now, if the builder has a sufficient supply of brick or stone, but a deficiency of either sand or lime, he can continue building an inferior type of wall—a dry wall—without the lime. In like manner a beast fed on albuminoids and carbohydrates, but without the third ingredient, oil, can continue living and even increase in weight, because the carbohydrates and fat are interchangeable.

Again, a beast can be fed—but not economically—on albuminoids and fat without carbohydrates. As in the building of the dry wall, though, the results of feeding on two foods are not as good as when the three substances are available.

Without either sand or lime a perfectly dry wall can be erected with brick or stone alone, and in like manner a beast can—again not economically—be fed for a time on pure albuminoids. *This is because the albuminoids can fulfil the functions of both fat and carbohydrates*, but the point to be especially remembered is that NEITHER FAT NOR CARBOHYDRATES CAN BE CONVERTED INTO OR FULFIL THE FUNCTIONS OF ALBUMINOIDS. In other words, no matter how liberally a beast be fed on fat or carbohydrates, in the absence of albuminoids, the beast will die.

THE ALBUMINOID RATIO

The fat and carbohydrates in a food are often spoken of as the non-albuminous portion, and the albuminoids or protein as the albuminous.

Realising the necessity for a ration to have the digestible ingredients of a food in certain proportions, scientists have devised what is known as the albuminoid ratio. This means the ratio between the albuminous food and the non-albuminous, when the fat in a food is expressed in its carbohydrate equivalent. That is to say, 1 lb. of digestible fat is as valuable for nutrition as 2.3 lbs. of carbohydrates, so that the method of determining the albuminoid ratio is to multiply the digestible fat by 2.3, add to it the digestible carbohydrates, and divide the sum obtained by the amount of the digestible albuminoids.

For instance, in 100 lbs. of milk we have—

Digestible albuminoids 3.25 lbs.

Digestible fat 3.75 lbs.

Digestible carbohydrates 4.75 lbs.

According to formula :— $(\text{Fat} \times 2.3 + \text{carbohydrates}) \div \text{albuminoids} = \text{the albuminoid ratio.}$

In figures, the albuminoid ratio

$$= \frac{3.75 \times 2.3 + 4.75}{3.25} \\ = 13.375 \div 3.25 = 4.11$$

The answer is approximately 4. That is to say, the albuminoid ratio of new milk is as 1 to 4, or, for every 1 lb. of digestible albuminoids in milk, there are 4 lbs. of digestible non-albuminoids.

BALANCED AND UNBALANCED RATIONS

Now, when a ration contains a proper proportion of digestible albuminoids to digestible fats and carbohydrates, it is spoken of as a balanced ration. On the other hand, if there is a deficiency of albuminoids, or, what amounts to the same thing, an excess of fats or carbohydrates, the ration is unbalanced.

All this may seem very complicated, but, after all, it is only common sense. Potatoes, for instance, when eaten alone, do not contain sufficient albuminoids for a human being, and hence would not keep a man in health, and, apart from this, if fed on nothing else the man would become nauseated. Neither would a man keep in health and live on a purely albuminous dietary like lean meat. The same applies to farm animals.

Rice or Indian meal is comparatively deficient in albuminoids for pig feeding, and whilst a fairly well-grown pig could be fed on it, it would thrive very slowly and probably get rickets. That the pig would thrive on either meal, even though slowly, is due to the fact that it would eat a large amount of the meals in order to get a sufficiency of albuminoids, which means passing through its body unused the excessive amount of carbohydrates.

MEASURING FOOD VALUES

Just as we can express the length of a wall in feet and inches, the quantity of a liquid in pints and the weight of a substance in lbs., the heat of a substance in degrees, so have we a unit to express the true values of a food. This unit is known as the STARCH VALUE. That is to say, scientists have found just exactly what the food value of a pound of starch was, and expressed all food values in terms of starch.

For instance, the starch value of linseed cake is 76, which means that 100 lbs. of linseed cake for feeding purposes—assuming it to be used in a properly balanced ration—is equal to 76 lbs. of starch. In like manner the starch value or equivalent of 7 lbs. of vetch hay is 2.59, which means that this quantity of vetch hay has the same feeding value, approximately, as $2\frac{1}{2}$ lbs. of starch.

The starch value of foods, in a manner which need

not be here described, is calculated from the total amounts of digestible albuminoids, fats, and carbohydrates in a food, and hence enables us at once to see the nutritive value of a food without referring to the amounts of the particular food ingredients which the food contains.

THEORY AND PRACTICE—A SHORT CIRCUIT

A study of the foregoing is useful in order to get a thorough grip of the principles underlying the science of feeding. In practice there is not the slightest need to worry about the percentage of digestible oil and carbohydrates, or to calculate albuminoid ratios in the manner described. Neither is there any need, as nearly all text-books state there is, to study the amount of dry matter or digestible fibre in a ration.

All that need be considered by the practical man in making up a ration is the amount of digestible albuminoids and the starch value of a ration. If these two things are correct, there is bound to be a sufficiency of non-albuminous food and dry organic matter in any practical ration, a fact which seems to have been lost sight of by writers of scientific text-books.

Further, by only considering the two factors mentioned and also by giving the actual weight of digestible albuminoids contained in, and the starch value of, such quantities of foods as are usually used in practice (instead of giving the percentage composition only as the text-books do) we can make a short circuit in the calculation of food rations. In short, the whole science of compounding rations can be boiled into such a simple and brief calculation, that any man, even a farm labourer, can use the system.

We now give a table showing the total amounts of digestible food ingredients, and the starch value of different foods. The quantities of food stated are such

as are usually used in the daily rations for farm animals. In accordance with what has been said before, there is really no reason for the compounding of foods to include anything more in this table than the figures relating to the digestible albuminoids ("proteins" is the same thing) and the starch value, but the amounts of digestible oil, fat, and carbohydrates are included in order to admit of useful comparison being made between the different kinds of foods.

TABLE SHOWING DIGESTIBLE CONSTITUENTS, STARCH VALUE OR EQUIVALENT CONTAINED IN CONTINUOUS CROPS AND OTHER FOODS

Food	Quantity stones of 14 lbs.	Digestible Quantities			
		Oil or Fat lbs.	Carbo- hydrates lbs.	Protein or Albu- minoids lbs.	Starch Value lbs.
Oat Straw .	$\frac{1}{2}$	·035	2·73	·07	1·33
" "	1	·07	5·46	·14	2·66
" "	$1\frac{1}{2}$	·105	8·19	·21	3·99
Wheat Straw .	$\frac{1}{2}$	·035	2·38	·017	·84
" "	1	·07	4·76	·034	1·68
" "	$1\frac{1}{2}$	·105	7·14	·051	2·52
Barley Straw .	$\frac{1}{2}$	·035	2·8	·035	1·33
" "	1	·07	5·6	·07	2·66
" "	$1\frac{1}{2}$	·105	8·4	·105	3·99
Meadow Hay .	$\frac{1}{2}$	·07	2·87	·28	2·17
" "	1	·14	5·74	·56	4·34
" "	$1\frac{1}{2}$	·21	8·61	·84	6·51
Clover Hay .	$\frac{1}{2}$	·1	2·66	·385	2·17
" "	1	·2	5·32	·77	4·34
" "	$1\frac{1}{2}$	·3	7·98	1·155	6·51
Mixed Vetch and Cereal Hay .	$\frac{1}{2}$	·07	2·898	·724	2·59
" "	1	·14	5·796	1·448	5·18
" "	$1\frac{1}{2}$	·21	8·694	2·172	7·77

	Food	Quantity stones of 14 lbs.	Digestible Quantities			
			Oil or Fat lbs.	Carbo- hydrates lbs.	Protein or Albu- minoids lbs.	Starch Value lbs.
ROOTS	Mangolds	1	·014	1·26	·014	·98
	„	2	·028	2·52	·028	1·96
	„	3	·042	3·78	·042	2·94
	„	4	·056	5·04	·056	3·92
	Swedes	1	·014	1·12	·035	·98
	„	2	·028	2·24	·07	1·96
	„	3	·042	3·36	·105	2·94
	„	4	·056	4·48	·14	3·92
GREEN FORAGE CROPS	Hardy Green Turnips	1	·035	·7	·07	·84
	„	2	·07	1·4	·14	1·68
	„	3	·105	2·1	·21	2·52
	„	4	·14	2·8	·28	3·36
	Rape	1	·07	·84	·21	1·12
	„	2	·14	1·68	·42	2·24
	„	3	·21	2·52	·63	3·36
	„	4	·28	3·36	·84	4·48
	Kales	1	·07	·98	·21	1·26
	„	2	·14	1·96	·42	2·52
	„	3	·21	2·94	·63	3·78
	„	4	·28	3·92	·84	5·04
	Green Rye	1	·07	2·66	·196	1·58
	„	2	·14	5·32	·392	3·16
	„	3	·21	7·98	·586	4·74
	„	4	·28	10·64	·784	6·32
	Green Vetches	1	·035	·98	·28	1·12
	„	2	·07	1·96	·56	2·24
	„	3	·105	2·94	·84	3·36
	„	4	·14	3·92	1·12	4·48
	Italian Rye Grass	1	·07	1·58	·18	1·69
	„	2	·14	3·16	·36	3·38
	„	3	·21	4·74	·54	5·07
	„	4	·28	7·32	·72	6·76

Food	Quantity stones of 14 lbs.	Digestible Quantities			
		Oil or Fat lbs.	Carbo- hydrates lbs.	Protein or Albu- minoids lbs.	Starch Value lbs.
Vetch Silage .	1	·1	1·75	·41	1·47
„ „	2	·2	3·5	·82	2·94
„ „	3	·3	5·25	1·23	4·41
„ „	4	·4	7	1·64	5·88
	lbs.				
Decorticated Cotton Cake .	1	·085	·2	·34	·71
„ „	2	·17	·4	·68	1·42
„ „	3	·255	·6	1·02	2·13
„ „	4	·34	·8	1·36	2·84
Undecorticated Cotton Cake .	1	·05	·2	·155	·4
„ „	2	·1	·4	·31	·8
„ „	3	·15	·6	·465	1·2
„ „	4	·2	·8	·62	1·6
Earth Nut Cake .	1	·095	·2	·4	·79
„ „	2	·19	·4	·8	1·58
„ „	3	·285	·6	1·2	2·37
„ „	4	·38	·8	1·6	3·16
Palm Nut Cake .	1	·095	·36	·14	·72
„ „	2	·19	·72	·28	1·44
„ „	3	·285	1·06	·42	2·16
„ „	4	·38	1·44	·56	2·88
Cocoa Nut Cake .	1	·095	·39	·17	·78
„ „	2	·19	·78	·34	1·56
„ „	3	·285	1·17	·51	2·34
„ „	4	·38	1·56	·68	3·12
Linseed Cake .	1	·095	·32	·25	·76
„ „	2	·19	·64	·5	1·52
„ „	3	·285	·96	·75	2·28
„ „	4	·38	1·28	1·	3·04
Maize or Indian Meal .	1	·045	·68	·07	·84
„ „	2	·09	1·36	·14	1·68
„ „	3	·135	2·04	·21	2·52
„ „	4	·18	2·72	·28	3·36

	Food	Quantity lbs.	Digestible Quantities			
			Oil or Fat lbs.	Carbo- hydrates lbs.	Protein or Albu- minoids lbs.	Starch Value lbs.
GRAIN CROPS	Wheat (Grain) .	1	·012	·65	·09	·73
	" "	2	·024	1·3	·18	1·46
	" "	3	·036	1·95	·27	2·19
	" "	4	·048	2·6	·36	2·92
	Oats (Grain) .	1	·053	·45	·09	·63
	" "	2	·106	·9	·18	1·26
	" "	3	·159	1·35	·27	1·89
	" "	4	·212	1·8	·36	2·52
	Rye (Grain) .	1	·01	·65	·09	·72
	" "	2	·02	1·3	·18	1·44
	" "	3	·03	1·95	·27	2·16
	" "	4	·04	2·6	·36	2·88
	Barley (Grain) .	1	·017	·64	·07	·74
	" "	2	·034	1·28	·14	1·48
	" "	3	·051	1·92	·21	2·22
	" "	4	·068	2·56	·28	2·96
SUNDRY FOODS	Field Beans or Bean Meal .	1	·012	·48	·19	·67
	" "	2	·024	·96	·38	1·34
	" "	3	·036	1·44	·57	2·01
	" "	4	·048	1·92	·76	2·68
	Wheat Pollard or Sharps .	1	·03	·56	·12	·74
	" "	2	·06	1·12	·24	1·48
	" "	3	·09	1·68	·36	2·22
	" "	4	·12	2·24	·48	2·96
	Potatoes .	1	·001	·19	·001	·19
	" "	2	·002	·38	·002	·38
	" "	3	·003	·57	·003	·57
	" "	4	·004	·76	·004	·76
	" "	5	·005	·95	·005	·95
	Treacle .	1	—	·55	—	·48
	" "	2	—	1·1	—	·96
	" "	3	—	1·65	—	1·44
	" "	4	—	2·2	—	1·92

Food	Quantity gallon	Digestible Quantities			
		Oil or Fat lbs.	Carbo- hydrates lbs.	Protein or Albu- minoids lbs.	Starch Value lbs.
New Milk .	$\frac{1}{2}$	·175	·237	·162	·8
„ „	1	·35	·474	·324	1·6
„ „	$1\frac{1}{2}$	·525	·711	·486	2·4
„ „	2	·7	·948	·648	3·2
Separated Milk .	$\frac{1}{2}$	·005	·25	·175	·4
„ „	1	·01	·5	·35	·8
„ „	$1\frac{1}{2}$	·015	·75	·525	1·2
„ „	2	·02	1·	·7	1·6

FEEDING STANDARDS

In addition to ascertaining the starch values or equivalents of foods, Kellner, a famous German agricultural chemist, conducted a large number of epoch-making experiments, and drew up tables showing the amount of digestible protein required per day, as well as the starch equivalent of the daily ration necessary for the economical feeding of farm animals. These tables may be studied in any modern text-book, as well as in the admirable translation made by Dr. Goodwin of Kellner's work.*

It may be here stated that whilst the writer has found Kellner's feeding standard very useful in his practical work, he is of the opinion that the amounts of digestible proteins recommended by Kellner seem in several instances to be too low for the requirements of animals in this country.

For instance, for an 11-cwt. cow giving 2 galls. of milk per day, Kellner recommends a ration containing 2 lbs. of digestible albuminoids per day, and having a

* Published by Duckworth and Co,

starch equivalent of from 10.75 lbs. to 12 lbs., and for such a cow when yielding 1 gall. of milk per day from 1.1 to 1.4 lbs. of digestible protein, the total daily ration having a starch equivalent of from 8.5 to 9 lbs. Now, when a good dairy cow, one say which will yield 4 galls. of milk per day at her flush period, has declined in her milk yield to 1 to 2 galls., she has reached the stage when, if in calf, an extra strain is thrown upon her.

Fed strictly according to the Kellner standard, she will come to the calving time in a weak and poor condition. The result is that the calf may also be weak, and invariably after calving, a large amount of food which should go to milk production, is used to tone up the cow. In plainer language, the thin dairy cow, after calving, "puts the fat on to her ribs instead of into the pail," or if by nature she is a heavy milker she loses weight during her flush period. Better fed when drying off or when dry, such a cow would improve in her condition and have a reserve, which she could afford to lose during the heavy milking period.

The importance of keeping dairy cows reasonably well fed in the later stages of the milking period, and also when dry cannot in the writer's opinion be over-emphasised. Again, in the case of a cow, which is not in calf, when she has commenced to dry up, it is then generally more profitable to feed her well, so that she is fat for beef when finished milking rather than keep her even on a low dietary and a long time dry.

CHEAP PROTEIN

It must also be kept in mind that Kellner and others who have written on the feeding of farm animals, have always had at the back of their minds the very high cost of albuminous foods, which under the ordinary system means in practice the purchased

foreign foods. Hence in compounding rations the general recommendations would be to keep the albuminoids or proteins in a food at the minimum, but in the continuous-cropping system we grow a large amount of cheap albuminous food, and strict economy in its use is not so essential.

CHAPTER XX

NEW FEEDING STANDARD FOR MILCH COWS

As a guide, the following table of feeding standards is put forward by the writer. Later experiments conducted by those who have more time for the purpose than he has, may demonstrate that the table and the continuous-cropping rations recommended are not the most economical. For the time being, the rations may be put forward with confidence since they are such as the writer uses in practice, and by their use he is able to produce milk, beef, and mutton at about one-half the cost involved where stock are fed on ordinary farm crops, with the necessary complement of purchased albuminous feeding stuffs to form balanced rations.

It will also be of interest to state that in arriving at these continuous-cropping rations, the chief method followed has been that of the comparative principle of ascertaining the digestible protein contents, and the starch equivalents of well-known ordinary rations, and then compounding the continuous-cropping rations of approximately the same composition.

TABLE SHOWING STANDARD RATIONS RECOMMENDED FOR
DAIRY COWS OF ABOUT 10 CWT. LIVE WEIGHT

	Digestible Protein lbs.	Starch Equiv. lbs.
When dry or yielding 1 gal. of milk per day	1.5	9
Yielding $1\frac{1}{2}$ gals. per day	1.75	10
2 " "	2	12
$2\frac{1}{2}$ " "	2.5	13.5
3 " "	3	15
$3\frac{1}{2}$ " "	3.5	16.5
4 " "	4	18

It will be noticed that in the table, starting with a 2 gals. per day cow as standard, an additional $\frac{1}{2}$ lb. of digestible protein is allowed and the starch equivalent of the ration is increased by $1\frac{1}{2}$ lbs. daily for every additional $\frac{1}{2}$ gal. of milk yielded.

As an example of the use to which the table given can be put and to demonstrate the comparative principle, previously referred to, on which rations may be compounded, a winter dairy cow yielding from $2\frac{1}{2}$ to 3 gals. of milk per day would be considered to be well fed on a daily dietary of $1\frac{1}{2}$ st. of meadow hay, 4 st. of swedes, 3 lbs. of decorticated cotton cake, and 3 lbs. of maize meal. We can set out the digestible protein and starch equivalent of this ration in the following manner:

RATION No. 1

Food	Digestible Protein lbs.	Starch Equiv. lbs.
$1\frac{1}{2}$ st. meadow hay	·84	6·51
4 st. swedes	·14	3·92
3 lbs. decorticated cotton cake	1·02	2·13
3 lbs. maize meal	·21	2·52
	<hr/>	<hr/>
Total	2·21	15·08

This ration, according to the table, whilst having a correct starch equivalent even for a 3-gal. cow, is deficient to the extent of approximately $\frac{3}{4}$ lb. of digestible protein per day for such an animal; whereas the following continuous-cropping ration has practically the same starch equivalent and contains over 3 lbs. of digestible protein.

RATION No. 2

Food	Digestible Protein lbs.	Starch Value lbs.
1 st. of vetch hay	1·44	5·18
1 st. meadow hay	·56	4·34
5 st. of rape	1·05	5·6
	<hr/>	<hr/>
Total	3·05	15·12

In the case of a cow yielding, say, 4 gals. of milk per day, it would not, as may be supposed, be sufficient to increase the quantities of each of the foods contained in Ration 2, in order to supply additional nourishment. So doing would make the ration too bulky.

In practice, 2 st. or 28 lbs. of dry fodder is about as much as a cow can consume, especially when 5 or 6 st. of green fodder is also being fed. It may also be mentioned that fed on green fodder alone a cow will consume up to 9 or 10 st. per day.

We may look upon No. 2 as a basal ration, and for a cow yielding over 3 gals. of milk per day (or even $2\frac{1}{2}$ gals. if the cow is in poor condition) obtain the higher starch equivalent required, and the extra digestible protein by feeding concentrated food.

A useful rule to follow would be to allow about 2 lbs. of concentrates for every $\frac{1}{2}$ gal. of milk over the 3 gals. standard, or over $2\frac{1}{2}$ gals. if the cow is in poor condition.

According to the table a 4-gal. cow would require a daily ration equivalent to 18 lbs. of starch and containing 4 lbs. of digestible protein.

The question arises what concentrates should be used to bring the basal or No. 2 ration up to this standard? The basal ration contains :—

	Digestible Protein	Starch Equiv.
and 4 lbs. of maize meal in	3.05	15.12
addition gives . . .	.28	3.36
Totals . . .	3.33	18.48

The starch equivalent of the ration is near enough for practical purposes, but the digestible protein is deficient to the extent of a little over $\frac{1}{2}$ lb. If, however, we substitute 2 lbs. of earth-nut cake in place of 2 lbs. of the maize meal, we get a ration—Ration 3—with a

starch equivalent of 18.3 and containing 3.9 digestible protein, which is near enough to the standard.

Another method by which the feeding value and protein contents of the ration could be increased, without purchasing foreign feeding stuffs, would be by substituting more vetch or clover hay in place of an equal weight of meadow hay, and using home-grown grain as concentrates. Example :—

RATION 4

Food	Digestible Protein in lbs.	Starch Equivalent in lbs.
1½ st. vetch and cereal hay .	2.17	7.77
½ st. of meadow hay .	.28	2.17
6 st. rape	1.26	6.72
3 lbs. crushed oats	.27	1.89
Total	3.98	18.55

To take a further illustration of the “comparative principle.” It is recommended in the Board of Agriculture leaflet No. 79 to feed a 2 gals. per day cow on the following daily ration :—

RATION 5

Food	Digestible Protein in lbs.	Starch Equivalent in lbs.
56 lbs. swedes	.14	3.92
14 lbs. oat straw	.14	2.66
3 lbs. oats	.27	1.89
2 lbs. bean meal	.38	1.34
3 lbs. decorticated cotton cake	1.02	2.13
Total	1.95	11.94

The above ration is recommended for an arable farm, where straw is abundant. The following continuous-cropping ration, which also contains straw, would have practically the same starch equivalent but would be richer in digestible protein, being in addition compounded entirely from home-grown food :—

RATION 6

1 st. oat straw	} containing 2·42 lbs. of di-
1 st. vetch and cereal hay	
4 st. kale	
	gestible albuminoids with
	12·88 starch equivalent.

WET OR FROSTY WEATHER WINTER RATIONS

There will be times in winter, during frosty or very wet weather, when it may not be possible to use winter greens, kale and rape for the feeding of dairy cows. Under such circumstances, as previously stated, we shall have to resort to such succulent food as vetch and cereal silage or mangolds. Suitable rations for a 3-gallon cow containing these ingredients are as follows :—

RATION 7

2 st. vetch and cereal hay	} containing 2·96 lbs. of digest-
5 st. mangolds	
	ible albuminoids, with 15·2
	lbs. starch equivalent.

A ration containing silage as a succulent food would be :—

RATION 8

1½ st. meadow hay	} containing 3 lbs. of digest-
½ st. vetch and cereal hay	
3 st. vetch and cereal silage	
3 lbs. ground rye	
	ible albuminoids, with
	15·6 lbs. of starch equivalent.

SPRING RATIONS

In the month of April the green food would usually be in the form of green rye. A suitable daily ration at this period would be :—

6 st. green rye	} containing 2·98 lbs. digestible
1 st. vetch and cereal hay	
2 lbs. bean meal	
	protein, with 16·0 starch
	equivalent.

THE VALUE OF GREEN FOOD

The bean meal and vetch and cereal hay being astringent would counteract the laxative tendency of

the green rye. The writer considers the above ration one of the best he has used. Whether there is something in green feeding we yet do not properly understand, there is no doubt that such feeding has a value far above that indicated by its chemical composition. The same remark applies to such green feeding as kale and rape fed in winter, and green soiling crops, e.g. vetches and rye grass, in summer.

If the supply of vetch and cereal hay or dry fodder has become exhausted by spring-time, as often does happen, or if a supply of home-grown beans is not available, or decorticated cotton cake is comparatively cheaper than bean meal, the latter could be sold and decorticated cotton cake, which is also an astringent, used to replace it. When fed in conjunction with decorticated cotton cake, the rye can be used more liberally, say, up to 8 st. per day. With this quantity, 4 lbs. of decorticated cotton cake would be necessary to form a suitable ration, without any long fodder.

SUMMER RATIONS

Later, in early summer—May and June—according to our rotation, we shall have available both rye grass and green mixed vetches, from 4 to 5 st. of each being given per day according to the amount of milk yielded. In addition cattle giving over 3 gals. of milk per day would repay for one or two pounds of concentrated food, at least in Great Britain, but in Ireland where summer milk is often sold at from 4½d. to 5d. per gal., it would scarcely pay to use concentrates.

According to our standard rotation, on our 20-acre holding, we should have available for green food 4 acres of Italian rye grass and 4 acres of vetches. The former would give three and sometimes four crops in the summer, and the latter at least two. Well manured, an average minimum of 20 tons of green fodder per statute acre can be obtained from these crops.

SOME USEFUL CALCULATIONS

From the feeding standpoint our summer will be from, say, May 1st to October 7th, that is 160 days, a very convenient unit to work by. If we allow an average feed of 8 st. of green soiling per day each collop will consume during the summer 8 tons. Therefore, each acre yielding 20 tons of soiling, we shall have a sufficiency of this food on 8 acres to feed 20 collop.

Let it be emphasised that 20 tons of green fodder per acre per annum should be regarded as a minimum. It may not be possible to exceed this yield, or even obtain it in the first few years but after a time, in virtue of the greater fertility of the soil, resulting from cropping land on the principle recommended, far heavier yields can be obtained.

The writer has several times obtained a total annual yield of 25 to 30 tons of rye grass and 25 tons of vetches. If a surplus of these crops is available it can always be converted into hay.

As previously stated, on our typical 20-acre holding, during the winter months we shall have available 36 tons of fodder (vetch hay and clover hay) and 160 tons of forage and roots, as well as 24 tons of potatoes, which sold at the moderate price of £2 10s. per ton, give £60 to be spent on litter, oats for the horses and concentrates for the cattle.

THE FEEDING IN AUTUMN

To continue the feeding throughout the year. For the remaining portion of October, the first winter-green crops, preferably kale or rape sown after the vetches in the second summer of the rotation, will be ready for consumption. These winter-green crops at that time of the year, remote from the flowering stage, can be fed very liberally to cattle, up to 8 st. per day,

without any danger of tainting milk, provided the feeding is done outside and always after milking.

The horses, of course, cannot be fed on rape.

The remaining 18 "collop" from the 8th to the 31st of October, receiving an allowance of 1 cwt. per day per collop, will, allowing for a little wastage, consume the produce of one acre yielding 25 tons.

This acre, well manured, will yield in the following April at least another 10 tons of rape. The available forage and roots from the 1st November to April 30th will therefore be 160 minus 25 tons consumed, plus 10 tons of a second crop of rape or kale, that is, 145 tons, or for the 18 collop would allow, during the period mentioned, 160 days, an average daily feed per collop of 8 stone.

THE DISPOSAL OF DRY FODDER

Making an allowance of 30 cwt. per horse of dry fodder for the winter months, we shall have 33 tons of this food available for the remaining 18 collop, or from the 1st November to April 30th, when dry fodder will be necessary, a daily allowance of 2 st. Taking one period with another, that is, averaging the food requirements of a dairy cow during the time she is dry, also when yielding both a low and a high milk yield, the average daily requirements of a mixed dairy herd will be about the equivalent of 12 lbs. of starch.

Two stone per day of dry fodder (equal parts vetch and clover hay) equal 9.5 lbs. of starch, whilst 7 st. per day of the various types of winter greens and roots will be approximately equal to 8 lbs. of starch. It is therefore easily seen that on this basis we shall have more food in our forage and fodder crops than is necessary for the feeding of the 18 collop.

It must be borne in mind that all the winter stock will not be dairy cows. Nevertheless the daily starch allowance of 12 lbs. will suffice for the feeding of the

equivalent of a dairy cow in the form of dry stock and sheep. That is to say, if two dairy cows require daily food with a starch value of 24 lbs. and three store cattle from 1 to 2 years old are equivalent to 2 dairy cows (2 collop), then each of the latter will be liberally fed on a daily ration having a starch value of 8 lbs.

Of course, the proportion as well as the amount of fodder and forage used to the stock will be varied in the case of dairy cows, according to the milk being yielded, and in the case of young stock according to their age, the latter receiving a more liberal dietary at the end than at the beginning of the winter.

A VERY USEFUL FACTOR

The method of estimating the food requirements of the farm stock has been fully explained because in practice it is extremely useful and very necessary to make such calculations. Not only is it essential for the farmer to feed properly balanced rations, but in doing so, he needs to exercise care that throughout the winter a sufficiency of the different types of food, albuminous, dry fodder, and forage, will at all times be available.

Apart from continuous cropping, the writer has found it extremely useful and very necessary to follow the system of calculation indicated.

Briefly stated, the system is to reduce all the food on the farm to its starch value and then by dividing the total starch value by 12 (the figure representing the starch value of the average daily requirements of an animal) estimate the number of stock which can be carried through the winter.

Farmers who neglect to make some such calculations often find themselves, on the approach of spring, in difficulties and frequently have to purchase food at a high price, similar food to that which, in the previous autumn, they foolishly sold at a low figure.

CHAPTER XXI

NEW FEEDING STANDARD FOR DRY STOCK

THE comparative principle of first ascertaining the starch value and the digestible protein contents of a well-known ordinary ration, and then compounding a continuous-cropping ration of like composition and value is equally applicable to all other kinds of stock.

For instance, the ration stated below is recommended in the Board of Agriculture's leaflet No. 7 for cattle from 6 to 12 months old :—

	Digestible Protein	Starch Value
8 lbs. meadow hay . . .	·32	2·48
2 st. swedes . . .	·07	1·98
2 lbs. oat straw . . .	·02	·38
2 lbs. linseed cake . . .	·5	1·52
2 lbs. oats . . .	·18	1·26
Total . . .	1·09	7·62

A continuous-cropping ration consisting of—

4 st. of hardy greens . . .	{	containing 1·05 lbs. of digest- ible protein, with 7·7 starch equivalent
1 st. clover hay . . .		

would be equally useful.

It will be understood that both are average rations. At 6 months old the weaned calves would be consuming only about two-thirds of each ration, the amount of food increasing as the animal increased in age.

CALVES ON "WINTER-GREEN CROPS"

The actual method followed by the writer in feeding weaned calves is to turn them out wherever possible on a plot of rape, say, from September to the end of November. Whilst on the rape, as a corrective, they receive about 1 lb. per head per day of palm nut or cocoanut cake and have a little clover or vetch hay placed in a rack, which they can eat as they desire.

Later, they are put into a movable shed in which the dry fodder is fed on a more liberal scale and the cake increased to 2 lbs. per day. For succulent food, they are allowed, except in very wet or frosty weather, to graze a piece of winter greens an hour or so every day. During unsuitable weather, when out-grazing is not possible, the youngsters receive in the shed an allowance of from 2 to 3 st. of roots or $1\frac{1}{2}$ to 2 st. of vetch silage. Fed this way, the calves are very healthy. Hoose, the bane of the calf rearer, need not be feared since the pest causing this disease is not to be found on the winter-green crop.

Further, being hardier than in-fed "coddled" animals, they are better able to withstand other ailments. The greater advantage of out- as compared with in-feeding is most marked in the following summer, whilst the way calves thrive when grazing rape pasture cannot fail to strike the least observant.

In the leaflet mentioned above a standard fattening ration for young cattle from 18 to 24 months is as follows :—

$\frac{1}{2}$ st. meadow hay	.	.	.	} containing 1.48 lbs. digestible protein with a starch value of 11.4 lbs,
$\frac{1}{2}$ st. oat straw	.	.	.	
4 st. swedes	.	.	.	
2 lbs. ground nuts	.	.	.	
2 lbs. linseed cake	.	.	.	
2 lbs. undecorticated cake	.	.	.	

An alternative continuous-cropping ration not costing more than half the preceding one, and necessitating no trough food, would be :—

2 st. vetch and cereal silage	} containing 1·9 digestible protein with 11·07 starch value.
1 st. oat straw	
4½ st. kale	

Space does not permit of our giving further instances of the application of the comparative principle of blending continuous-cropping rations. With the examples already supplied, however, and with the help of the table, no difficulty will be experienced in compounding other rations for any other class of stock.

AGRICULTURAL AND NATIONAL ECONOMY

One feature deserving special attention in connection with the continuous-cropping rations is that unlike ordinary rations very few—in several instances none at all—foreign feeding stuffs are used. This is of importance not only from an agricultural, but from a financial and a *national* standpoint. The economic war will really commence in these countries when peace is declared, and the generation whose chief concern will be the patching up of the Nation's wounds, will give the matter of the importation of foreign food and the exportation of British capital far more attention than it has received in the past. At present we annually import £300,000,000 worth of foreign food for the feeding of ourselves and our flocks and herds, a sum of money which might well be kept in the country did a more productive system of agriculture prevail.

THE PREPARATION OF FOOD

Just as is the case with ordinary foods, there is room for the exercise of considerable ingenuity in the actual preparation of continuous cropping rations.

In the case of dry fodder, vetch hay, etc., particularly the latter, a small amount at least should be chaffed and mixed with a certain amount of chaffed winter silage greens, or pulped roots, and the whole allowed to ferment together for 24 hours before feeding.

Treacle is also a great appetiser, and when procurable at a cheap rate should certainly be included in a dairy cow's ration. From 1 to 2 lbs. per day can be given, dissolved in the warm water and poured over chaffed vetch hay, etc.

This making of the food appetising is well worth while in the case of dairy cows and very young stock. In the case of older cattle, except in the later stage of fattening, the writer simply "gives the food as it grows," the winter greens being eaten where grown, roots thrown out unpulped on grass land, and the dry fodder fed in movable sheds. It must be remembered though that practically all the dry stock are fed this way and fed outside, the open air acting as a good appetiser and the chief economy being in the labour saved in avoiding crop and manure carting, as well as the less labour involved in feeding cattle outside, as compared with stall feeding.

CHAPTER XXII

FOLDING BY MOVABLE FENCES AND MOVABLE SHEDS

ONE of the great economies in connection with the system of continuous cropping results from the possibility of consuming a large amount of the food in the fields where grown. Economy in this direction is not very pronounced in the case of the twenty-acre farmer, because of necessity the distance between the fields and the buildings is not very great. Nevertheless, even on such a small farm there is no use in performing unnecessary labour. Therefore, in the case of both summer and winter soiling crops, wherever practicable, the feeding should take place on the field.

At the same time, if a real saving of labour is to be made, there is room for the exercise of considerable ingenuity on the part of the farmer in using the movable folds and fences, necessary for consuming crops on the land. As the system is practised in some districts, there is really more trouble taken in shifting the folding and fencing material than there would be in carting the crops home and the manure back.

No hard-and-fast rule can be laid down as to the best system of folding. This must be varied according to circumstances. In this chapter, however, I intend to describe the best methods and to point out as clearly as possible the conditions under which each is most effective

LEAP-FROG FOLDING

This system is the most economical one for the folding of sheep, pigs, and young stock. Briefly, a

plot of 2, 4, or 6 acres is first inclosed by what we may speak of as the boundary netting. In small fields the ordinary fences will serve as the boundary fence. Then, across from one boundary to another, two or three nettings are run, two where only one fold is required and three where two are necessary.

These cross fences are shown in the illustration, marked as A A, B B, C C. A glance at the illustration will show that a new fold can be made by simply "leap-frogging" the cross-netting A A over B B, C C, to the new position shown by the dotted lines.

In the same manner the cross-netting B B can be "leap-frogged" over C C and A A to the new position shown by dotted lines and marked B B.

This double system of folding is worth a good deal of attention. Under the ordinary system of folding, especially with sheep, the animals are confined on a small space until they have completely consumed every particle of the food. Incidentally, if the land is at all heavy, by the time the fold is moved, it is a quagmire. Consequently the sheep get very wet and dirty and anything in the nature of a second growth is impossible.

Now in the case of ewes with lambs, fattening

hoggets, weaned calves, in short any class of animals it is desirable to keep in a thriving condition, this system of close folding is very unsuitable, for, of necessity, during the last few days before the fold is moved, the animals must become very hungry before they will consume the last remnants. It is far more economical to use the double folding, let the best animals eat the choice stuff and the cleaning up be done by a second lot in poorer condition. In practice also, since no animal will eat readily after its own kind, it is better to have a different class of animal contained in the second than is contained in the first folding. For instance, pigs or weaned calves could follow ewes with lambs or fattening hoggets.

On farms where the rotation described in connection with the cropping of a mountain farm is in operation, and under other circumstances where it is desirable to fold over the land more than once, the second folding, or that done by the animals we may describe as scavengers, should not be too close, that is a good stubble should be left and the land not unduly trampled. In practice it will be found that in six to eight weeks, during the growing season, the different crops described will be ready for refolding.

WINTER FOLDING

Anyone with any experience of folding sheep or young stock (it is not possible to winter-fold pigs) will appreciate the great advantage of shelter. Often, however, especially in mountainous districts, shelter is lacking. When this is so it is an admirable plan always to fold towards the prevailing wind, and, in addition, to leave about four yards on either side of the outer edge of the crop unconsumed. By this means, the growing crop around three sides of the field forms a very effective wind break. On the fourth side

ordinary wattle hurdles or some kind of shelter should be provided.

For the folding of small animals, netting, of course, is used. The uprights to support the netting are very varied; but one of the cheapest and most useful consists of a piece of square wood about $2\frac{1}{2}$ inches in diameter. This is pointed at one end, so that it can be easily driven into the ground, but the chief thing is to have a picture-hook at the top and bottom of the stake, the top one with the hook turned upwards, and the bottom one with the hook turned downwards. The distance between the two hooks should be about four inches wider than the netting, so that the netting is stretched when fixed to the stakes. These hooks are, of course, intended to obviate the necessity for fixing the netting to the stakes by the use of wire, staples, or string.

THE FOLDING OF CATTLE

Whilst the folding of sheep has long been practised, a like custom as regards cattle seems not to have been applied. True, on the Continent, where years ago they realised what a far greater revenue can be obtained from soiling than from grazing cattle, dairy cows especially, the cattle are all tethered in the fields, and the stuff carted to them. This system, the writer has also tried, but not with very good results.

Again, even where he has succeeded in getting the cattle accustomed to the idea of being tethered, the fly trouble in summer time (which perhaps does not obtain in Continental countries) has rendered the system of tethering impracticable.

The system followed by the writer now is to use movable fences. About an acre of the crop is first cut off and fed out in an adjacent pasture. Directly this acre is cleared a movable fence is erected separating the growing crop from the part which has been

cut, and every morning the stockman cuts two or three swathes of the growing crop with a one-horse mowing machine, fitted with a corn-reaping attachment. This greatly facilitates the labour of gathering the crop. The sheaves are thrown over the movable fence.

As the distance from the growing crop to the fence increases, the heaps are carried to the cattle on an ordinary hay bogie, which is fitted with "creel" sides.

There is great economy in this system of soiling. The carting of the green fodder is reduced to a minimum, and, a still greater saving, the necessity of carting out manure from the houses is avoided.

In order to distribute the manure properly, the soiling heaps should be spread over the area as evenly as possible.

The above is the system followed for summer feeding of such crops as vetch, rye-grass, etc. As a crop is cleared a second fence is run up, inclosing between the two fences about one acre for every twenty cattle. In moving the fences later, the "leap-frog" system is again followed.

Another system which the writer has followed and which he has found very useful for the winter folding of such crops as rape and kale is to erect what may be called an angle movable fence. By altering the position of a portion of the fence, an operation which only involves the removal of about four stakes, a fresh piece of food can be given to the animals every day. This system obviates the necessity of cutting the crop and prevents the trampling of the crops which would result if a large area of the crops was given to the animals. It is remarkable how intelligent cattle are, and how soon they learn (where this system of folding is followed) not to trample on the fresh portion of food.

This movable fence is quite a feature in itself. It

simply consists of three strands of wire, the top one barbed, and the two lower ones plain. A post is put down about every four yards, and to these posts the wire is fastened. The wire is not stapled to the posts. If it were there would generally be more trouble in pulling out the staples and shifting the fence than there would be in carting the crop.

One small staple is put above the wire and one below it. The wire is placed between the two, and then a slate nail with a big head is dropped behind the wire. In moving the fence the nail can be picked out with the fingers. All the other apparatus required is a barrow for a man to stand in and a mallet to drive in the posts.

Better far than a fence made of three strands of wire is one of Canadian or woven wire fencing. In fact for the angle system of movable fencing, this is absolutely necessary in order to keep the cattle from getting through. At present, of course, this is costly, but in normal times it can be purchased for about £2 5s. per 100 yards, and is well worth while.

As in the case of the three-wire fence, the woven fence is attached to the posts by the use of two staples and a large-headed nail.

Considerable labour economy can also be practised, especially in summer time, when the land is hard, by using a post hole-borer to make the holes into which the posts are fitted. In purchasing a borer, care should be taken that the diameter of the hole made by this useful implement is not greater than the diameter of the post. In fact if a 4-inch diameter hole-borer is used where 5-inch diameter posts are used, the posts will be all the more staunch when driven into the land.

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