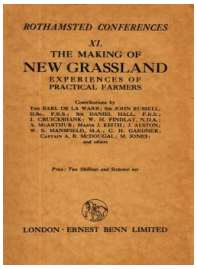
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The Making of New Grassland

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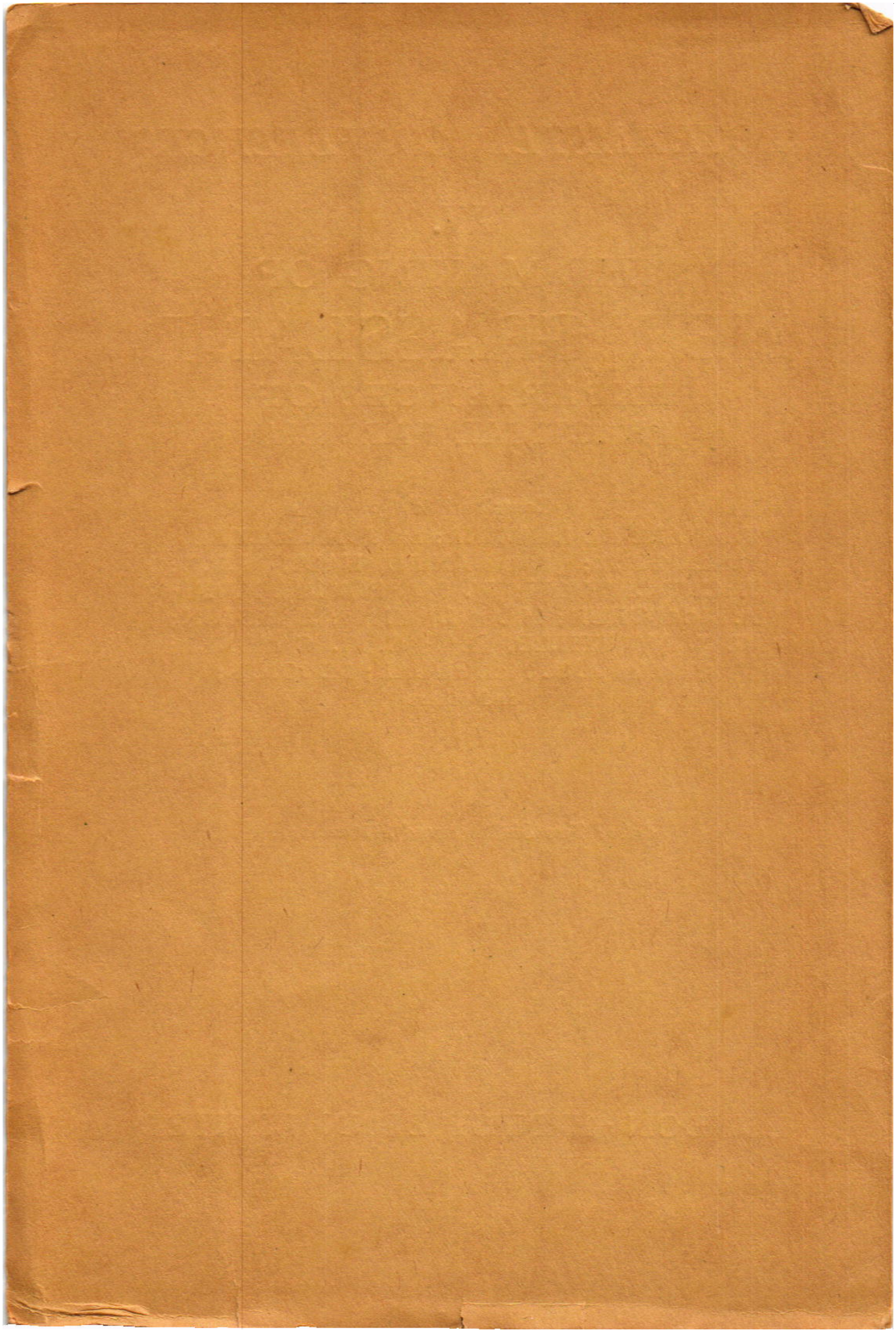
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ROTHAMSTED CONFERENCES

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THE MAKING OF NEW GRASSLAND

EXPERIENCES OF PRACTICAL FARMERS

BEING THE REPORT OF A CONFERENCE HELD AT ROTHAMSTED ON FEBRUARY 11TH 1931 UNDER THE CHAIRMANSHIP OF

SIR DANIEL HALL, F.R.S.

With Contributions by

THE EARL DE LA WARR; SIR JOHN RUSSELL, D.Sc., F.R.S.; SIR DANIEL HALL, F.R.S.; J. CRUICKSHANK; W. M. FINDLAY, N.D.A.; A. McARTHUR; MAJOR J. KEITH; J. ALSTON; W. S. MANSFIELD, M.A.; C. H. GARDNER; CAPTAIN A. R. McDOUGAL; M. JONES; and others



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INTRODUCTION

Since the war there has been a great increase in the area of land laid down to grass. The reasons are to be found in the rising cost of arable farming and the fall in prices of the final products: costs of production and prices are not related under British conditions of farming, where our own agriculturists are forbidden by law to pay less than the statutory wages, but overseas agriculturists, who pay less than our wages, can sell their products in our markets without let or hindrance. Anything that can be sent from overseas, therefore, can without difficulty drive the home-grown article off the market, and by no means yet discovered can this be prevented.

We are, therefore, consuming less and less fresh food and relying more and more on preserved imported food. The results of the Ministry of Agriculture's recent inquiry [1] show that as compared with the years before the war we eat about the same amount of food, but less of our meat is fresh and more is chilled or frozen, and may be months old before we eat it; more of our eggs are "liquid" or "dried," from China and the East; more of our "butter" is margarine, and the real butter is often many weeks old, having been made thousands of miles away. Even milk has not entirely escaped the change: the liquid milk is still fresh, but we consume per head less than half-a-pint per day, no more than before the war, though there has been an increased consumption of dried milk and condensed milk.

We are not here concerned with the question whether meat and dairy produce are better fresh or old: we have to recognize and adjust ourselves to the fact that the overwhelming majority of British housewives are profoundly indifferent, and choose the cheaper. Only the few insist upon freshness.

At the present time the most hopeful outlook for British farming is the production of milk, cheese, young meat, poultry, certain fruits and vegetables, and good-quality malting barley. The market for all is restricted, especially for the three last-named; it remains, however, still good for milk and young meat provided the cost be kept low. To these, therefore, the farmer is looking, and he is keeping down costs by laying away as much land as possible in grass, thereby dispensing with labour and reducing expenditure. It is a process we all deplore, but cannot prevent.

[1] *The Agricultural Output and the Food Supplies of Great Britain*, 1929.

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The extent to which it has gone is shown by the following figures:

ACREAGES OF CROPS IN GREAT BRITAIN (ENGLAND, SCOTLAND AND WALES) IN MILLIONS OF ACRES

	Total all Crops	*Rotation Grasses*	*Permanent Grass*	*Arable, including Rotation Grass*
1871-1875 .	31·13	4·39	12·88	18·24
1891-1895 .	32·70	4·64	16·47	16·22
1913 . .	31·93	3·97	17·57	14·36
1920 . .	31·25	3·89	15·85	15·40
1921 . .	30·87	4·03	15·91	14·97
1928 . .	30·17	3·94	16·93	13·24
1929 . .	30·09	3·87	17·03	13·05

Grass-growing presents little difficulty in the north and west, where the coolness and moistness favour a continuous growth of leaf rather than production of seed. It is, however, much more difficult in the eastern parts of England, where, indeed, it has long been regarded as impracticable for any but a one-year's clover or clover and ryegrass ley. Many experiments have been made in different parts of the country with the purpose of effecting improvements in the management of the grassland, and these, together with the accumulated experience of farmers who have recently laid land down to grass, constitute a considerable body of useful knowledge. The purpose of this Conference was to obtain from a group of practical men, carefully chosen for their success with grass in important agricultural regions of Britain, a clear statement of what they did, what they observed, and what they learned for future guidance.

The regions represented were Aberdeenshire and Berwickshire in the north, Norfolk and Essex in the east, Cambridge, Northamptonshire and Bedfordshire in the centre.

The broad results that emerged are here summarized briefly.

Soil and Climate.—In any part of Britain it is possible to obtain good grassland, even in the dry Eastern Counties. It is, however, difficult and expensive where the water-supply is too low or the land is too wet.

Necessity for good Condition of Land.—Where the general conditions are very favourable to the growth of grass, as in the north and west, there is little difficulty in establishing a sward. In the less favourable Eastern Counties it becomes important to help the young plant, and this is done by ensuring that:

(1) The land should be in good heart;

(2) The land should be free from perennial weeds, such as twitch[1]: annual weeds, however, are of less importance, as they soon

[1] *Agropyron repens.*

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die out; they may even serve a useful purpose in affording some shelter in the first winter;

(3) The land should be manured before the grass is sown, unless the manuring is liable to encourage too dense a growth of the nurse crop, in which case the manure should be given immediately the nurse crop is removed;

(4) The seed bed should be well prepared and firm.

The Sowing.—Broadcasting has obvious advantages, but in the Eastern Counties "Safety First" must always be the motto, and drilling is safer. Sowing should be early and the nurse crop light and early. Barley sown thinly (2½ bushels per acre) is suitable; in the north "bere," an unimproved early and thin-growing sort, is better than the improved varieties: spring oats can be used, but winter oats are unsuitable, as liable to grow too densely. The possibilities of rape have not been fully studied.

There has been a complete change of opinion as to the best mixture of seeds to sow. The older agriculturists favoured a mixture of many sorts: the old Roman method had been to sow the mixture of seeds shaken out from good natural meadow-hay. Ryegrass was the first of the grasses to be introduced into Britain (about 1677), and it was at first sown alone; then some of the more enterprising agriculturists mixed it with seeds from meadow-hay in the Roman fashion. Gradually definite grasses were substituted for this indefinite mixture, and by the middle of the nineteenth century some very complex mixtures were in use: in Morton's *Cyclopedia* (1855) the recipes contain some fifteen to eighteen different species. This kind of mixture remained in use to our own times, the justification being that the different species would sort themselves out and finally give a good pasture.

The introduction of wild white clover, however, revolutionized ideas of pasture-making. The large number of varieties was no longer necessary: wild white clover with ryegrass and a little cocksfoot gave perfectly satisfactory results. In the first year or two the bulk might not be very great, but after a while a good pasture resulted.

It was, however, shown that this question of the early years could be solved by the judicious introduction of a few other species, such as broad red and late-flowering red clover, timothy and meadow-grass: but these might cause trouble by injuring the wild white clover.

The present practice is, therefore, to keep to simple mixtures in the Eastern Counties, where pasture-making is difficult, thus sacrificing some present gain for the greater certainty of a good pasture. In the north and west the risks are less, and the grasses and clovers giving bulk in the early years may be introduced without harm. It will improve matters in the Eastern Counties when early bulk and later success can be combined with greater certainty: perhaps this can be done by suitable grazing, as suggested by Mr Martin Jones (p. 58).

Modern mixtures are based on wild white clover. With this rye-

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grass seems to be a natural associate: perennial is the more generally useful, though Italian makes good grazing, and a little is introduced in the more complex northern mixtures. Other plants, however, may damage the wild white clover, and the risk is much greater in dry than in moist conditions. Hence much greater care is needed in introducing further species in the Eastern Counties than in the west and north. Something must be added, because the ryegrass does not give much early keep and it does not at first completely cover the ground; on the bare patches weeds may come in and do much harm. The safest and most generally useful partner for the wild white clover and ryegrass combination is cocksfoot, but it needs some restriction. It everywhere provides valuable early food for cattle; it stands drought, and it is therefore useful for dairy stock on light land in the Eastern Counties. In the north it has the great advantage that its tussocks hold up the snow and make little heaps, which the sheep have learned to scratch aside to find the grass below. But it needs to be grazed hard or in the late summer and autumn its strong growth becomes stemmy and distasteful to stock, and, further, it injures the wild white clover. There are numerous strains of cocksfoot; some are leafy and some are stemmy, and part of the difference of opinion as to its value may arise from differences in the plants themselves. The wider use of the leafy strains—the indigenous strains—is highly desirable. But when all is said it remains true for the Eastern Counties that cocksfoot is, in Mr Mansfield's words, "a good servant but a bad master": indeed Mr McArthur of East Hertfordshire will have none of it. A small amount of timothy is also added for this same purpose of giving early food in spring and filling up the bare spaces so as to keep out weeds.

In the Eastern Counties nothing more is sown: the red clovers—broad-red, late-flowering, Montgomery, and so on—are omitted, in spite of the bulk they would give, because they may damage the wild white clover. In the north and west, with the higher moisture content of the soil, they do less harm and are therefore included, as also is alsike clover. Other plants can also be added there, and Captain McDougal's Berwickshire mixtures, with their thirteen components, begin to approach the complexities of eighty years ago, and stand in marked contrast with the Norfolk mixtures of five or six species, or Mr Gardner's Bedford mixture of four species.

The Management of the Grass.—All the farmers agreed that management was of the utmost importance: no matter how sound the mixture or how good the "take" it could speedily be ruined by mismanagement.

The central purpose, as always, is to protect the young wild white clover. In dry conditions the roots must be well pressed into the soil so as to ensure an adequate moisture-supply and a good spreading habit of growth; this pressing is best done by animals: grazing, therefore,

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is the best treatment for the first year or two in the Eastern Counties, and many other places. On heavier soils and in wetter conditions (*e.g.* Mr Cruickshank, p. 20, and Mr Elworthy, p. 61) the rain may do all the necessary compacting, and indeed the treading of animals might poach the land: here, therefore, the young crop is better hayed than grazed at first. If grazing is more convenient, some red clover can be added to the mixture to give a firmer tread and avoid poaching.

The grazing must be so done as to give the white clover every chance of growth: the grass must be well eaten down till the clover is established, but then the grazing should be less severe. At all costs however, the grass must be prevented from growing up and forming stalks; this lowers its nutritive value more than anything. If by July it is running up it should be cut with the mowing-machine.

The northern farmers insisted on the need for leaving some of the land rough during the winter in order, as already explained, to hold up snow and to provide some food for the sheep, but this should not be done too often, and at least one year in two the grass is eaten close down. In the south the necessity for winter roughness does not arise.

Rather unexpectedly no one was in favour of much winter cultivation. If the grassland be properly treated the animals do all that is needed: only rough patches or matted pastures—sure signs of something wrong—need harrowing. Indeed, Mr Gardner went so far as to claim that harrowing and rolling of grassland are signs of mismanagement!

Manuring.—All the farmers agreed about the importance of phosphate, especially basic slag, given early, either before sowing or just after the nurse crop is cut, at the rate of about 8 cwt. per acre: some had obtained good results with mineral phosphate, though the experimental evidence is that high-soluble slag is quicker in action and therefore better. Only few attached much importance to nitrogenous manuring of the pastures, and these were from Norfolk and Bedford. Major Keith (p. 34) finds that a February dressing of complete artificials so hastens growth that the grass is ready for ewes and lambs by the beginning of April, when otherwise it would not be ready till much later; he had not, however, found much advantage from late summer dressings. Mr Gardner also (p. 45) emphasized the advantage of nitrogenous manuring. Kainit at the rate of 4 cwt. per acre was commended for inducing the animals to finish up herbage they had left to grow coarse. Farmyard manure had the advantage of inducing early growth.

There were some interesting experiences in regard to the treatment of weeds in pastures. Thistles were dealt with by cutting: if necessary the land was hayed for two years. Buttercups, Yorkshire fog, and crested dog's-tail were kept down by hard early grazing; and Agrostis, a sure sign of wetness and sourness, by draining and thinning. Where, however, the grass had got into too bad a state the best remedy

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was to plough it up, dress the land well with slag, and if necessary lime, and then re-sow.

Many of the points raised in the discussion are already the subject of experiment at Rothamsted. It is hoped during the forthcoming summer to arrange a day for grassland demonstrations.

Finally, those who read this book, written by farmers in order to set forth their experiences for the benefit of others, will surely recognize that the ancient myth about their supposed backwardness and lack of receptiveness has singularly little foundation in fact.

E. J. RUSSELL.

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SEEDS MIXTURES FOUND SUITABLE BY VARIOUS FARMERS

LB. PER ACRE

	Aberdeen		Norfolk	Bedfordshire
	Mr Cruickshank	*Major Keith*	*Mr Alston*	*Mr Gardner*
Italian Ryegrass	3	..	..	..
Perennial Ryegrass	14	14	12	16
Cocksfoot	10	8	6	$7\frac{1}{2}$
Timothy	4	4	2	3
Rough-stalked Meadow-Grass	1	..	1	..
Late-flowering Red Clover	2	..	2	..
Broad Red Clover	2	3	..	..
Alsike Clover	1	1	..	..
Common White Clover	..	1	..	..
Wild White Clover	1	1	2	$1\frac{1}{2}$–3
	38	32	25	28–$29\frac{1}{2}$

	Berwickshire *Captain McDougal*		
Italian Ryegrass	2	3	3
Perennial Ryegrass	4	8	8
Cocksfoot	15	15	15
Tall Fescue	15	..	..
Meadow-Fescue	6	6	10
Timothy	3	6	6
Rough-stalked Meadow-Grass	2	3	$\frac{1}{4}$
Crested Dog's-tail	1	$\frac{1}{4}$	$\frac{1}{8}$
Sweet Vernal	..	1	..
Smooth-stalked Meadow-Grass	..	..	$\frac{1}{4}$
Late-flowering Red Clover	5	5	5
Alsike	1	1	1
Ordinary White	$\frac{1}{2}$	$\frac{1}{2}$	$\frac{1}{2}$
Wild White	1	1	$\frac{1}{2}$
Yarrow	$\frac{1}{4}$	$\frac{1}{4}$	$\frac{1}{8}$
	$55\frac{3}{4}$	50	$49\frac{3}{4}$

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ROTHAMSTED CONFERENCE ON GRASSLAND

By The EARL DE LA WARR

Parliamentary Secretary to the Ministry of Agriculture

I am glad to have this opportunity of attending one of the series of important Conferences that are now held, at intervals, each winter at Rothamsted. I had always looked upon Rothamsted as the head-centre of fundamental research concerned with the discovery of basic facts and principles rather than with the attainment of any tangible advantage in the first instance. The eminent scientist Huxley once said that the great end of life is not knowledge, but action, and I am glad that it has been found possible at Rothamsted to combine fundamental research with work for more or less well-defined practical objects of immediate economic importance. For many years the work at Rothamsted was applied to the increase of food production: its application is now to costs of production; to increasing the output per unit of labour and of money put into the land, and to reducing wastes and losses. An outlook of this kind is an invaluable stimulus to imagination and observation. Some of the most important problems in agricultural production, at present, are associated with grassland, and it is to consider such problems that we are met here to-day.

My interest in grassland questions is not derived solely from my activities as a Sussex farmer farming a large area of grassland, nor even from my position as Parliamentary Secretary to the Government Department responsible in this country for agriculture, in which live stock and live-stock products play so predominant a part. As a member of the Empire Marketing Board, which has to survey the agricultural problems of the British Commonwealth of Nations, I realize that grass is the greatest of the Empire's crops. It is at the same time the most neglected, and it can be no exaggeration to say that the carrying capacity of the Empire's pastures could readily be doubled with proper treatment. Of the Empire's population of 450 millions, the 300 million farmers are practically all either owners of, or directly interested in, domestic live stock.

We possess in the Empire one-third of the world's cattle and one-half of the world's sheep and goats.

We have made a beginning with a co-operative attack on the Empire's grassland problems, and the team-work between agricultural investigators in Scotland, Australia, New Zealand, Kenya and Southern Rhodesia, under the leadership of Dr Orr of the Rowett Research Institute, on the mineral content of natural pastures is an outstanding example of such co-operative research.

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The demand for animal products is bound to increase in the future, not merely on account of the increasing population, but also on account of the rising standard of living of that population. It is a significant fact that a higher standard of living results in an increased consumption of meat and other animal products.

We usually think of the agriculture of this country as being of small account compared with that of the big Dominions, but when you come to compare the output of live stock and live-stock products you find that the United Kingdom is in this respect still far ahead of any one of the Dominions. In England and Wales about 70 per cent. of the agricultural output is of live stock and live-stock products, totalling some £154 millions worth. Notwithstanding this large production we import about £120 millions worth of live stock and meat, and a further £160 millions worth of other live-stock products. There is still therefore a vast market awaiting capture by the home producers.

The acreage of permanent grass in 1930 was 15,545,000 acres, and of clover and rotation grass 2,424,000 acres, so that there are some 19,000,000 acres of grass in this country, which compares with 7,410,000 acres of arable land other than temporary grass. Even this is not a complete picture, since there were over 5,250,000 acres of rough grazings in 1930. Since the war there has been a very large turnover from arable to grass, and this is no doubt due to an effort to adjust costs of production to prices.

In the depression of the eighties and nineties, Scottish farmers, as we shall no doubt hear presently, solved their economic difficulties by converting the normal four-course rotation, with its 50 per cent. of corn and 25 per cent. of roots, into a six- or seven-course rotation with two or three, instead of one, years' grass. With a rotation containing three years' grass it is still possible to allot 43 per cent. of the land to corn and, at less expense, to produce as much corn as on the former 50 per cent. Indeed, as a result of using *Mr Findlay's* modern grass-seed mixtures, the difficulty has been to secure a crop that will stand up.

So with roots, reduced from 25 per cent. to little more than 14 per cent., it is possible, by being able to concentrate on a smaller area, to produce, if not quite as much in the aggregate as formerly, at least sufficient, in the light of modern knowledge, to satisfy all requirements of animals in winter.

Mr Cruickshank, from the heart of Aberdeenshire, has abolished roots from his strong land and now pins his faith to silage. As you know, it has for long been a maxim among cattle-feeders that, for winter fattening, roots are almost, if not quite, indispensable. We may hear to-day that the succulence so desirable in a fattening diet can be suitably supplied in the form of silage. This is a rather important point, because if everybody turns to grass the market for first-class beef, which it is so desirable to extend and even-out over the year, will be

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more than ever liable to seasonal gluts and shortages; and the same will apply to the store market—autumn gluts and spring shortages.

The objection is often raised that it is only in a comparatively wet and cool climate, such as prevails in many parts of Scotland, that one can hope to establish satisfactory temporary leys. While the establishment of good pastures may be difficult in the driest parts of England there is abundant evidence to show that the practice is capable of much wider adoption than is generally supposed. We can see examples of this on the Rothamsted farm. It would appear that the main considerations in establishing a good sward, anywhere, are soil fertility—particularly with regard to humus and phosphates—and the inclusion of wild white clover in a mixture of grasses suited to the particular circumstances.

It is possible to control moisture to a large extent by the development of a close sole of grasses and white clover and by not grazing too closely where protracted spells of drought are common.

The arable farmer, turned grazier, will find that successful grass-farming is a much more intricate business than it seems. The limit of development has not been reached with the application of basic slag and the inclusion of wild white clover in the seed mixture. For the establishment of a successful sward a nitrogenous manure is, in certain circumstances, indispensable. In Germany, where grassland is strictly limited, the farthest stage in the productiveness of pastures has been reached by intensive complete manuring and short-period rotational grazing. There appear to be possibilities in the same direction in this country, but more particularly where, as in Germany, grassland is limited as in suburban farming or, perhaps, in small-holdings. But the new system has its lessons for all graziers. For one thing, it indicates the possibility of extending the grazing season—lengthening it at both ends.

Mr Keith tells us that store cattle wintered-out thrive better the following summer and are more profitable than similar cattle housed and well fed over the winter. If winter grazing is to be extended, and it is important that it should in the interests of animal health and a more regular supply of beef and mutton, then we must consider ways and means of increasing the supply of winter grass. This is possible by improving our pastures so as to encourage winter-green grasses. Because we can choose the plant species, temporary leys and new leys are generally more responsive than old pastures, which so often abound in plants that die down over the winter. Our chief competitors in dairy produce rely chiefly upon grass for cow-feeding, and, with the exception perhaps of New Zealand, no country in the world is better adapted than ours for grass production. And fresh green grass is at least one commodity which cannot be imported.

There are, of course, obvious drawbacks to the extension of temporary leys in, say, the arable districts of East Anglia. Wide open

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fields are the ideal for corn ; small sheltered fields are best adapted for grazing. It is difficult to combine the two. There are, also, the difficulties of fencing and water-supply and the fact that new leys, on strong land, do not carry horned stock well in winter, at least not for several years. But water-supply is not so difficult where only sheep are concerned, and, in any case, there is the alternative of mowing temporary leys and of further utilizing them for sheep-grazing in winter.

With the decline in arable sheep-folding, and the corresponding increase in grass flocks, the markets in late summer and autumn tend to be glutted with lambs and fat ewes. By improving winter grazing it should be possible to spread production of mutton and lamb more evenly over the year. Perhaps *Mr McDougal* will tell us how to become less dependent on the Scottish borders for our grass ewes.

The Scottish system of combining grass and corn in one rotation, as opposed to East Anglian grass and arable in water-tight compartments, is doubtless sound for Scottish conditions, as, indeed, it has been proved sound in northern and western England, but there are difficulties in the way of its complete adoption in the arable regions of eastern England. Some have been indicated. There are others. On the lighter soils of the south, wire-worm, for which so far there appears to be no remedy, will frequently ruin the corn crop following grass. The principle, however, of the Scottish system can be and is being increasingly adopted by substituting lucerne for temporary leys. Lucerne is a plant par excellence for the drier regions of the south. As a soil-improver I am doubtful whether it is surpassed even by wild white clover, and as hay its virtues are too well known to need elaboration.

We in the south may not be able to compete with the north in luxuriant summer pastures, but we have compensations in our longer growing season and in our milder winter, and it is for us to develop these advantages to the full. We can do more out-wintering, particularly on established pastures that are not water-logged, and we might be devising ways and means of providing more winter shelter in the fields, either in the form of hovels or shelter-belts. Then we can look forward to corn-growing in larger fields and on mechanized lines.

[*In the unavoidable absence of Earl De La Warr this paper was not read at the Conference.*]

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THE MAKING OF GRASSLAND

By J. CRUICKSHANK
Cruden Bay

In giving you my experiences of making grassland I am afraid I must go beyond the past five years, as by 1926 I had over two-thirds of my land in what I considered good pasture. Since then my attention has been devoted to maintaining and improving the value of these pastures by judicious manuring, grazing and treatment. The area is 650 acres, situated in East Aberdeenshire, within two miles of the coast and about 100 feet above sea-level.

The soil is locally known as clay. It is of glacial origin, the subsoil being reddish clay, in some parts eighty feet deep, and overlying red granite.

There is a considerable area of this type of soil on the east coast of Aberdeenshire, which has been described as " good for wheat and beans."

The area originally consisted of four small farms, and was acquired on lease as the farms fell vacant (the first 415 acres between 1902 and 1910 and the last 235 acres in 1921). The rents varied from 9s. to 17s. per acre, the latter a post-war rent for the 235 acres. A large portion was pretty much waste, having been allowed to go down to poor grass or weeds and rushes. I have since bought the land at an average price of £8, 5s. per acre.

I have been familiar with this class of soil all my life, and have seen many farmers ruined financially through working it in regular rotation, particularly between 1872 and 1900.

I have always held the opinion that a rigid adherence to a regular rotation on a clay farm is a mistake. The largest possible proportion of such a farm should be in grass, and that as good grass as possible, and when a really good field of pasture-grass is secured the farmer simply cannot afford to plough it up again until it becomes one of the worst pastures on the farm.

I began to put this idea into practice in 1910 and have followed it since, when breaking up any pasture always ploughing the worst fields, irrespective of age.

The first really good field of pasture I got was in third-year's grass in 1913. It was sown out in 1910 after a poor crop of turnips in 1909.

The nurse crop was common bere, and the seeds sown per acre were :

14 lb. Perennial	2 lb. Broad Red
3 lb. Italian Ryegrass	2 lb. Cowgrass Red
10 lb. Cocksfoot	1 lb. Alsike
4 lb. Timothy	1 lb. Wild White

1 lb. Rough-stalked Meadow-Grass

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Although the land was in poor condition only 2 cwt. per acre of superphosphates were sown with the nurse crop.

A dressing of 10 cwt. of high-grade slag was applied after the nurse crop was harvested. The field was cut for hay in 1911 and also in 1912. Both crops were good, and it was grazed for a few years and then cut for hay again.

It was the result in this field that convinced me of the real value of wild white clover in making a pasture.

I have practised the same type of seeding and manuring with little variation since, always applying 10 cwt. slag or 8 cwt. ground mineral phosphates to the young seeds, but rarely applying nitrogeneous manures to a nurse crop, and never without bad results, which were generally apparent on the pasture for several years after, the adverse effect being due to the increased luxuriance of the nurse crop.

Prior to 1910—with the help of Mr W. M. Findlay, Aberdeen—I had experimented with different varieties and quantities of seeds, and had found those already mentioned the only varieties of much value on our soils, and the quantities those most likely to give the best results.

Many of the fields I found so weedy and rough that even after two oat crops—generally poor ones—there was little chance of getting them clean except by bare-fallowing.

When this was done autumn wheat was sown, and seeds on the wheat in spring. Some of my best pastures are those sown out with wheat. This is contrary to the experience of many, I know.

From 1913 to 1923 over 200 acres of the worst land was bare-fallowed and practically the whole of this area got two tons carbonate of lime per acre during the process of fallowing.

This had the effect of making the land more easily worked, and made it drain distinctly better. This was most marked when the limed fields came to be ploughed up a second time.

I did not always get a good take of seeds—much depended on the season, whether wet or dry. Dry seasons were always the best. For example, I have not ploughed up a single acre of seeds sown out in 1914, 1918 or 1921, as these pastures became too good to plough up. The seasons were fine dry ones of course, and admirably suited for getting a good take of seeds on our hard clay.

The seeds sown in 1916—a wet season—were all broken up again after the first year, and most of those sown out in 1924 also have been ploughed up. The failures were entirely due to the adverse effect of weather.

I found the best method of preparing the soil for getting a good pasture was by using an ordinary swing plough when breaking up any land, taking one or two grain crops, manuring these well with phosphates—generally superphosphate—and sulphate of ammonia when necessary, liming when I thought advisable and time permitted. I either took a cleaning crop, such as turnips or silage, or made a bare-

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fallow, being always careful not to have the tilth too fine. If too fine it is apt to run together after rain and form a hard crust, in which the seeds do badly.

I generally roll with a heavy roller just before sowing the seeds, harrow lightly after sowing and roll again at once if thoroughly dry.

On several occasions during the past twenty years I have tried taking two grain crops after pasture and sowing seeds for a permanent pasture with the second grain crop. I have never found this the success I would like.

The pastures were generally fair for a year or two, but not in my opinion good enough to leave permanently, and they have all been ploughed up and seeded down again after a cleaning crop.

It is most important to work our heavy land when in dry condition, and never work too much land at a time. There is one exception, and that is when making a bare-fallow, don't plough until late spring, and plough as wet as you can get it. This turns up the soil in a fine solid mass, which dries out readily in early summer, and if you keep ploughing backwards and forwards the weeds dry out nicely and the lumps come down readily with the August and September showers and make it easy to prepare for drilling wheat.

I have varied the seeding very little since 1910, always using about the same mixture as previously referred to, using English clovers, Scotch perennial and timothy, French-Italian and Kent Wild White, sometimes Danish and sometimes New Zealand Cocksfoot. This latter I have found much the best for pasture, but rather expensive when sowing 10 lb. per acre. Last year I sowed a quantity of what was called Evergreen Perennial Ryegrass, collected from Kent pastures. I am not yet in a position to give the result of this.

The nurse crop is most important. Many fields of what might be excellent pasture are completely spoiled by having too thick, too heavy, too leafy and too late-maturing a nurse crop. The best nurse crops I know are barley and common bere; the latter especially so. It can be seeded with $2\frac{1}{2}$ bushels per acre, can be sown a fortnight later and cut ten days earlier than barley.

There is a very great difference in the take of seeds sown with even different varieties of oats. The past season I had five different varieties of oats drilled in strips across a cleaned-land field and there is a marked difference in the take of seeds.

After Marvellous is by far the best, and Glasniven Sonas the worst; Potato R.30, Sandy and Victory in between.

The system of manuring has followed the lines of Cockle Park, and has remained the same, varying only in the form in which the phosphates have been applied.

In every case I have dressed the young seeds when the nurse crop was cut with 10 cwt. high-grade slag or 8 cwt. finely ground mineral phosphates, no nitrogeneous manure being applied, and I have cut hay

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crops of 65 to 75 cwt. per acre weighed out of the stack in November to January after this treatment. I generally followed with 4 to 6 cwt. phosphates every third year after.

If inconvenient to apply at the three-year period it is generally left for five or six years, when 8 to 10 cwt. are applied. I rather like the heavier dressing as the result is more apparent.

I used either basic slag or ground mineral phosphates according to which I considered best value at the time. The latter was much the better value for a few years after the war, when slag was both dear and of low grade.

I have made a practice of missing a strip in every field when sowing manures and have found this most useful and interesting.

Particularly has it shown the cumulative effect of phosphates. I have in mind specific examples. I may mention that our rainfall is fairly heavy, round 34 to 35 inches. This, I think, favours the action of ground mineral phosphates particularly.

When ground mineral phosphates were to be applied I always found it advisable to sow them not later than the middle of November.

Slag I found gave good results sown as late as January. Where the rainfall is low I should think ground mineral phosphates would act rather slowly.

For timothy hay, grain, silage and root crops, superphosphates and sulphate of ammonia have invariably been the manures used.

During the past autumn I have treated 70 acres of pasture with bone-flour at the rate of 4 cwt. per acre. This is the first occasion on which I have used bone-flour. Large quantities have recently been used in Aberdeenshire on account of the low price.

The making of a good pasture does not end with the seeding and manuring.

I do not allow stock on the young seeds in the first year, and in my particular case I have found it advisable to take hay crops the first two years to avoid the risk of the land being poached by cattle in wet weather.

I always cut the hay crops early, and I am sure I get better and cleaner pastures than I could do by grazing at this stage. The aftermath is eaten off by sheep, and even these are not allowed on the aftermath the first year after October, unless the weather is exceptionally dry.

Once the pastures are properly established they will stand any amount of grazing and should go on increasing in value. My difficulty is to keep them sufficiently closely grazed, particularly in June and July. They are grazed with a mixed stock of cattle and sheep, and the mower is run over some of the roughest fields in late June or early July. Every year some of the fields are left rough to provide winter grazing for 450 breeding sheep in case of frost or snow. The fields are varied so that every field is eaten quite bare once, if possible,

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in two years. A few Galloway cows and calves are kept for this purpose.

One or more fields of old grass are put up for hay every year, generally after an application of phosphates and getting 1 or 2 cwt. sulphate of ammonia in April and being cut early.

If thistles appear in a field to any extent I take a hay crop two years in succession, cutting early ; this effectively clears the thistles for a few years.

The worst weeds I have to contend with are buttercups, Yorkshire fog and crested dog's-tail, and I find nothing helps much but hard grazing early in the season.

Slag I have found a great help in controlling rushes.

Although potash has little or no apparent effect on our cultivated crops or ordinary pasture, 4 cwt. kainit per acre has a wonderful effect in making stock clear off a bit of rough neglected pasture.

One or more pasture fields are treated with farmyard manure every year. This is applied in June, the pasture being previously well grazed.

These fields are harrowed at intervals during the summer with parmiter harrows to get the manure thoroughly broken up. A great flush of grass comes up which stock do not relish during the summer, but it provides excellent and valuable feed for the Galloway cows and sheep during the winter, and they eat it readily.

Fields hard grazed up to the end of July and then left provide excellent winter food for sheep or cattle, and provided they are grazed hard the following season do not deteriorate.

Little or no mat has formed on the wild white pasture sown out by myself, and I have not found it necessary to use the harrows on much of the ordinary pastures, although the timothy meadows are harrowed every season if time permits.

To enable a large portion of the farm to remain in pasture it is necessary to have a short rotation in the remainder.

The present distribution is as follows:

About	380	acres in good Wild White pasture
,,	50	,, in old pasture (twelve to thirty years) not sown out by me, but manured regularly
,,	70	,, for grain crop
,,	35	,, for silage crop
,,	35	,, for turnips, potatoes and bare-fallow combined
,,	30	,, for Timothy meadows, now ten to twelve years old
,,	35	,, for one year's seeds hay, Italian, Perennial, Timothy and Red Clover
,,	15	,, Wild White Clover pasture cut for hay
	650	

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The fields for grain, silage, roots and Italian ryegrass hay are worked intensively and are all near the farm buildings.

This is to economize labour, and the bulk of the farmyard manure is distributed on these fields, most of them being treated with this twice in three years.

As all the produce, including hay, is consumed on the farms there is a large quantity of farmyard manure to distribute annually.

The real value of pasture lies in the stock it will carry and the live weight it will produce.

I have on occasion got 3 cwt. live weight per acre during the grazing season and my aim is to get this increase on all my pastures.

Particulars of Stock

The farm is worked from one centre by seven horses and a tractor, the latter being used for threshing and bare-fallowing only.

The stock carried in summer is larger than during the winter. At 28th May 1930 it consisted of 283 cattle, including calves, and on 10th February 1931 of 215—a reduction of 68; and 893 sheep, including lambs, and on 10th February 1931 of 524—a reduction of 369.

The sheep will be reduced by another 40 before 1st March by the sale of fat sheep, and the numbers will be brought up to about 900 again before May by lambs dropped. The cattle will be brought up to about 290 at the same time by calves dropped and purchased for suckling.

Nearly all the stock sold go off the grass fat during the summer, very little winter fattening of cattle being done. About 250 male lambs are fattened in autumn and early winter, the female lambs being kept and sold for breeding in September following year of birth, having meantime reared a number of lambs.

THE MAKING OF NEW GRASSLAND DURING THE LAST FIVE YEARS

By W. M. FINDLAY, N.D.A.

North of Scotland College of Agriculture, Aberdeen

Experiments at Craibstone

In the north of Scotland, where 80 to 90 per cent. of the soil is what may be called a light medium loam about a plough-furrow deep, a large proportion of the arable land is worked on the six-course rotation with three grasses, which may be either one year's hay and two years' pasture or three years' pasture. In a few cases there is a five-course rotation with two grasses, while in some other cases the pasture may be lengthened

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to four, five or more years. In one or two districts there is a more intensive rotation with only one year's hay.

The general method is to apply dung to the root crop, and artificials either wholly to the root crop or partly to it and partly to the nurse crop. Very little artificials are applied directly to the grass. After the wonderful results obtained by the application of slag to permanent pasture, several farmers applied it to their temporary grassland, but as there were apparently sufficient phosphates already in the soil it had little effect.

There is very little permanent pasture, what there is being mostly round mansion-houses. A large part of what is classified in the agricultural returns as permanent pasture is unfit for ploughing and would be more correctly called rough grazing.

It is now fully twenty-five years since Sir Robert Greig started experiments with different grass-seed mixtures. Before that time the mixtures contained large quantities (often up to 2 bushels) of perennial ryegrass and clovers, only in a very few cases were small quantities of cocksfoot and timothy or other grasses included.

Those trials showed (1) that many other factors besides the seed mixture affected the result; (2) that perennial ryegrass could be considerably reduced without reducing the hay crop, and the addition of cocksfoot and timothy improved the pastures by making them earlier for use in spring, more lasting in summer, and prevented to a large extent the entrance of such weeds as Yorkshire fog; (3) that there is a considerable interaction between the different ingredients of mixtures, such as the effect of perennial ryegrass on cocksfoot, timothy, meadow-fescue and Italian ryegrass; Italian ryegrass on perennial ryegrass; Italian ryegrass, and to a less extent other grasses, on clovers; red clover and white clover on grasses, and so on: this interaction is modified by the weather conditions and methods of treatment and manuring; (4) that the improved pastures are due, so far as the seed mixtures ar econcerned, in equal proportion to the reduced perennial ryegrass and increased cocksfoot and timothy on the one hand, and to the inclusion of wild white clover on the other.

Since those early days the subject has been further complicated by the introduction of several distinct strains of grasses and clovers, each of which again exercises its own peculiar reactions on the others.

Fully ten years ago a commencement was made with trials of the more late-flowering types of grasses, especially perennial ryegrass and cocksfoot. At first, a study was made of the relative proportions of leaf and stalk in individual plants, and it was generally concluded that these late types, owing to their ability to produce much more leaf, would evidently be better suited for pasture than ordinary commercial samples. Several of the best plants were broken up and multiplied.

One important point observed in connection with ordinary commercial perennial ryegrasses, which are almost invariably seeded from

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first year's grass, is that its longevity and value have undoubtedly increased since the introduction of wild white clover. Apparently the nitrogen provided by the wild white to the growing perennial ryegrass encouraged the more perennial of the ryegrass plants present, so that they have stocked out and filled a much larger proportion of the soil surface. This is especially true where the pasture has been kept comparatively well eaten down and not allowed to form ears until the white clover got established.

During the past five years several trials have been carried out where the different types were sown in small plots alone and were also included in turn in the same seed mixture. The mixture used was generally 13 lb. perennial ryegrass, 8 lb. cocksfoot, 4 lb. timothy, 2 lb. broad-leaved red clover (English), 1½ lb. late-flowering red, 1 lb. alsike and ½ lb. wild white clover per acre. The same mixture was used in the trials with cocksfoot and red and white clovers.

Most of the commercial perennial ryegrass used comes from Ayrshire, although a fairly large proportion, especially in some districts of Aberdeenshire, is home-grown. The late-flowering samples used in addition to the home selection have been mainly what is called Evergreen, or wild or indigenous—in most cases likely sifted out of wild white clover—Cornish Eaver and a Swedish selection called Victoria. When made into hay the differences between the plots were very marked, the stalks of the commercial samples of perennial ryegrass being much earlier and more numerous than in the late-flowering. On the other hand, the amount of cocksfoot, timothy and red clovers was generally much greater where the latter type was sown. The comparative weights of hay have varied in different seasons. In some seasons the commercial plot was distinctly heavier, while in other seasons the late-flowering was the heavier, and this variation is likely to happen in all trials of this kind so long as we have different soils and different seasons. In pasture, the relative appearance necessarily varied according to how the field was grazed. In a typical example the difference was quite marked, the commercial tending to go into ear early and thereafter consequently somewhat neglected by stock. The late-flowering on the other hand was much thicker with leaf blades and was usually better eaten, so that it had not the same chance to form ears. Some of the samples, for example Cornish Eaver, appeared to be intermediate.

The trials with the late-flowering strains of cocksfoot included, in addition to the home selection, Akaroa, Swedish and several English selections. Danish was usually the commercial kind used. In the hay crop the ears of Danish were quite prominent, while there were comparatively few in any of the late-flowering samples, although there was a considerable quantity of green blades present, and the latter also showed much thicker in the aftermath. In pasture the Danish came away very much earlier in spring, and was preferred, and well eaten down

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by the cattle. However, it soon went into ear, after which the produce was much less. This early tendency of the Danish is, however, of considerable importance in the north-east of Scotland, where early grazing is much required. Further, if there is too large a proportion of succulent material in a pasture the tendency to scouring is increased, especially in a wet season, and the presence of some of the grasses in ear helps to counteract this. The late-flowering stocked out and produced a considerable amount of blades, which were generally well eaten.

These results are so far favourable to the late-flowering types, but there is just a danger that we may expect too much from them, as has been the case in too many instances in the past. The comparison is not between early- and late-flowering types but between grass-seed mixtures containing these types, and we must not forget the effect of the interaction between the different ingredients of the mixtures. The final test is: how much beef or how much milk will mixtures with the late-flowering types of grasses produce compared with the early-flowering types.

Two other considerations that must be taken into account are (1) that the seed of the late-flowering strains of grasses is often of inferior quality, and (2) that there may be some difficulty in getting genuine samples. For example, we have compared a good many samples of "Evergreen" perennial ryegrass during the last year or two, and a fairly large proportion have been little better than ordinary commercial samples.

Turning now to the mixtures for one year's hay, these consist mainly of Italian ryegrass and red clovers; the hay is mainly Italian ryegrass, the amount of clover being usually small. A difficulty in making up mixtures for one year's hay is that there are several methods of dealing with the produce. The mixture that may be best for one purpose may not be best for another. If winter and early spring grazing are wanted then the inclusion of Italian ryegrass is essential, but trials show that the subsequent hay crop is less; on the other hand, if the grass is not to be eaten down previously, mixtures with perennial ryegrass substituted for the Italian will produce heavier hay crops with more red clover. Possibly the most notable feature in these trials for one year's hay has been the value of including 5 or 6 lb. of timothy. This not only increases the weight of hay but also helps the crop to stand better.

The chief feature of red clovers in the north-east of Scotland is their susceptibility to be affected by different conditions of soil, management and weather. In one trial where little or no dung had been given to the turnip crop there was very little red clover in the hay, whereas where a good dressing was given, and especially along with a good application of artificials, there was abundance.

The previous crop has often had a marked effect on the amount of

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red clover. For example, on several occasions there has been much more red clover after a potato crop than after a turnip crop. This was due to the fact that the grain crop, both oats and barley, was much lighter after potatoes and so enabled the red clover to get better established. Further, a comparatively thin grain crop, cut early, favoured not only the red clover but also the grasses, whereas a thicker grain crop, especially when late in being cut, reduced both the amount and vigour.

The weather conditions have affected the red clover in at least two different ways. First, in spring at the time of sowing the seeds, when the soil was dry, and dry conditions continued, there was very little, whereas in another part of the field where the seeds had been sown earlier there was quite a good stand. Secondly, in the following spring, red clover was slow in starting to grow when there was a dry spell, and especially when the temperature was low there was very little in the hay, although there was plenty in the aftermath. This happened last year, and it is interesting to note the effect on the different types and nationalities. Generally, the late-flowering was superior to broad-leaved, and among the former some English samples were best, the later Montgomery, Cornish Marl and Swedish were next, and about the same, while American Mammoth and Russian were very poor. In other seasons Montgomery and Cornish Marl were best, while in still others all the late-flowerings were very poor and the broad-leaved good and vigorous. In the case of the broad-leaved, English samples were most reliable. It is only in an occasional season that any foreign seed gives good results.

Keeping these results in mind, then, our conclusions are that we require both broad-leaved and late-flowering in a mixture, and it is well to include several different samples of each. One other point in connection with red clover is that we look to English farmers to sow acclimatized English seed and not to sow weakly foreign stuff, seed it and sell it as English. We have had experience of this.

White clovers have occupied our attention during the last five years, and we have tested samples from different parts of England, from New Zealand and America, and with ordinary white. About 90 per cent. of the English samples were genuine, but the other 10 per cent. gave a poor result and were evidently from cultivated grassland.

Chemical tests were made of all the samples, and those that did poorly gave weak reactions, the big seeds being generally weaker than the small seeds. Two samples from Oxford and York respectively were of special interest. While they produced lasting plants, the leaves were much larger and the stalks much thicker than ordinary English wild white.

In the trials with New Zealand wild white when sown in rows many samples showed considerable vigour, but they showed much less prominently in the field. In no case where the same amount of seed

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had been sown was the New Zealand so vigorous or so well spread as good English. All American samples lacked vigour. As some farmers still sow ordinary white in addition to wild white, mixtures were sown with different quantities, but even where 5 lb. of ordinary white were included there was hardly a plant to be seen in the pasture.

We like to get a good vigorous mixture of grasses and white clover as soon as possible in our pastures, and in this connection the effect of the previous treatment has been observed on several occasions. In part of a field the hay was cut early while the remainder was cut late. The result was very marked during the three years the field was in pasture, the first part having a fine uniform " sole," while in the latter part the white clover was very patchy. In another case where part of the aftermath was late in being used the result was similar.

After the white clover is well established we find it is an advantage not to eat it too bare, otherwise if dry weather sets in the pasture is practically finished for the season.

During the last few years a considerable amount of attention has been paid to what is called rotational grazing, along with intense manuring. We have had several small trials on both points. There is no doubt but that our commercial friends spoiled a good case by making far too extravagant statements, and it is gratifying that they have considerably toned down.

Taking the manuring first, there must necessarily be a considerable difference in their needs between poor permanent pastures and temporary grasses growing on land in good heart. There are fields of the latter that are growing all the grass they possibly could except at the beginning of the season, when an application of a nitrogenous manure would provide earlier grazing.

When applied to young pasture, nitrogenous manures, even with abundance of lime, phosphates and potash, encourage the grasses, including annual meadow-grass, to such an extent that they act adversely on the young plants of white clover, which, after all, is the cheapest source of nitrogen we have.

Our conclusion is that on arable pastures little or no nitrogen should be applied until the white clover is well established, then some may be applied at discretion, especially at the beginning of the season.

Several small trials have been carried out on the rotational method of grazing, but these have not shown it to be of any advantage, as quite as much live-weight increase was obtained where the cattle were not shifted as where they were.

What the trials do show, however, is that the success depends on the management. Where the pasture was eaten comparatively bare until the white clover was established, then where there was a good mixture of grasses and white clover, and when the pasture was not eaten too bare early in the season, it was not affected so much during dry spells as where it was eaten barer. Also, where a field was sufficiently

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stocked so that the pasture was evenly eaten down the grasses did not go readily into ear and there was a good supply of pasture of the best quality.

One point of importance is that if there are different types of soil in a field which produce different kinds of pasture these should, if practicable, be sown with mixtures suitable for the different types of soil, or be fenced and grazed separately.

But, the best-laid schemes "gang aft agley." Weather conditions often upset plans.

MAKING OF NEW GRASSLAND

By A. McARTHUR

Buntingford, Herts

I HAVE been asked to read a paper, or rather to relate to you my experience in laying down arable land to permanent pasture.

About fifteen years ago I put several acres of land down to grass in Cambridgeshire, on land that was absolutely unfit to grow corn and which is now a fine pasture; there has been no deterioration at any time since being put down, which often does happen.

I succeeded in getting an excellent plant the first year, and never at any period in the summer months was it closely grazed, and to this I attribute the successful result. At no time during the first ten years was any of the pasture cut for hay. I strongly believe that to cut your pasture for hay goes a long long way towards ruining it. Graze it, and feed it, either by fattening stock with cake, or by applying artificial manure.

In 1922 I purchased a farm of 580 acres, near Buntingford, 80 acres of which was old pasture, the remainder arable; the most of it two-horse land in dry weather, and three horses when wet. One would call it a medium heavy soil, all mole-drained, the subsoil being suitable for this treatment. I started putting one field down to grass and then another, until I now have 300 acres in pasture out of a total of 580 acres, and it has gone down splendidly, with the exception of one field, from which I cut hay. That field has lost a large percentage of the clover, the clover plant having been choked with the vigorous growth of varieties of grass plants, which always grow quicker and more robust than the clovers. When I put down mixtures for cutting on arable land, sainfoin or clover, I have found in the case of Italian ryegrass and sainfoin the best mixture is four bushels of sainfoin and one-eighth of a bushel of Italian ryegrass, which is quite sufficient grass. Now why such a small quantity as one-eighth of a bushel? Because if you put more it spreads out so much it will smother the sainfoin or clover, and you never see them any more. The same thing applies to new permanent

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pasture, but far more so, because you are using a finer and much less robust variety of clover, and you have to apply a larger quantity of grass seed. Take most old pastures, and look for clover after the hay has been made. You will find very little clover; but if the same pasture was grazed and manured properly you will get, in most cases, abundance of clover. Now, to partially destroy the clovers in new pastures and then to try to build them up again, or to recover them, must be a retrograde and not a progressive step.

With regard to the proper mixture of grasses and clovers to be used. I think a lot of money is wasted in using a quantity of fine grasses or a quantity of coarse grasses. You want to strike a happy medium, and I have come to the conclusion that wild white clover, Dutch clover, alsike and perennial ryegrass are sufficient to make an excellent pasture. Cocksfoot, no !—indigenous or otherwise. Timothy, no ! I always see cocksfoot grasses left uneaten by cattle, so why use them ? In an examination of the pastures which I have put down each year since I started in 1922 you will see that perennial ryegrass and wild white clover are the principal mainstays. I don't see that you want anything better. They both seem to like one another, and as long as they are kept within reasonable bounds of growth, by the grazing of cattle, I believe, if the cattle could speak, they would say the grass was delicious. If, through exceptional weather for grass, the pasture should get beyond the stock on the ground don't worry, but when the ryegrass and clovers get heads, and are very ripe, run a mowing-machine over it, and, if not worth raking up for hay, let it lie and the seed will be trodden into the ground and will germinate with the first rain, and a large proportion of it will become a part of the pasture, and by running your machine over your pastures you kill two birds with one stone—you cut all the thistles that may be there.

With regard to manure, I apply with the crop 5 cwt. North African phosphate, and continue to give 20 per cent. of the land in grass 5 cwt. each year. This means, if I have 300 acres in grass, 60 acres are dressed with 5 cwt. per acre per annum. Possibly someone may say, why don't you apply nitrogen and potash as well as phosphates ? I do not want to choke my clover by using nitrogen, and from experiments which I have carried out I do not think my land requires any potash.

I do not think I could wish for better results than I have secured.

Now a word with regard to my experience in the actual sowing down and preparing of the seed bed. It is of first importance that the bed should be solid, so that the seed may be deposited at the proper depth and as regular as possible. No end of small seeds are sown at far too great a depth, and if they do manage to struggle through the heavy covering of earth they are weak, and invariably die. It must be apparent to anyone that to get a plant is the first essential in forming a pasture. Taking one season with another, I do not think you can do

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better than put your seeds down with a growing crop and sow early. If you are in the habit of using steam ploughs, try to use them when ploughing the field for the last time. This may not appear to be of much importance. The object is to get your land free from hollows, as no furrows are left when steam ploughs are used. When grazing sheep in after years, especially ewes in-lamb, you will be almost sure to lose several by them getting cast if furrows remain as they would do if the land had been horse-ploughed.

With regard to after-cultivation of young grassland, if this is grazed judiciously the only work required on same is to roll it well at the proper time in the spring. Harrowing is detrimental for many years after laying down.

I should just like to say in conclusion that those who wish to lay down pastures other than permanent—that is, with two objects in view, a hay crop as well as grazing—a different mixture should be used, so don't compare a three years' ley with permanent pasture.

I have been relating my experience. All I have told you represents the methods which I am convinced are correct in my case, although it is possible that all present may not see eye to eye with me. I did not, nor do I, presume to dictate to anyone that there is only one method, and that my own. Far from it. I have farmed too many years, and have met with too many rebuffs, to be so bigoted. I started farming when I left school, and have been at it for forty years or more ; and my father was a farmer before me, worse luck ! I wish he had been a lawyer. I might now have been laying down the law to you in place of simply relating to you my humble experiences of farming operations.

GRASS DURING THE PAST FIVE YEARS

By MAJOR J. KEITH

Pitmedden

It is now rather more than five years since the full possibilities of rotation grasses sown under the newer systems have been realized in Aberdeenshire, but one can hardly deal with the most recent development of one's ideas in these years without looking at the previous practice. Except in a few gentlemen's parks and on high-lying grounds there has never been much permanent grass, and it was generally believed that only on limited areas of the best soil would grass hold for more than three years or so.

Prior to the great improvements on grassland which began about twenty years ago, as the result of experiments and propaganda by the

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North of Scotland Agricultural College, most of the grass in Aberdeenshire was laid down for three years only, and much of it was very poor, frequently consisting in the third year almost entirely of Yorkshire fog. In a rough way it was valued at first year's grass three times the land rent, second year's grass twice the land rent, and third year's grass at just the land rent: older grasses at varying figures according to whether improvement or further deterioration set in. On good or well-managed land it frequently improved in the fourth and subsequent years, but on ordinary or indifferently managed land it became practically valueless. Some improvement began to take place early in this century through sowing cleaner ryegrass, and the better mixtures of grasses recommended by the Agricultural College and writers such as Elliot of Clifton Park, but it was not till the fundamental discovery of wild white clover came that real improvement took place. It was only about the end of the war that the sowing of wild white clover became general and a few years longer till the change in the carrying capacity of the pastures became fully appreciated. Rather more than five years ago I found that my grassland had so improved that instead of requiring $1\frac{3}{4}$ to 2 acres to carry a cow I was now able to carry one cow or her equivalent to the acre, and it was seen that the extra carrying capacity lay largely in the improvement of the older grasses. Third year's grass had now become as valuable as first year's. For milk I think it is very much more so, and older grasses seem to become even better with age, if reasonably well treated and managed.

Very serious trouble began to be experienced with the corn crops following the wild white clover—they grew so luxuriantly as to be frequently lodged soon after coming into ear, and very serious losses were sustained. These heavy corn crops also made the re-establishment of the grass more difficult, and a legend arose that wild white did not do so well the second time it was grown. Every imaginable plan was tried, with more or less success—chiefly less—to enable one to have the best possible pasture and at the same time to have manageable corn crops.

I tried most of these plans, but about five years ago I came to the conclusion that the best plan was to alter the whole system by changing the rotation. To this end I have adopted the plan of allowing most of the grass to lie from five to eight years, and keep part of the farm under continuous cropping for a similar period.

So far as I can yet see, this plan will work excellently; one can concentrate on establishing good grass as quickly as possible and on improving it to the utmost extent without being troubled by the bogey of laid crops. When any of these older grasses have to be broken up I do not take a corn crop till the land has been sucked a bit by two green crops, one of which is turnips and the other either silage or potatoes.

As to the actual management of grass, I should make it clear that

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the land I farm is entirely different from the strong clay of Mr Cruickshank's land. Mine is mostly a strong loam overlying boulder clay or rock, but it is nearly all well drained, and not much inclined to poach in wet weather. It is much heavier, I think, than Mr Findlay's Craibstone land or even average Aberdeenshire land, but none of it will grow a bean. So far I have not altered the seed mixture from that recommended by the North of Scotland College of Agriculture—

14 lb. Ryegrass	3 lb. Red Clover
8 lb. Cocksfoot	1 lb. Common White Clover
4 lb. Timothy	1 lb. Alsike White Clover
	1 lb. Wild White Clover

—but I am inclined to think that in our climate, on many soils, the timothy and cocksfoot might be left out and the ryegrass increased to 20 to 24 lb.

The enormous amount of nitrogen stored by the white clover induces a great vigour and persistence in the ryegrass, which always predominates on the best-eaten parts of the field, while the cocksfoot tends to get into patches not eaten by stock, and increases the difficulty of management.

A friend of mine, who has laid out a great deal of grass very successfully in Norfolk, says cocksfoot is essential to get early grass, but suggests that one should have part of one's pastures almost entirely cocksfoot and wild white clover and the remainder without any cocksfoot.

Contrary to my previous practice, I have adopted the plan of grazing the new layer pretty closely after harvest and in early winter. The treading is beneficial on my land and the grazing checks the ryegrass and seems to give the clover a better start. I have no doubt it also reduces the hay crop, if one is taken, and prevents the smothering out of the white clover in the first year. Personally, I have always been more successful in getting good grass quickly if no hay crop is taken and the first year's grass is pretty closely grazed with cattle.

If a hay crop is taken it is most important that the aftermath should not be allowed to get too strong. It is no use having a moderate crop of hay and cutting it early to save the clover, and then allowing the aftermath to destroy it. Cocksfoot, which throws a strong aftermath, is almost worse than the red clover. I had two very interesting examples of this last season. On my Norfolk farm I had a 70 acre field laid down for pasture, in hay, the aftermath of which was grazed by cows, and the plan adopted was to give the cows part of it at a time, say 10 acres, and move the wire back to give another 10 acres as soon as they had fairly well cleaned up the previous piece. The first section eaten has now very much the best white clover and it grows progressively worse on each later section, while on the last part, where the cocksfoot became rusty and was scarcely eaten, the white clover has almost disappeared. The other example was in Aberdeenshire. A

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field was split, and one half eaten early by lambs, while the other was saved for the cows, and not eaten till pretty late. The early-eaten half has now by far the better bottom of clover.

My land, on analysis, has a high amount of available phosphates, but I have manured freely with phosphates both for arable and grass, and usually apply, when sowing out, 4 cwt. steamed bone-flour or 8 cwt. high-grade slag, and repeat the dressing at the third or fourth year. This seems quite sufficient, but a neighbour who has extraordinarily good grass applies 3 cwt. steamed bone-flour to all his grass each winter, and says he sees the benefit of the application every spring by April.

Another thing I have adopted in recent years is dividing the larger fields into areas of 10 to 15 acres, to enable the grazing to be better controlled. After dividing my fields, I conceived the idea of giving the milking cows the first eat, and cleaning up the field with dry cows and in-calf heifers, but however well this plan may work out on farms with very uniform land, which grazes evenly, it was an entire failure with me. The store stock would not eat the rough, which just ran to seed, and they made the best-eaten parts so bare that their recovery was too slow, and the field not again ready for milking cows at the proper time.

The mowing-machine is really the only way to keep a pasture even. As far as possible I cut the pastures which look as if they would run to seed, and the results are so good that I would run all over the grass, only it has to be done at a time of extreme pressure on the farms, and I do not object to some rough grass, as it provides employment for the sheep in the snowstorms, but unless in snow the sheep will not look at the old rank patches, they remain determinedly on the green parts, so I doubt if it is worth while leaving much rough grass. It used to be thought that rough grass, not too much eaten in winter, gave an earlier bite in spring, but with good wild white pastures this does not seem so necessary. This year I am trying the experiment of giving a fairly large area of closely eaten grass a light coat of strawy farmyard manure, not for manurial effect so much as to see if the shelter of the straw will save the grass from spring frosts and wind and give an earlier bite. I shall also give part of this strawed area some nitrogenous manure. If this experiment is successful I shall abandon the practice of leaving any rough grass except what gets beyond me.

The difficulty with this rotational grazing is to know when to move the cows. I generally found when grazing from five to six cows per acre that the milk has begun to drop before the grass looks as if it was requiring relief. The only plan I can think of is to move the cows to a fresh field through the day at least one day before making the complete move. Cows are rather less particular about what they eat at night and not so inclined to wander about as during the day. Perhaps someone can throw light on this point, it does not arise when grazing two or three cows per acre.

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The only fresh thing I have tried during the past five years is systematically manuring part of the grass to get it to come earlier. This has been a most complete success. One thirty-acre field on the Norfolk farm has been manured each spring for the past five years with a complete manure applied in February, and has always been ready for folding ewes and lambs about 1st April, after which it makes a quick recovery and carries more than its fair share of the other stock all summer.

I have also experimented in trying to get later grass by manuring in August or September, but it has not been so successful. A very experienced friend tells me his experience is exactly the contrary—no good in spring and very useful in autumn. I have also for a year or two harrowed and broken up any rough patches in late winter. This seems very beneficial to both rough and green grass and I will gradually extend the practice till I give all the grass a thorough harrowing: fortunately it is perhaps the only farm job which is best done in wet weather, when a not too heavy harrow will enter easily and tear up the old grass and moss.

THE MAKING OF NEW GRASSLAND

By J. ALSTON

East Harling, Norwich

I THINK the first thing I had better explain is the nature of the soil which I have been attempting, I believe not unsuccessfully, to convert from arable land to pasture.

In Norfolk it would be described as useful, medium loam, but in most parts of England it would be considered rather light and sandy, but as the subsoil is mostly brick earth it holds moisture much better than might be expected from the appearance of the top soil.

The average annual rainfall in Norfolk is only in the neighbourhood of twenty-five inches, which must be taken into account when deciding the seeds to be included in the mixture. After deciding to put a field down to pasture it is, to my mind, essential that it should be absolutely clean. It is often said that if land is laid down to pasture it will automatically clean itself, even if it is foul when the seeds are drilled, but I have never heard how many years it will take for this cleaning to come about. I have seen land ploughed up after having been down for ten years and the twitch-grass was as strong and healthy as when it was laid down, and the pasture had never been anything but rubbish all the time. I have even gone to the expense of taking two root crops—potatoes, followed by swedes—to make sure that there was no foul grass left before putting in the seeds.

It should, however, be possible in the normal rotation to get the land sufficiently clean. Then the Norfolk sequence of roots, barley,

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seeds is usually successful, for at that position in the rotation the heart of the land ought to be good. Just as, in my experience, to lay land down when foul so it is an equally short-sighted policy to lay it down when out of condition. Condition should be built up before the seeds are sown, then the pasture will usually go right ahead. Manuring before the seeds are sown is to my mind as important as, if not more important than, manuring afterwards, although that too must not be neglected. I do not mean that it is necessary to spend years preparing for grass. There is usually no time for that when grassing down is contemplated. Condition, by sound tillage and high farming, is, in my experience, fairly quickly built up. I have, for instance, this year grown 13 tons per acre of sugar-beet on land that was derelict four years ago, and I am sure I could lay that field down to permanent grass with success next year. It is clean and in good heart.

In regard to the seed, the next point to be considered, I might mention, is what a very prominent Essex agriculturist insisted was essential in making a really first-class pasture. His essentials were, "Wild White Clover and a Scotsman," and I thoroughly agree with the former part of the mixture. When I first started laying down permanent pasture I had to a great extent to be guided by the seedsmen's catalogues, and I can assure you it was a most elaborate and expensive mixture, as you will be able to judge when you hear it contained, 5 lb. Cocksfoot, 1 lb. Tall Fescue, 1 lb. Meadow-Fescue, 2 lb. Timothy, 2 lb. French-Italian Ryegrass, 6 lb. Irish Perennial Ryegrass, 2 lb. Hard Fescue, 1½ lb. Sheep's Fescue, 1 lb. Fiorin, ¾ lb. Bunnett, ¾ lb. Chicory, ½ lb. Single-cut Cowgrass, ½ lb. Wild Red Clover, 1 lb. Giant Red Suckling, 2 lb. Pivurie Lucerne, ½ lb. Giant White Clover, ½ lb. Wild White Clover, 2 lb. English Trefoil and 2 lb. Canadian Alsike—32 lb. all told, and 19 species.

I did not repeat that mixture, as it was not only too expensive (as far as I can remember the cost was in the neighbourhood of 65s. per acre; of course seeds, like everything else, were much dearer then than they are now), but a lot of the seeds I was never able to find, and a few of the others I wish I had never found, as they have been an eyesore to me ever since. I might mention chicory in that category. The cattle seem to eat a bit of the leaf in its young stages, but it soon runs up a big coarse stalk which nothing will touch, and which gives the meadow a very rough, uncared-for appearance. Gradually I eliminated one thing after another, as I considered they were either ineffective or not worth their money, till eventually the mixture has been cut down to 6 lb. Cocksfoot, 2 lb. Timothy, 12 lb. Perennial Ryegrass, 2 lb. Single-cut Cowgrass, 1 lb. Rough-stalked Meadow-Grass and 2 lb. Wild White Clover—25 lb. in all; and I am doubtful if the single-cut cowgrass is worthy of a place, as the cattle always seem to avoid it as much as possible.

As I prefer to graze rather than hay in the first year, believing that

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a quicker and better-knit turf is produced that way, I shall in all probability drill no more cowgrass, and in that respect I do not except Montgomery late-flowering red clover, which in my experience has little to commend it under the dry Norfolk conditions. I well remember two adjacent fields, tilled in exactly the same way for years, and permanently seeded at the same time; one was hayed in the first year, the other was grazed; the latter is now a good pasture, but the former has been ploughed up; and I cannot forget that lesson. The omission of late-flowering red clover, the cowgrass of the seedsman, will cheapen my mixture but it is not expensive as already it stands, and I use it with little modification on every occasion. It is a very plain, inexpensive mixture, last season costing only in the neighbourhood of 25s. per acre, and for our part of the country I believe it is all that is necessary. Some of you may think the quantity of wild white is excessive, as you would no doubt get the same result eventually, and more cheaply, from a smaller quantity, but you would have to wait longer for it. When I start I want pastures at once, and a heavy seeding of wild white goes a long way towards that end.

I have tried putting the seeds down in August after a bare-fallow, but I have been much more successful drilling with a barley crop in the spring. The only thing to avoid is getting the barley too heavy and smothering the small plants, and it is advisable in a dry country like Norfolk to drill the seeds as early as possible, so that they may be well established before the hot weather sets in. I sow as early as the end of March or the beginning of April, drilling on a flat-rolled surface, harrowing and rolling again. Having secured a plant I give it a top-dressing during the first winter of 4 cwt. of meat or bone meal, containing 6 per cent. ammonia and 35 per cent. phosphates, and this I like to repeat every second or third winter. I am told that I am wasting money by using meat or bone meal, but I am not so sure. I know I could buy slag and, say, sulphate of ammonia more cheaply; but should I get the same result? Should I get the benefit of readily available phosphates combined with continued nitrogenous action?—which I think is so desirable in the first few years. I am afraid I shall stick to my meat or bone in spite of the prospect of economy, which is supposed to be so attractive to all of my race.

As I have already said, I think it is a mistake to cut a new pasture for hay the first year, as the coarse grasses are apt to get too rank at the expense of the finer ones.

When grazing a young pasture with cocksfoot in it, it is most essential to feed it down hard in the early spring and summer, and even then it is difficult to prevent some of the cocksfoot from running to seed, in which event the grass-mower must be brought into use, otherwise you will soon have a very rough pasture of poor feeding-value. In spite, however, of the extra care that is required in grazing cocksfoot I have come to the conclusion that it is indispensable, for the

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grazing of dairy cattle, on land inclined to be light. I have come to rely on cocksfoot to give me a bite in April, without the use of any forcing manures. I can often turn stock on to it by 1st April, and I have on occasions been feeding my lighter pastures in the middle of March. That has been entirely due to cocksfoot. Most of the cocksfoot I have used recently has been Swedish Scandia, which I have found much easier to handle than that usually supplied in commerce, and I trust we may look hopefully to the future selections of cocksfoot for real practical assistance, which should make that invaluable grass even more useful.

In conclusion, may I add a few words regarding the carrying capacity of my new pastures and my experience of the extension of grassland in conjunction with dairy farming in Norfolk. It will be necessary to introduce a few personal items. I farm something over 2000 acres of land. There used to be about one-tenth of the farm permanent grass. I have increased that to one-fourth and my cows to 280. I am therefore called upon to provide feed for those cows during the summer, and I would emphasize, to provide it in one of the driest counties in England, although I am glad to say I do not farm the worst of the land in that country. Nevertheless, we are not supposed to be able to produce grassland in the Eastern Counties. We are supposed to be parched up in July and August, but although I prepare every year for that drought, by growing crops on the arable land in anticipation, I find that they are not wanted in more than half the years. When the drought really comes, and it is only in times of general drought that I suffer, we are usually no worse off than other districts.

Nevertheless, with my head of stock, I must be ready each year. I used to save mangels for July, now I save sugar-beet pulp. I grow marrow-stem kale, sown in March, for August and September feed, and I find it better than maize for the purpose in mind, and, as I think I have suggested, I am one of those who refuse to believe that East Anglian grass is useless.

In 1924 I ran 70 cows during the day for the whole of the summer on twenty-seven acres of grassland down in 1922, and in 1930 nine acres carried 18 heifers from the middle of April, and 7 more two weeks later until the field was shut for wild white clover seed on 7th June. With my simple mixtures, with heavy wild white clover seeding, and suitable manuring, I find that the poverty period, which I was taught was inevitable, does not exist. There seems no reason why, given clean land in good heart, and suitable seeding and subsequent management, arable land should not be as effective as old grassland two years after laying down. Ryegrass and wild white clover, with cocksfoot on the light lands, are the important species in the process, and I believe that a heavy seeding of wild white clover is essential. Occasionally I have had scouring on my new wild white pastures.

There is an old saying that "To break a pasture makes a man and to

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make a pasture breaks a man." Well I did a little of the former during the war, with not too satisfactory results, and I have done a lot of the latter since the war, and up to the moment have not filed my petition, but, so far as I can judge, unless I continue this policy more rapidly than I have done I will soon be compelled to do so.

LAYING LAND DOWN TO PERMANENT GRASS

By W. S. MANSFIELD, M.A.
University Farm, Cambridge

The methods which may be employed in laying down permanent grass are so varied that it is impossible that any one man should have first-hand experience of them all. Having had experience of several methods, and having been a close observer of several more, my observations are based on these cases, all of which were confined to the heavier types of land in the Eastern Counties.

I think that it must have been in the Eastern Counties that the saying "To make a pasture breaks a man" had its origin. In any event, putting land down to grass in these regions has always been regarded as a "dark and difficult adventure."

In the days when wild white clover seed was unobtainable I believe there was every justification for this being so, but now that we have reliable supplies at a reasonable price the position is very different. In this comparatively dry climate (an average rainfall of twenty-one inches, with spring drought) our land does not take naturally to grass. Wild white clover seed has revolutionized the whole outlook. Personally, I no longer regard the laying down of permanent pasture with misgivings.

When, where, how and what to sow would seem to be the first questions that arise; followed by such points as suitable manurial treatments and management of the new pasture in the first few years.

When to Sow.—I have seen permanent grass seeds sown successfully in every month from March to September. This does not mean that I believe that all times between these dates are equally good, but that, given suitable conditions of soil and weather, there is quite a wide range of time in which seeds may successfully be sown. My experience leads me to believe that April and July are the optimum months for sowing in the Eastern Counties. If sown in April there will be plenty of moisture in the soil to germinate the seed rapidly, and the plant should be fairly well established before a drought is likely to occur. Moreover, if undersown in a corn crop the seedlings will have an opportunity of making a certain amount of growth before the cover-crop robs them of light and air.

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I choose July as the other date, for this is usually a wet month, and if sowing is postponed after July it may be that a dry August will compel deferring it until September. My objection to a September sowing, and it has been supported by several instances, is that, though it may be quite satisfactory as far as the grasses are concerned, the little plants of wild white clover are too small to withstand the attacks of slugs which so often occur on clay lands in a wet and open winter. Moreover, there can be no doubt that a larger and more mature plant is better able to withstand the wet and cold of the winter. It sometimes happens that in a September sowing all the wild white seed does not germinate the same year. Quite a high proportion, even as high as 50 per cent., may remain dormant until the following spring or summer. In some ways this is an advantage, as the risk of losing the whole of the seed is very much reduced for this reason. For this reason also, where a fair quantity of wild white has been sown, I would never quite give up hope of getting a plant until twelve months after the first seeds had germinated.

Where to Sow.—Some prefer to sow on the open land, some under a winter-sown corn crop, and others under a spring-sown corn crop. I have seen all these methods applied successfully, and circumstances must decide, but on the whole I am inclined to favour the last-named arrangement.

The plants require plenty of light and air if they are to flourish, at the same time they are the better for a certain amount of shade in the hottest weather. Successful plants on headlands where the middle of the field is a failure is often pointed to as emphasizing the importance of the solidity of the seed bed. Without belittling the importance of solidity I am inclined to think that the seeds on the headlands often flourish best because the cover-crop is here the thinnest, rather than through any additional solidity of the soil.

If the plants are to get plenty of light and air then the cover-crop must not be too thick and heavy. It must not lodge (this rules out winter oats as a suitable cover-crop), and for preference it should be so arranged that the small seeds are given a good start in order that they may get reasonably established before the cover-crop shades them excessively.

For this reason I prefer a light seeding of barley sown rather late (the middle of April), followed immediately by the sowing of the small seeds. It may be that this will make the harvesting of the barley difficult, but I regard the corn crop as of small importance compared with obtaining a successful plant of permanent grass.

It is rarely possible to get a maximum corn crop and a perfect plant of seeds. It can be done if the season is suitable, as in 1929, but if attempted in such seasons as 1930 (and unfortunately we seem to have more of the 1930 variety than the 1929) it means disaster. In any case, the season cannot be foretold at the time of sowing.

Some people prefer sowing under winter wheat, and I have used it

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successfully myself as a cover-crop. It has the undoubted advantage of a firm and fine seed bed, but by April the wheat is growing fast, and may shade the land very thoroughly before the small seeds sown in April have established themselves.

I once saw an old and worn-out field of lucerne used successfully for sowing permanent grass seeds. The land was not ploughed, but was torn about with cultivators in the late winter, and the seeds were drilled in the spring. The result of the cultivation was to rejuvenate the old lucerne ley, which served as a very useful cover-crop for the young seeds, which planted well. Wherever it is decided to sow the seed, and the possibilities are many, one thing is essential—that is, a uniformly firm and fine seed bed. It can hardly be too fine or too firm, and of course the cleaner the better, though annual weeds are of no consequence. In fact, if not too numerous or too strong, they may be an advantage in some seasons where a July sowing or fallow is being made. In such a case the annual weeds will take the place of a light cover-crop, shading the young plant in the event of a dry, hot autumn, and affording protection in the winter.

How to Sow.—I have no hesitation in affirming that in the Eastern Counties small seeds are better drilled than broadcasted. Broadcasting is admittedly cheaper, and a perfect distribution may be obtained with a minimum amount of labour ; if, however, the condition of the seed bed is not uniformly perfect, or if a period of dry hot weather sets in immediately after sowing, then the loss of a quantity of expensive seed may result. Drilling is very much safer, and if a proper small seeds-drill is used (one with coulters four inches apart), and the seed divided into two portions, and half is sown each way, the distribution will be perfectly satisfactory.

What to Sow.—So much has been said and written on the subject of suitable grass mixtures that I hesitate to say anything. However, perhaps a fool may rush in where angels fear to tread. Where I have adopted the following rules I have generally been successful :

(1) Do not use too complicated or elaborate a mixture.
(2) If you decide that a particular species is worth including, sow plenty of it. A small quantity of a single species is never worth while.
(3) Sow between 30 and 35 lb. per acre.
(4) Whatever else you sow always include a minimum of 1 lb. of wild white clover seed, and let it be the best certified indigenous stock that can be bought. I would sooner sow ½ lb. per acre of the best seed than 1½ lb. of some cultivated strain. If conditions are perfect there seems little to be gained by sowing more than 1 lb. per acre, otherwise I should suggest 1½ lb. I have been told by one farmer that when he puts land down to permanent grass he sows 4 lb. of wild white per acre, and nothing else. He assures me that his results are highly satisfactory.

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(5) If indigenous varieties are obtainable at reasonable prices they are to be preferred to ordinary commercial strains.

(6) Do not include cocksfoot unless you are prepared to graze the pasture thoroughly and carefully. Cocksfoot is a splendid servant but a bad master. In seasons of drought it provides keep when other species are dried up ; all stock seem to like it in its leafy stage, but if kept not grazed down it may spoil a pasture with its strong, rank, tufty growth. Some indigenous strains are much easier to manage than the commercial. Their growth is much more " leafy," they are less inclined to become tufty if undergrazed, and the tendency to send up flowering shoots is reduced. If cocksfoot is to be included at all, at least 8 lb. per acre should be sown.

(7) You cannot have your cake and eat it. When making up your mixture take the long view. It is surely wiser to consider what the pasture will be like in three or four years' time than to think mainly of the weight of the hay crop that may be taken in the first year. For this reason I do not care to include much red clover, or any Italian ryegrass. I cannot say that I have found any of the strains of late-flowering red clover persist sufficiently to warrant their inclusion. After the first year 90 per cent. of the plants seem to die out. Moreover a strong growth of red clover will inhibit the development of the wild white clover, and, though it does not kill it, it delays the formation of a close sward, which is so much assisted by the rapid spread of wild white.

Manuring.—On heavier land, with which I have had most experience, basic slag is a *sine qua non* for pasture formation. I have been in the habit of using 8 cwt. per acre of high-grade Bessemer slag, applied either the previous winter or at the time of sowing the small seeds. This may seem a heavy dressing, but the results seem to justify it.

I have seen astonishing results from the use of lime applied just before sowing the seed on a clay soil which already contained an adequate quantity of lime, but am at a loss to explain the reason. I have never, so far, used it myself, and have never felt the need for it on the soils with which I have had to deal.

Management of Newly Sown Permanent Grass.—To my mind this is perhaps the most important consideration of all, and on it depends the success of the pasture.

Nothing can compensate for mismanagement in the first few years, however perfect the mixture chosen may be, or however liberal the manuring.

It is by grazing, and grazing only, that a sward can be obtained *rapidly*. I do not mean that taking a hay crop in the first year will ruin the chance of ultimately obtaining a close sward, but I am sure it will postpone the objective. The aim should be to keep the new

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pasture grazed *closely and evenly*, and never to allow any of the plants to send up flowering shoots. This can be done only by skilful grazing with mixed stock. Sheep are invaluable as an aid to pasture formation. Some of the best results I have seen have followed the close folding of ewes and lambs on a new pasture in its first season, instead of mowing it for hay, which I suppose is the most usual practice. I should not advocate this course in the case of fields sown late in the previous autumn, where the clover plants will probably be too small to stand the close grazing of the sheep.

At the same time, I have convinced myself that the old teaching that the grazing of a pasture in the first year should be confined to cattle is erroneous. If the plants are reasonably well established, as they will be by the time they have been sown twelve months, they may be grazed, and grazed closely, by sheep with advantage. This close grazing will cause the wild white to spread as will nothing else, and in this way the whole of the ground will rapidly become covered with a close and dense sward.

I have outlined only a few of the more important considerations, and I am afraid I have not contributed anything new or original. At the same time, I am satisfied that if, under Eastern Counties conditions, the work is carried out on the lines I have suggested a good pasture will result in almost every instance.

MAKING OF NEW PASTURES

By C. H. GARDNER

Kitchen End, Silsoe, Beds

In no way is it intended to present this paper as containing superior knowledge of the subject in any way likely to supersede general practice. It is but a plain statement of procedure that has produced satisfactory results with land of average possibility, my soil being a rather sticky clay, situated a few miles north of the Chilterns.

Just sowing down unwanted arable land is not enough. Some guiding principle is needed as to its subsequent use and place in farm economy. I conceive most things in life and business as working in one of two circles of sequences. In laying down land to grass the first requisite is to plan and work within the accommodating circle, so that each possible sequence makes possible yet another advantageous one. Here are factors we need to consider—labour is expensive, straw is scarce, cattle prices boom in spring and slump in autumn, store and growing cattle are best wintered out. Land is warmer where compressed. Clovers subsequently feed grasses, nitrogen is cheap. It is necessary to grasp the part expected to be played, or a full stop may occur at a vital moment and so nullify a good original intention.

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I am not a believer in the orthodox way of seeding land to grass, having been convinced by experience that it is expensive and far from being always reliable. In no way, however, do I wish to impeach either the ability or integrity of seedsmen. I simply say I have found a better way than buying a mixture of seeds at a cost of 70s. an acre, the actual cost for 22 acres sown down by me in 1919. It is assumed that the land under review is comparable.

This field, and another sown by my predecessor, showed signs of restricted growth and development from the time the nurse crop was harvested. The grass plant was too thick and the clover content out of proportion, with the wild white obviously a sickly little plant and incapable of any domination.

I became so disappointed that in the spring following I dressed the whole with superphosphate, and made experiments with kainit and sulphate of ammonia. The results were not good except in the case of sulphate of ammonia, which to my surprise developed the clovers as well as the fine grasses, and continued to show an advantage for at least five years from the one initial dressing. During ten years this field has been dunged twice, "supered" once, slagged twice (6 cwt. each time), and all has received ¾ cwt. of sulphate of ammonia. Part was dressed with lime, which had no marked effect. The conclusions I came to in regard to this particular seedsman's mixture were (*a*) that the wild white was not a persistent or robust strain, or suitable to my locality; (*b*) that ½ lb. was insufficient to dominate the pasture in its early stage, and (*c*) that far too many varieties of grass seeds were included, and thus gave little chance for the wild white in the struggle for existence. In 1926 I came across a very robust strain of semi-cultivated wild white clover, with exceptional creeping propensities. I bought a quantity direct from the growers for sowing down other fields, and drilled 1½ lb. per acre upon the above-mentioned field. The year following the improvement was very pronounced. The whole field developed a nice carpet, which encouraged the cattle and sheep to spend more time upon it.

Bearing all this in mind, I determined in future to confine new mixtures of seeds to essential varieties only, and to give the new strain of wild white more chance. The mixture was made up roughly as follows:

	s.	*d.*
Perennial Ryegrass, 15 lb.	5	0
Cocksfoot, 7½ lb.	5	0
Timothy, 3 lb.	1	6
Wild White Clover, 1½ to 3 lb.	8	6
A few pounds of Red Clover and Cowgrass I had by me—say	3	0
Total cost at market price	23	0

Timothy was included because I had seed on the farm.

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I believe that it is unwise to mow in the first year a new pasture intended for permanent grazing because of (*a*) the curtailment of the incentive for reproduction; (*b*) the absence of beneficial treading, with its effect upon capillarity, and (*c*) the impoverishment of young seeds at a vital stage.

But I have personal knowledge of cases where the maximum development of a pasture has been held up in the succeeding years until a hay crop has been cut. On this assumption the addition of big clovers does not jeopardize the chances of the wild white, but it ensures greater stock-carrying capacity the first year, particularly in the first autumn and early spring, and provides a firmer tread for stock, which is essential for the root development of the grasses. I give the highest possible place in new-pasture making to consolidation through treading by stock, particularly sheep, as by this means the soil's warmth is helped during the cold months, and capillarity during the summer months is also better served than by the use of the roller when the soil is plastic.

It is obvious that much beneficial splitting of grass roots is effected, for, as in an oat crop, the less competition for root-room the healthier the growth and the more foliage in proportion to stalk of the individual plant. This to my mind is a point in favour of reasonably thin sowing and stabilization of individual plants of grasses. In regard to wild white clover, no better method could be named than treading for encouraging the stolons to take root and so spread at a greater rate. It may be supposed that treading by stock other than sheep would be too drastic a treatment for young grass on heavy land; but where any fall exists, and if land needs draining, a light mole plough and a tractor can work wonders in diminishing this risk, and it is surprising where stock-treading is persisted in how firm it becomes eventually when the wild white mat has formed, and the late arable tilth has been consolidated evenly and from the bottom.

Bearing in mind the elementary character of the seeds mixture used, and the necessity for strengthening later on, we rely upon inoculation from adjacent old pastures for this. Indeed the original sparse seeding is designed to allow room for successful inoculation as the annual and biennial clover die down. In practice this works well, for if patches are found about the third year not strangulated by wild white, most of the indigenous grasses can be clearly marked, and are in ample supply. This system implies a modified form of ranching, which, incidentally, simplifies the question of water-supply. No dirty gateway or rough hedge not essential for shelter is allowed to remain. I estimate that each gateway spoils at least a rood of valuable winter feed, through over-treading, and that each rough hedge means a water-logged ditch, and a low temperature for the whole field during the cold months. We therefore take away the unwanted gates and hedges and pipe in the ditches, thus releasing more money from labour, for buying nitrogen, which gives a better return. I would here interpose that

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more labour than has been displaced by my grassland farming has been absorbed by intensifying some of the arable portion into market-gardening. Not only this, but it enables cattle to cross and recross new pasture, and as the tendency is for stock to spend more time on sweet young pasture, old pasture tends to become less coarse, and its super-richness moved through dung to new pasture. I know of nothing calculated to depress and irritate a farmer's mentality more than numbers of unwanted dirty and broken-down gateways and untidy hedges. The little shelter these hedges afford in winter is as nothing to the pests they harbour, and the loss of sun. Cattle in summer are less tormented by flies in open fields and sheep need only half the attention. All foddering is done as much as possible on the new pasture, to help consolidation and provide natural seeds if any exist in the hay. (In theory they should not, but in practice they always do.) I may be a rebel, but the only control of grazing I adopt is to stimulate with nitrogen when supplies are short, or threaten to become short. On an average about once in two years this is necessary. We used 11 tons of sulphate of ammonia in November 1929, which helped winter and early spring growth very considerably—rate of application, ¾ cwt. per acre. My method is to play for safety the whole time, and I certainly should not be safe in facing the winter without rough keep, and at the mercy of slump stock prices in autumn and a boom in spring. Like most farmers who carry a big head of stock and sheep on pastures all the winter, I have never once in thirty years' farming had any grass left in late March. It is the market value, and not the food-unit value only, that counts in the balance sheet. It is to be noted that we never seek to establish a new pasture as a self-contained field.

Under our system the robust semi-cultivated wild white is the starting-point of accommodating factors. In both theory and practice this provides an abundance of keep for the first few critical years, and enables the land to be trodden well with stock; it also provides a drought-resisting mat, and fertility for the grasses subsequently. Assuming the semi-cultivated wild white does die out in a few years (and I do not concede this point), its place is certainly taken by the indigenous varieties—for I believe there are more than one distributed in the dung of stock, particularly horses. For this and other reasons we never disturb by harrowing any droppings on a new pasture, but allow the seedlings to root. Indeed harrowing and rolling is but a sign of ill management, for a better return can always be obtained by spending money, not upon mechanical equipment and effort, but upon nitrogen, and stock can do much better all that is necessary. At this point I would interpose that we adopt one of two methods for dealing with rough patches of grass—either mow and store for winter use, or give a liberal dressing of dung—and I incline to the latter method as the best. Dung soon converts hard unpalatable grass into succulent and sought-after food. It should also be noted that apart from an initial dressing

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of, say, 6 cwt. of slag before or during the first winter, and possibly ¾ cwt. of sulphate of ammonia the spring following, we do not force the pace of growth. Even dung gives a better return if applied circuitously through the old pasture. In grass management we aim at a condition that no water is allowed to stagnate; that further addition of slag no longer gives any appreciable result, and that some growth can always be expected when the thermometer is above freezing-point. A point of interest worth mentioning is whether it is wise to sow foul land. I give my experience in the case of two fields, each of 15 acres. Half of one field was foul, but in really good heart. All was sown together, and after the first year the clean portion showed no superiority over the foul. This I attribute mainly to the firmness in tread, which helped the wild white and stultified the couch and other weeds. (In a self-contained field this advantage would not obtain, as the numbering head of stock would be limited.) The other field was all in poor heart, half being clean and the other half foul. The foul portion is still considerably inferior (five years later) to the clean portion, although dung has been applied since, and none to the clean half. I therefore conclude that foulness is no bar if, at the time of sowing, available fertility is present, and if stock from adjacent old pastures are allowed to spend the time they are wont to do upon it. I would go further, and say that no amount of plant food added after the first year equals a good start before the first winter. If, however, I were faced with a similar problem, I should hesitate to spend, say, £3 per acre in cleaning, when cheap nitrogen is available. I think basic slag at seeding time, say 8 cwt. per acre, and sulphate of ammonia in both autumn and early spring, would overcome the difficulty of a good start. I now give some of my experience of lime upon grass. It so happens that my farm is sufficiently near to a newly opened lime hill to allow me unlimited supplies at a cheap rate, and two years ago I dressed 150 acres with about 3 tons or more to the acre. The effect was not so striking on my clay during the drought of 1929 that followed as it was in an impressive case at Woburn in the drought of 1895 (with a more sandy soil), but it was quite obvious it helped to preserve growth. I am aware that the theory is that lime acts mainly, if not exclusively, by chemical action, but ever since the Woburn experiment I have always contended lime also acts as a capillary or absorbing agent. I may be wrong, but I think it a point worth considering.

Lest anyone should have the idea that my grass is of a rough non-nutritious character, this idea can soon be dispelled by my stating that a herd of cows I kept on behalf of a relative has gained the highest place this year in milk recording for the county of Bedfordshire. These cows graze pasture every day through the winter, and their condition is second to none in the whole of the country. Further, by wintering out I am able to market many fat beasts in the early summer, and I am still selling to local butchers cattle off the grass, receiving cake. My

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ewes, which have had access since harvest to fifty acres of new-sown grass, together with old pasture, are really too fat for successful lambing, with no additional food.

Needless to say, anyone wishing to inspect my grass will be welcome to do so. In conclusion, I would urge a more liberal use of current possibilities as they come along. A few years ago it was good slag. To-day it is cheap nitrogen. To-morrow it will—we hope—be something else to continue the accommodating circle. Extension and stimulation of wild white clover, whilst being good for the individual farmer, carries also an advantage to the nation's real wealth, in that huge stores of nitrogen are assured ready for use in more normal times, or in a national emergency. We do not realize sufficiently that under all old rich pasture there exists more latent than potent fertility. It should be our business, and profit, to cash more of this annually without diminishing the source. Grass that grows in winter can look after itself in summer.

THE MAKING OF NEW GRASSLAND

By Captain ARTHUR R. McDOUGAL

Blythe, Lauder

In 1901 I took over the tenancy of my present farm from my father's trustees. It consisted of about 1000 acres of high, poor arable land, along with a big area of moorland grazings. The arable land had all been reclaimed, out of heather, bog, birch, scrub and bracken, by my father, from 1852 onwards. He had a twenty-six years' lease, and under its security he reclaimed this 1000 acres and made it arable land, and built a steading, and ten cottages, etc., all as a tenant. This was typical of hundreds of others—our forefathers—whose optimism, fanned by high grain prices, led them to drive the plough in Lammermuir higher than anywhere else in the country, right up to the 1200 foot mark in the case of my father.

It was cropped on the five-shift rotation for one or two rotations; then as prices fell, and the virgin turf which was its only wealth was exhausted, it was sown out with the old-fashioned ryegrass mixture and left. The lower areas were retained under regular crop, but the higher and poorer areas were left to revert slowly to Agrostis and Bent. The problem is to reconvert this into good modern pasture. It had all been drained, and had got about 5 to 6 tons of shell lime per acre. It all lay at an elevation of from 700 feet to 1200 feet. The soil varies from sharp slaty land to stiff blue clay, with peat on top, and it is all very stony.

At the time I took it over we had twelve work horses, and sold

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some grain annually. So my position in 1901 was that I was faced with this 1000 acres of so-called arable land, with 240 acres of oats, 120 acres of turnips, and approximately 640 acres of inferior temporary pasture, which had been of course sown out in the fashion of those days, with a bushel of perennial ryegrass, half-a-bushel of Italian and a few clovers —English red, white and alsike. It kept 1½ twins per acre as young grass, barely one twin per acre at second year's grass, and after that about one single per acre was its limit. These figures refer to half-bred ewes and lambs. After mid-June there was no bottom in the pasture and little but a forest of ryegrass windlestraes. My problem was to produce the maximum number of lambs for sale of as good quality as possible, and clearly the output could be greatly increased if I could only improve the pasture. It is to be clearly understood that my opinions and experience are definitely limited to this high Lammermuir land. I am too well aware of the great differences in land, climate and methods of stocking and types of pasture desired to say this or that is the best grass or mixture for everyone. Every farmer ought to carry out simple experiments on his own farm to find out what suits him. A simple experiment is described later, which I sowed for many years, in almost every field.

I attacked the problem on three main lines, experimentally:

(*a*) By top-dressing some of the worst deteriorated pastures with manures and lime.

(*b*) By special stocking with cattle to eradicate or check Agrostis, and mowing rough bits in the better pastures.

(*c*) By plowing out the bad fields, and by lessening the ryegrass in the mixtures and increasing the natural grasses.

After thirty years' experiments I have never seen any advantage from top-dressing pastures on my farm with phosphates and potash, and my experience in this respect is fairly general all through Lammermuir.

The results from liming were more encouraging, and several times I could see very distinct results from it.

On the whole, results from top-dressing have been so disappointing that I have given up the idea of improving pasture in this way. I have come to the conclusion that, in my experience, on the particular land I have to deal with, heavy doses of phosphate and lime on the turnip crop are very beneficial to the following pasture.

A typical mixture for my turnip crop is either 1 ton 34 per cent. slag plus 1 cwt. nitrate of soda, or 8 to 10 cwt. 65 per cent. mineral phosphate plus 4 cwt. superphosphate plus 1 cwt. sulphate of ammonia. This ensures as good a turnip crop as may be, and leaves plenty over for the following grass.

A neighbour top-dresses his seeds with slag after the corn is led. I have not tried this, and it is possible that top-dressing then may be more effective than on an older pasture.

Most of my experiments with top-dressing pasture have been done

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on old deteriorated pastures and were mostly failures. I am inclined to think that perhaps when one has a good pasture it could be kept good for an indefinite, or at any rate a much longer, time by top-dressing with phosphates, etc.

However, I am in favour of getting the pasture first by resowing and utilizing the old turf as manure, and then, if desired, top-dressing may be effective in some cases. I have tried manuring with nitro-chalk and sulphate of ammonia for an early bite, but it too was a failure.

As the old temporary pastures got older they were overrun with Agrostis, and I found that lack of lime favoured the Agrostis, and that liming in sufficient quantity will overcome it. Nothing is any use unless the ground is sufficiently drained. Agrostis will appear on poorly drained land within two years of sowing down.

As regards (*b*) I found that by heavy stocking with Galloways or West Highland cattle just before the Agrostis came away in summer, and by wintering these on the bad fields, we very greatly diminished the Agrostis and encouraged the white clover, etc., and improved the pasture.

I have found that the cutting with the reaper of a grazing that had got too rough in June or July always made a great and lasting improvement, and one could see the places that had been cut for two or three years after. They were better grazed and the wild white clover had increased greatly in them.

My experience with this has mostly been with better pastures, and not on the most inferior. The only drawback to it is that the job should be done when one is fully employed with hay, turnips, singling and clipping, so that it is very difficult to get it done. I have not tried surface cultivation as my land is so stony, and the turf mat is not thick.

(*c*) *Improved Seeds Mixtures.*—In 1919 I obtained a very long lease and I went right ahead ploughing out all the worst pastures, manuring the turnip plots heavily with phosphates, liming where necessary and sowing out with the best possible mixtures that my experiments[1] had suggested to me.

About 1923 I reduced my horse strength to eight work horses, cropping 60 acres turnips, 80 to 120 acres oats, and the rest (840 acres) in pasture of various ages. I had expected to employ fewer men, but I saw that in order to benefit properly from the changed rotation many improvements were necessary. I have been steadily executing improvements since the war, such as roads, drains, water-supply, sheds, dipper, alterations to steading, liming, etc., so that I am still employing as many men as I did when I had twelve horses—that is, I have put off two pairs, but am employing two extra men who keep the work always well forward, and when any slack occurs we get on with improvements.

My present position now is that I have ploughed up and resown as much of the land over 1000 feet as I thought could be profitably done,

[1] *Scottish Journal of Agriculture*, January 1919 and April 1925.

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and have handed about 400 acres of it over to the Blackface sheep hirsel, whose numbers have been increased, and I still keep the same number of half-bred ewes on the land under 1000 feet that I did when they had the extra 400 acres. They have about 440 acres temporary pasture plus 200 acres permanent pasture. I let my temporary pasture lie always four years, and as much longer as possible, and I regret having to plough up good pasture at five or six years old. It may lie ten to fifteen years before reploughing. To avoid this, and to reduce the grain crop as far as possible, I take turnips off lea where the land is sharp and light, making the rotation—turnips, oats, turnips, oats and seeds. Where the land is stiff, and turnips off lea impossible, I sometimes take rape off the lea, sowing 6 lb. plus 10 lb. Italian ryegrass, following with turnips, oats and seeds. In other cases I take oats, turnips, oats, turnips, oats and seeds.

I find that the heavy manuring (quite double my pre-war standard) plus the lime, and the excellent pasture we have, has resulted in the rather astonishing fact that, I estimate, I am growing almost as big a tonnage of turnips on the 60 acres now as I did on the 100 to 120 acres before, and my yield of oats per acre has increased by at least one-quarter per acre.

This result is also partly attributable to my working a smaller break with the same staff, so that we are always in time and on top of the work. As an instance of the advantage of renovated pasture the case of a sixty-acre field at 1000 feet that I handed over to the Blackfaces in its third year is interesting. They got it in late summer and a big lot were tupped on it and another field. The result was that we had 100 pairs of twins more next year on that hirsel than we ever had before. The extra lambs alone for that year would go far to pay for cost of seed.

Last year I ploughed out a field at 1000 feet which had lain since 1833. I had turves analysed, and it consisted of 98 per cent. Agrostis and was almost worthless. It kept 2 ewes or hoggs per acre. I have given it 2½ tons Billingham lime per acre, and sowed it with rape and Italian ryegrass last year. We had an enormous crop, and it is now ploughed for turnips this year. We have drained parts of it and I am confident that in a couple of years or so it will be beautiful pasture, carrying 2½ twins per acre and good for ten years in diminishing ratio. This old land is absolutely clean, and grows enormous turnip crops, and as long as one rests it long enough it will do so. Its wealth lies in the old rotting turf, and it should be sown down to lie and regain a turf before it is ploughed up again. I expect to convert pasture worth 10s. per acre into young grass worth £4 or £5 per acre, diminishing gradually to, say, 20s. in ten years. We graze our young grass always, and take hay off our older fields. The young grass is worth far more for grazing than for hay.

I also have drained, limed and reclaimed a small field which was

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simply a useless water-logged bog. This I sowed out in 1920, and it carried last year over 2 twins per acre. I consider it has repaid me handsomely.

The ninety-three-year-old field above will cost over £8 per acre for seeds, lime and manure alone, but the crops during the rotation mostly pay their way, and the better grass after is real profit. This gives some idea of the cost and value of good pasture.

As regards seeds to sow. A very great deal depends on strain, and it is encouraging to see seedsmen devoting attention to that now. I never care to sow less than about 20,000,000 seeds per acre, and am inclined to think that the mixtures advocated by colleges, etc., are too thin. Of course on good land it is all right, but on poor, rough, high land the survival ratio is sometimes very low. My mixture depends on comparative prices, but the main idea of it is:

(1) Cut down the ryegrass, as its only merit is that it is sure to grow, but pretty useless as pasture plants.
(2) Cocksfoot is the staple grass of the mixture.
(3) Late-flowering red clover is absolutely the most important plant for the first two years.
(4) Wild white clover is the backbone of the pasture in its later years.

Ordinary red clover is absolutely worthless in Lammermuir, and it was very difficult, in fact impossible, a few years ago to be sure of getting the real late red. However, it is now possible to get it; but one must be careful. Certified Montgomery and Cornish Marl are all right, and if one knows a grower one can get it privately from other counties. Mine comes from Essex and is true to strain. It was not till 1913 that I fully proved to myself the great virtues of late red clover.

Wild white is so well known that no remark is necessary. Personally, I consider late red a better plant in every way, and if we could only get it perennial we would be in luck indeed.

The real New Zealand white is a bigger and better plant than the Kent. I have a nine-year-old field sown with New Zealand ordinary white which has been, and is, as good a white clover field as ever I had. In 1921 it was called New Zealand ordinary, and I daresay it was wild white I got. Now it is mostly called wild white, and some of that is very ordinary. The right strain has done well here.

Cocksfoot is the best grass we have, and is the backbone of the mixture here. I sow about 15 lb., and have sown up to 25 lb. It is very palatable to sheep.

Cocksfoot and tall fescue are the best weed-suppressors I know. In the pure plots, of all ages, the tall fescue plot is the one which never has a weed in it; no Holcus, Agrostis, or other vile grass dare grow there.

The palatability of late fescue is in doubt, but I think this is due

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to its earliness. It comes away first after cutting and is too old by the time the field is stocked. If stocked early, sheep eat it all right, but if the pure plots were stocked late the tall fescue was never touched.

Last year I sowed a field with 15 lb. tall fescue and 15 lb. cocksfoot, amongst others, with a view to letting it lie six or seven years, and suppressing the couch-grass which is in the field. In a trial on a particularly bad piece of sticky blue clay tall fescue was the best survivor, followed by timothy, cocksfoot and wild red clover. Tall fescue was far the best, and stood out strongly at seven years old when the field was ploughed.

Among the less well-known grasses meadow-foxtail is the best—in fact it is one of our best grasses, but the only seed one can buy is Finnish foxtail, and it is a useless weed. I saved a lot of hand-gathered indigenous foxtail from the roadside one year, and sowed it out in pure strip against Finnish foxtail and other grasses. It was a beautiful strip, whilst the Finnish one was very bad. It is much to be desired that our seedsmen should take up indigenous foxtail. A stock of my foxtail is at the Scotch Plant-breeding Station now.

As regards the merits of Danish, Swedish and New Zealand cocksfoot, my experience in practice is that the Swedish and New Zealand are not worth the extra price. I have sown them in strips, and whilst they were certainly different plants I could not say that one was better than the other. The Danish is the earlier, and that is an advantage, as we want earlier grass. I think that the Danish plant has deteriorated since 1914, and is now seedier and less leafy. The liability of strains of cocksfoot to winterburn here is that Danish is worst, Swedish fair and New Zealand very good, and not liable to burn badly.

As regard crested dog's-tail, it is a poor affair, but better than Agrostis, and I find that on poor land the crested dog's-tail appears to be able to squeeze out the Agrostis, so it has a use on Agrostis land.

I habitually sow yarrow, and am convinced it is a useful plant, though I note that it is classed in the Ministry's *Journal* as a weed.

Perennial ryegrass is in many respects a useless weed here. Its merit is that it will grow the first year, so I sow it solely to act as an insurance against the failure of better natural grasses. I have sown strips of the indigenous ryegrass experimentally, but as far as I observed it was no better pasture than the ordinary, although it was later and a different plant. Ryegrass is disliked by sheep.

The indigenous ryegrass I tried out was, I think, seed saved from the cleaning of wild white clover. It lay for five years before ploughing up, and was carefully observed all the time, along with two ordinary commercial ryegrass strips alongside. The strips were grazed with sheep mostly. Wherever perennial ryegrass is mentioned I mean the commercial strain, unless otherwise stated.

Poa trivialis grows very badly alone, but in mixture it is a very

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good grass, and grows well and strongly, though a small producer. It is a good bottom grass.

I found that meadow-fescue was the best bottom grass and could by itself, pure, make a bottom. When price is reasonable I sow 10 lb. per acre or so. It thrives well here at 1000 feet. The outstanding things I considered in my thirty years' investigations were:

1. Identification of grasses.
2. Palatibility of grasses.
3. Productivity of grasses.
4. Longevity and hardihood of grasses.
5. Earliness of grasses.
6. Bottoming qualities.

There is one simple experiment, fully described in my article in the *Scottish Journal of Agriculture* for April 1925, which every farmer wishing more information should make in every field. It is simply to sow strips of pure grasses about five yards wide and twenty yards long into the field and to sow pure clover strips across these. Fence off one half of the grasses and leave the other half for grazing; or, preferably, duplicate the plots and graze one and fence the other. This experiment will give one information as to all the points named above, but one must remember that many grasses, and Poa trivialis in particular, thrive better in mixture than by themselves.

The general result of the temporary pastures I have made here—about 800 acres in all—is that I have increased my sheep output greatly, and increased the yield of other crops per acre.

I consume all my own grain at home, and buy anything up to 90 tons of cake and feeding-stuffs per annum as well.

I have looked on cattle as a necessary evil to graze rough fields and to break down one's straw, and have not bothered to keep more than could easily be handled.

I have looked on labour in the light that the more labour one employed the more one prospered, and similarly with manures, drains and improvements.

In brief, my experience has been that the best, cheapest in the long run, and most effective way to improve poor arable land pastures is to plough them out, treat them well during the rotation, and sow down with good seeds, avoiding ryegrass. It also is a sound paying position.

[Herewith

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Herewith are some mixtures I have been sowing, amongst others:

Mixtures in lb.

	a	*b*	*c*
Perennial Ryegrass, Ayr	4	8	8
Italian Ryegrass, French	2	3	3
Cocksfoot, Danish	15	15	15
Tall Fescue, Dutch	15	..	..
Meadow-Fescue, American	6	6	10
Timothy, American	3	6	6
Poa trivialis, Danish	2	3	$\frac{1}{4}$
Crested Dog's-tail, Irish	1	$\frac{1}{4}$	$\frac{1}{8}$
Yarrow, Dutch	$\frac{1}{4}$	$\frac{1}{4}$	$\frac{1}{8}$
Late Red Clover, Essex	4	5	5
Late Red Clover, Montgomery	1	..	..
Alsike, Canadian	1	1	1
White Clover, New Zealand (ordinary)	$\frac{1}{2}$	$\frac{1}{2}$	$\frac{1}{2}$
Wild White, Kent	$\frac{1}{2}$	$\frac{1}{2}$	$\frac{1}{2}$
Wild White, Essex	$\frac{1}{2}$	$\frac{1}{2}$	..
Sweet Vernal, Dutch	..	1	..
Poa pratensis, American	..	..	$\frac{1}{4}$
	$55\frac{3}{4}$	50	$49\frac{3}{4}$

On the better fields at lower elevations these temporary pastures stabilize into good permanent pasture at about five or six years old, and continue without deterioration indefinitely, according to treatment. Laying down turnips on them in winter and box-feeding sheep on them helps, and manuring and haying also keeps them good. I hayed one field continuously for ten years, and its botanical composition varied little from its original. It was manured every year. The fields over 1000 feet are thinner and poorer and more acid, and deteriorate steadily up to about ten years, when they stabilize for a long time at a level considerably above the original. Whether regular manuring would prevent this deterioration I do not know. I think the limiting factors are (1) the continual sheep-grazing, (2) thinness of the soil and (3) want of lime. However, the winter grazing with sheep is hard on cocksfoot (and better grasses), and I find plenty of cocksfoot plants eaten out to the heart, and some pulled right up by the Blackface sheep in winter.

On the lower fields under 1000 feet, and stocked by half-bred sheep, the grass gets a rest for three months every spring, which helps greatly. The sheep is a highly selective grazer, which is bad for pastures. I have failed to get good pasture to remain more than a year or two on muirband, with peat over it, or on clay with peat over it. The failure is, I think, due to three causes in varying degree—viz.

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(1) Deficiency in lime. The requirement on one peat experiment was 6 tons shell lime on land that had received 6 tons sixty years ago;
(2) Bad aeration of subsoil;
(3) Water-logging, owing to impervious pan of muirband clay. These always reverted to Agrostis.

I have found barley the best nurse crop, strong-strawed Tartarian type oats next, but rape a bad nurse crop. With all the care in the world the fate of the pasture depends a great deal on the weather for eight weeks after sowing. There are vintage years for pastures as well as wine, and one has had disappointing takes due solely to bad after-sowing weather.

Turning now to the system of management. The whole of the cultivation is primarily to produce winter keep for the sheep stock. The grass is grazed from lambing time onwards till spaneing time, and the sale of the ewes and lambs. The twins all get extra box-feed, being mostly run off their mothers for it. The young grass, if the late red is good, can keep $2\frac{1}{2}$ twins per acre, and the older grasses in diminishing ratio. The late red is very good mostly for two years, and thereafter a sporadic sprinkling of plants remains, and the wild white takes its place. On the better land the cocksfoot persists indefinitely, but on the worse land it disappears considerably.

The problem one has is that the best grazing fields are the best croppers also, and yet one wishes to plough up the bad grass to renovate it. One has to compromise in this, for one cannot get, by any economic process, really good permanent pasture on the poorer land, but by lifting at longish intervals one does get a vastly better pasture that pays its way. However, I have given up one field as hopeless—a blue sticky clay with little soil at all.

As far as I can form an opinion, the proper course for the future is for farmers on the poorer land to improve their pastures. There are plenty of reasons for pasture, but none for bad pasture. The better-land farmers should change part of their grain crop to silage and go in for intensive stock arable farming.

We are yearly adding greatly to our technical knowledge, thanks to Professor Stapledon and others.

In answer to the query as to what is the line of research most likely to be beneficial I would without reservation say that it is that of *developing our own indigenous grasses*.

I am convinced that in the wild strains of the natural grasses we have far better pasture plants than we can at present buy from the seedsmen. The timothy varieties isolated at the Scotch Plant-breeding Station are extraordinary examples of what I mean.

If the farmer who is willing to pay the extra cost, as many are, could buy definite strains of natural grasses, as one buys different kinds of oats, etc., and be sure of their genuineness, it would mark a great

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step towards better pastures on our inferior lands. Timothy, cocksfoot, foxtail, ryegrass, permanent late red clover, etc., are all types that exist wild, and are better grazing plants than the cultivated ones. One gets permanent red amongst the late red. Personally, if I had a drier climate, I would grow much of my own seed, but our high rainfall makes it very difficult.

I have twice saved my own cocksfoot seed, and have now a seven-year-old pasture sown with home-saved cocksfoot which is very good. The seed was from a field sown in 1914 with New Zealand cocksfoot, and the present cocksfoot in it is very permanent-looking, and is a nice leafy type. I have more hope of good results from selected strains from old pastures than from artificially cross-bred plants. Of course different districts would require different strains, and I imagine that as many strains of a grass would be required as there are strains of sheep, to suit different localities.

Here then is a very wide field for research. A good deal has been done already by enterprising seedsmen and farmers, and by Research Stations, such as Aberystwyth and the Scotch Station. Professor Stapledon's work seems to run on very useful and practical lines. We are fortunate in having many public-spirited and enterprising seedsmen who are doing good work in producing and marketing selected strains, and who can be relied on not to ruin a good plant, as has been done in the past. Much has been done, but far more remains to do, as the selection of indigenous strains is still in its infancy.

When one compares the pastures of twenty years ago with now one sees a great advance. The good land seems about as good as one can hope for, and it is in plants suitable for inferior land that the room for research lies.

Manurial and cultivation matters seem to be about fully elucidated, and the remaining weak link is the plant itself, and its suitability for the different areas and jobs.

LEAFY INDIGENOUS STRAINS OF GRASSES

By M. JONES

Imperial Chemical Industries

The need of securing high production from grassland over a number of years is bound up with the nutritive value of the produce and the persistency of the plants. The recent work on the nutritive value of leaf and of stem in plants has shown that leaf is far richer than stem in the useful constituents. It therefore behoves us to consider leafiness as well as persistency in our pasture plants, but luckily the two factors

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(leafiness and persistency) go together in this case, and, what is still further luck, the plants which have these two useful characteristics are the ones that will give the maximum yield of produce over a number of years, provided the raw materials by way of plant food are supplied to them in the soil.

The use of the proper strains of the grasses and clovers therefore is essential before any success can be expected from seeding down grassland.

During recent years great strides have been made by the plant breeders in the breeding and selecting of more suitable strains of herbage plants, and in the near future the farmer may refer to breeds in his seeds just as he does now to breeds in his live stock.

The making of a pasture does not end, however, with the selection of the seeds mixture, as the proportion and production of any component of the seeds mixture is dependent on the treatment meted out to it during the following years. For instance, I have seen a field sown out uniformly with the same mixture give on one part a sward with 90 per cent. grass at the end of the second year, whilst the other part gave a sward nearly 90 per cent. clover at the same time, and this was all due to the different management. Similarly, the proportion of the various strains of grasses is governed by the management, and a very important factor that the farmer has to contend with is that the more persistent the species or strain the slower it is in establishing itself, and also in attaining to maximum production.

In order to make a permanent pasture, therefore, the production during the first year should be placed as a secondary consideration to persistency. When this point was first realized a general advice given to farmers was to leave out altogether the quick-developing plants, as they were found to compete with the slow-developing plants for the available plant food. This competition not only retarded the full establishment of the more permanent plants, but usually ruined their chances of survival. However, an appreciable loss of winter and early spring keep was sustained during the first two years by not sowing the quick-maturing species. It has now been found that this winter and spring keep need not be sacrificed, as the competitive effect of the quick-maturing grasses can be eliminated by combining the use of two controlling factors—viz.

(*a*) Grazing the sward at regular intervals, so as to prevent the rapid-developing plants from attaining their full size, and

(*b*) Supplying the plant population with a sufficiency of food to supply the needs of the biggest plants as well as the smallest.

It has been found that the size of the roots of a plant during its vegetative development is closely correlated with the size attained by the aerial part. Therefore by preventing the aerial part from attaining its full size the shading effect above ground is done away with, and also the root system is prevented from getting unduly large, so as to be

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able to absorb an undue proportion of the plant food available in the soil. This controlling, in practice, resolves itself to grazing the young sward lightly at intervals of about a month. Where the seeds are sown under a nurse crop the first grazing should be taken as soon as the corn is cleared, but where the seeds mixture has been sown without a cover-crop the first grazing should be done from ten to twelve weeks after sowing.

An important point to remember in the establishment of permanent pastures is that we are dealing not with annual plants but with perennials, and we wish to encourage those perennials that grow for eight to nine months of the year rather than those which grow for four months only. This necessitates supplementing the natural supplies of plant food in the soil towards both ends of the growing period in respect of the nitrogenous constituents—*i.e.* supplying a spring dressing and an autumn dressing in a readily available form.

As the animals prefer a mixture of grasses and clovers to grasses alone, an attempt should be made to establish and retain a proper balance of clovers to grasses in new grassland. For the first year it is comparatively easy to have a high clover content, as red clover, which is a short-lived plant, can hold its own against the grasses. From the third year onwards, however, we have to rely on the white clover for keeping up the leguminous population of a sward. The white clovers, it is true, vary within wide limits in regard to type, and even persistency, but as a class their general characteristics may be summed up by saying that they are very persistent but have a prostrate habit of growth, and are comparatively late in commencing active growth.

These two features—late and prostrate—put the white clover at a disadvantage in the competition with the grasses, and particularly so if the manurial ingredient phosphate, to which it so readily responds, is available only to a very limited extent. There are indications that though phosphates in a comparatively insoluble form, such as basic slag, may be applied in heavy doses during the " dead " period (December and January), the application of a readily soluble form, during May and June—the time when clover grows actively—still gives the clover a marked stimulus, and this stimulus will be reflected in the composition of the pasture in subsequent years.

Indeed, so pronounced are the effects of management of grazing, together with time and nature of manuring, during the establishment of a new pasture, that the character of the sward in five years' time has been made or marred, even though the right seeds mixture has been selected, and those seeds sown at the optimum rate of seeding.

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THE DISCUSSION

Professor Engledow (Cambridge) opened the discussion by summing up the points on which further information from practical men was necessary. Most speakers had agreed on the necessity for a firm seed bed, the management of the nurse crop, and the time of sowing; whereas on the question as to whether the seed bed must be clear or whether it was possible to succeed on foul land there was some difference of opinion. It was important that this matter should be cleared up. The place of cocksfoot in grassland husbandry was another disputed point. Dealing with the question of indigenous strains, Professor Engledow said that the collection of the experience of farmers who had grown both types of seed side by side would be very useful.

Mr Clayton urged farmers to consider the composition of their seed mixtures in relation to their productivity over a period of years rather than to order, as frequently happened, the cheapest mixture which the seedsman could provide. He feared that their seedings as advocated by some speakers might lead to the new pastures being colonized by weeds instead of by desirable indigenous grasses and clovers.

Mr Hawkins (East Anglian Institute of Agriculture), discussing the cocksfoot question, stated that one of his fields which was full of clumps of cocksfoot was examined by three different observers. One said that too much cocksfoot had been sown, another too little, and the third that the wrong strain of cocksfoot had been used. In view of the great difference which exists between strains of this grass the last opinion was the most likely.

Mr H. B. Turner (Essex) said that he had been more successful with his grassland since adopting the indigenous strains. For grazing he advocated leafy types of cocksfoot and ryegrass and good strains of late-flowering red clover, the latter being essential for the first year. He regarded crested dog's-tail as an insurance against drought in his part of Essex, where it provided excellent grazing for sheep. Laying the land in ridges, and where necessary drawing a mole drain down the furrow, was a cheap method of drainage.

Sir Robert Greig urged the necessity of further work to explain the diversity of opinion which existed on certain points. When this had been done we could expect great improvements in grass husbandry. He drew attention to the great increase in productivity obtainable by good after-management, and illustrated this by results obtained on certain of Mr Cruickshank's fields. He supported

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Mr Cruickshank's opinion that cutting for hay in the first two years was the best way of establishing pasture under the conditions prevailing in that district.

Professor H. E. ARMSTRONG emphasized the need of a careful study of the feeding value of grass, as well as the milk and other products derived from grass.

Sir DANIEL HALL, in closing the discussion, said that some of the divergencies noted in the course of the Conference arose out of soil and climatic differences, but there was also the possibility that different means would lead to the same end. He advocated the substitution of the idea of semi-permanent grass in place of permanent pasture, for the occasional use of the plough was very beneficial. The simplification of seed mixtures was a development which was steadily gaining ground. The use of nitrogenous manures at critical periods was a further valuable development. When nitrogen was applied in spring, grasses and clovers benefited alike. The mowing of pastures to remove grass which had grown past the stock was a sound and valuable practice. Finally, more important even than seeding and manuring was after-management, which was responsible for the final result.

Communicated by JOHN B. BARR, *Cornhill-on-Tweed*

The longer the land is under tillage before the grass seeds are sown the better; say for a period of six years or more. Roll before sowing and use fairly heavy seed-harrows to ensure that the larger seeds are properly buried, although by doing so some of the smaller seeds may be buried too deeply. Roll well to finish off with.

After the corn crop has been removed give a dressing of a suitable manure. In this district 6 cwt. of a mixture made up of 4 parts of North African phosphate to 1 part of potash salts gives good results, followed up with further dressings every three years or so.

The first year I prefer to graze lightly with ewes and lambs till about 1st May, then take a light crop of hay, taking care to mow early.

The second year and afterwards I prefer to stock with two-thirds cattle and one-third sheep.

The best pastures about here carry, say, on a thirty-acre field 20 to 24 cattle and 30 ewes and twin lambs. After shearing time just one lamb to the acre, but the same number of cattle is usually carried to the end of the season. The mower may be used occasionally in parts of the field not so well grazed as it should be.

It seems a great mistake to overgraze cocksfoot the first year. A few years ago we had a backward spring, with keep very scarce. I overgrazed a field with sheep and the cocksfoot disappeared entirely.

Our pasturelands, when suitably manured and attended to, seem

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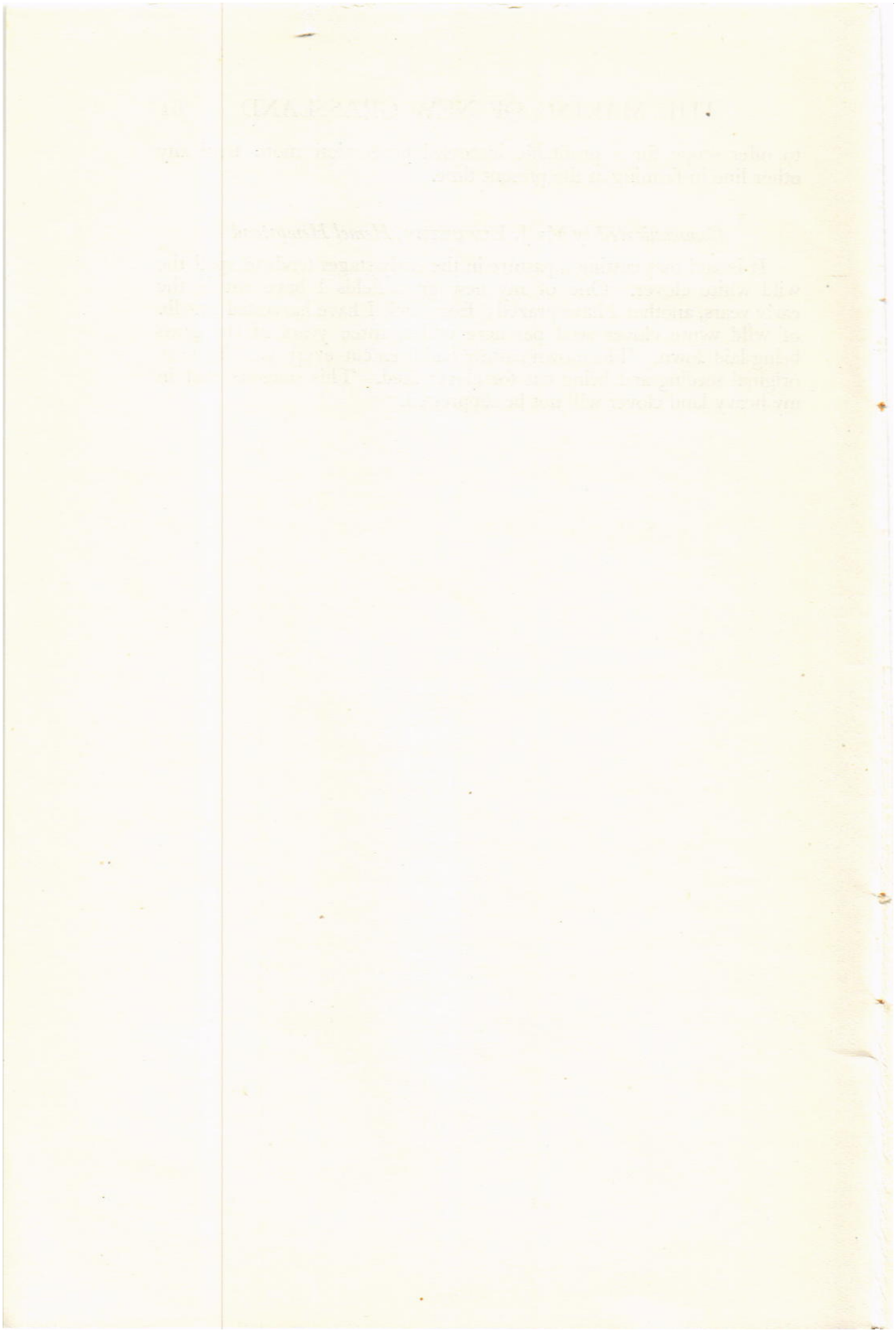
to offer scope for a profitable increased production more than any other line in farming at the present time.

Communicated by Mr J. Elworthy, *Hemel Hempstead*

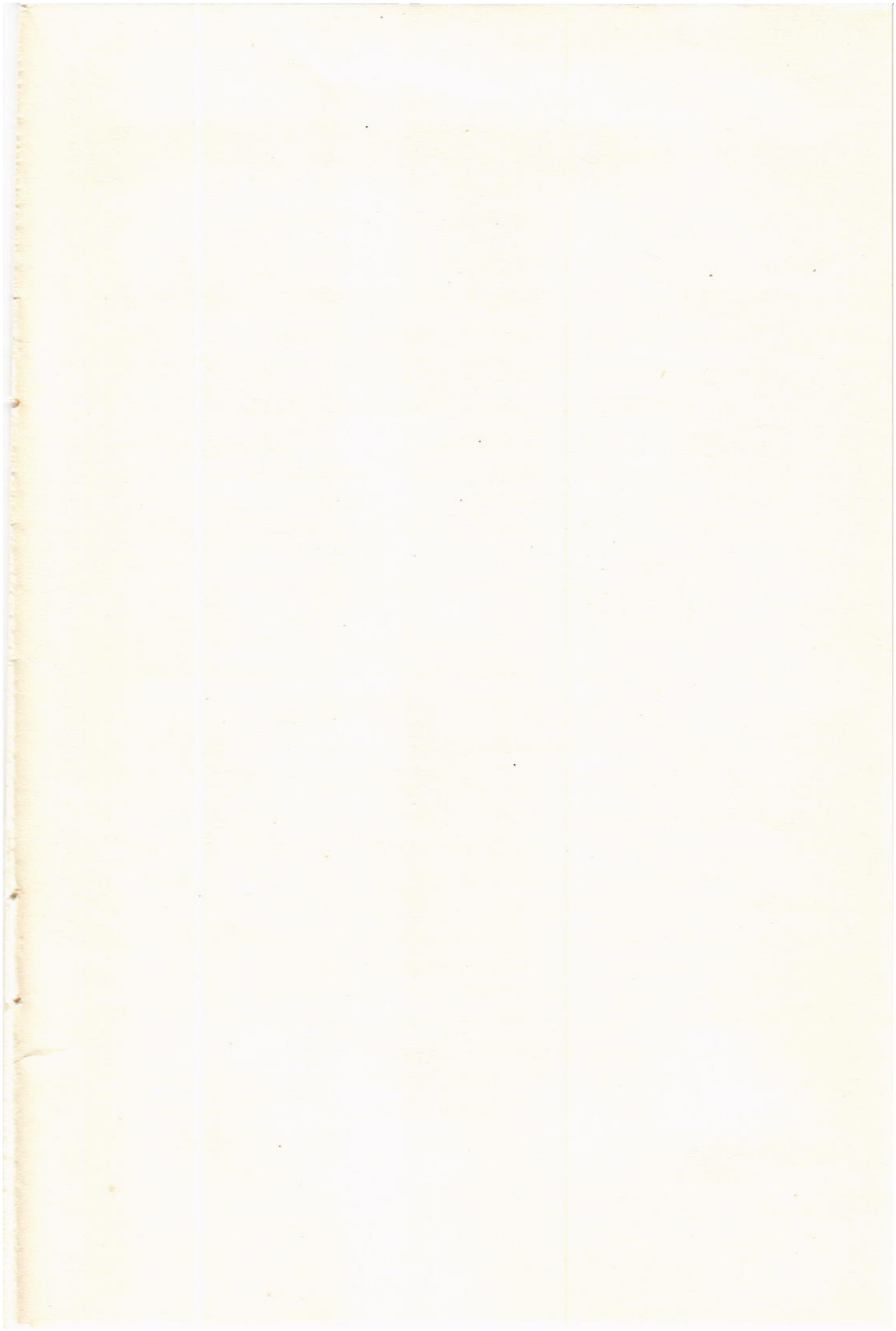
It is said that cutting a pasture in the early stages tends to spoil the wild white clover. One of my new grass fields I have cut in the early years, another I have grazed; from each I have harvested 112 lb. of wild white clover seed per acre within three years of the grass being laid down. The mown pasture had been cut every year between original seeding and being cut for clover seed. This suggests that in my heavy land clover will not be suppressed.

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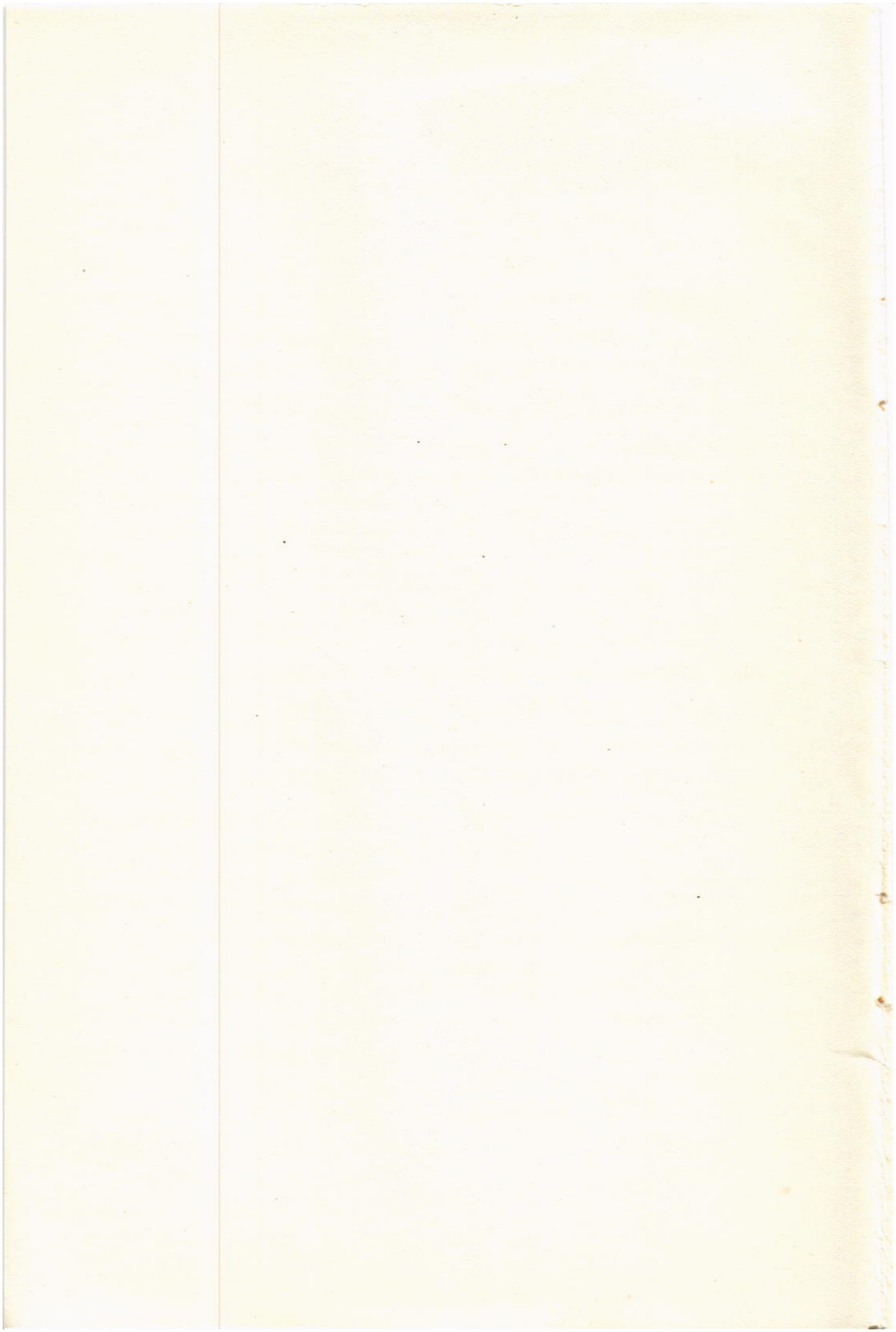
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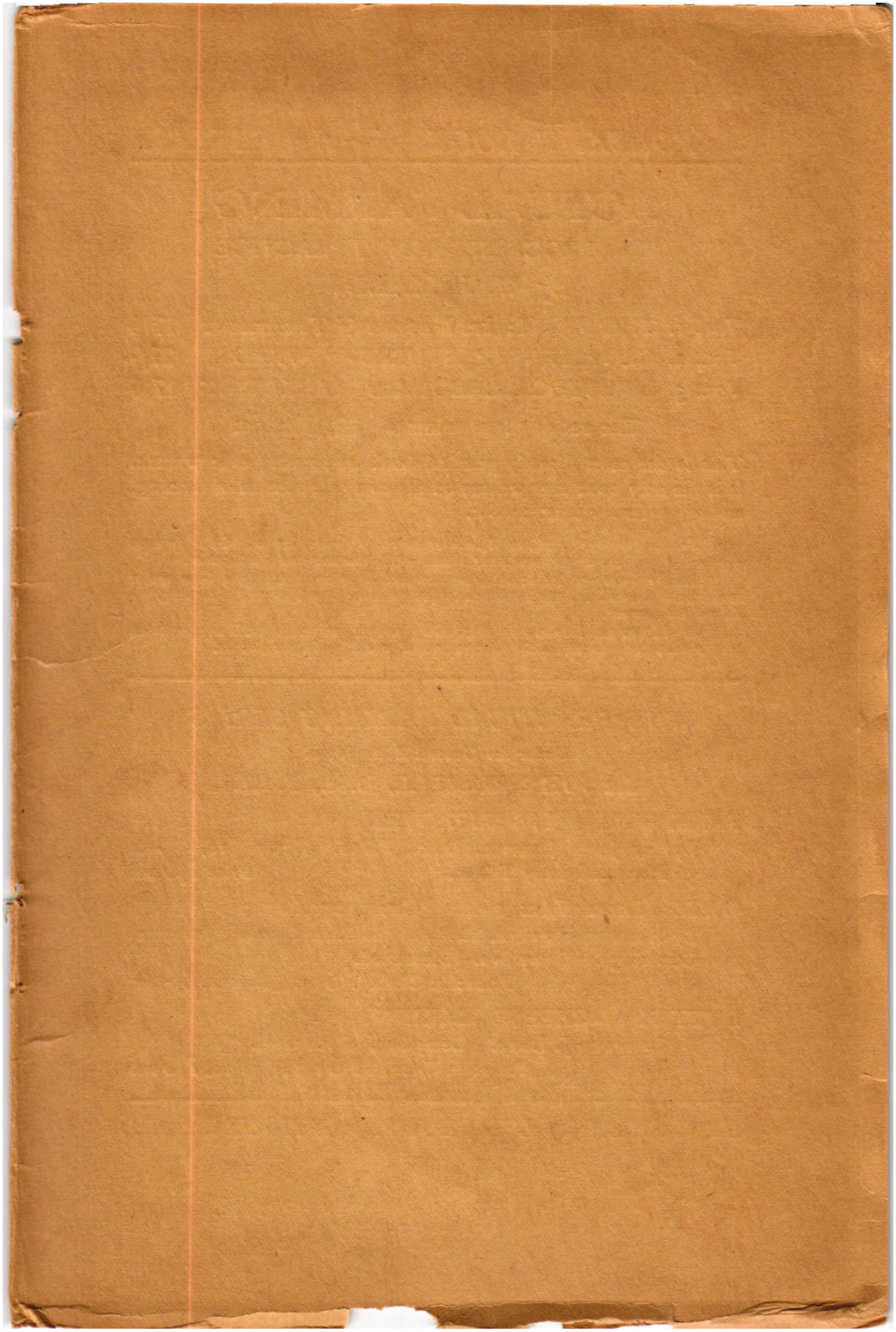
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