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PRINCIPAL CONTENTS.

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THE JOURNAL
OF THE
MINISTRY OF AGRICULTURE

Vol. XXIX. No. 2.

MAY, 1922.

NOTES FOR THE MONTH.

Milk Prices.

At a meeting held at the Ministry of Agriculture on Wednesday, 12th April, 1922, under the Chairmanship of the Minister of Agriculture, Sir Arthur G. Boscawen, the representatives of the producers and distributors announced that they had agreed to recommend to the organisations concerned that the price to be received by the producer for milk delivered into London from areas outside the Home Counties should be: April, 10d.; May and June, 9d.; July, 11d.; August and September, 1s. per gallon, which represents an average for the six months of 10½d. per gallon. The price to be paid for milk delivered to creameries within 100 miles by rail of London should be as follows:—April, 9d.; May and June, 6d.; July, 7d.; August, 8d., and September, 9d. per gallon, which represents an average for the six months of 7½d. per gallon.

Milk delivered to creameries at a greater distance than 100 miles by rail from London would be paid for at the same rate less the increased cost of railway transport to London.

It was agreed that the revised prices should be retrospective to April 1st, and that those farmers who had already entered into contracts should receive the benefits accruing under the above arrangement.

The Minister understands that in the case of certain distributors, contracts have been entered into to supply milk based on prices ruling previous to this agreed alteration, and he hopes that in such cases the holders of such contracts will agree to a revision in accordance with the altered terms to the producer.

The price to the consumer of 5d. a quart which had previously been announced for the 3 months of April, May and June will not be raised during that period.

* * * * * *

(42802) P.14/35. 11,000. 5/22. M. & S

Agricultural Research and the Farmer.*

THE Ministry will shortly issue a report on Agricultural Research which describes clearly, for the benefit of farmers and others, the scientific work now in progress in the interests of agriculture. Hitherto, if a farmer inquired what the research worker was doing for his industry, he could only be referred in the main to technical papers published in scientific journals, and these, even if intelligible to him, contained results which might be apparently remote from farming practice. The practical man realises that while these highly scientific investigations may not immediately help him in securing increased returns, they are vital to the industry, for progress depends on the acquisition of knowledge. The farmer and gardener reap the benefit of research after it has passed through various experimental channels, and when the results have been put to the crucial test of experience in the field. This may be some years after the patient toil of the scientist in the laboratory. Many farming operations which are commonly practised to-day can be traced back to discoveries made years ago by scientists who at the time had only a faint conception—if any at all—of the use to which their results would eventually be put.

For some time past, however, the need has been felt for a comprehensive and readable account of the important research which is being conducted in agriculture and horticulture.

The Ministry consequently commissioned one of its officers, Mr. V. E. Wilkins, to visit Institutions where research is being conducted, and prepare a report which would not only describe the work in a readable and non-technical style, but would link together as far as possible the various phases of investigation, and show their relation to the practical problems of the farmer. The report deals with all aspects of research, and contains ten chapters, devoted respectively to the soil, plant breeding, plant physiology, fruit growing and preserving, plant diseases, animal husbandry, animal breeding, dairying, animal diseases, and farming as a business. A list of Research Institutions and Advisory Centres in England and Wales, and a Bibliography giving the titles of papers published by research workers in 1920 and 1921, are included as Appendices. A prefatory note has been written by Sir Arthur G. Boscawen, Minister of Agriculture and Fisheries, in which he refers to the

* Agricultural Research and the Farmer: A Record of Recent Achievement. Published by H.M. Stationery Office, Imperial House, Kingsway, W.C.2. price 2/6 net; obtainable through any Bookseller or direct from the Publisher.

report as an attempt to remedy the existing fault in the line of communication between the research worker on the one hand, and the farmer and the general public on the other. Sir Arthur also expresses the hope that the farming community and the general public will show by the practical test of buying the volume that the attempt has been successful.

* * * * * *

Remission of Duty on Home-grown Sugar.

IN reply to a question in Parliament on the 30th March, the Minister of Agriculture, Sir Arthur G. Boscawen, said :—

"The Government have decided that, in view of the exceptional conditions of this new industry, and the condition of unemployment in this country, no excise duty should be charged on home-grown sugar, and the necessary provision for the removal of the existing duty will be made in the Finance Bill of this Session. It is of course impossible to bind any future Government, but in view of the fact that the remission of excise is intended to assist a new industry during the experimental period, it may be hoped that Parliament would not re-impose any excise duty until the industry has been firmly established."

* * * * * *

Appointment of Departmental Committee on Foot-and-Mouth Disease.

THE Minister of Agriculture and Fisheries has appointed a Departmental Committee "to inquire into the origin and circumstances of the recent outbreak of Foot-and-Mouth Disease and into the policy and procedure which was pursued in dealing with the disease, and to report whether any alteration of the methods of administrative control hitherto adopted, or any amendment of the existing law is necessary or desirable."

The Committee is constituted as follows :—

Capt. the Rt. Hon. E. G. Pretyman, M.P. (Chairman).
A. Batchelor, Esq.
David Ferrie, Esq.
F. W. Garnett, Esq., C.B.E., J.P.
H. German, Esq.
William Graham, Esq., J.P., D.L.
Alfred Mansell, Esq.
Sir G. Douglas Newton, K.B.E., M.P.
Professor John Penberthy, J.P.
W. R. Smith, Esq., M.P.

The Secretary of the Committee is Mr. S. A. Piggott, Ministry of Agriculture and Fisheries, 4, Whitehall Place, S.W.1, to whom all communications should be addressed.

* * * * * *

Report on the Produce of Crops in 1921.

THE Ministry's Crop Reporters estimate the yields of the chief crops in the autumn of each year, and the estimates of total production in the country are issued immediately tabulation is completed. These data as regards corn and hay were issued on 2nd November last year; potatoes and roots on 30th November; while those relating to hops were issued earlier on 20th October. The Report now issued gives details regarding the different counties of England and Wales as well as totals for Scotland and Ireland. Attention is drawn in the Report, not only to the special features of 1921 as regards crop production, but also to the relative money value of the grain and potato crops as compared with previous years. The use of forecasts of the yields of crops made before harvest, as well as of returns of production made after harvest when the actual results are known, is also discussed as regards their bearing on world trade.

This Report, which forms Part II of the Agricultural Statistics for 1921, can be obtained through any bookseller or direct from His Majesty's Stationery Office, Imperial House, Kingsway, W.C.2, and 28, Abingdon Street, S.W.1.

* * * * * *

Conciliation Committees in Agriculture.

THE Conciliation Committees continue to work satisfactorily, and the total number of agreements in operation on 20th April was 45. The question of milk prices has no doubt been somewhat responsible for delaying negotiations in certain cases, but in most areas where no wages agreement exists, the Committees have arranged to hold further meetings at an early date.

A full statement of the agreements in operation on 20th March was given in the April issue of the Journal. The agreements reached during the succeeding month are as follows:

Current Agreements

Area.	*Period.*	*Wages.*	*Hours per week.*
Derby	Up to 30th June, 1922	7½d. per hr. for all employment on weekdays. Sunday employment 10d. per hr.	

Current Agreements.

Area.	*Period.*	*Wages.*	*Hours per week.*
Hampshire -	Up to 11th Oct., 1922	7½d. per hr. for all employment. Guaranteed week of 50 hr.	
Lancashire—			
Southern area -	,, 30th Sep., ,,	42/6	Customary hr.
Eastern area -	,, 30th ,, ,,	45/–	..
Northern area -	,, 30th ,, ,,	42/6	..
Leicester—			
Melton Mowbray and Belvoir	,, 30th ,, ,,	32/–. Weekday overtime 8d. per hr. Sunday employment 10d. per hr.	53
Leicester - -	Until such time that one side gives notice of alteration.	7½d. per hr. up to 54 hr. Guaranteed week of 54 hr. Weekday overtime 8d. per hr. Sunday employment 10d. per hr.	
Loughborough -	Until such time that one side gives notiee of alteration.	7½d. per hr. up to 54 hr. Guaranteed week of 54 hr. Weekday overtime 8d. per hr. Sunday employment 10d. per hr.	
Denbigh and Flint	Up to 10th Sept., 1922	31/3d. Overtime, proportionate rate up to 61 hr.; over 61 hr. 9d. per hour	50
		Stockmen and waggoners, 38/1½d.	61

Full details of the agreement for any particular area will be furnished on application to the Ministry.

* * * * * *

The Agricultural Index Number.

THERE was practically no change in the average of the market prices of all descriptions of agricultural produce during March as compared with the previous month, the general level of these prices being 82 per cent. above the average of the three years 1911-13 as against 83 per cent. in February.

The percentage increase during each month from January, 1919, as compared with the pre-war years, is shown in the following table:—

Month.	1919. *Per cent.*	1920. *Per cent.*	1921. *Per cent.*	1922. *Per cent.*
January	148 ...	213 ...	186 ...	77
February	150 ...	205 ...	172 ...	83
March	150 ...	199 ...	158 ...	82
April	153 ...	199 ...	141 ...	—
May	132 ...	169 ...	112 ...	—
June	128 ...	164 ...	102 ...	—
July	141 ...	174 ...	100 ...	—
August	138 ...	177 ...	116 ...	—
September... ...	148 ...	181 ...	105 ...	—
October	166 ...	191 ...	90 ...	—
November... ...	182 ...	197 ...	84 ...	—
December	207 ...	194 ...	82 ...	—

Considerable changes have taken place in the prices of certain commodities, the principal increase being in the case of fat sheep. The average price of fat sheep in March was 120 per cent. above the average of 1911-13, as compared with 83 per cent. in February and 60 per cent. in January. Other descriptions of fat stock also advanced, although the rise was much less marked than in the case of sheep. Wheat has continued to advance in price, being in March 61 per cent. above the pre-war average as against 45 per cent. in February.

The March price for milk delivered into large towns showed a considerable reduction on the prices for February, while the low prices offered for summer milk were reflected in the fall in the price of dairy cows, which averaged about 37 per cent. more than in the pre-war years as against 89 per cent. in January, this decrease representing a cash difference of about £11 per head. Eggs showed the usual large seasonal reduction and butter was also appreciably cheaper than in February.

Feeding stuffs as a whole showed little change in price since February. Millers' offals declined 7 points but this fall was compensated by a rise in the price of maize, while oilcakes, brewers' grains, maize meal and barley meal remained practically unchanged.

Among fertilisers, superphosphate depreciated slightly in value, but nitrate of soda and sulphate of ammonia were dearer, while basic slag remained unchanged. The general average prices of feeding stuffs and fertilisers were estimated to be between 50 and 60 per cent. above the pre-war average.

* * * * * *

Foot-and-Mouth Disease.

SINCE 19th March, the date referred to in the note contained in the *Journal* for April, 1922, 50 outbreaks of foot-and-mouth disease were confirmed in Great Britain up to 23rd April, making a total of 1,079 outbreaks, which included 978 in England 2 in Wales and 99 in Scotland. These additional outbreaks all occurred in counties which had been previously affected, but in one instance disease reappeared in a county (Warwickshire) from which restrictions had been withdrawn.

The Ministry has now been able to authorise the freedom of a large proportion of the earlier infected premises, and the total number of premises in Great Britain so freed up to 23rd April was 707. Restrictions have also been withdrawn from a number of counties in England and Scotland.

The total number of animals slaughtered up to 23rd April was 52,195, viz., 22,666 cattle, 20,276 sheep, 9,206 pigs and 47 goats.

Modifications of Restrictions on Movement since 19th March.—Representations were received that (*a*) the resumption in some form of the trade in store stock was becoming essential in order to make use of the summer grazings; and (*b*) that the return of wintering sheep to their summer grazings could not be delayed after about 1st April. The Ministry therefore made an Order re-opening the store stock trade from Ireland from 29th March without allowing the aggregation of store stock in internal markets, which was still considered to be attended with risk. The Order allowed the landing of store stock subject to licence of the receiving Local Authority and to the stock being railed direct to their farms of destination for 28 days' detention. No obstacle was placed in the way of the holding of store stock sales in the landing places, and Local Authorities still had powers to prohibit the movement of the cattle into their districts if they thought fit. All trucks were required to be specially disinfected before the animals were placed therein. As regards the return of wintering sheep an Order was made taking effect on 5th April enabling sheep not in existing infected areas to be moved to any premises in Great Britain by licence of the receiving Local Authority after counter-signature by the sending Local Authority and after the sheep had been examined by a Veterinary Inspector of the sending Local Authority. A further examination of the sheep on arrival at their destination was required and railway trucks conveying them were required to be specially disinfected before being used for the sheep.

Note.—The figure of £65,000 given in the April issue of the *Journal*, p. 91, as the cost of compensation for animals slaughtered should have read £655,000.

GREEN MANURING.

H. J. PAGE, M.B.E., B.Sc., A.I.C.,
Rothamsted Experimental Station.

The Scarcity of Animal Manure and its Causes.—One of the most serious practical problems with which the farmer is faced at the present time is the shortage of farmyard manure. This manure is almost everywhere more highly esteemed than any other, and it was largely in order to investigate the cause of this well-known superiority that Lawes started at Rothamsted in 1843 the famous field experiments which have now been going on there continuously for nearly eighty years. It is interesting to know that even at that time farmers could not usually get enough farmyard manure, and yet how much better off were they than the present-day farmer!

Let us pause a moment before considering the reasons underlying the value of farmyard manure, and look a little more closely at the extent of, and the factors causing, the present shortage. With regard to the extent of the shortage, the rise in the price illustrates this point sufficiently. At the present time a ton of stable manure on rail in London may cost as much as 7s. 6d., and even then it is often of poor quality; in 1912 the cost was 4s. 6d., while in 1905 it was only 1s., and usually no difficulty was experienced in finding a supply. What are the causes of this enormous change? The obvious one which immediately suggests itself, is the driving of horse transport from the roads by mechanical transport. Whatever the benefits that the tractor has conferred on the farmer in the fields, its elder brothers, the lorry and the motor 'bus have proved for him by no means an unmixed blessing. The returns of H.M. Commissioners of Customs and Excise show that from 1906 to 1920 the number of licensed motor vehicles (excluding motor-cycles) increased by nearly a quarter of a million, whereas licensed horse vehicles decreased by 200,000. When it is borne in mind that the bulk of this fall in horse-drawn vehicles will have occurred in the big stables of commercial firms whence the greater part of the town stable manure is derived, it is not difficult to see why stable manure is now so scarce and dear.

Nowadays, therefore, the farmer is very much more dependent on his beasts for a supply of dung than formerly, and even this supply is not being wholly maintained. The number of head of cattle in Great Britain in 1921 showed a

decrease of 400,000 as compared with 1914, and of nearly 800,000 compared with 1919, while sheep decreased by nearly 4 million between 1914 and 1921. So much as regards a dwindling supply. As to demand, this, so far from dwindling, has increased, for although the number of acres of land under the plough in Great Britain has been steadily falling since 1918, in 1921 it still showed an increase of 800,000 compared with 1914, and the more land there is under the plough, the greater is the need for organic matter.

The Value of Farmyard Manure and the Need for Organic Matter in the Soil.—The shortage of farmyard manure and the causes of that shortage have thus been discussed in order to show that the situation is one which is not likely to improve in the future, but rather is likely to become more serious. Now although every practical man admits the value of farmyard manure, and knows that in order to maintain the fertility of his soil and to keep it in good heart, a plentiful supply of organic matter is indispensable, there is very little certainty as to the mode of action of that organic matter. We know that the main requirements of a crop for mineral substances and nitrogen can be completely satisfied by artificial fertilisers, so that it is unlikely that the unique properties of farmyard manure reside intrinsically in the mineral substances and nitrogen it contains. There is indeed the possibility that certain of the rarer elements, such as boron, present in farmyard manure and usually absent from artificials, may play a part in soil fertility —and this question is under investigation at Rothamsted at the present time—but it is practically certain that the superiority of dung is mainly due to the organic, humus-forming material in it. As to the exact nature of "humus" we still know little, and the term, although commonly used, is only one of the many convenient labels which scientists, no less than other mortals, use to hide their ignorance. Humus may be regarded as pre-eminently *the* characteristic constituent of a fertile soil, in which it exists as a gelatinous brown or black material. The influence of humus on the growth of crops is mainly indirect: it is intimately related to the life of the complex soil population of micro-organisms, and it has important effects on the tilth, moisture relations, and other physical properties of the soil. It affects plant growth by so modifying the properties of the soil as to secure a well-regulated supply of the soluble mineral and nitrogenous substances absorbed by the plant roots, and of the water which serves as the vehicle by

which those soluble substances are conveyed to the plant, and without which this "plant food," however plentiful it may be in the soil, cannot be obtained by the plant. A light soil is given more "body" and rendered better capable of withstanding drought, while a heavy soil is made more open and workable. This is not the occasion to discuss the exact mode of action of humus in bringing about these effects, nor for that matter are we in a position to do so with any degree of certainty;* but from the practical point of view the important thing is that these effects undoubtedly exist, and are of great significance.

Alternative Sources of Organic Matter.—It is therefore as a source of humus that farmyard manure must be chiefly prized, and in the face of a growing scarcity the agriculturist is faced with the problem of finding an alternative source of organic matter, that is to say, of keeping part of his soil in good heart without the assistance of animals as manure-makers. What are the possibilities of such alternative supplies? Apart from purely local or undeveloped sources, such as seaweed, which is used in maritime districts like the Channel Islands and many coastal districts of Scotland,† or such as activated sewage sludge,‡ there are at least three possible sources of general applicability. These are (1) The ploughing of raw straw into the soil; (2) The use of artificial straw-manure made by the process of Hutchinson and Richards as worked out at Rothamsted;§ (3) The use of green manures.

With regard to the first method, although the practice of ploughing in raw straw in the autumn is being adopted in some parts, notably on the heavy land in Essex, it is as yet of unproved value. One great danger of such a practice is that the addition of a large bulk of non-nitrogenous, carbohydrate matter to the soil, may cause a temporary locking up of nitrogen by biological agencies in an insoluble form not available to the plant; such an effect, if sufficiently transitory, might be all to the good, as for example, in preventing loss of nitrates by leaching during the winter months, but in other circumstances much harm might result.‖ The question needs careful in-

* For a discussion of this aspect of the part played by humus in the soil, see a paper by the writer in the "*Transactions of the Faraday Society*," *17*, 272 (1922) (General Discussion on Physico-chemical Problems relating to the Soil, held on 21st May, 1921).

† See Ministry of Agriculture Leaflet No. 254.

‡ See *Journ. Soc. Chem. Ind.*, *39*, 177, *41*, 62 T.

§ See this *Journal*, *28*, p. 398, (1921).

‖ See *Journ. Agr. Sci.* *9*, 92.

vestigation before the practice can be recommended for general adoption. As to the use of artificial farmyard manure made from straw, there seems to be little doubt that this material will prove a valuable manure, and provided its production on a large scale can be made economically practicable, it will doubtless ultimately find a large application in agriculture. Both of these methods, however, apply pre-eminently to those farms where straw is available in sufficient quantity on the spot, and in a less degree in cases where the straw would need to be brought in. The object of this article is to call special attention to the third method mentioned above, namely, *green-manuring*. In doing so it must be clearly understood that it is as a means of supplementing a dwindling supply of animal manure, and not necessarily as a competitor with animal manure, that green manures are here treated. It is often urged that it is a far more practical proposition to feed a green crop to sheep folded on the land than to plough it in, and on light lands this is no doubt usually the case, but on heavy lands on which sheep cannot be folded, and even on light lands, if sufficient sheep are not available, green manuring merits serious consideration by the arable farmer who does not feed enough stock off the land to supply his requirements of animal manure.

Existing Green-Manuring Practice in this Country.—Few farmers neglect a favourable opportunity of taking a catch crop of a quick-growing nature, such as mustard, between harvest and seed-time, or on a freshly ploughed seeds ley, and turning it in if it is not convenient or practicable to fold sheep on the land or to feed cattle off the land; and to this extent green manuring may be said to be fairly general in this country, but in most districts it cannot be said to play more than a very minor part. The difficulty in ordinary farming is that in any of the usual rotations, after doing the necessary amount of cultivation to keep the land clean it is often too late to get in a green manure crop with any hope of its making sufficient growth before next seed-time. In a normal four-course system of seeds, wheat, roots, barley, the land is seldom available until August, and in a late season it may well be a month later before the harvest is in. Although nowadays the tractor has made it possible to finish the ploughing of stubbles and cultivation for weed-killing in a much shorter time than formerly, in a late season the interval available is usually too short for taking a catch crop. Another factor which adds to the difficulty is the

fact that the land may be so dry after harvest that germination is very bad.

The result is that green manuring forms a regular and essential part of the system of husbandry only in districts given over to special crops, such as the Fens, the Lothians, and Ayrshire, where it is extensively used after early potatoes; the market-gardening districts around Biggleswade; and the flax-growing areas of North Ireland; or in cases where the nature of the soil is such that special rotations are used, as for instance on the London Clay in Essex, where a bare fallow provides the necessary opportunity, or on the light blowy sands of East Anglia, which can often only be profitably farmed by giving one year in four to a nitrogen-gathering crop such as lupins. Another system which is adopted in some parts is to sow the green manure crop in the spring corn, as for a seeds ley, and after harvest to let the green crop grow on till early in the following year before turning it in. Systems of green manuring can thus be classified under three main heads:—(1) Green manure crops grown as catch crops in the intervals in the rotation; (2) Green manure crops grown as part of a special rotation in which the whole or a large part of one growing season is given up to the green manure crop; (3) Green manure crops sown in the spring corn, for turning in the following year.

To the first category belong the systems referred to above as employed by early potato growers. Thus in the famous potato districts of East Lothian and Ayrshire, rape or Italian rye grass, or a mixture of the two, is sown down immediately the tubers have been lifted, in any case not later than the third week in August. Some growers then feed the green crop to sheep, but many prefer to turn the crop in.

Again, in the Holland division of Lincolnshire, and in the black lands of the Fens, mustard, rape and oats are similarly largely used by potato growers as early autumn-sown green manures, and some farmers have latterly been trying beans for the same purpose. In Essex and Suffolk, on the heavy lands of the London Clay, it is a common practice to sow mustard on the bare fallow in July, and plough it in before sowing winter corn; similarly many flax growers in County Down have got splendid results from mustard sown in August after the flax has been pulled, and turned in during January or early February.

The most outstanding example of a system in the second category is that used on the poor light glacial sands of Suffolk. This land is so poor that it scarcely repays cultivation on ordinary straightforward lines, yet by adopting a rotation such as rye, lupins, potatoes, silage crops, it is possible to make farming on this land pay well. The lupins are sown in the late spring or early summer and may be ploughed in either when in flower, or seed may be gathered, and the plant then turned in. The lupins do so well, even on the poorest of this land, that when turned in they give as much organic matter and nitrogen as a dressing of about 8-10 tons of farmyard manure. The use of lupins as green manure on poor sands is extending to other counties, notably Notts., where some striking results have been obtained in trials (*see* Part II in next month's *Journal*).

Of systems in the third category, an example is afforded by the practice common in the market gardening districts around Biggleswade in Bedfordshire, where red or white clover is commonly sown with the corn in spring and turned under in the autumn or the new year, before potatoes. In a moist season the green matter ploughed in is often found to be as effective as a dressing of 25 tons of stable manure. Similarly some of the growers in the Lothians sow rye grass and red clover in the spring corn and turn it under in the following spring. The same practice has been tried in the Aberdeen district, but it is not general there, for owing to the late harvest, green stuff in the bottom of the sheaves adds to the difficulty of drying, and after harvest it is too late for the rye grass and clover to make much growth. Of course the ploughing up of a temporary seeds ley incorporates a large quantity of valuable organic matter in the soil, and to this extent most arable land is green-manured at intervals. The potato growers of Lincolnshire commonly turn in the aftermath of the clover as a green manure, with good results. Where the land is left down to grass for several years, as in the Aberdeen district and many districts in England, the sod of grass which is ploughed down is an excellent green manure, and gives so much nitrogen to the soil that no nitrogenous artificials are needed for a following oat crop, and indeed, their use is liable to cause lodging.

Green Manuring Abroad.—We must, however, go overseas to find the practice of green manuring in its most highly developed state.

An outstanding example on the Continent is that of Germany, where large tracts of barren sandy heath have been reclaimed

and made profitable almost solely by the use of green manures, mainly leguminous; the pioneer work of Schultz at Lupitz, in Saxony, is a well-known instance in this connection. Again, in America green manures are widely used, both for farm crops, and, especially in California, for orchards. It is, however, in tropical countries, perhaps, that green manures find their widest application. Thus in India, in many districts where animal manure is practically unobtainable, the whole of the requirements of the soil for organic matter and nitrogen are obtained by the use of leguminous green manures.

Results of Green Manuring Trials.—Although there are a certain number of results on record showing that distinct and valuable crop increases can be obtained by green manuring, there are very few critical experiments designed to test the relative values of different green crops and different methods of application. The most extensive series of experiments in this country is that carried out by Voelcker at the Royal Agricultural Society's Station at Woburn. In these experiments vetches, rape and mustard were grown side by side as spring-sown green manure crops which were turned in before winter wheat. The experiment has been in progress for over twenty years, and the results are summarised below :—

Yield of Wheat after Green Manures, Woburn, Lansome Field (Light sandy soil).

Average of results for eight seasons 1899, 1901, 03, 06, 08, 10, 12, 15.

	Dressed grain, bush. per acre.
After vetches, grown with mineral manures	16·3
,, rape ,, ,, ,, ...	20·4
,, mustard ,, ,, ,, ...	25·2
For comparison :—	
Wheat on Stackyard Field, complete minerals only ...	9·1
,, ,, ,, farmyard manure (equiv. to 200 lb. ammonia per acre)	20·4

Unfortunately there are no control plots on Lansome Field, so the values for Stackyard Field (continuous wheat) which have been added for comparison, are not necessarily strictly comparable, but they serve to indicate the sort of result that can be obtained with green manures compared with mineral or farmyard manure. An experiment on similar lines was carried out at Rothamsted. Here the land was given up to spring-sown green crops for two seasons, the crop being turned in each autumn, and in the third season winter wheat was grown. The

experiment was then repeated on the same land. The results were as follows :—

Yield of Wheat after Green Manures, Rothamsted, Little Hoos Field (Stiff clayey loam).

	1000.	1917.
After vetches, grown with mineral manures ...	39·7	34·4
„ crimson clover „ „ ...	32·5	30·8
„ rape „ „ ...	21·3	26·8
„ mustard „ „ ...	29·9	19·6
For comparison :—		
Wheat on Broadbalk Field, complete minerals only	11·5	10·0
„ „ „ „ farmyard manure (14 tons per acre) ...	33·7	27·9

Again there were no control plants on Little Hoos Field, but the figures for Broadbalk Field afford a rough basis for comparison. Apart from the obviously beneficial effect of green manures on winter wheat, which is clearly brought out by the above Woburn and Rothamsted results, it will be noticed that the relative values of leguminous and non-leguminous crops, such as vetches and mustard respectively, come out very differently in the two sets of experiments. This is a striking instance of the danger of applying the results obtained in one district on a certain type of soil, to another with an entirely different soil. This difference is further discussed later. Both of the sets of experiments quoted above referred to summer-grown green manures for winter wheat. Trials were started by the writer at the Royal Horticultural Society's gardens at Wisley in 1919 in which green crops were sown in August for digging in late in the autumn or early the next spring, as a preparation for white turnips. Some of the results for 1919-20 are shown below* :—

Green Manuring Experiment at Wisley, 1919-20. (Light sandy soil).

Green crop.	Tons per acre.	Yield of Turnip Roots after green crop. Tons per acre.	Per cent. of control Plot.
A. Green crop turned under in Spring.			
Crimson clover ...	17·0	10·5	239
Vetches	8·6	9·7	220
Red clover	3·9	9·3	206
Rye	8·4	8·6	195
Rape	9·3	6·4	145
Control	2·2 (weeds)	4·4	100
B. Green crop turned under in Autumn.			
Rye	2·9	6·3	162
Oats...	3·6	6·3	162
Mustard	5·6	5·9	151
Vetch	4·3	5·5	141
Control	0·8 (weeds)	3·9	100

* These results will shortly be published in full in the *Journal of the Royal Horticultural Society.*

As an illustration of the value of lupins on light blowy sands the results may be quoted of an experiment carried out in Notts., for particulars of which the author is indebted to the Agricultural Organiser of that county. Lupins were sown in May, 1920, and turned under in September, and winter oats sown. The land received no farmyard manure or artificials. The oats after lupins yielded $7\frac{1}{4}$ quarters per acre, while an adjacent control plot on which no lupins had been turned in, yielded only $1\frac{1}{2}$ quarters per acre. This experiment is being extended during the present season.

Many more results of a similar character to those given above could be quoted, but these suffice to demonstrate broadly the very considerable increase in yield that can be obtained by green manuring. As already pointed out, however, a comparison of the Woburn and Rothamsted results serves to show that, as soon as more detailed and precise information is sought with regard to the best system of green manuring to adopt in any particular district, difficulties and uncertainties are encountered. In fact, if green manuring is to find a much more general adoption in this country than at present, it will be necessary for careful experiments to be carried out in different districts before the system best adapted to specified conditions of soil, climate, etc., can be definitely laid down. In order to bring out clearly the complexity of the problem, it is desirable to consider at this point, as far as space and the present state of our knowledge permits, the principles underlying the action of green manures, particularly in comparison with farmyard manure.

(To be concluded.)

* * * * * *

FARM BUILDINGS FOR SMALL-HOLDINGS:

A WEST RIDING IMPROVEMENT.

MAJOR H. P. G. MAULE, D.S.O., M.C., F.R.I.B.A.,
Ministry of Agriculture.

THE planning of new farm buildings, whether on a large or small scale, presents many problems to the architect, and at no time more than the present, when the results of scientific research are becoming more generally recognised, and many of the old established methods and customs of farming practice are being weighed in the balance. Certain broad and elementary principles of planning may, however, be said to be firmly established and to be applicable to any type of English farming, and it may be well to record some of these before proceeding to discuss the main subject of this paper.

First, buildings must be suited to the nature of the land, the type of farming, and the prevalent climatic conditions.

Secondly, the buildings must be planned with a view to the utmost economy of labour in the care of stock, *i.e.*, in feeding, cleaning and general work, the guiding factor in this being the correct placing of the storage rooms and mixing floor for the collection, preparation, and distribution of fodder.

Thirdly, the health and well-being of stock must not be sacrificed to either of the above considerations by inadequate planning or insufficient area.

Fourthly, attention must be given, especially in the case of the small holder (who cannot be expected to purchase artificials to the same extent as the large farmer) to the adequate conservation and economic distribution of manurial produce.

A careful analysis of many of the existing farmsteads in this country shows that these principles are more often honoured in the breach than in the observance, and even buildings erected in the "golden age" of farming in the last century, leave much to be desired when viewed in the light of modern conditions and practice.

It is to be expected, therefore, that the immediate future will show several variations from existing types, and already there are signs of approaching changes in the construction and placing of cow houses, in the greater attention paid to the conservation

of farmyard manure, in the provision of covered yards, hay and straw barns, and in the use of utility boxes which can be adapted to varying needs.

Any variation from the normal, whether in buildings for large farms or small holdings, should therefore be of special interest at the present time to practical agriculturists, and to those concerned in the equipment of farms or small holdings.

The object of this article and illustrations is to draw attention to what in effect amounts to a departure from the normal in small holding equipment, and as the main feature, a single span roof covering the whole area of the buildings is much in accord with modern American practice on large farms, it is hoped that criticisms and suggestions will be forthcoming and that practical farmers will express their views on the general principle involved.

In small holding equipment for mixed farming of from 40 to 50 acres there may be said to be two principal types of plan in common use :—

(1) A range of low roofed buildings grouped round three sides of an open space which, by the addition of a fence on the fourth side, becomes the central stock or fold yard. When funds are available this stock yard is covered in by a "space boarded" or corrugated iron roof, which is a separate structure and quite distinct from the roofs over the main buildings.

(2) Two low-roofed ranges of buildings meeting in a right angle, the open stock yard being formed by the addition of an open or closed fence on the two remaining sides.

The actual arrangement of the various parts of the buildings differs slightly according to local custom and climatic conditions, but, broadly speaking, these two types are prevalent all over England and have been the basis of most of the larger holding plans submitted to the Ministry by the County Councils during the past three years under the Land Settlement Act.

The most notable exception to this practice is to be found in some plans submitted by the West Riding County Council in the early part of 1920. The main feature of this design lay in the fact that while more or less following the normal type (1) referred to above, the whole area was intended to be covered in with a single pitched roof which converted the open space in the centre of the quadrangle into a covered stock yard. A model of this plan was submitted by the County Council, the scheme was approved, and seven of these single roof buildings have been erected on the Whixley estate.

Some months ago the writer had an opportunity of inspecting several of the completed and occupied buildings, and was much struck with their obvious efficiency and convenience in general plan and arrangement, and was impressed with the idea that there were possibilities of further improvement and development, in planning and construction, which would minimise both labour in working and the initial cost of the building. It is not suggested that this type is entirely novel in this country. In the Report of the Departmental Committee on the Equipment of Small Holdings, published in 1913, several plans are given which provide for a covered yard which is under the same roof as the remainder of the buildings, but in each case the construction and general layout is markedly different from the plan now under consideration. Fig. 1 shows the West Riding plan as carried out.

It should be stated that these holdings are utilised for mixed farming, that the country is of somewhat high and exposed elevation and cold in winter. The land is of medium texture and a plentiful supply of farmyard manure is imperative. The plan is thoroughly sound in general layout. On the north, adjacent to a hard road, is placed the mixing and storage floor for " roots " with granary over. On the west, with immediate access to the mixing floor are placed the cow house and stalls for fatting beasts. These latter have direct egress into the open without passing through the stock yard. Dunging out can be either into the yard or directly to the open if desired.

Thus so far as this part of the plan is concerned there is simple and direct access from the mixing floor to beasts, cows, and covered yard.

On the east side is placed the cart shed, three-horse stable, and a large utility box which might be used for pigs.

The stable has to be approached for feeding purposes either from the external door on the east side or through the covered stock yard: the cart and implement shed, being placed to the north adjacent to the hard road, cuts off any direct communication from the mixing floor and granary over. This latter arrangement is, I think, open to improvement, and in the plan showing a suggested rearrangement (Fig. 3) the positions of stables and cart shed are reversed.

In the centre is the covered stock yard only 19 feet wide and somewhat long in proportion to its width. The yard is completely enclosed on the south side, but is provided with high and wide doors and ventilating shutter above (see Fig. 2.).

The whole is built of timber very strongly constructed. Heavy oak posts are used to support the roof trusses, which are designed on the Belfast truss principle, perhaps without sufficient regard to the double line of intermediate supports forming the inner walls of the cow house and stable ranges.

The building is lighted by windows in the outside walls and by an ample number of roof lights, and provision is made for continuous roof ventilation on either side of the ridge.

Obviously the questions of choice of materials and method of construction are at present of secondary importance to the question of principle involved by the single span roof over the whole building, which makes the covered yard so essentially an integral part of the scheme.

These particular buildings are constructed of timber mainly on account of the exceptional building difficulties of 1920 and 1921, but there is no practical reason why the outer walls should not be built of stone, brick or concrete, if such materials were available and showed a better economic result. On the other hand, a complete timber construction gives opportunities of standardisation, and the fact that seven such were ordered as one contract must have assisted in reducing the cost of all. The main point to determine is whether a building of this nature, under one roof forming a covered yard in the centre, gives satisfactory results with regard to the health of cows and stock generally, whether it proves economical in time and labour and results in carrying a larger head of stock per holding, together with the production of an adequate quantity of manure.

These are farming questions, and if they can be answered in the affirmative there is no reason why further improvements should not be effected.

It is obvious that the internal arrangements can be modified and amended to suit the exact nature of the land and the holder's requirements without departing from the general principle and without loss of efficiency.

To this end an illustration is given (Fig. 3) showing more direct internal access to the various parts, together with a lighter and more economic form of roof construction. The chief variations from the West Riding scheme are the increased width of the covered yard, which is in Fig. 3 shown as 25 feet instead of 19 feet, the provision of a feeding passage between the mixing floor and covered yard whereby more direct and distributed access is given to the long trough in the yard, and direct internal access from the mixing floor to every part of the building, includ-

FIG. 1.—The West Riding Standard Homestead.

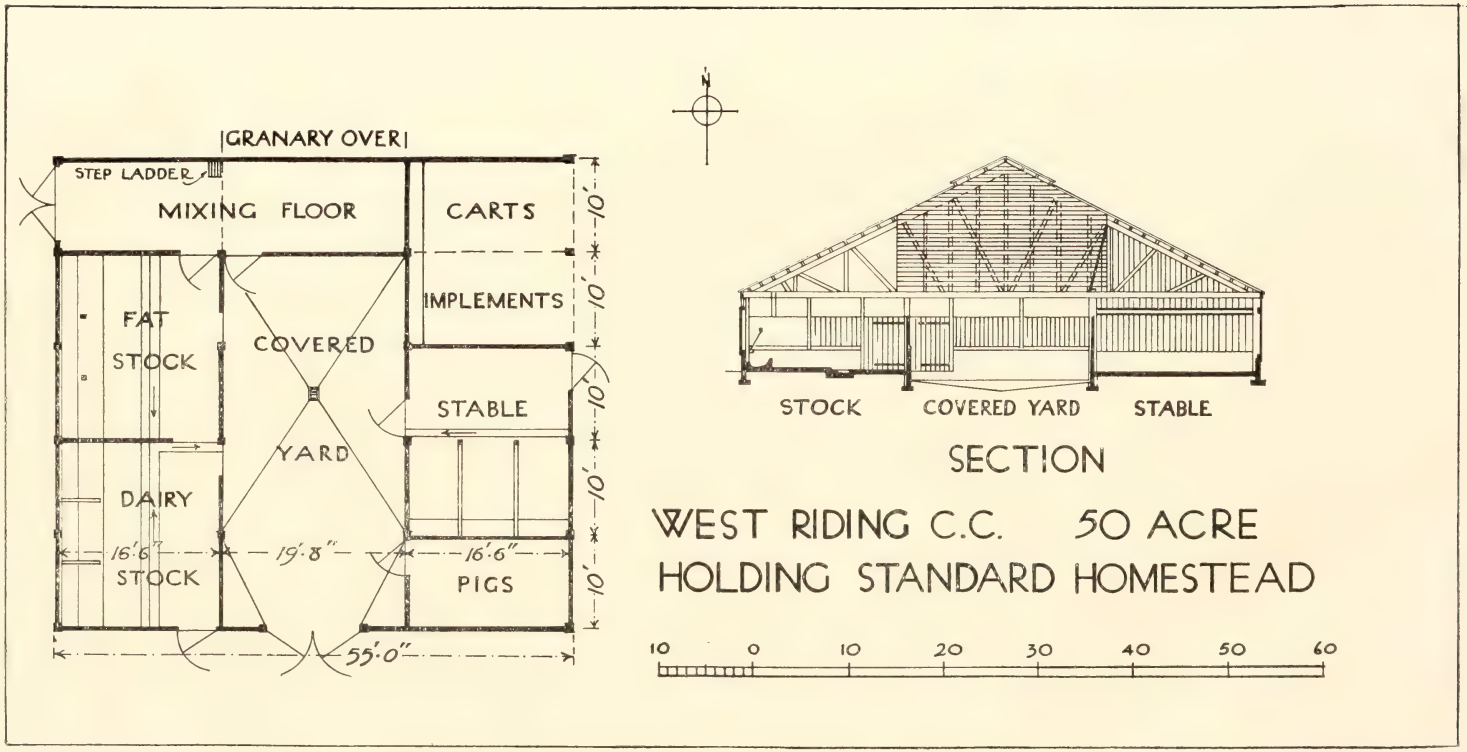
GRANARY OVER
STEP LADDER
MIXING FLOOR
CARTS
IMPLEMENTS
FAT STOCK
COVERED YARD
STABLE
DAIRY
STOCK
PIGS
16'6"
19'8"
16'6"
55'0"
10'
10'
10'
10'
10'
N
STOCK
COVERED YARD
STABLE
SECTION
WEST RIDING C.C. 50 ACRE HOLDING STANDARD HOMESTEAD
10 0 10 20 30 40 50 60

FIG. 2.

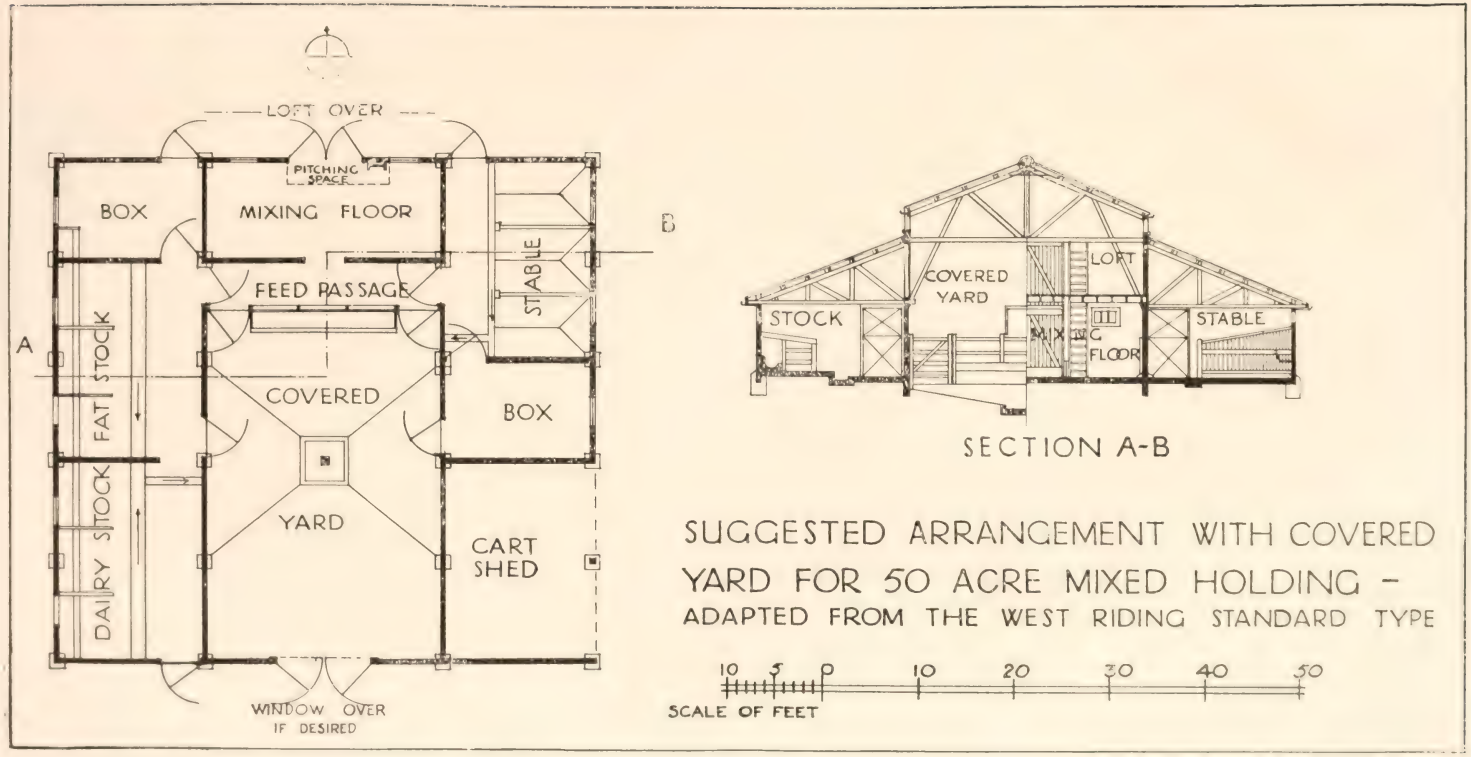
LOFT OVER
PITCHING SPACE
BOX
MIXING FLOOR
FEED PASSAGE
STABLE
B
A
FAT STOCK
DAIRY STOCK
COVERED
YARD
BOX
CART SHED
WINDOW OVER IF DESIRED
COVERED YARD
LOFT
STOCK
MIX
W.C.
FLOOR
STABLE
SECTION A-B
SUGGESTED ARRANGEMENT WITH COVERED YARD FOR 50 ACRE MIXED HOLDING –
ADAPTED FROM THE WEST RIDING STANDARD TYPE
10 5 0 10 20 30 40 50
SCALE OF FEET

Fig. 3.

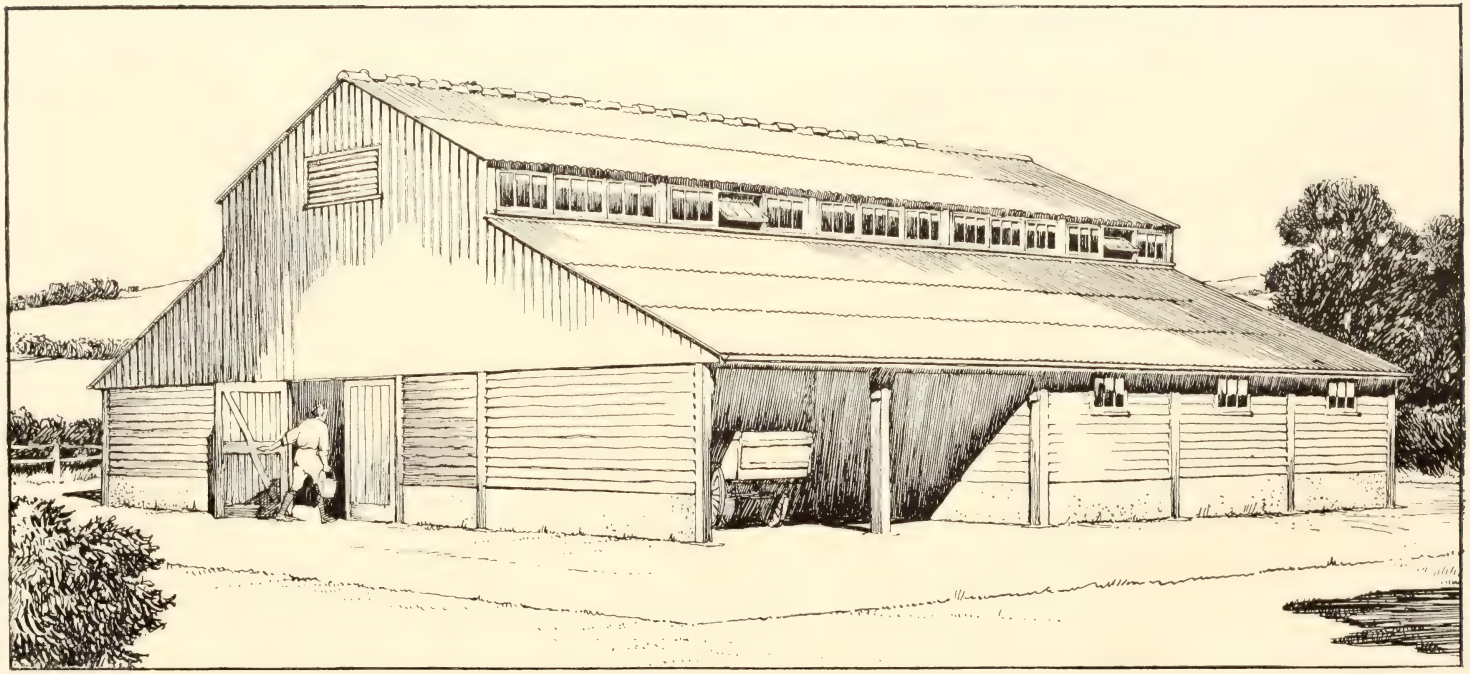

Fig. 4.—General View of the Building adapted from the West Riding Standard Type.

ing the stable, which, as before stated, has changed positions with the cart shed. It should be noted that there is also external access to all stalls and boxes, and direct internal access to the covered yard for dunging out.

The construction is somewhat different from the West Riding Scheme, and is similar in principle to the construction designed for the Ministry's Arable Dairy Farm Cowshed at Hucknall, which it is intended to deal with in a future number of this *Journal*. It is more simple in design, and in place of roof skylights a continuous range of vertical lights is shown on each side of the roof. No special advantage is claimed for this method of lighting, and in practice it would probably resolve itself into a question of cost balanced against the relative merits of the two systems as regards annual upkeep.

A Comparison of Costs.—The question of the relative cost of covering in a quadrangular building with a single span roof or of roofing the three ranges with small span roof and leaving the centre space open, is somewhat difficult to determine without actual estimates, but the following figures are instructive :—

The cubical content of the West Riding building as carried out are approximately 45,800 cubic feet and the roof area is 3,160 square feet. If the yard is left open and the surrounding three ranges are covered with a 30 degrees pitch roof, excluding the yard, the cube is only 22,150 cubic feet, but the roof area is 2,520 square feet, a difference of nearly 50 per cent. in the cubic contents, but only 20 per cent. difference in the actual amount of roofing.

In addition, with the single roof a considerable saving would be effected on rain-water spouting, down pipes and drains, and the three exterior walls enclosing the yard become interior walls under the span roof, and thus there should be less annual maintenance.

Probably the extra cost of the single span roof with its many advantages and the greater centre space would not exceed 10 per cent. to 15 per cent., and might under favourable circumstances be even less.

Conclusion.—It is probably too early to form a decided opinion as to the ultimate results of this departure from accepted normal type, but if the building enables the small holder to carry more stock and obtain better results, then there is every reason to elaborate this type of building for larger sized holdings and its future development will largely depend upon the amount of prac-

tical information which can be derived from a study of the actual holdings in working occupation. In any event the Small Holdings Committee of the West Riding and their architect, Mr. Foster, are to be congratulated upon their originality in producing a building of such merit, and may feel assured that the progress of the experiment will be watched with the utmost keenness by all those who believe that finality in farm planning has by no means yet been reached in this country.

* * * * * *

GERMINATION OF INDIGENOUS GRASS AND CLOVER SEEDS.

PROFESSOR R. G. STAPLEDON, M.A.,

Plant Breeding Station, Aberystwyth.

IN a prevous article in the *Journal** the present writer drew attention to the probable usefulness of strains of indigenous herbage plants for use in the preparation of temporary and permanent grass.

This matter was under consideration at the Food Production Department in 1917-18, when with the assistance of numerous interested persons a considerable amount of seed of various species was collected.† During the past three years much additional seed has been obtained in connection with the work now in progress at Aberystwyth. It is not proposed to deal here with the evidence that has now been accumulated as to the undoubted merit of indigenous strains of many of the grasses,‡ but it is only the purpose of this article to compare the germinating capacity and other characteristics of seed collected from plants growing in their natural habitats, on one hand with seed grown and harvested at Aberystwyth, and on the other hand with ordinary commercial samples. In certain cases it is also possible to give some idea of the amount of seed that may be collected per person per unit of time. The yields obtained from plots producing "once grown" seed are not here discussed. The necessary tests on seed collected during

* See "The Temporary Ley": This *Journal*, February, 1919, p. 1280.

† See "Plant Breeding Work at Aberystwyth," *ibid* October, 1920, for acknowledgment to those who then rendered assistance.

‡ See "Preliminary Investigations with Herbage Plants," Welsh Plant Breeding Station, Aberystwyth, Bull. H.1. for particulars of quantitative trials so far conducted.

1917-18 were conducted at the Official Seed Testing Station (then at the Food Production Department) while those on samples collected subsequently have been made by similar methods at Aberystwyth.

It will be convenient to deal with the species that have been collected under separate headings: "Legumes," "Grasses" and "Miscellaneous Plants."

Legumes.—The figures in Table I give particulars relative to indigenous legumes and where possible figures for ordinary commercial samples have been included in the table for the purpose of comparison.

TABLE I.—Percentage Germination, Hard Seed, and Weight per 1,000 Seeds in the case of Indigenous Legumes collected from various native habitats. When possible, comparisons are made with Commercial samples.

Species	No. of Lots	INDIGENOUS					COMMERCIAL		
		Average Germination	Highest and Lowest germination	Average Hard Seed	Highest per cent Hard Seed	Weight per 1,000 in gr.	Average Germination	Average Hard Seed	Weight per 1,000 in gr.
Wild White Clover	9	28	74-12	47	82	·49	77·3	12·7	*6 & 7†
Wild Red Clover	7	52	100-11	32	87	1·49	81·7‡	4·7‡	‡1·9
Bird's Foot Trefoil	3	26	37-15	48	58	—	70	17	—
Trefoil	3	39	—	50	65	1·68	79·8	2·7	1·8
Tuffed Vetch ...	3	3	7-0	65	99	—	—	—	—
Meadow Vetchling	2	12	25-0	79	100	—	—	—	—

* Commercial Wild White. † Commercial White Dutch.
‡ English Grown Ordinary Commercial Red Clover.

The result of the tests bring out very prominently the high percentages of hard seed that are to be met with amongst legumes and which show themselves in the germination test when the seed has not been subjected to any rasping process.* It is interesting to observe that hard seed is by no means confined to red and white clover but is equally in evidence in the case of the wild vetches and bird's-foot trefoil—whilst trefoil, one of the "softest" seeds after being subjected to the hulling and cleaning processes, is exceedingly hard when collected by hand and tested without any pre-treatment.

It has been noted, moreover, that hardness appears to be at its maximum in the case of samples harvested late and when the seed has fully matured. The poor average germination

* Hardness can be greatly reduced by rubbing the seed with sand paper or on a smooth surface with a bath brick or by shaking violently in a box lined with sand paper.

given by the indigenous legumes is therefore seen to be chiefly due to excess of hard seed and not so much to poor viability.

The evidence suggests that on the average the grain weight (wt. in gr. per 1,000 seeds) of the indigenous seed tends to be less than that of their commercial counterparts. It has to be remembered, however, that the collected seed had not been cleaned or dressed and that the grain weight has been the "natural" weight. It is, however, a well-known fact that even commercial samples of wild white clover have decidedly lower grain weights than samples of commercial white or Dutch Clover. Comparison between samples of wild red clover and of ordinary English grown red clover show moreover that the wild red seldom contains many seeds as large as the larger of those met with in the cultivated clovers.

The collection of indigenous legumes is a very slow and tedious process. This is particularly so in the case of the wild vetches, which do not as a rule grow in large masses and the individual plants of which appear to be rather poor seed bearers, ripening their seed moreover irregularly over a somewhat long period.

The collection of wild white clover by hand is certainly not lightly to be undertaken, and the heads collected often yield most disappointing crops of seed.* The hand collection of wild red clover is even more tedious than of wild white—for it is not so frequently met with in large masses. Both are species that in the writer's opinion could only be remuneratively harvested from old swards on which they are abundant, and then only by resort to the reaper or to the scythe or possibly the daisy rake.†

Grasses.—Particulars with reference to the grasses are given in Table II. All the germination figures have been arrived at on the basis of including "light" seed with the pure seed for the germination test.‡ In order to make the comparisons more thorough the percentage of "heavy" seed is given in the case of those species in samples of which "light" seed is frequently

* Mr. H. H. Dunn, of Dunn's Farm Seeds Ltd., informs me that 4 bush. of heads have in one case yielded no more than ¼ lb. seed—while it is said that under favourable circumstances 20 lb. of heads will yield 1 lb. of seed.

† The writer is not enamoured of the daisy rake as a very helpful implement, although he is prepared to admit he may be prejudiced against it by his own lack of skill in its use, but even in the hands of a practical gardener the results did not appear particularly encouraging.

‡ That is to say, the plan of testing that was adopted at the Food Production Department, and is still adopted at the Seed Testing Station of the Department of Agriculture and Technical Instruction for Ireland, has been followed.

abundant. The grain weight (wt. per 1,000 seed) has in all cases been taken on "heavy" seed and not on the sample as a whole. This plan has been adopted in view of the fact that the indigenous seed both collected and "once grown" has not been well cleaned or in any way dressed, thus a "heavy" seed grain weight gives a more accurate comparison between indigenous (collected and "once grown") and commercial than a grain weight based on the weight of 1,000 seeds taken from a sample before removing the "light" seed. The grain weight figures given for commercial samples are of necessity based on special tests made at Aberystwyth and have been obtained for the most part on high-grade seed which has been used in connection with the nationality trials conducted at the Plant Breeding Station.*

It will be seen that the germination of the indigenous grasses collected from various habitats is in the main very low—the average of all the samples together being only about 50 per cent. Individual samples, however, gave high figures; this was particularly so in the case of Timothy and crested dogstail. The low germination is very largely due to the considerable amount of light seed present, which in all cases averages more than that found in commercial samples. The germination of heavy seed was, however, also found to be lower than that of heavy commercial seed. One reason, and perhaps the chief reason of the relatively poorer germination of collected than of commercial seed, is undoubtedly the result of greater injury by the grubs of various insects. This was particularly marked in the case of cocksfoot—the seed of which suffered in a marked degree from attacks by the larvæ of *Glyphipteryx fischeriella*. The attack was greatest on plants growing in thickets and relatively shaded places. Meadow foxtail showed

* The average figures given in the first, second and third Annual Reports of the Official Seed Testing Station are not generally applicable to the comparisons here made, for the reason that grain weight, percentage of heavy seed and germination figures for the different nationalities of the grasses are not recorded. Average figures from the reports in respect of germination have however in some cases been drawn upon; the reports in question should be referred to: See First Annual Report in this *Journal*, Vol. XXV (6), September, 1918, Second Annual Report, *ibid.* Vol. XXVI (9), December, 1919, and Third Annual Report, *ibid.*, Supplement No. 20. The majority of the Aberystwyth tests have been made specially in connection with the work under review; results previously recorded have, however, also been drawn upon, see, *e.g.*, Stapledon, "Seed Studies," *Journal Agricultural Science*, Vol. X (1), June, 1920, and report on the "Condition of the Seed Trade in the Aberystwyth College area"—Univ. Coll. of Wales, Aberystwyth, *Bulletin*,—February, 1914. Results of tests made by Jenkin (see "Seed Testing and Report on Seeds Tested 1913"; Univ. Coll. of N. Wales, Bangor, Bulletin) have also been drawn upon in arriving at some of the average figures.

considerable injury due to Thrips (*Thrips cerealium*),* while tall fescue was also attacked by a grub not yet identified. These attacks were responsible for a failure of much of the heavy seed to germinate and also gave rise to much light seed and impurity.†

Another factor influencing the poor quality of collected seed is probably connected with the variable nature of any particular habitat from which seed is collected. Seed collected in bulk from hedges will be taken from numerous sub-habitats—from the top, bottom and different sides of a hedge, while from thickets there will be every degree of exposure to light and shade. Thus it is impossible to collect any considerable quantity of seed all under reasonably identical conditions of growth and harvest, and still less under the best conditions. This may be achieved with fair success in the case of plants growing in large masses together. Thus perennial rye grass growing in relatively large practically pure association near the Harbour at Aberystwyth and harvested when nicely ripe gave a germination of 88 per cent., while a lot of 5½ lb. of cocksfoot collected from the top of a long hedge germinated 54 per cent., compared with a lot of 7 lb. collected from a thicket germinating 44 per cent. and with a 3 lb. lot from another thicket germinating only 12 per cent. Individual panicles and small bunches of panicles were, however, selected from numerous habitats, the seed of which germinated over 80 per cent. Crested dogstail collected off old permanent pastures with a southern aspect has given attractive bright samples germinating over 90 per cent.

The "once grown" seed at Aberystwyth under uniform garden and field conditions has on the average germinated better, and in practically all cases has given considerably more heavy seed than the collected, and this despite the very unfavourable harvest conditions of 1920.

It is of interest to note in this connection that "once grown" cocksfoot was less severely attacked by the larvæ of *Glyphipteryx fischeriella* than the collected.

A comparison of the grain weight of heavy indigenous seed with that of heavy commercial seed, as with the legumes, shows the advantage as to weight to be considerably in favour of the commercial. The only exception is meadow foxtail, in the case of which, however, only very inferior commercial samples

* See "Preliminary Investigations with Herbage Plants," *loc. sit.*

† Single husks and chaff.

came under test. It will be seen that in the main there is fair agreement between the grain weights of collected and "once grown" indigenous seed having regard to the fact that only comparatively few of the collected samples were "once grown." Thus in the case of cocksfoot where a comparatively large number of lots were tested it seems quite evident that the indigenous types give rise to decidedly lighter "heavy" seed than the Danish and U.S.A., but that the New Zealand approaches more nearly to the indigenous.*

Even under the most favourable conditions, for instance, species growing in relatively large pure closed associations, the collection of indigenous grass seed for the purpose of sowing direct in mixtures would probably be too tedious and costly to be adopted, while the collection of seed from scattered plants (*e.g.*, tall fescue) would be quite out of the question. Fair quantities of seed can none the less be harvested by persons with sickles from cocksfoot growing, for instance, on hedge tops or in thickets. Thus the writer and three other adults collected heads which thrashed and winnowed down to 1 lb. 4 oz. of seed per person per hour from a thicket where cocksfoot was growing particularly abundantly, and 7 oz. of seed per person per hour from hedges where the same grass was exceptionally abundant. In the former case it was possible to cut the seed almost continuously, while in the latter considerable blank distances had to be covered. It should be remarked that reduced to weight of viable seed per person per hour the thickest harvest represented but little over ½ lb. and the hedge only 3¾ oz. Children with pocket knives even from a thicket where cocksfoot was very plentiful did not collect more than ¼ lb. of dressed seed (not adjusted for viability) per child per hour.

The collection of meadow foxtail which ripens very irregularly represents considerably more labour per lb. of viable seed, while the hand collection of crested dogstail by children, even on pastures where exceptionally plentiful, is a very slow process.

Miscellaneous Plants.—Yarrow is frequently plentiful on railway embankments and other waste places where fair quantities of seed may be collected. Four samples thus collected gave an average germination of 72 per cent. with a range of 96 per cent. to 26 per cent.

* This is interesting in view of the differences in growth habit that have been noted as between Danish and U.S.A., on the one hand, and indigenous and New Zealand on the other—see "Preliminary Investigations with Herbage Plants," *loc. cit.*

Summary and Conclusions.—It has been shown that the seed of indigenous species collected from various habitats tends on the average to be of poor germinating capacity, and that this is in part at all events due to the ravages of various insects, and in part to the difficulty of harvesting large quantities of seed under suitable and similar conditions. "Once grown" seed appears to be less attacked by insects and to germinate more satisfactorily. It has been shown also that the collection of indigenous seed is a slow and laborious process.

The amount of labour involved is, however, not excessive if it were only desired to collect indigenous seed for the purpose of obtaining a supply for inclusion in mixtures by the process of "once growing."

The precise value of "once grown" bulk collected seed* of such important grasses as perennial ryegrass, cocksfoot, timothy, meadow foxtail and the like can only be definitely settled by further investigation. With the lesson of wild white clover before the agriculturist it would seem that he may reasonably expect good results from the inclusion of such "once grown" seed in mixtures designed for the preparation of long duration and permanent grass. The trials so far conducted at Aberystwyth tend to show that indigenous cocksfoot, ryegrass and timothy, for instance, have important qualities for long-duration pastures and are undoubtedly more persistent than their commercial counterparts.†

The growing of grasses for seed production would not entail much labour—it would be necessary to keep the land scrupulously clean; this may be achieved by growing in drills and by scuffling and hand hoeing. Provided weeds were absent, a highly dressed sample for the purpose of sowing would of course be quite unnecessary.

It is suggested, therefore, that apart altogether from results that may finally be achieved by processes of breeding and selection, the question of the growing of bulk collected seed of indigenous grasses is one demanding considerable experimentation and one that should be considered as possibly an economic practice by those farmers who contemplate seeding considerable areas to long duration and permanent grass.

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* *i.e.*, seed collected without any selection from grasses growing in fairly large masses together.

† See "Preliminary Investigations with Herbage Plants," *loc. cit.*

TABLE II.—Comparison of the germination and other characteristics of the seed of indigenous grasses when collected from various natural habitats with those of "once grown" at Aberystwyth and ordinary commercial seed.

Species.	Collected Indigenous or Purchased Commercial.						"Once Grown" at Aberystwyth.				Remarks.
	No. of Samples	Per cent. Germination	Range	Per cent. Heavy Seed	Range	Grain wt. (= wt. 1,000 seed in gr.)	No. of lots	Per cent. Germination	Per cent. Heavy Seed	Grain wt. (= wt. 1,000 seed in gr.)	
COCKSFOOT.											
Indigenous from eleven Counties in England and Wales... ...	53	50	85-6	65	98-6	·85	5 1	*62 ‡75	75 93	·78 ·84	Majority of collected samples badly attacked by grubs and many ergotted.
Danish and U.S.A.	8	88	—	92	—	1·06	12 4	*78 ‡92	86 95	1·14 1·24	
New Zealand	9	70	—	86	—	·89	1	‡76	92	·95	New Zealand and Indigenous "once grown" appreciably attacked by grubs.
MEADOW FOXTAIL.											
Indigenous from six Counties in England and Wales	11	28	66-8	60	76-22	1·31	30	*60	71	·95	Several of the collected samples considerably attacked by grubs.
Commercial	5	40	—	79	—	·93	—	—	—	—	
TALL FESCUE.											
Indigenous from four Counties in England and Wales	7	30	87-3	15	71-8	1·11	—	—	—	—	Several of the collected samples badly ergotted.
Commercial	†	60	—	—	—	2·2	—	—	—	—	
TALL OAT GRASS.											
Indigenous from two Counties in England and Wales	6	54	56-37	—	—	2·2	—	—	—	—	
Commercial	†	69	—	—	—	3·0	—	—	—	—	
TIMOTHY.											
Indigenous from five Counties in England and Wales	7	81	97-71	—	—	0·28	2	*85	—	·31	
Commercial	†	87	—	—	—	0·40	1	‡94	—	·32	
PERENNIAL RYE GRASS.											
Indigenous from Cardiganshire...	4	73	76-62	90	96-86	1·42	2	‡97	99	2·00	
Commercial	†	80	—	96	—	2·25	1	‡97	99	2·10	
CRESTED DOGSTAIL.											
Indigenous from seven Counties in England and Wales	17	59	98-8	—	—	·44	6	*42	—	·43	
Commercial	†	68	—	—	—	·53	5	*55	—	·45	

† Average figures from various reports, see foot-note p. 121, and from tests made at Aberystwyth. * Harvest of 1920. ‡ Harvest of 1921.

CROPPING OF A DERELICT ESTATE IN SUSSEX.

R. H. B. JESSE, B.Sc., N.D.A.,
East Sussex Agricultural Executive Committee.

THE name Peacehaven has been given to a tract of land originally forming part of Hoddern Farm, Piddinghoe, lying between Newhaven and Brighton in the very heart of the South Downs. The greater part of this estate was taken possession of and farmed by the East Sussex Agricultural Executive Committee in May, 1917, and other parts at later dates.

The soil is extremely variable as, although resting on the South Downs, a considerable portion of it, probably some 300 acres, consists of an extremely light, poor sand, an almost equal area consists of the thin chalky loam so common on the South Downs, and at one place there is a "clay pocket" where the soil is extremely heavy and "unkind."

Previous Method of Farming.—Before 1915 the land was farmed according to the usual South Down practice, but as it had been for some years in the market, and was eventually sold for building purposes, it cannot be said that it had been cultivated in such a way as to leave any appreciable amount of residual fertility.

For about 20 years a flock of South Down sheep had been kept, and the system of farming seems to have depended entirely on the flock, but towards the latter part of this period, as dairying spread in East Sussex, cows were also kept.

For a considerable period no fertilisers of any description were used on this farm, and, as it had probably been "sheeped" for centuries, there is no doubt that the soil, like so much other poor hill land, had been "sheeped out" or depleted of all available phosphates.

Season 1916.—During the season 1916, practically no farming was carried out on the land, and the Committee were informed that the produce from the greater part of the land was actually sold for £100, so that the quantity of food produced from it in 1916 was practically negligible.

Season 1917.—In January, 1917, two of the best known surveyors in Sussex described the land as derelict.

The Committee made every effort to arrange for the cultivation of this land but it soon became apparent to them that, if

it was to produce anything like the amount of food that it was capable of doing, the management and work would have to be carried out under their direction. Consequently, in May, 1917, they commenced operations, but under exceptional difficulties.

Buildings, Implements, etc.—The farm-house and buildings which had previously gone with the land had been sold separately, and it was, therefore, necessary for the Committee, whilst erecting temporary galvanised buildings, to hire stabling. The Committee had neither horses, implements nor men, but one of the earliest tractors to be supplied under the Food Production Department's scheme was sent to Peacehaven. This was of the caterpillar type, unwieldy and powerful, but very effective in tearing through the weed and other growth which had accumulated since the autumn of 1915. Subsequently a set of steam tackle was hired by the Committee and proved very helpful in cultivating the land after it had been ploughed once, but it was found that, owing to the rubbish which had accumulated, this tackle was not very effective for ploughing.

Labour, Horses, etc.—In the early summer of 1917 a number of Metropolitan Police (many of whom had previously been Sussex ploughmen) were drafted into the county, and four of them were selected and sent by the Committee to Peacehaven, whilst in June, 1917, the Food Production Department inaugurated their scheme for supplying horses, and eight were sent in charge of the Metropolitan Police to Peacehaven.

Fallowing Operations.—During the summer of 1917, 164 acres of land were thoroughly fallowed, and prepared for wheat, although the summer was not one of the best for fallowing operations owing to the somewhat exceptional rainfall for the district.

Fertilisers Used.—It was known from the previous history of the farm and the farming, together with the nature of the soil and the surrounding land, that, if satisfactory crops were to be grown, the soil must be supplied with suitable fertilisers. All the land sown with wheat (164 acres) was therefore dressed with 5 cwt. per acre of a good grade basic slag. As the work was not carried out for an experimental purpose no part was intentionally left without its dressing, but, in one place, where the manure distributor broke and consequently the slag was not applied, the omission could be plainly seen for several months.

Season 1918.—In the spring of 1918 all the wheat was dressed with 1 cwt. of sulphate of ammonia per acre. The

combination of the basic slag applied in the previous autumn with the sulphate of ammonia in the spring was most effective, as may be gathered from the fact that the 164 *acres of "hill" land averaged* 44 *bus. of wheat to the acre.*

Varieties of Wheat.—The varieties of wheat grown were "Garton's Victor" and "Little Joss," both of which were supplied by the Food Production Department and gave excellent results on this land. It is probable that the "Garton's Victor" yielded slightly better than the "Little Joss," but on the other hand, with a large acreage of wheat, it was considered that "Little Joss" could be sown more safely at a later period in the year than could "Garton's Victor."

In addition to the wheat, 225 acres were sown with oats. The oats produced an average crop but not comparable with the results obtained from the wheat.

Harvesting.—The Committee had exceptional difficulties in dealing with the harvest in 1918, as labour was scarcely obtainable. Further, there was not even a barn suitable for even temporarily accommodating labour or storing corn. Newhaven, the nearest town, was closed for military reasons, so that for the harvesting operations the Committee had to rely very largely on German prisoners supplied from Lewes—a distance of 6 miles. These had to be sent by lorry in the morning and fetched at night.

Season 1919.—Although the yield of wheat during the first season was so heavy it was generally thought by farmers in the district that it would not be possible, on this poor land, to grow a remunerative crop during the following season. As, however, this was an attempt to produce the greatest amount of wheat possible, during the following season the greater part of the acreage previously under wheat was again sown with wheat, together with an additional acreage, making in all 262 acres.

The same varieties of wheat were again grown, viz., "Garton's Victor," and "Little Joss," whilst, in addition, 19 acres were sown with "Yeoman" wheat.

Fertilisers Used in 1919.—It was not possible to obtain a high-grade basic slag, but only one of a very low quality, viz., 20 per cent. total phosphates, so that on the average approximately 7 cwt. of this slag were applied per acre to all the wheat land. In the spring of the year the land which had previously been cropped with wheat, was dressed with a mixture

FIG. 1.—Crop of Wheat, 1919.

FIG. 2.—Crop of Little Joss, 1920.

FIG. 3.—Field of Potatoes in 1919.

of 2 cwt. of sulphate of ammonia and 2 cwt. of superphosphate per acre.

Harvesting in 1919.—In the harvesting operations of this crop tractors were very largely used. All the binders were drawn by tractors. It was found that the most satisfactory plan was for a "Titan" to precede a "Fordson," as this tended to keep the driver of the latter tractor steadier than if left to his own devices.

The total amount of wheat grown in 1919 amounted to 2,109 sacks—an average of over 36 bushels per acre on the total acreage. Fig. 1 shows the crop.

Wheat after Wheat.—One reason for growing this large acreage of wheat after wheat was that, in common with most of the land on the Sussex Downs, spring crops are much impeded by the prolific growth of charlock. It is, of course, recognised that this weed can be combated by spraying, but spring crops on the Downs are very susceptible to checks of any kind.

In 1919, again, the oats grown were an average crop for the district but not more. This was due to the very light rainfall in 1919, the competition of the charlock, and to the fact that, owing to the scanty rainfall the spring corn could not avail itself of the fertilisers as did the longer growing and deeper rooted wheat crop.

Potatoes. — In 1919 potatoes were introduced into the cropping. In all about 20 acres were grown. Local opinion was again discouraging to such an experiment, as it was stated that the soil was so light that it would be blown away. The results, however, were most gratifying (Fig. 3).

Scotch seed potatoes were obtained. These were manured with approximately 5 cwt. of flue dust, 6 cwt. of superphosphate and 2½ cwt. of sulphate of ammonia per acre. A quantity of the earliest dug potatoes were sold in Brighton at £13 per ton, but the remainder were sold at a lower rate when the price was controlled.

Further, as the seed had been obtained direct from Scotland no difficulty was experienced in obtaining a ready sale for the smaller potatoes as seed potatoes—"once grown" from Scotland.

Season 1920.—Having regard to the excellent crops of wheat which had been grown in 1918 and 1919, and to the fact that the autumn sown wheat was so much more successful than the

spring sown oats, approximately the same acreage was again sown with wheat in the autumn of 1919.

Much the same type of manuring was again carried out as in 1919, viz., approximately 7 cwt. of low-grade basic slag per acre, and, owing to the better facilities for obtaining nitrate of soda, the spring dressing of wheat generally consisted of 1 cwt. of sulphate of ammonia and 1 cwt. of nitrate of soda.

About 70 acres of "Yeoman" wheat were grown in this season, the remainder again being "Garton's Victor" and "Little Joss."

There was again promise of a successful harvest, and this was borne out by an average yield of 33 bushels per acre (Fig. 2).

Extension of Potato Acreage in 1920.—A larger acreage of potatoes was grown in 1920, in all nearly 100 acres.

The varieties grown were chiefly "Arran Chief" and "Lochar" as these were considered to be the two varieties which had given the best results in the previous year. The greater part of this acreage was manured with 6 cwt. of superphosphate, 1 cwt. of sulphate of potash, and 3 cwt. of sulphate of ammonia per acre. Some part, however, received kainit and steamed bone flour, instead of sulphate of potash and superphosphate.

The best area of Lochar averaged over 13 tons per acre, and the best of the Arran Chief slightly under 12 tons, although this high average was, of course, not maintained over the whole acreage.

Nearly all the potatoes found a ready sale in Brighton and were of excellent cooking quality—a quality in no small way due to the very sandy soil.

Despite the prevalence of potato disease in this district, the potatoes kept remarkably healthy and free from disease. Spraying probably did not pay in 1919, but in 1920 it undoubtedly doubled the crop. Spraying was commenced early in June, and continued until the potatoes began to ripen off.

Spring Corn in 1920.—The spring-sown crops in 1920 were much better than in the two previous years. This was due to the exceptionally heavy rainfall in April which so materially benefited the spring crops on the Sussex Downs.

The question has frequently been asked as to how long this system of farming could be maintained on such poor and impoverished land, without stock. The writer thinks that, with suitable modifications, it could have been continued almost indefinitely.

Continuous cropping with wheat must of course be regarded purely as war-time farming and as an endeavour to produce the greatest quantity of wheat possible.

The success of the crops was undoubtedly due to the recognition of the fact that this land, like so much other land on the hills in Sussex is, or was, almost deficient in available phosphates, and that the fertility could only be restored by the liberal application of phosphates in conjunction with a nitrogenous fertiliser.

Although the value of basic slag on grassland has been widely appreciated locally, very few realise its importance on cereal crops on this hill land which is so markedly deficient in phosphates.

During the three years that this land was farmed by the East Sussex Agricultural Executive Committee, the receipts from sales of crops grown exceeded £22,000. The crops consisted chiefly of wheat and potatoes, so essential during that critical time as producing the greatest amount of human food per acre.

* * * * * *

DEPTH OF SOWING GRASS AND CLOVER SEEDS.

PART II.

R. D. WILLIAMS, B.Sc.,
Plant Breeding Station, Aberystwyth.

White Clover.—In spite of the high percentage of surface seedlings given by the surface sowings—67 per cent. for the pots and 75 per cent. for boxes—these sowings must be regarded as failures on account of the stunted nature of many of the seedlings. The best results were obtained when the seeds were lightly covered.

In the box experiment the best results were given by $\frac{3}{8}$ in., $\frac{1}{2}$ in. and $\frac{1}{4}$ in. depths; in the pot experiment $\frac{1}{8}$ in., closely followed by $\frac{1}{4}$ in. and $\frac{3}{8}$ in. gave the greatest number of surface seedlings. The $\frac{3}{4}$ in. depth was only slightly inferior to the shallower coverings, while the 1 in. depth in the pot experiment gave about the same number as the shallower depths; but in the box experiment which approximated more closely to field conditions the number of seedlings that reached the surface from 1 in. dropped to 66 per cent. as compared with 92 per cent. from $\frac{3}{8}$ of an inch. When covered to depths of 2 and 3 in. hardly any of the seedlings were able to break through to the surface.

Not only did the shallower depths ($\frac{1}{8}$ in. to $\frac{3}{4}$ in.) give higher percentages of surface seedlings but the seedlings also reached the surface sooner and more regularly; consequently the growth was more even than at the $\frac{3}{4}$ in. to 3 in. depths. When covered to 2 or 3 in. depths the seedlings were very slender when they reached the surface, and remained etiolated for quite a considerable period.

White clover seedlings closely resemble red clover seedlings in form and general habit, but as the radicles are not so stout and the tips not so blunt they are able to penetrate the surface with greater ease than red clover seedlings. But as in the case of surface sown red clover seeds, a considerable portion of the radicle remains exposed on the surface even after the seedlings have become fixed.

When covered, white clover seedlings (with their smaller cotyledon leaves) are able to force their way through fairly light coverings with greater ease than the seedlings of red clover, thus when sown at half an inch 95 per cent. of the white clover

seedlings as compared with only 74 per cent. of the red clover seedlings reached the surface in 10 days after sowing; but when sown at depths of 2 and 3 in. this advantage was more than counterbalanced by the smaller amount of reserve food material contained in the cotyledons of white clovers. This is the probable explanation for white clover seedlings failing to reach the surface when sown at these depths.

Sowing in Wet Weather.—That a fairly satisfactory "take" can be obtained by merely sowing the seeds broadcast on the surface during a prolonged period of wet weather is shown by the following experiment in which the surface soil of one series of pots was maintained in a thoroughly saturated condition while the other series were given normal watering:—

	Saturated.	*Normal watering.*	
	Surface sown.	*Surface.*	*¼ in. depth.*
Percentage germination ...	98 ...	88 ...	97
Percentage rooted	91 ...	67 ...	97

Conclusions.—(1) White clover seeds should never be left uncovered except during a long spell of wet weather.

(2) The best results appear to be obtained by covering the seeds to depths of ¼ in. to ½ in.

(3) If covered to depths of over an inch only a very small percentage of seedlings may be expected to reach the surface.

Perennial Rye Grass.—As in the case of the two clovers, rye grass seeds allowed to germinate on the surface generally produced poor stands, much poorer than is indicated by the percentages of seedlings given in the Table. The germination of surface sown seeds, especially those sown in boxes and beds, was often delayed for several weeks, consequently the growth was correspondingly uneven and during the early stages many of the seedlings were weak and stunted. The inferiority of surface sowings as compared with shallow covering of the seeds is fully confirmed by the weights of green fodder obtained from the different beds; the surface beds gave only 29 per cent. of the yields produced by the ⅛ in. beds.

The best results both as regards the number of surface seedlings and yields were obtained when the seeds were buried to depths varying from ⅛ in. to 1 in. When the seeds were covered to depths of 2 in. about ⅓, to depths of 3 in. about $\frac{6}{7}$ of the seedlings failed to reach the surface. The yields given at these depths were even poorer, only 21 oz. and 4 oz. of green fodder being obtained from the 2 in. and 3 in. beds respectively as compared with 50 oz. given by the 1 in. beds. At these depths the

surface seedlings were invariably weak and much etiolated during the early stages and were very irregular in the time taken to reach the surface; some took over five weeks to break through.

Behaviour of Seedlings from Surface Sowings.—Under suitable conditions as regards moisture the slender rootlets assisted by the long root hairs, had no difficulty in becoming fixed to the soil, but when germination was immediately followed by a spell of dry weather a large number of the seedlings failed to become established because the exposed cells of the root hairs were killed. This was clearly demonstrated by the two surface sowings in the bed experiment. The "a" bed was sown on 16th August; on the 17th and 18th it rained heavily while the next two days were warm and dull. The conditions were thus conducive to rapid germination; but on the 21st a dry spell set in, which lasted 13 days with only a short break of a few hours' rain on the 23rd. As a result only 16 per cent. of the seedlings became established. On the other hand the germination of the seeds of "b" plot, which were not sown until the 20th, was delayed until 2nd September when a long period of wet weather set in, with the result that 57 per cent. of the seedlings on this bed became fixed.

Behaviour of Seedlings when Buried too Deeply.—The rye grass seedlings are able by virtue of the pointed apices of the sheaths and first leaves to force their way up through the soil with greater ease than the clover seedlings, but when buried too deeply the food supply contained in the caryopses is exhausted before the surface is reached.

Conclusions.—(1) Rye Grass seeds should not be sown on the surface except during a long, unbroken spell of wet weather.

(2) Good results were given when the seeds were covered from $\frac{1}{8}$ in. to 1 in. In a normal year it would probably be safer, however, to cover the seeds to a depth of $\frac{1}{2}$ in. to 1 in.

(3) Only poor "take" can be expected when seeds are sown at depths of 2 in. or 3 in. and over.

Cocksfoot.—For reasons described when dealing with rye-grass, cocksfoot gave poor stands when the seeds were merely sown on the surface. The number of surface seedlings (51 per cent.) was fairly high at the time of counting, but the very low yield obtained from the surface beds—only 43 per cent. of the weight given by $\frac{1}{8}$ in. depth—suggests that the weak seedlings must have suffered very heavy winter casualties.

If a comparison of the percentage number of surface seedlings given by the different depths is made (see the Table) it will

be seen that it is not advisable to cover cocksfoot seeds even to a depth of $\frac{3}{4}$ in. The number of surface seedlings decreased with the depth, and at a depth of 1 in. the number had fallen to 50 per cent. compared with 69 per cent. given by $\frac{1}{8}$ in. depth. At 2 in. depth only 16 per cent. of the seedlings reached the surface, while the 3 in. boxes and beds were complete failures.

The superiority of the fairly shallow depths ($\frac{1}{8}$ in. to $\frac{1}{2}$ in.) over surface and deep sowings is borne out by the weights of green fodder obtained from the beds. (See the Table.)

A comparison of the results given by cocksfoot and rye grass at depths of 2 in. and 3 in. will show that cocksfoot seedlings are not able to break through such great depths of soil as rye grass seedlings, chiefly no doubt because the sheaths and first leaves are broader and the caryopses smaller than those of rye grass.

That a very deep covering has a detrimental effect on the tillering capacity of the young cocksfoot plants is shown by the following figures :—

	Surface.	$\frac{1}{4}$ *in.*	$\frac{1}{2}$ *in.*	1 *in.*	2 *in.*
Number of tillers per plant	5·2	4·6	4·6	4·5	2·6

Conclusions.—(1) As in the case of perennial rye grass, surface sowings gave very poor results.

(2) For field sowing the best depth for cocksfoot seeds appears to be about $\frac{3}{8}$ in. to $\frac{1}{2}$ in.

(3) When buried to depths of 2 in. and 3 in. cocksfoot gave even poorer results than perennial rye grass. This is an important fact since cocksfoot is often included with seeds subjected to deeper sowing, and should be started under the most favourable conditions when set in competition with quicker growing grasses like the rye grasses.

Meadow Foxtail.—*Time of Sowing.*—The uniformly low germination of the pot cultures of meadow foxtail as compared with the fairly high results given by the box cultures was probably due to the fact that the pot experiment was carried out during April when the maximum room temperature seldom exceeded 14° C. (57° Fahr.), while the box experiment was carried out in July when the maximum temperature often rose to 26° or 28° C. (79 or 82° Fahr.).

The following figures giving a comparison of the germinating capacities of meadow foxtail and perennial rye grass in spring and again in the summer are very interesting :—

	Meadow Foxtail.		*Perennial Rye Grass.*	
Depths.	*April.*	*July.*	*March.*	*June.*
$\frac{1}{8}$ in.	15 per cent.	62 per cent.	86 per cent.	80 per cent.
$\frac{1}{4}$ in.	21 ,, ,,	48 ,, ,,	83 ,, ,,	78 ,, ,,
$\frac{1}{2}$ in.	23 ,, ,,	42 ,, ,,	84 ,, ,,	80 ,, ,,

They show that while the ryegrass seeds will germinate equally well during both seasons, meadow foxtail seeds will not germinate satisfactorily except during warm weather.

That the best stands of meadow foxtail are obtained when the seeds are sown in June or July was confirmed by an experiment in which the seeds were sown weekly from early May to August.

When excessive moisture is associated with low temperature the germination is still further reduced as shown by the following figures for surface sown pots :—

	Normal watering.	*Excessive watering.*
Percentage germination	25 ...	18

It was observed that the caryopses readily decomposed when exposed to excessively moist conditions, chiefly because the seeds were kept in a constant state of saturation by the large and very hairy glumes.

Best depths.—Since the germination of the pot cultures was so low no reliance can be placed on those results.

In the box experiment the uncovered sowing gave nearly the same number of surface seedlings as $\frac{1}{4}$ in. and $\frac{3}{8}$ in. depths, but, as in the case of perennial rye grass and cocksfoot, the germination was retarded, while many of the seedlings were dwarfed for a considerable period after germination.

All the covered sowings down to a depth of 1 in. gave fairly uniform results with the exception of $\frac{1}{8}$ in., which actually gave 13 per cent. more surface seedlings than the $\frac{1}{4}$ in. depth. The 2 in. depth was practically a complete failure, while the 3 in. depth was a complete failure.

Conclusions.—(1) The best time to sow meadow foxtail appears to be either June or July.

(2) Satisfactory stands may be obtained from surface sowings in wet weather, but it is nearly always advisable to cover these light seeds if only to prevent them from being blown away.

(3) Although the experiments on meadow foxtail are not conclusive, it would seem that the seeds may safely be covered to depths of $\frac{1}{2}$ in. and $\frac{3}{4}$ in.

(4) The sowings will result in complete failure if the seeds are covered with 2 in. to 3 in. of soil.

Rough Stalked Meadow Grass.—The results of the pot and box experiments, confirmed by observations made on the beds, show that the seeds of this species should either be left uncovered or buried very slightly, as even a shallow covering of only $\frac{1}{4}$ in. had the effect of reducing the number of surface seedlings, especially if the surface soil showed the least sign of caking over. At 1 in. depth only 4 to 6 seedlings per 100

seeds sown were able to penetrate through the soil, while at 2 in. and 3 in. depths no seedlings were able to reach the surface.

In an experiment similar to that referred to when discussing meadow foxtail, in which the seeds were sown weekly from May to August on the surface, and at a very shallow depth, the surface sowings gave the best stands when these sowings were followed by fairly long periods of wet weather; when, however, the germination was interrupted by a spell of fine weather, the best results were obtained from the lightly covered seeds. The germination of many of the surface sown seeds is often delayed for a period of 6 weeks of more, even under normal conditions as regards moisture. On the other hand, shade and excessive moisture are conducive to a good "take," as shown by the following figures given by pot cultures (surface sown):—

	Shaded.	*Exposed to light.*
Surface seedlings	61 per cent. ...	49 per cent.

That the lower percentage given by the "exposed to light" pots was due rather to the drier condition of the surface soil of these pots than to the influence of light as such is suggested by the following:—

	Excessive watering.	*Normal watering.*
Surface seedlings	63 per cent. ...	57 per cent.

Time of Sowing.—The June and July sowings produced superior stands to the May and August sowings in the weekly sowing experiment already referred to.

Conclusions.—(1) If sown under a nurse crop or during wet weather it would probably be best to leave the seeds uncovered.

(2) If sown without a nurse crop or during dry weather the seeds should be very lightly covered—preferably to about $\frac{1}{8}$ in. to $\frac{1}{4}$ in.

In order to test the evidence given by the experiments here discussed, field trials designed largely to ascertain the depth of sowing under various operations, and to test the degree of excellence of the stands, were also conducted during 1920 and 1921. It is hoped that these results will be dealt with in a subsequent article.

* * * * * *

CULTIVATION OF THE HOP CROP.

V.—PICKING, DRYING AND PACKING OF HOPS. PART I.

ARTHUR AMOS, M.A.,
School of Agriculture, Cambridge.

Picking.—Hops come into flower or "burr," as the hop-grower describes it, from the early part of July onwards, and normally seven or eight weeks elapse from this period before the hops are fit to pick, so that the beginning of hop picking coincides closely with September 1st in Kent, and about a week later in Worcester and Hereford. The formation and fertilization of the "burr" is a critical period; if the weather at this time is fine and warm, the pollen produced by the male plants drifts freely through the hop gardens and quickly fertilizes the "brush" on the "burr," but if the weather is cold and wet much of the pollen is carried to the ground by the rain, so that many hops may escape fertilization. If fertilization is delayed the hops remain in burr, looking very pretty but in a critical condition, because the soft and delicate "brush" forms a happy feeding ground for the spores of the hop mildew, which may rapidly develop upon it and cause the hops to develop into nasty little mouldy hops. Even when mould does not develop, the cones which result are small and ripening is delayed.

As soon as fertilization is complete the "brush" shrivels and the hops begin to develop. The tiny seeds begin to grow and the bracteoles in which they are contained as well as the sterile bracts and other parts of the hop commence to develop; later yellow lupulin grains begin to be formed principally near the bases of the bracteoles in close contact with the seeds.

As ripening advances the hop begins to assume a primrose yellow colour: especially is this true of the bracteoles; the bracts always retain a somewhat greenish tint. The seed, at first soft and milky, gradually develops into a nutty kernel and becomes purplish in colour when ripe. The grains of lupulin continue to develop for a considerable period after the hops have become apparently ripe, and since these lupulin grains contain the resins, etc., which the brewer wants, it is of the utmost importance to secure the maximum yield of them. Far too frequently hops are picked before they are ripe, in which case not only is the weight per acre small, but much resin is undeveloped.

The following signs may be taken as indicating when hops are fit to pick:—

They must be full-grown, and feel crisp as distinct from soft when crushed, and tend to rustle when shaken.

The colour should have changed from the vivid green of the unripe hop to a primrose yellow colour.

The kernel within the seed should be ripe and the colour of the seed purple.

The hops should contain plenty of lupulin.

Other considerations besides that of ripeness may have to be taken into account when deciding the date for the commencement of picking: of these, disease is the most important. If aphis is present, even in comparatively small quantities in the late gardens, picking must be pushed forward lest the aphis multiplies, as it is sure to do, and the hops "go black" before they can be picked. So too, if mould is prevalent, picking must not be unduly delayed lest they "go off" with red mould; on the other hand, unripe mouldy hops are unsaleable, so they should be allowed just to get ripe and then be picked as quickly as possible. Other factors to be considered are the size of the crop to be picked, the number of pickers available and the accommodation for drying at the oast; it is generally considered that the organization should allow the picking to be completed within three or at most four weeks.

Organization of Picking.—Three classes of employees are engaged in the picking. The pickers themselves with their children carry out the actual work of picking the hops, each family taking one "bin" or "basket," as the case may be; the "binmen" or "pole-pullers" are men engaged to wait upon and supervise the pickers by pulling down the hop-bines and seeing that no hops are wasted on the ground or on the bines; they are lotted out one man to from 12 to 18 baskets, and help to measure and bag up the picked hops and to load the carts; finally there is the "tallyman" or "measurer" who files the "tally" or books the number of bushels to each picker. Two methods of measuring are employed in different districts: in East Kent the measuring is done in 5 or 6 bushel baskets, in which the top of each bushel is marked by a dark line; in the Weald of Kent, Worcester and Hereford the hops are picked into bins consisting of a framework 8 or 10 ft. long over which sackcloth is stretched so that the centre bags down and forms a receptacle for the hops; the hops are emptied from these bins by a one-bushel measure, by which the quantity picked is ascertained. The advantages and disadvantages of each system probably counterbalance each other, but it is im-

portant to realise that the quantities contained in the bushel measure are very different in each case, that measured from the bin being much less than that measured in the basket, and hence prices paid for picking as well as other data based upon these units of measure, are not comparable.

Drying.—Until nearly the end of the twentieth century hop drying was practised much more as an art than a science; the hop dryer was all-powerful and carried out his work by rule of thumb; he was guided only by the experience of his former chief dryer, under whom he had worked as assistant, and generally paid scant attention to the suggestions of his employer, who probably knew little about the principles underlying the practice of hop-drying.

In the last decade of the twentieth century Sir A. D. Hall, then Principal of Wye College, began to investigate the subject; he showed how best to make use of the thermometer by placing it just below the hops so that the temperature of the air as it entered the hops could be gauged. He also published a leaflet* showing how the temperature of the air should be regulated during the period of drying so that the hops could be economically dried without being spoilt in the process. As a result of this work every grower can now exercise direct control over his hop-drying by installing a thermometer bulb just below the drying hops, connected with a scale outside the oast upon which the temperature of the drying air can be read. With such thermometers the grower can direct his dryer to follow the table of temperatures suggested by Hall, and progressive hop-growers have adopted or are adopting this or some similar method of control. There is still, however, much to be learnt about the principles of hop-drying, and the hop-growing industry is looking forward in the course of the next 10 years or so to the accumulation of much valuable knowledge by those in control of the experimental hop-drying plant recently installed under the Brewers' Institute Research Scheme on a farm belonging to Messrs. Whitbread & Co., near Paddock Wood.

The Principles of Hop-drying.—Ripe hops when picked for drying normally contain 60 to 75 per cent. of moisture, unripe hops in moist weather may contain 80 per cent. of moisture, and very ripe hops in dry weather may contain as little as 50 per cent. During the drying process the moisture content is reduced to about 5 to 8 per cent., but is allowed to rise again

* Leaflet No. 5. *South Eastern Agricultural College, Wye.* "The Temperatures of Hop Drying."

to 8 to 10 per cent. before the hops are packed. It is thus clear that the amount of water to be evaporated from the hops at the beginning of picking when hops are barely ripe may be very much greater than at the end of the season, and this, of course, coincides with experience that much greater quantities of ripe hops can be dried on the kilns than of green ones. This surplus water is evaporated by causing a current of warm air to pass through the hops whilst they lie upon a horsehair cloth supported upon the drying floor of the kiln. The next point to be considered is the means whereby the current of air or draught is produced.

Draught.—In some cases kilns are now fitted with fans to produce the necessary current of air through the hops, but in the vast majority of cases draught is produced through the operation of the well-known fact that "hot air rises."

When the air within a kiln is warmed it rises and passes out of the top through the cowl, whilst cold air enters below to take its place. The draught created is thus proportional to the difference in temperature between the air within and without the kiln, but it is also proportional to another factor, namely, the height of the kiln. Factory chimneys are built high to give better draught, so the higher the kiln the better the draught. The height both below and above the hops is important, and of the two probably that between the fires and the hair cloth below the hops is the more important, because the temperature of the air below the hops is always greater than that above and hence this air is relatively lighter and creates the greater draught. Especially in the early part of drying, the air above the hops is cooled by passing through them and therefore has no great lifting power unless it is warmed again by absorbing heat from the walls and roof above the hops. This re-absorption of heat from the walls of a warm oast is by no means unimportant and the absence of it may play a serious part with the first load of the season unless the kiln has previously been well warmed. For this reason the good dryer makes a point of lighting the kiln fires early in the morning of the first day of picking and on each Monday, for the purpose of warming his kiln, though no hops will be ready for drying till perhaps 11 a.m.

Another factor of great importance in the maintenance of a good draught is the sealing of the walls and roof so that no air can enter the kiln at any point above the position of the fireplaces. Every such inlet of air weakens the effective draught.

The positions most likely to be faulty in this respect are the doors of the kiln and the roof.

One further point in this connection is worthy of notice; in some few kilns one finds the position of the fireplaces excavated, so that the firebars themselves are situated at or close to the ground-floor level and the topmost inlet of air above the fires is correspondingly lowered; this arrangement provides for additional effective height and so better draught is obtained economically, provided that facilities are made for easy carriage of coal to and cinders away from the fires.

In some kilns draught is much curtailed by the narrow apertures through which the air has either to enter or escape from the kilns, especially in still weather when there are no air currents. This restriction of openings is also liable to prejudice draught when fans are substituted for natural draught in a transformed oast.

Lastly, it is much easier to establish a good draught when the wind is blowing past the cowl, a contrivance specially fashioned to facilitate suction of air out of the kiln; in order to increase this aid to draught the kiln should be built in an open situation and trees should not be planted closely around which would tend to shelter the cowl from wind.

Evaporation.—The drying of the hop is somewhat but not completely analogous to the evaporation of water from a wet cloth, for in the case of the hop the water is contained within the tissues of the cones, partly in the bracts and bracteoles (or "petals" as the hop-grower calls them) and partly in the strig of the hop; from the former evaporation is rapid, but from the strig, protected as it is by the bracts, evaporation is much slower.

Water evaporated from the hops passes into the air, which is capable of absorbing varying quantities of water vapour according to its temperature. For each temperature of the air there is a maximum water vapour content, and if more water vapour is put into such saturated air, then either a mist is formed or water vapour is deposited as dew. Such a deposit of water vapour may occur in hop drying upon the top surface of the hops during the early part of the drying. At 50° F., a frequent temperature of the outside air during drying, air can only contain $\frac{3}{4}$ oz. of water vapour in 10 cub. yd.; at 100° F., the temperature at which hop-drying generally starts, air can contain $3\frac{1}{2}$ oz. of moisture in 10 cub. yd.; whilst at 150° F., the temperature at

or slightly above which drying finishes, the maximum content of water vapour is as much as 15 oz. of water vapour in 10 cub. yd. That is to say the rate of drying of hops in a current of dry air at 150° F. may be nearly 5 times as fast as in dry air at 100° F. and nearly 20 times as fast as in dry air at 50° F.

If, therefore, hop drying merely consisted of evaporating water it is clear that the use of air at a high temperature would be both more expeditious and more economical, but another factor is involved; the passage of the air through a depth of 10 in. or so of hops spread over a wide floor is necessarily slow; contact at the beginning of drying between the cold hops and the air, as well as the evaporation of the water into it, cools the air so that as the warm air passes up through the hops its moisture content becomes greater and greater and its temperature lower and lower. If these two processes reach the point at which the air becomes saturated with water vapour, then if cooling proceeds further moisture is deposited upon the hops which are consequently "reeked" and spoilt. The initial temperature of drying must therefore be adjusted so that with the draught available the air can pass through the layer of cold hops without the deposition of any "reek." It is obvious that this initial temperature is not necessarily a constant; it may be varied somewhat with the draught available, the initial temperature of the green hops, the depth of the hops and other factors.

Temperature.—In the previous paragraphs upon evaporation emphasis has been laid upon the necessity of so controlling temperature that no condensation of reek occurs upon the upper layers of hops. Two golden rules will serve to prevent this misfortune: a warm oast before drying commences, *i.e.*, warm walls and roof, and a sufficiently low initial air temperature. The table of temperatures recommended by Hall already referred to still remains the best guide. From this extracts are quoted below:—

"*General rules if draught is moderately good.*"

"The temperature at starting should not be higher than 100° Fahrenheit."

"For the first three hours the temperature must rise steadily to about 140°."

"If the temperature falls at all during this period the colour of the hops will suffer."

"For the next five hours the temperature should be kept pretty steady; it may be allowed to rise a little more but never above 160° Fahrenheit."

"If the draught is poor the temperature must rise more slowly after starting, and four or even five hours should be taken to get to 140°."

These rules provide an admirable guide for a young dryer, who can scarcely make a mistake if he follows them intelligently.

When the hops have "feathered," a name given to describe the condition of the cones when the bracts have dried and opened out like the feathers of a bird on a frosty morning, and whilst the strigs are still sappy, the temperature is allowed to rise to 150°—155° F., to quicken the rate of drying. It is probable that such high temperature tends to evaporate some of the more volatile oils in the hops and so depreciate their flavour, but may be justified by the economy of time and fuel. In any case the temperature must not go above 160° or the hops will be burnt.

The Practice of Hop Drying.—*Loading.*—A kiln of hops can usually be dried in about 10 hours, so that each kiln can be loaded and unloaded twice in 24 hours. Hops that are picked in the morning are loaded as soon as they arrive at the oast, but the afternoon's pickings are stored until the morning's hops are dry and are loaded at night. Care must be exercised in storing the afternoon's pickings that these do not heat in the bags before they are loaded lest they be discoloured. In some cases the hops are stored in a "green-loft" above the cooling floor in the oast, so that they can be easily carried on to the kilns at night, but if so, considerable precautions must be taken in sultry weather and with unripe hops. The green loft must be well ventilated and each bag of hops should be untied and stood up, so that air can freely circulate around. A better plan, though one entailing more labour, is to erect a staging outside and near the oast upon which the bags of green hops can be laid and freely exposed to air; a temporary roof of galvanised iron is advisable to protect such hops from rain.

The quantity of hops to be loaded is a matter requiring careful judgment, and beginners may be warned that no practice prejudices profits more in hop growing than over-loading at the beginning of picking when hops are green and contain much moisture. Such practice not only results in spoilt hops from reeking but it disconcerts the drier who cannot be expected subsequently to do himself justice. When hops are fully ripe they may be loaded 10-11 in. thick on well-constructed kilns; this is equivalent to about $\frac{3}{4}$ bushel per sq. foot, East Kent measure, where hops are measured in 5 bushel baskets. In districts where "bins" are used the measured bushel of green hops is frequently much less than the basket measure. If hops are unripe, the cones small, the oast badly constructed, or the drier inexperienced, the load should be considerably less.

In loading great care must be taken to spread the hops uniformly over the drying floor and to leave them as light as

possible; light, so that the draught may be free; uniformly, so that the hops may dry evenly—or otherwise, as soon as the thin places are dry the draught of hot air passes almost completely through these spots and the denser spots dry very slowly.

Turning.—This operation is carried out after the hops have "feathered" well on top. It is done for the purpose of mixing the comparatively moist hops above with the dry hops next to the floor and also to redistribute any thick or thin places on the drying-floor. It should not be done too soon, and care must be taken not to break the hops unnecessarily, since the lower hops will have now become brittle. The operation tends to expedite drying and to produce a sample, all the hops in which are uniformly dry.

Cooling.—It is not an easy matter to test exactly at what stage drying should stop and cooling commence. On the one hand it is most important to "home-dry" the hops, since if unloaded from the kilns still moist they are either spoilt in the pockets or have to be again put on the kilns and re-dried, resulting in loss of time and much breaking of the cones. On the other hand, over-dried hops become very brittle and are broken to pieces badly in unloading and packing. The test most generally adopted is to take a handful (or several handfuls) representative of the bulk and rub them to pieces between the hands: the majority of the cones should rub down to powder, leaving only two or three cones in the handful which are still sappy, though these should be "killed" in the sense that they have already begun to shrivel. Drying should then cease, and cooling commence by damping down the fires with ashes and opening wide all blowers or shutters below the drying floor. Cooling should occupy from one half to one hour during which time the home-dried hops absorb moisture from the air and from the few partly dry hops amongst them, thus becoming less brittle so that they can be unloaded with little damage. Per contra, the few hops still undried at the beginning of cooling complete the process.

Two commonly occurring misconceptions in regard to cooling may here be mentioned: just as in the drying process the bottom hops feel the heat first and the top hops last, so in cooling the bottom hops feel the effect of the cold air first and so does the thermometer placed below the hops: for this reason the recorded temperature rapidly falls and the hop drier is inclined to think that his hops are cool, when in fact only the lowermost hops may be so; to test whether hops are sufficiently cool the drier

must handle the hops, or alternatively leave them a length of time which experience may indicate to be correct.

Another common mistake is to open not only the shutters and doors below the hops but those above the drying floor as well; by such practice the air above the hops only is cooled, but since the cool air entering above the hops does not pass through them, the hops themselves are not cooled. This sounds very obvious, but the mistake is very frequent in the oast.

Control of Fires.—The work of the hop drier is made considerably less anxious if his kilns are fitted with large enough fireplaces; if these are greater than required he is not obliged to utilise the whole of the fire bars, but if too small they may have to burn too fiercely and constantly need attention. This fault is particularly likely to arise when hops are dried over open fires with fan draught. Wherever fires are liable to burn fiercely, or the fireplaces are nearer than usual to the drying floor a baffle plate should be suspended above them to prevent heat being directly radiated from the fires to the cloth, in which case the hops are liable to be burnt. It may be noted in passing that this radiated heat is very different in its properties from heat carried by warm air; the former "strikes" one's face when sitting before a blazing fire, the latter is produced when hot water pipes are used to warm a room. In hop drying radiated heat is dangerous and must be prevented from acting; it is the current of warm air passing through the fire by means of which the hops are dried.

At the beginning of drying and as soon as the hops have been loaded the fires are made up with large lumps of coal so that they will burn slowly and steadily for 4 or 5 hours, gradually gaining in heat as the hops begin to dry and the draught consequently improves. Should the temperature tend to rise too rapidly the fires are checked not by damping them with ashes but by raising the blowers to admit more cold air to the kiln and by this admission of air check the draught through the fire. So, too, if the fires want lifting after restoking or because they tend to deaden, this should be done by increasing the draught through the fires by partially closing blowers. Some driers use large quantities of charcoal for the purpose of raising their fires; this is costly and unnecessary except when the fire is very dead when made up.

The stoking of the fires during the latter part of drying calls for much less skill than at the outset; the only precautions necessary are to avoid great fluctuations in temperature and to

be careful that the heat produced does not exceed the given maximum.

Control of Draught.—This is closely wrapped up with the control of the fires and is fundamental to successful drying. It is especially important during still, foggy nights. Every effort must be made to get a good draught from the beginning. Assuming that the oast is sufficiently high and well coiled, the other points of importance are to see that the cowl points directly away from whatever wind there may be; failure to do this leads to certain spoiling of the hops. Well balanced cowls, kept well oiled, should automatically swing round with the wind, but a wise precaution consists in tying a piece of string to the tongue of the cowl. The other end is attached to a stone on the ground so that, if by mischance the cowl sticks, it can easily be swung round. Next, the kiln must be warm before the hops are loaded, and the hops must be spread as lightly as possible over the drying floor.

Sulphuring.—During the drying of hops brimstone is burnt for the purpose of bleaching or mellowing the green colour of the hops, especially when unripe, so that the whole sample may present an attractive, and uniformly yellow colour. It is sometimes wrongly thought by buyers that this is the sole function of the brimstone. This is not the case for, if experimentally or accidentally hops are dried without sulphur they assume a harsh, partly green and partly bronze colour, which resembles the original colour of the green uncured hops less than does the sulphured sample. Again, such unsulphured hops have a peculiar smell resembling that of withered foliage. There is also some slight evidence that the use of the brimstone helps to hasten drying, and to preserve the hops if long storage is necessary.

The peculiar colour associated with unsulphured hops may frequently be observed by picking up a handful of hops from off the hair when the lighting of the brimstone has been delayed a few minutes after drying has commenced. This serves to indicate the importance of lighting the brimstone immediately the hops have been levelled, because the sulphur can only produce its effect on the hops before they have begun to get dry.

The quantity of brimstone required is about 1 lb. per 40 sq. ft. of drying floor, perhaps rather more when hops are green and rather less when ripe. Brimstone is sometimes burnt directly upon the fires, but a better method consists in burning it in separate iron pans within the kilns.

(*To be concluded.*)

INCREASING THE COMMERCIAL VALUE OF APPLES.

E. M. BEAR.

Now that efforts are being made to bring about improvements in our methods of packing and marketing apples, the need for better culture with a view to enhancing the commercial value of the fruit is bound to make itself felt. A grower who sets out to market his apples in accordance with standards regulating grade and quality, such as those adopted by the Federation of British Growers, quickly realises the importance of having a good sample of fruit to deal with. If the general quality of the crop as gathered from the trees is low, the proportion fit to include in the higher and more valuable grades will obviously be small, and the bulk will have to be disposed of at a much lower rate. It is, in fact, almost hopeless to attempt improved methods of packing unless an effort has been made to produce a crop of good quality.

It is to be hoped, therefore, that the movement in favour of a better system of marketing will lead to a general improvement in cultural methods. The importance of this matter is fully realised by growers in other countries who compete with us in our markets. In many cases they succeed in growing crops of apples, 75 per cent. of which are of high enough quality to pack in boxes for export under very stringent regulations as to grade and quality. On the other hand, it has been said, and probably without exaggeration, that the average crop of apples grown in commercial orchards in this country does not include more than 15 per cent. of fruit of boxable quality. There is thus plenty of room for improvement, and growers who accomplish it are not likely to go short of their reward.

The attributes of chief commercial value in apples are size, colour, and freedom from skin blemishes.

Size.—Whilst abnormal apples are not desired, it is of great importance that as large a proportion of the crop as possible should be typical specimens of their variety in this respect, since apples are graded primarily by size. It is particularly desirable in the case of cooking apples, which for most markets can hardly be too big. In a time of glut there is little demand for any but large cooking apples; and the public prefer them to small ones at any time, because they are less wasteful and less troublesome to prepare for the table. In dessert apples extra large size is not favoured, but any specimens under $2\frac{1}{4}$ in. in

diameter cannot be considered as being of the highest grade. Some of the smaller varieties commonly yield a large proportion below this size unless means are taken to improve them in this respect. On the other hand, there are a few big varieties, such as Charles Ross and Blenheim Orange, which often grow too large for dessert purposes if given generous treatment. It is desirable, therefore, that the grower should understand the conditions which influence size. In the case of most varieties, however, both cooking and dessert, his object will be to increase the average size, so as to avoid having to deal with large quantities of small fruit which must be sold at a low price.

Size in apples is influenced largely by the character of the soil. Medium loam soils or clay, which are naturally retentive of moisture and plant food, produce apples of great size and substance, and are therefore particularly suitable for cooking varieties. On soils of lighter, drier nature big, heavy apples are not so easily grown, but dessert varieties often attain better colour and more delicate and attractive appearance than on the stiffer land which gives size. But, since growers cannot materially alter the character of their soil, they need to know how size may be influenced by cultural methods.

Conditions which encourage strong growth of the trees also increase the size of the fruit. The finest apples are generally gathered from young trees that are growing vigorously. As the age of the trees increases and the wood growth decreases the apples tend to become smaller. The vigour of the trees, and consequently the size of the fruit, may be increased in several ways, the chief of which are soil cultivation, manuring, pruning and thinning the crop.

Cultivation and Manuring.—Apples grown in cultivated plantations are commonly larger than those yielded by orchards under grass. Thorough surface cultivation during the spring and summer, with the object of maintaining a dust mulch, and so hindering the rising and evaporation of moisture from the soil below, has a beneficial influence on the size of the fruit. On land inclined to be light and dry surface cultivation can hardly be overdone, particularly during the spring and early summer.

Manuring also has an important influence on size, the most useful manures for this purpose being those of a bulky organic nitrogenous character, such as farmyard or stable manure and wool shoddy. In the writer's experience a dressing of shoddy at the rate of 2 to 3 tons per acre has always given a noticeable increase in the size of apples. Whilst it is easy to overdo the manuring of young trees which are growing vigorously, and have

not come into full bearing, there is little doubt that older plantations are commonly given insufficient manure. Trees that have steadied down in growth and are in regular bearing probably require annual assistance in the way of feeding.

In some countries the requirements of fruit plantations in the way of nitrogen and organic matter are supplied by sowing a leguminous crop in autumn and ploughing it under green in the following spring. If such a crop is grown with the help of mineral fertilisers supplying phosphates and potash, the manurial needs of the trees are very cheaply and effectively provided, and increased size in the fruit is one of the benefits secured. It is very desirable that such a system should be tried in this country, and experiments made to find the best green crops for the purpose.

Grass orchards are generally manured with sheep grazing the grass closely, and at the same time receiving cake and other concentrated foods.

Pruning.—Pruning is well known to stimulate wood growth, and it increases the size of the fruit as well. There is no doubt that the finest apples are produced in orchards which receive annual attention in the way of pruning. In experiments in progress at the East Malling Research Station in Kent, trees which have the leaders tipped annually consistently yield larger fruit than trees which are allowed to grow naturally or merely thinned out where overcrowded. In the case of old trees, which have become overburdened with fruit spurs, it is very desirable to reduce the spur clusters to reasonable dimensions, and generally to thin out spurs where too numerous.

Thinning.—Undoubtedly the most direct influence on the size of the fruit is the thinning of the crop; and no other means will attain the object when too heavy a crop has set. It is a laborious and expensive process, but profitable for all that. In the case of some of the earliest cooking varieties, which are saleable when quite immature, it is perhaps allowable to leave the thinning until some of the fruit reaches a marketable size; but the thinning of most varieties should be done in May or June. The amount of thinning required depends on the quantity of fruit set. In many cases it suffices if the apples are singled, or the clusters reduced to one apple in every instance; but in some cases this leaves the fruit still too thick, and further thinning is required. As a rough rule, where large apples are wanted, they should be allowed to hang about 8 in. apart, this distance being gauged nearly enough by spanning with the hand, fingers

extended. Much thinning is avoided if the trees are regularly pruned, and the number of spurs reduced where necessary, as already described.

Colour.—Colour in apples is of great commercial value, particularly in dessert varieties. Unfortunately it is much less under the control of the grower than is size. Certain districts are noted for the high colour of the apples they produce, this being the result of natural conditions of soil and climate. The soils which yield cooking apples of great size and substance are not remarkable, as a rule, for the colour they impart to the fruit. Apples of the brightest colouring usually come from trees growing on lighter and drier land, which is therefore particularly suitable for the culture of dessert apples. On such land neither the trees nor the apples grow so big. It may be said, in fact, that conditions that make for size and growth are antagonistic to high colour. We see this when comparing apples grown in a cultivated plantation with those from a grass orchard on the same farm. The latter are always smaller but of decidedly higher colour. The same rule applies in manuring. The organic nitrogenous manures used to give size tend to reduce colouring. What it amounts to is this: colour comes with maturity, and anything that hastens maturity or ripening gives colour. Nitrogenous manures promote growth and prolong the season of development, thus delaying maturity and working against colour. If any fertilisers achieve this object they would be those supplying phosphates, which are well known to bring about early maturity. As a matter of fact, there is no reliable evidence that colour can be fed into apples, whilst there is no doubt that over-stimulation with nitrogenous manures has the opposite effect.

Colour is, of course, greatly influenced by light, especially sunshine. This is clearly seen from the extra colour of apples on the exposed parts of the tree as compared with those hidden by foliage in the centre or on the lower branches. It is really only by taking advantage of this knowledge that growers can work to secure bright colour. There should be ample space between the trees, and pruning should be done with a view to admitting light to all parts of the tree, the branches being well spaced and the centre of the head open. In the case of coloured varieties, particularly those that ripen early in the season, further help towards getting a sample of uniform colour is afforded by picking over the crop several times, taking the fruit as it colours; for apples in the shaded parts do colour eventually.

Whilst sunshine greatly assists colouring, rain also helps matters. Apples colour best when showers alternate with periods of bright sunshine. Very dry, hot seasons, with continuous sunshine, are not the most favourable to colour, although the contrary is often assumed. In the writer's district, where the drought of 1921 was very severe, and the amount of sunshine was abnormal, apples did not colour so well as they have done in normal summers.

Skin Blemishes.—A very serious amount of waste and loss in the packing of apples for market is caused by skin blemishes. Fruit that is actually damaged, either mechanically or by pests and diseases, so badly that its keeping quality is affected, is quite unfit to market at all. But even minor skin blemishes, which affect merely the appearance of the fruit, lower its value enormously. Apples packed under the label of the Federation of British Growers must not include more than 10 per cent. showing such blemishes. Growers will find that a large proportion of their crop falls short of this standard unless they give the matter very serious attention.

Blemishes arise in several ways. A few are caused by the weather, and cannot be prevented. Many mechanical injuries occur as a result of careless or improper handling during picking and can be guarded against only by training of the pickers and constant supervision of the work, together with the provision of proper appliances for carrying it out. But the majority of skin blemishes arise through the attacks of various insect pests and fungus diseases. Capsid bugs puncture and deform the fruit, aphides stunt and disfigure it, codlin moth causes "maggot-eaten" apples, and various caterpillars injure the fruit as well as the foliage. Amongst fungus diseases brown rot and apple scab are the most serious. Apples affected by the former soon decay and are entirely wasted, whilst scab, even in a mild attack, disfigures the fruit and greatly lowers the value of the crop.

The chief means of controlling these and other pests and diseases is intelligent spraying; and the grower who does not spray might as well give up all idea of improved packing and enhanced returns. It is not sufficient to wait until a particular trouble appears, and then seek a remedy. Pests and diseases are much more effectively controlled if the season's spraying campaign is carefully planned in advance, and put into operation at the right times. This is also the most economical plan, as it enables

the grower to buy his materials beforehand, when they are generally cheaper than if purchased at the last minute.

Apple Scab.—By far the most serious of the skin blemishes are those caused by the fungus disease apple scab, or black spot. This trouble is much more virulent in some seasons than in others, but it is always present to some extent, and annually causes an enormous loss to the growers of this country. Far too often the crop of varieties that are liable to scab, which include some of our best dessert kinds, contains many more than 10 per cent. of apples blemished by the disease, and in bad cases it is difficult to find an apple that is quite clean. It is therefore of the utmost importance to growers who wish to make the most of their crop by improved packing that they should be able to control scab. Unfortunately our present knowledge does not enable us to prevent it altogether, but we can control it to an extent that is quite worth while.

Mycologists seem rather to have lost faith in the value of winter spraying to prevent scab, but many growers find it distinctly valuable. In the writer's opinion spraying in early March, when the buds have just begun to move, with a simple solution of copper sulphate, 10 lb. to 100 gallons of water, is an excellent start in the year's campaign against scab, brown rot, and other fungus diseases. The chemical must be 98 per cent. pure, and should be in powder form to facilitate dissolving. Lime-sulphur at winter strength is also useful, provided that it is not applied until the outside leaves surrounding the bloom clusters are on the point of opening out. Further delay is dangerous, but slight scorching of the outside leaves apparently does no ultimate harm. If used too early lime-sulphur is of little value against scab, and in any case copper sulphate is to be preferred for the purpose. The latter scorches foliage badly, and must not be applied when the buds are at all advanced.

In some seasons this delayed winter spraying may do all that is necessary against scab, but it is never safe to rely upon it. The orthodox summer spraying is done within a fortnight after the fall of the bloom; and it ought to be repeated about a month later. Bordeaux mixture is the most effective wash to use at this time, but it is so liable to russet the fruit and to scorch the foliage of certain varieties, that it has been given up by many growers in favour of lime-sulphur used at summer strength. This is rather less effective against scab, and there is some evidence that it causes a proportion of the crop to drop before reaching maturity; but it does not russet the fruit, and is harm-

less to the foliage of all but a very few varieties if properly applied. It will be seen that we have at present no entirely satisfactory fungicide for summer use, and it is most desirable that further research should be carried out to find one.

Scab is controlled to some extent by pruning, and unless this has attention spraying is much less effective than it might be. On certain varieties, notably Cox's Orange Pippin, the winter stage of the disease may be observed in a blistered or roughened appearance of the bark of the young shoots. Such shoots should be cut off during winter pruning and burned; otherwise the fungus breaks through the bark later on and distributes spores freely. All dead wood should also be cut out. It has been found, moreover, in the pruning experiments at the East Malling Research Station, that scab is less troublesome on the fruit of trees that have their leaders tipped every winter. This benefit is not confined to varieties which show the winter stage of scab on their young shoots. It is assumed, therefore, that it is due to the fact that the tipping produces tougher, more vigorous leaves which resist the disease.

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THE LIVER ROT EPIDEMIC IN NORTH WALES, 1920-21.

C. L. WALTON, M.Sc.,
Adviser in Agricultural Zoology, University College, Bangor.

THE epidemic of Liver Rot which devastated the lowland flocks of North Wales in 1920-21 was undoubtedly the worst experienced since the noted outbreak of 1879-80, although, to judge by statements made by the older men, that attack was even more widespread. The present notes deal solely with the counties of Anglesey, Carnarvon, Denbigh and Flint. The writer had carried out work in the Aberystwyth area in connection with this disease, more particularly regarding the life history of the host snail, *Limnaea truncatula*,* which experience proved very useful in dealing with the 1920-21 outbreak.

The parasite causing the disease is the Flatworm, *Fasciola hepatica*, which inhabits the biliary duct, gall bladder and liver of sheep, cattle, rabbits, hares, etc. This worm has a complicated life history, and has as its intermediate host the small fresh-water snail, *Limnaea truncatula*, within which it

* See The Liver Rot of Sheep and Bionomics of *Limnaea truncatula* in the Aberystwyth Area. *Parasitology*, Vol. II., December, 1917, pp. 232-266.

passes its early stages; the final hosts being infected through the ingestion of infected pastures or drinking water. *L. truncatula* is abundant and widespread, especially in shallow ditches and on ill-drained pastures, and more particularly on heavy lands, but is apparently very rare, or absent, on peaty soils, and infrequent on sands (for reasons to be explained below). The outbreak apparently commenced about August, 1920, on some of the worst infected pastures, but did not become serious until about November.

The writer carried out a preliminary survey of the Agricultural Zoology of the Bangor district during the summer of 1920,* when data were obtained regarding some 300 holdings. These were almost all within a limited district, which contained relatively little of the worst affected land. It was discovered, however, that the Liver Fluke was endemic in the district examined, and caused persistent losses on a number of farms in most years: 25 such cases were recorded. In the light of subsequent experience it appears evident that a similar (or worse) state of affairs existed in most of the lowland districts of North Wales, and that on certain of the ill-drained clay soils 10 per cent. losses from this cause were not unusual; while from time to time serious (though local) losses occurred, at times involving an entire flock, or a number of neighbouring flocks. Such being the case it will be seen that the conditions favourable to an epidemic existed, which under the exceptional conditions that followed, became serious. Owing to other duties, no further field work was done in connection with Agricultural Zoology until 29th December, 1920, by which time the outbreak was widespread and the losses very severe. During the following twelve months this disease occupied a large part of the writer's attention. In all, 145 personal visits were made during the period, and a list of 260 affected farms and holdings has been made, though this is not by any means complete.

Localities affected.—The districts most severely affected were (1) the Vale of Clwyd, from Denbigh to the sea, and from Abergele to Prestatyn; (2) a narrow coastal area from Aber to near Bangor; (3) wide areas around Carnarvon; (4) about Ynys and Afonwen; (5) from Sarn Meyllteyrn to near Llanengan; (6) the vicinity of Aberdaron; (7) a wide area in south-west Anglesey extending from Llanfair P.G. to Dwyran, thence

* A Preliminary Note on the Agricultural Zoology of North Wales, *British Association*, Cardiff, 1920.

northward through Llangaffo to the Malldraeth Marsh, and up to the vicinity of Holland Arms; (8) an adjacent district extending from near Llangefni to Llangadwaladr and Bodorgan. In addition to these chief areas there were some 20 others in the four counties, mostly of smaller extent. It is interesting that in very few cases was the elevation greater than 300 ft., and the majority of the most severe losses occurred below the 100 ft. contour. Strictly speaking, the mountains escaped, the conditions there being unfavourable to a wide extension of the host snail. Owing to the custom of pasturing young sheep from the mountains to the lowlands during the period October to April, there was a concentration of sheep on the worst infected lands during that period, and many of these "tack" sheep were infected soon after arrival, so that in this way many upland farmers sustained heavy losses. For example, one sheep farmer wintered young sheep on six different lowland holdings, and four of these proved infective, causing the death of about 300. Heavy losses continued up to the end of spring, while deaths continued here and there until the late autumn of 1921. So far, up to the time of writing (January, 1922), no further fresh outbreaks have been reported, although a few chronic cases exist.

Losses due to the Outbreak.—On first taking over the work, attention was given to gaining a general idea of the extent and severity of the outbreak, and in getting the flocks away from infected pastures on to the soundest land available, and under treatment. With this end in view many farms had to be rapidly surveyed, and farmers instructed as to procedure. In some seriously infected flocks the disease was detected and the sheep marketed sufficiently early to minimise the losses. In many others the infected sheep were not sold until they had become badly affected, and in such cases realised very low prices, ewes purchased but a few weeks or months previously at from £4 10s. to £7 10s., selling at from 30s. down to 2s. 6d. each. Other flocks were allowed to die; or died with a rapidity totally unexpected by men who were accustomed to the comparatively slow wasting associated with the usual "chronic" form of the disease. Indeed, these very rapid deaths while the animals were still fat, were a marked feature of the epidemic, and led to several prevalent ideas which had to be combated. The first was that the disease was not Liver Rot at all, since death was rapid and the accustomed symptoms did not always appear. This was due to the fact that in many cases the sheep

died while the flukes, although actually present in great numbers, were frequently so small as to pass unnoticed even when the livers were examined. Again it was often contended that the disease was not endemic on the farm on which animals died, but had been imported from some other district, the sheep having been infected prior to purchase. This idea also proved to be erroneous in the majority of cases, and it was generally possible to demonstrate this to the farmers concerned by taking all the facts connected with the flock, and surveying the land. By these methods the actual place where infection had taken place could often be demonstrated. On a number of farms cattle were also affected, and in one instance over 30 died. Three flukes were obtained from the liver of a pig—the only instance reported.

As to the actual loss, it was found impossible to get even an accurate estimate, the data being incomplete, and many cases were very complicated. Very heavy individual losses were frequent, and reckoning only the price of those which died on the farm, and the difference between buying and selling price, these individual losses ranged from £50 to £1,500; £400 to £800 being frequent figures. In addition, there is the loss of the expected lamb and wool crops, etc. Many methods were recommended and tried during the year to endeavour to maintain remains of flocks free from further infection, and to prevent the infection of fresh flocks purchased during the autumn of 1921. Many farmers had to give up sheep keeping (at any rate for a time). Others, after survey of their land, were able to keep reduced flocks on their drier fields. Others fenced out or ploughed infected fields or parts of fields. Considerable drainage was undertaken, there being no doubt whatever that certain cases were aggravated by neglect of ditches, etc., especially during the war period. The majority now recognise the dangers, and that is the great step to prevention, although there is always a small residue who cannot be reached by visit, leaflet, lecture or press. It is gratifying to be able to record that taken as a whole, the agricultural community have shown interest in the scientific side of the work, and have been most helpful as regards data, experiments and in many other ways.

Causes Leading up to the Outbreak.—In a previous paper* the close connection between soil characters, meteorology, and the relative distribution and abundance of *L. truncatula*, the

* *Parasitoloyy*, op. cit.

host snail, has been discussed: the epidemic of 1920-21 has illustrated some of these points in a most interesting manner. The snail, as already mentioned, has normally a distribution coincident with shallow ditches and pools, more particularly on clays and silts. From these centres, distribution takes place on to ill-drained adjacent land, and, in fact, anywhere where suitable conditions can be found, and it is surprising how soon such movements take place, the animals appearing to move almost automatically against any slight flow of water and so penetrating steadily during suitable weather from the centres to considerable distances in a few weeks.

Such extensions of range undoubtedly occur each winter, and indeed throughout the year should wet weather prevail. The natural check to this distribution is drought, and normally, during the average spring and summer such periods occur, killing off those snails which have reached the least suitable (most readily dried) situations; such process being progressive as long as the dry weather lasts. Although the amount of annual rainfall is of great importance here, nevertheless, its distribution throughout the months is of hardly less importance. In West Wales all winters may be regarded as wet from this biological standpoint. It is those years in which rainfall is general and persistent throughout the spring and summer that lead up to marked extensions of range of *L. truncatula*, and to its further increase by uninterrupted breeding on the ground gained. Given the infection of such snails by means of the normally present chronic or mild cases of Fluke infection usually present among the flocks, we have the conditions which precede and cause an epidemic of "Rot." The following diagram shows the rainfall in months for North Wales during the period 1920-21, illustrating the points mentioned. It will be seen that we have a period comprising the autumn and winter of 1919-20, the wet and sunless summer of 1920, and the winter of 1920-21; a period of eighteen months during which distribution and infection could proceed simultaneously. The snails became remarkably abundant, particularly on some of the low-lying heavy land, some limited areas yielding up to 130 to the square foot, as on the Malldraeth Marsh in Anglesey. In some instances several hundred acres became heavily stocked, in others only certain limited spots were invaded.

Effects of the Drought of 1921.—The long wet period described above was succeeded by the remarkable drought of 1921. This drought afforded an opportunity for studying the effects on

L. truncatula. Colonies of the snail inhabiting land of different types were watched. For instance, in Anglesey, strong and widespread colonies on limestone, sandy, and heavy marshy soils were under observation; while in the other counties colonies on various grades of soil were similarly studied. As had been previously noted* the resistance of the snail to drought is en-

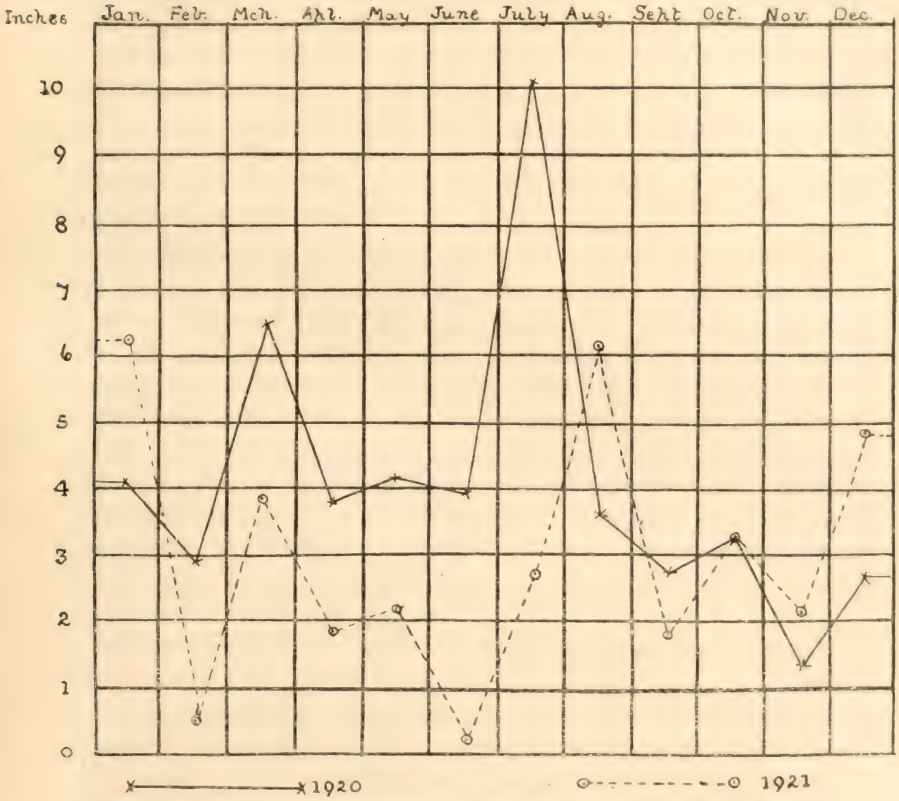

FIG. 1.—Monthly Rainfall for 1920 and 1921 at Penrhyn Gardens, Bangor.

tirely dependent upon the environment. In many instances the snails were present in numbers on grass land that was wet, but not actually under water, and such spots dried out rapidly. In such situations survival depended upon three factors (*a*) the amount and type of vegetative covering present, (*b*) soil characters, (*c*) whether the soil was level, or had cracked or been trodden ("poached") much by stock. If the land was bare and level, death speedily took place, but as the protection afforded was increased by long and dense vegetation or by shade

* *Parasitology*, op. cit., pp. 251-2 and p. 257.

of any kind, survival was prolonged. In quite a number of cases such protection enabled up to 30 per cent. of the snail population to survive right through the drought, rendering such land unfit for stock almost as soon as moisture returned.

The most favourable conditions for survival prevailed on old grass land on heavy soils which had been trodden into deep holes by horses and cattle during the winter and spring, and which dried into a series of miniature ridges, alternating with holes which were frequently from 4 to 6 in. in depth, and retained the form of the hoof, thus forming more or less overhanging and cavernlike pits. In these pits water remained for a long time, while sufficient moisture was retained in many instances to sustain life throughout the drought. A heavy growth of coarse grasses, rushes, etc., further hindered drying by affording shade from sunlight, protection from winds, and retention of dew. Shaded and grass-grown ditches, especially if on the north side of a bank, and land to the north side and under the shade of woodlands, also afforded sufficient shelter for survival in several instances. During previous work it was found that the egg masses of *L. truncatula* dried to a hard scale, but on being replaced in water, speedily resumed their original form. It was further noted that even after prolonged drought large numbers of young snails re-appeared after the return of moisture (even in ditches, etc., that had remained dry for as long as 3 months, and where all snails had died). A number of laboratory and field experiments were undertaken at the time, but owing to mischance, etc., did not produce conclusive proof of hatching of ova after drying, and since then time has not yet allowed of their repetition. Nevertheless, soon after the return of moisture numbers of minute snails appeared in many places during the autumn of 1921, so that should wet conditions again prevail during the spring and summer of 1922, there will be a further increase in the amount of land affected. It is hoped to carry out further investigations in this connection.

Field Experiments against *L. truncatula*.—Owing to lack of time, no experiments were undertaken until June, 1921, by which time the land had become very dry and vegetation dense. Nevertheless, a series of spraying trials was commenced on 1st June on heavy grass land, very rough and much "poached," situated on the Malldraeth Marsh in Anglesey. Snails were abundant and living. Plots of 1/10th and 1/20th acre were sprayed with copper sulphate in 1/1000, 1 per cent. and 2 per

cent. solutions, using Holder Pneumatic and "Mysto" Knapsack sprayers. It was found that from 100 to 120 gallons per acre was required to wet the surface, and the spraying had to be most carefully done owing to the adverse conditions. The solution 1/1000 did not give satisfactory results, and several plots failed to give conclusive evidence, since, although snails were abundant enough when sprayed, but few could be recovered a few days later. This was attributed to the activities of a number of Lapwings which frequented the plots between the time of spraying and the subsequent counting of the snails. However, one plot in another field sprayed with 1 per cent. solution yielded 112 snails, all dead, on 6th June (100 per cent. killed), while of 62 snails collected alongside the plot, on unsprayed ground, 52 were living.

In the following week several long and deep ditches near Conway heavily populated with both *L. truncatula* and *L. peregra* (an allied, but larger species) were cleared of rank vegetation, and sprayed with 1 per cent. solution of copper sulphate on 6th June. The ditches contained no water, but were still damp, and the snails living. On 14th June ditch (a) (160 yd. × 1 yd.) gave 72 per cent. dead snails, and ditch (b) (84 yd. × 1 yd.) 100 per cent. dead. Subsequently, the cost of this type of spray was worked out for 5 acres so treated in Anglesey by a farmer. A horse-drawn 40 gallon barrel sprayer was used, 100 gallons of 1 per cent. solution being applied, and the cost was 6s. per acre.

Subsequently, in October and November, a series of trials was made, using powders, which were distributed by means of hand bellows, and a Knapsack dry sprayer. This method proved very successful for narrow ditches and small wet patches, but did not give good results when tried on larger plots on the open field. The expense also was considerably higher than in the case of the copper sulphate solutions, the lowest cost working out at 16s. per acre. Nevertheless, this appears to be an excellent way of treating narrow ditches and small wet areas, being easy to carry out. The hand bellows gave the best results. The following are some of the typical results:—(1) Copper sulphate in powder form was first tried mixed with fine slaked lime as a dilutant and spreader. Lime was soon abandoned owing to a reaction with the copper sulphate, and being too light to ensure even spreading of the heavier copper sulphate; (2) one part copper sulphate mixed with two parts flour gave even distribution and excellent results, but flour was

too expensive for use on a large scale; (3) one part copper sulphate and two parts kaolin was finally used and was successful in every way, costing 16s. per acre. By means of (2) and (3) several ditches containing thousands of snails were completely and rapidly cleared, the death rate working out at 98 per cent. to 100 per cent. Subsequent trials with two parts iron sulphate and one part kaolin failed (as did also a trial with a heavy dressing of undiluted iron sulphate, applied by an Anglesey farmer).

As matters now stand, further extensive field trials on a commercial scale are needed to test the above results. For wet land the writer would favour a 2 per cent. solution of copper sulphate, while for narrow wet ditches dusting seems advisable, as the mixture is readily made and the apparatus cheap and easy to use.

Mr. W. H. Savage, M.R.C.V.S., carried out experiments with sheep on the College Farm with both Male fern and antimony tartrate, with very considerable success.

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THE MINISTRY'S TRIALS OF VARIETIES OF POTATOES, 1921.

THE importance of the potato crop in the scheme of farming operations is demonstrated by the fact that in 1921 nearly 558,000 acres were planted in England and Wales, from which the yield was estimated to be nearly three million tons. The cost of production, for various reasons, is high, and in order that growers may be in a position to obtain the best return for their outlay the Ministry, with the co-operation of County Education Committees, has instituted a series of annual trials at numerous centres throughout the country with the object of providing information as to the most profitable varieties.

A report on the trials carried out in 1920 appeared in the issue of the *Journal* for June last, and the results of those conducted in 1921 are given in this article.

Effect of Dry Weather.—The dry summer of 1921 to some extent impaired the value of the trials. On some porous soils the ripening process was so rapid that the haulm died away prematurely leaving a very small crop of undersized tubers in the soil. In other cases where the haulm was able to obtain even a meagre supply of moisture, it remained green although very little actual growth took place either at the roots or above ground. With the advent of heavier rainfall, "second growth" and "growing out" set in. The latter occurred mainly in the South, South-Eastern and South-Western Counties and may briefly be described as the result of the first crop of undersized tubers producing tendrils from which a second crop was obtained later in the summer. This latter crop was in many cases considerably heavier than the original. In the Midlands, North and extreme West, where rain came earlier and in greater abundance, the original tubers became enlarged producing what is usually termed "second growth."

Where the crop ripened prematurely it was abnormally light, but where ripening was deferred and both crops were harvested together, almost average weights per acre were obtained. The proportion of seed to ware was, however, everywhere very high. In some crops few ware-sized tubers were found.

Another characteristic of the 1921 crop was the tendency of all varieties of oval or kidney shape to produce an abnormal percentage of round tubers.

Scheme for Trials with First Early Varieties.—The growing of very early varieties for lifting "green" is becoming an important industry in many districts, and the Early trials were accordingly designed with the object of proving whether any of the first early immune varieties possessed sufficient merit to be suitable for cultivation for this purpose. Only those counties in which an early potato-growing industry exists were asked to undertake the Early trials.

The main object of the trials was to provide information regarding the comparative marketable value of the varieties lifted in the green state, and it was not intended to demonstrate the comparative earliness of the different varieties at maturity. The varieties immune to Wart Disease chosen for experiment were Ashleaf (Broadleaf), Dargill Early, Resistant Snowdrop (or Witch Hill), and Arran Rose. These were compared with the non-immune varieties Ninetyfold and Epicure.

Supply of Seed.—In order to obtain results fairly comparable, it was decided to obtain all the seed from the same source and arrangements were accordingly made with a seed merchant in Scotland for the supply of seed potatoes of the selected varieties.

Sprouting Seed.—County Committees were asked to arrange for 28 lb. of each variety to be specially boxed and sprouted under approved methods and conditions, and for 28 lb. to be bagged and placed in the dark, in a cool store or clamp until the time of planting.

Soil and Cultivation.—It was suggested that where possible the soil selected should be a deeply-worked light to medium loam, in good condition and with an aspect having a full exposure to the sun.

Manures.—It was suggested that the soil should receive a dressing of farmyard manure in the drills at the rate of 15 tons per acre (about 2 cwt. per rod). This was to be supplemented on dates to be recorded by a dressing of artificial manures mixed in the following proportions per acre, and if possible, applied broadcast immediately before the seed was placed in the drills :—2 cwt. sulphate of ammonia, 3 cwt. superphosphate (30 per cent. sol.), 1 cwt. steamed bone flour, and 1 cwt. sulphate of potash.

The combined mixed dressing worked out at the rate of 5 lb. per rod.

Planting.—The potatoes were to be planted on the usual dates ruling in each particular district in drills 24 in. apart, and sets 12 in. apart. The area for each variety was four rods (32 ft. by 34 ft.), which admitted of sixteen rows.

TABLE I.—*Average Rate of Yield per acre of Early Varieties on light, medium, and heavy soils in England and Wales.*

Variety.	On Light Soils.				On Medium Soils.				On Heavy Soils.			
	In England.		In Wales.		In England.		In Wales.		In England.		In Wales.	
	tons	cwt.	tons	cwt.	tons	cwt.	tons	cwt.	tons	cwt.	tons	cwt.
Arran Rose	5	2	6	6	4	0	6	4	3	2	8	14
Ashleaf (Broadleaf)	5	9	6	9	5	1	7	16	2	16	—	
Dargill Early	5	3	5	1	4	5	6	3	3	11	7	19
Snowdrop	6	4	6	9	4	1	6	2	3	8	7	6
Epicure	5	16	8	2	5	8	7	13	4	6	—	
Ninetyfold	4	0	—		4	9	—		2	19	—	

TABLE IV.—*Average Rate of Yield per acre of Second Early and Late varieties for all Centres in England and Wales.*

	Second Earlies.										Late Varieties.							
	Ally.		Arran Comrade.		Early Market.		Great Scot.		King George.		Kerr's Pink.		Lochar.		Majestic.		Tinwald Perfection.	
	tons	cwt.	tons	cwt.	tons	cwt.	tons	cwt.	tons	cwt.	tons	cwt.	tons	cwt.	tons	cwt.	tons	cwt.
Average Yield per acre in England. 228 Centres	8	7	8	11	8	12	9	19	10	2	10	7	10	3	8	15	8	0
Average Yield per acre in Wales. 95 Centres ...	10	1	10	6	11	3	12	5	11	14	14	19	13	11	11	10	10	13
Average Yield per acre in England and Wales. 323 Centres	8	15	9	0	9	1	10	10	10	10	11	9	10	19	9	6	8	12

Lifting.—Committees were asked to arrange for the potatoes to be lifted as soon as they were ready for market, and to record the results of the crop in terms of money value as well as in weight and to make careful note of the date when each variety was lifted and marketed.

Results of Trials with First Earlies.—These Early trials were carried out in ten English and six Welsh counties and the average yield of each variety from light, medium, and heavy soils is shown in Table I. It will be seen that in the English counties "Epicure" still retained its reputation as the best early variety for a heavy soil although it was surpassed as a cropper on light soils by "Snowdrop." The yields in the Welsh counties showed a heavier average, and this was presumably due to the heavier rainfall experienced during the growing season. "Arran Rose" gave the heaviest yield on any class of soil, viz., 8 tons 14 cwt. per acre on heavy soils in Wales, but it should be added that "Epicure" was not tested under these conditions.

When the average rates of yield at all centres are examined, it will be found that "Epicure" again heads the list as a cropper. This is entirely due, however, to the behaviour of this variety in the Welsh counties. "Snowdrop" was the heaviest cropper in the English counties and a close second in the average for all centres. It would appear therefore that the latter variety is able to withstand drought.

TABLE II.—*Average Rate of Yield per acre of each First Early variety at all the Centres.*

	Immune,								Susceptible.			
	Arran Rose.		Ashleaf (Broadleaf)		Dargill Early.		Snowdrop.		Epicure.		Ninety-fold.	
	tons	cwt.	tons	cwt.	tons	cwt.	tons	cwt.	tons	cwt.	tons	cwt.
Average yield in England, 53 Centres	4	14	5	6	4	11	5	17	5	14	4	7
Average yield in Wales, 38 Centres	6	5	6	3	5	13	6	3	7	7	—	
Average yield in England and Wales, 91 Centres	5	4	5	12	5	0	6	0	6	4	—	

The information afforded by the trials as to the earliness of the different varieties is far from conclusive, as it appears that

most of the crops were left in the ground until they had fully matured instead of being lifted as was originally contemplated. The earliest lifting took place in East Sussex, where "Arran Rose" from sprouted seed was harvested on the 8th June and realised 21s. per cwt., as compared with 18s. per cwt. for the produce of unsprouted seed of the same variety lifted three weeks later. The difference in the period of lifting of the sprouted and unsprouted seed of the other varieties varied from 12 to 22 days in favour of the sprouted seed.

The information supplied regarding market prices was, however, interesting as showing that the date of lifting had not such a marked effect on early potatoes in 1921, as would probably be the case in normal seasons. There was a decided stiffening in prices after the very early districts of the country had been cleared and it seemed probable that there would be a serious shortage of potatoes, as second earlies were late in maturing and growers were anxious to leave them in the ground as long as possible. The effect on the prices realised by first earlies is illustrated in the returns obtained in Devonshire where crops lifted late made more money than those marketed from Kent three weeks earlier. For instance "Epicure" lifted in Devon on the 30th July made 16s. 3d. per cwt. while the same variety lifted in Kent on the 6th July made only 9s. per cwt.

Sprouted and Unsprouted Seed.—Experiments with sprouted and unsprouted sets were carried out at twelve centres. Although in two cases the unsprouted sets produced slightly better crops than the sprouted, the general weight of evidence is decidedly in favour of using sprouted sets. The average yield of the sprouted sets for the twelve centres exceeded the average yield from the unsprouted sets by 1 ton 16 cwt. per acre. Not only did the former materially increase the crop (*see* Table III), but the maturity of the crop was hastened. Thus there is a dual advantage in favour of sprouting.

TABLE III.—*Statement showing the average Rate of Yield per acre obtained with "Sprouted" and "Unsprouted" sets at 12 centres in Kent and East Sussex.*

Variety.	Sprouted. tons.	Sprouted. cwt.	Unsprouted. tons.	Unsprouted. cwt.
Kent—				
Epicure	3	9	2	17
Ninetyfold	2	6	2	1
Dargill Early	3	1	1	1
Arran Rose	2	11	3	3
Ashleaf	3	4	2	14
Snowdrop	4	1	4	3

Variety.	Sprouted. tons.	cwt.	Unsprouted. tons.	cwt.
East Sussex—				
Arran Rose	4	2	2	8
"	8	19	7	0
Ashleaf	5	4	3	3
"	10	17	8	19
Dargill Early	3	7	1	8
"	9	15	5	19
Snowdrop	4	7	2	7
"	11	1	6	18
Epicure	4	9	2	3
"	10	9	7	10
Ninetyfold	3	16	2	6
"	9	15	6	2
Average rate of yield per acre at each centre	5	16	4	0

The results obtained confirm the results of previous experiments, but there is still the greatest need to emphasise these facts and to impress them on the notice of all growers, both commercial and domestic.

Trials with Second Early and Late Varieties.—The main objects of these trials were to demonstrate :—

1. The comparative value of the immune varieties for each district.

2. Approved methods of potato culture.

The second early and main crop varieties chosen for demonstration were :—Ally, Arran Comrade, Early Market, Great Scot, King George, Kerr's Pink, Lochar, Majestic, and Tinwald Perfection.

Supply of Seed.—In order that the results obtained in the different counties should be capable of comparison it was decided to obtain all the seed used in these demonstrations from the same source. The Ministry accordingly made arrangements with a Scottish seed merchant to reserve a quantity of seed potatoes of the trial varieties, for planting on the demonstration plots.

Quantity of Seed.—Committees were asked to arrange for 28 lb. of each variety to be planted on land which had been prepared according to the instructions given below.

Manures.—The land was to receive a dressing of farmyard manure at the rate of 15-20 tons per acre, applied in the drills at the time of planting. Artificial manures were also to be applied, on dates to be recorded, in quantities somewhat as follows per acre :—Superphosphate (26 per cent. sol.) 4½ cwt., sulphate of ammonia 1 cwt., sulphate of potash 1 cwt.

It was not expected that the above system of manuring would be adopted in every county without variation, and Committees were asked to modify the above suggestions in accordance with local customs and conditions.

Planting.—The time of planting was the usual time for this operation in each district. A distance of 30 in. between the drills, and 12 in. between the sets, was maintained throughout all the trials.

Results of Trials.—In the case of second early and late varieties 323 centres were established. The results showed that the effects of the drought were most severely felt in the Southern, Eastern and South-Eastern Counties. Conditions improved in the Midlands and West, while in the Northern Counties (York, Cumberland, Westmorland, Northumberland, and Durham) heavy crops of all the varieties were obtained.

An examination of the results obtained at all the centres shows that the average yields were not so inferior to those of 1920 as might have been expected. For varieties with which comparison is possible the yield was only one or two tons per acre lower than that of 1920.

In the English counties the heaviest crop was produced in Yorkshire by "Great Scot" where the yield was at the rate of 19 tons 9 cwt. per acre. In Wales first place was taken by "Kerr's Pink" with a yield at the rate of 21 tons 5 cwt. per acre in Flint. It will be seen from Table IV, p. 165, that the heaviest yields in every case were obtained in the Welsh counties, the average difference as compared with the English counties amounting in the case of "Kerr's Pink" to over 4 tons per acre and in the case of "Lochar" to over 3 tons per acre; in no case was the difference less than 1½ tons per acre. This difference was probably due to a more plentiful supply of moisture in the Welsh counties during the summer and autumn months.

It will be seen that "Great Scot" and "King George" maintained their reputation as the heaviest cropping second earlies. "Ally," which gave the lowest yield, appears to have been severely affected by the lack of moisture.

Amongst the late and main crop varieties "Kerr's Pink" and "Lochar," except at one centre in Hampshire, cropped most consistently in all parts of the country. "Majestic" came third amongst the late varieties at both the English and Welsh centres. The lightest cropping late variety in both England and Wales was "Tinwald Perfection."

TABLE V.—*Average Yields of Second Early and late Varieties on light, medium, and heavy soils in England and Wales.*

	Yield per acre on Light Soils.		Yield per acre on Medium Soils.		Yield per acre on Heavy Soils.	
	tons	cwt.	tons	cwt.	tons	cwt.
Kerr's Pink	11	11	11	10	11	15
Lochar	10	14	10	18	11	16
Great Scot	10	4	10	11	10	16
King George...	9	15	10	12	10	9
Majestic	9	6	9	11	9	6
Ally	8	13	8	19	9	16
Early Market	8	10	9	0	9	15
Arran Comrade	8	7	9	8	9	9
Tinwald Perfection... ...	8	6	8	2	8	18
Average yield of all varieties	9	10	9	17	10	14

If the above results are compared with those obtained in 1920, it at once becomes apparent that climatic conditions affect to some extent the relative productivity of the different soils. In 1920 the average rates of yield of all varieties were distinctly in favour of light soils; the figures being as follows :—

Average yield of all varieties on light soils :—10 tons 2 cwt. per acre.

Average yield of all varieties on medium soils :—9 tons 17 cwt. per acre.

Average yield of all varieties on heavy soils :—8 tons 10 cwt. per acre.

In 1921, however, the balance was cast in favour of medium and heavy soils, especially the latter. This is probably accounted for by the fact that the heavier soils retain natural moisture to a greater extent and for a longer period than the lighter soils. The latter would quickly dry out, save in special cases where the water table was high. Any rain which did fall would be retained longer by the heavy soils than the light; this appears to have been the case in Wales where the yields on the heavy soils were higher than in the English counties.

It is very unsafe on the results of the past season to make any definite suggestion regarding the varieties particularly suitable for heavy soils, though it would appear that "Lochar" may be regarded as coming within that category.

* * * * * *

A SUCCESSFUL EGG AND POULTRY CO-OPERATIVE SOCIETY.

E. G. WARREN,
Manager-Secretary.

THE Framlingham and Eastern Counties Co-operative Egg and Poultry Society, Ltd., is an offshoot of the very old-established Framlingham Farmers' Club, which has done good service in the past for agriculture.

Co-operation was first introduced to its members by Sir Horace Plunkett, supplemented later by Mr. C. C. Smith (Chairman of the Eastern Counties Farmers' Association, Ltd.), but it was left to the Agricultural Organisation Society to establish the first co-operative society in Suffolk in 1903.

The success of the Society is clearly shown by the following figures :—

	No. of Members.	*Shares.*	*Sales.*	*Collection of Eggs.*	*Share Capital.*
1903	114	1,600	£5,050	453,079	£400
1921	5,091	53,031	£282,353	24,146,059	£13,257

The Society has acquired valuable properties at some of the larger depôts, notably Ipswich, Framlingham and Wisbech, which originally cost (with improvements) £13,078, of which a proportion has been written off each year as depreciation. In accordance with the rules a reserve fund of £4,043 has been built up and the Committee receive loans at the same rate of interest as is paid on the share capital, the amount on December 31st, 1921, being £1,127. The value of a share is 5s. (fully paid up) to admit of cottagers joining, since it is recognised that, proportionately, more eggs are collected from cottage homes in the winter months than from farms, on account of the warmer housing of the hens.

The Society is registered under the Industrial and Friendly Societies Act, which affords the cheapest and simplest means of obtaining corporate existence. An individual can hold £200 worth or 800 shares, but needless to say there are many holding from one to four shares only. The Society has had no particular difficulty in obtaining share capital, interest on which is paid up to 6 per cent.

There are 50 or 60 depôts or agencies established by the Society which collect from the villages by horse or motor vehicles. These depôts are controlled by salaried or commission agents. Each agency collects, tests and despatches its own eggs in accordance with orders received from the Central Office,

Ipswich. Agents are instructed to return all bad eggs, to be replaced by good ones at the next collection. Great care is taken in appointing an agent to see that his premises are near a railway station, to prevent waste of time, petrol or horseflesh in carting eggs to the station after collecting and testing.

Each depôt has a set of books for recording in duplicate the collection and despatch of eggs, and sheets are detached and sent to the central office daily. Each agent is provided with a standing balance for the purchase of eggs, and on the purchasing daily sheet reaching the central office, the amount spent is forwarded to keep the standing balance normal.

The day book of each depôt is so ruled that the number of eggs collected and despatched on any one day can be seen at a glance, which enables the allocator of eggs at the central office to telephone, wire or write any extra order received, according to the quantity in hand.

For the first few years the Society supplied all agricultural requirements to its members, but in 1916 the Eastern Counties Farmers' Co-operative Association, Ltd., took over the Goods Department in exchange for their Egg Department, thus leaving the Society free to specialise in eggs, with the whole of the Eastern Counties as its field.

The Society had an uphill fight at first to secure reliable eggs, since producers were evidently unconcerned if an egg were fresh or not, and would not wash a dirty or stained egg, but sent as "new laid" all eggs they came across, without troubling to keep back those that had been partly incubated. The members soon found, however, that effective combination for productive or commercial purposes was not to be accomplished simply by recognition of the fact that it is necessary to combine. Certain regulations must be carried out, and it was thought advisable to adopt rules which would in time make the Society thoroughly reliable for the despatching of new laid eggs.

The Committee enforced the Rules by fining for "dirty eggs" and making a deduction for "cookers." It is interesting to give one member's analysis at first joining, and the analysis a month later.

	Eggs.	*Good.*	*Cookers.*	*Smalls.*	*Bad.*
First Collection ...	109	4	90	7	8
Later ,, ...	160	150	3	7	—

It is regrettable to confess that the War completely upset this system for organising a supply of reliable eggs, because, the continental supply being cut off, the multiple shops invaded

the Society's collecting areas and purchased good, bad or indifferent eggs at a slightly higher price in order to secure them, thus affecting the good work the Society had done in levelling up the quality of eggs. At the commencement of operations each member was provided with a small rubber stamp, with which to number the eggs, but it was found that clients confused them with foreign eggs, and refused them, thus defeating their own object of getting best English eggs.

The Committee worked out several examples with the idea of purchasing eggs by weight, but taking the 2-oz. standard it was found that, as a whole, the cost would be about 5 per cent. more than if bought in the ordinary local way, and there were still the "smalls" to cope with.

Each year the Society has shown a creditable trade profit, and during the last ten years has distributed in bonuses no less a sum than £19,973 4s. 3d. Members therefore have confidence in the Society, and in many instances the bonus and interest are returned for investment in further shares.

Since 1910 the Society has persevered in the preservation of eggs, and specially constructed tanks similar to those in Denmark have been built at the Ipswich depôt. Each measures 8 ft. × 7 ft. × 7 ft. 6 in., and each will accommodate 120,000 eggs. Altogether with smaller tanks at Framlingham, Stradbroke and Wisbech, about two million eggs can be preserved.

In order to prevent the selling of preserved eggs as new laid, a solution has been prepared which when applied to the shell of a preserved egg will cause it to "blush," but the solution will not affect a new laid egg. In the winter of each year, all agents are supplied with this solution, and lime or water glass eggs can easily be detected.

The Committee constantly urge members to improve their stock, by the introduction of pure bred cockerels of laying strains, either from some well-known breeder, or from members who keep reliable breeds. They also advise members to give the hens clean nests, to gather the eggs at least once daily, to keep the eggs in a cool place, and to kill or sell all male birds as early as possible save those required for stock purposes.

During 1921 an increased trade in poultry, rabbits, butter, etc., is shown, which is due to the provision of at least 300 fattening coops at Ipswich. A record handling for Xmas week alone of some 3,060 turkeys, 1,293 fowls, 329 ducks and 101 geese is noteworthy.

The Committee purchase live fowls (roasting chickens and

hens) at all times at given weekly prices per pound, weighed at Ipswich. They also purchase wild rabbits and hares during the season, and are buyers of butter, honey or other dairy produce.

One great drawback to the Society's working is the heavy charges for rail carriage, which increased 50 per cent. during 1921. To obviate this the Committee are negotiating for central premises in London where eggs can be sent in bulk by goods train, or otherwise, and by which it is estimated a considerable saving can be effected.

The eggs, poultry, and other produce are paid for at market rates and the profits realised by the Society are subsequently divided as a "bonus" to members in proportion to their deliveries.

The following application of profits for 1921 is of interest :—

	£	s.	d.
Interest on Share Capital, 6 per cent.	742	4	5
Bonus to Employees (as per Rules)	355	0	0
Bonus to Members on Eggs, Poultry, etc., sold to the Society	3,608	4	0
Reserve Fund as per Rules	429	0	0
Balance carried forward	376	0	6½
	£5,510	8	11½

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CHOCOLATE SPOT DISEASE OR STREAK DISEASE OF BROAD BEANS.

SYDNEY G. PAINE and MARGARET S. LACEY,
Department of Plant Physiology and Pathology, Imperial College, London.

THIS disease occurred as a serious epidemic in the summer of 1920. It was recognised first by an extensive marking of the leaves with chocolate-coloured spots, and was in many places confounded with "Rust" (*Uromyces fabae*). Simultaneously with the occurrence of the spots on the leaves there appeared upon the stems long and short streak-like markings of a rich bronze-brown colour, which recalled very forcibly the markings on the stems of tomato plants suffering from the "Stripe" disease. Investigation has shown that the bean disease is caused by the same organism as that producing "Stripe" in tomatoes. Now this organism was first described by Manns and Taubenhaus as the cause of "Streak" disease in sweet-peas, and was subsequently shown by them to produce streak disease of many leguminous plants. It therefore seems advisable to use the term "Streak" for this disease of beans, although perhaps "Chocolate Spot" would more adequately describe the most obvious symptom.

Occurrence of the Disease.—It is probable that field beans are never, or seldom, quite free from this disease, but it is only under exceptional weather conditions that it assumes the form of an epidemic, or does any considerable amount of damage. Such exceptional conditions prevailed in the spring and early summer of 1920. Hot, wet and thundery weather seems to have been general just previous to the appearance of the first symptoms of disease. The trouble was first reported from Hampshire in the latter part of April and South Wales in May, and rapidly spread from various centres. It was observed by the authors in Devon during June, in Sussex in July, and was reported to them successively from Buckinghamshire, Cambridgeshire and Lincolnshire. It was undoubtedly very general throughout a large part of England and Wales.

Description of the Disease.—In a typical case, beans planted in October, 1919, first showed signs of disease on 25th May, 1920, small purplish-brown spots on the leaves and streak lesions on the stems being observed on plants about five feet high. When next observed, 8th June, the plants were largely

defoliated, the remaining leaves showing a good deal of blackening. On 10th July the canes in the central portion of the field were beaten down by rain, all the leaves had fallen except a bunch at the top of each stalk, and the whole plants were being rapidly rotted by *Botrytis*, which in all cases observed followed rapidly after the "Streak" disease. In many instances the plants in the outer parts of the field were observed to be less severely attacked than those in the centre, the conditions in the outer more exposed portions being naturally drier than at the centre and hence less favourable to the spread of the disease.

Cause of the Disease.—As stated above, the organism causing this disease is the same bacillus which causes "Streak" in sweet-peas and "Stripe" in tomatoes—a small yellow bacillus named by Manns and Taubenhaus *Bacillus lathyri*. The entry of the organism into the plant may be through the stomata of the leaf; the apparent spread of the disease eastwards during 1920 would seem to suggest wind dispersal of the causative organism and entry into the leaf in this way. At the same time there is evidence that the organism is carried on the seed of winter beans, and especially on those which have been bored by the bean beetle *Bruchus rufimanus*. In its attack upon the young pod this beetle may inoculate the plant at the time of laying its eggs, and the young larvæ which develop in the pod may infect the seed when they bore their way in. Foreign *Bruchids*, e.g., *Bruchus obtectus*, can continue to breed in stored beans, and this species is not infrequently introduced on Canadian Wonder bean seed, though at present there are no records of this beetle having been found amongst field beans.

Control.—It should be remembered that the extent of the disease seems to be markedly influenced by weather conditions. The year 1920, when the disease was specially prevalent, was followed by the exceptionally dry season of 1921, in which the disease made its appearance in the early spring, but the plants soon recovered from the attack and a month later showed no sign of disease.

Where disease has occurred to a serious extent it would be well, before another crop of beans is sown, to dress the land well with potash, since it has been shown that this treatment has successfully checked the ravages of the bacillus upon tomato plants.

Further, it would be well to examine the seed carefully and to reject any showing an excessive amount of boring by beetles, and to sterilise the seed by soaking for 10 minutes in weak lysol

Portion of Broad Bean Haulm, showing Spots on the Leaves and Streak-like Markings on the Stem.

or formalin, or by dressing the seed with one of the tarry preparations supplied for the purpose.

In conclusion, the authors wish to express their thanks to Mr. W. P. Wiltshire, of the Long Ashton Experiment Station, for his reports of the disease as it occurred in South Wales, and to Mr. J. C. F. Fryer for notes upon the bean weevils.

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MARROW-STEMMED KALE FOR POULTRY.

LUCY A. HUTCHINSON, B.A. Hons. (Equivalent, Cambs.).

RECENT high prices have given a considerable impetus to intensive poultry-keeping and to "back-yard" poultry-keeping. One of the chief difficulties poultry-keepers of these classes have to face is that of providing green food for their stock. Where the so-called "yard" is of the nature of a garden, or where, in the case of larger poultry-keepers working intensively, a portion of the land can be devoted to the growing of greens, the cultivation of marrow-stemmed kale will be found to yield excellent results. The seed should be sown in late April or early May, according to the season. It may be sown in a seed bed, and the young seedlings planted out in rows 2 ft. apart and 1½ or 2 ft. apart in the row—or, as a labour-saving method, a few seeds may be dibbled into holes at the required distances, the plants afterwards being thinned out to two or three in each group. The writer's experience has been that the finest individual plants are obtained by the former method, but the greatest bulk of food by the latter. In the latter case, the thinnings supply some food from the outset. In both cases, during growth green leaves from the top of the stem can be gathered frequently, care being taken not to take sufficient to injure the growth of the plant. In this way a considerable amount of food is obtained throughout the

summer, but the real value of these greens is found when the first frosts have come, and succulent vegetables are scarcer. Any leaves left on the plants will succumb to the frost but the "marrow" contained in the stem, from the presence of which the plant obtains its name, will be protected by the outer covering which will by this time have become fibrous as in herbaceous plants. These stems should now be pulled up, and split in halves lengthwise, and thrown into the house or run. It will be found that the fowls readily eat the pith or marrow, leaving only the woody fibre of the outer coat of the stem, and in doing this they also obtain a good deal of exercise.

In order to ascertain exactly how much food was contained in the stems, some of them were weighed before being put in the runs and the woody remains afterwards gathered up and weighed. The following results were obtained:—

1. The finest individual stem was 34 in. in length, and had a circumference of 7½ in. Its weight was 2 lb. 14 oz., and the weight of the outermost coat after the fowls had eaten the "marrow" was 13 oz. Thus the amount of food from the one stem was 2 lb. 1 oz. This plant had been grown in the seed bed and transplanted.

2. Seven of the transplanted individuals, not selected, but taken in order from the plot, weighed 15 lb. 8 oz. The greatest length of a single stem was 36 in., and the greatest girth 7 in. The waste amounted to 4 lb. 3 oz., the quantity of food from the 7 stems being 11 lb. 5 oz.—an average of 1 lb. 10 oz.

3. Five consecutive groups of plants from "dibbled" seeds had the following respective weights:—6 lb. 8 oz.; 2 lb. 10 oz.; 5 lb. 1 oz.; 5 lb. 7 oz.; 5 lb. 9 oz.;—a total of 25 lb. 3 oz. The greatest length of stem was 39 in., and the greatest circumference 8 in. The amount of waste was 7 lb. 2 oz., the food extracted weighing 18 lb. 1 oz.—an average from each hole of 3 lb. 10 oz.

The results shown in (3) demonstrate clearly the superiority of the second method of sowing. The results as a whole show what a valuable green food this kale provides for poultry-keepers, especially when it is remembered that the food from the stems was available throughout a period of fairly keen frosts.

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NOTES ON FEEDING STUFFS FOR MAY.

E. T. HALNAN, M.A., Dip. Agric. (Cantab.),
Ministry of Agriculture and Fisheries.

The Composition of Wheat Offals.—In a letter received recently, a correspondent stated that he experienced great difficulty in ascertaining the exact value of any wheat offals he bought, owing to the fact that the local names under which they were offered differed from those usually given in the Notes on Feeding Stuffs. It may be useful to give a brief account of our present knowledge of the composition of wheat offals, and it is hoped that this account will help readers to classify their own local products under the appropriate headings. The writer would also appreciate any information as to the local names of any wheat offals not given in the list below.

A successful attempt to classify wheat offals was made by Prof. T. B. Wood and Mr. R. H. Adie in 1916, and very useful information was obtained as a result of their investigation. The following is a brief account of the chief facts established by this investigation.

In milling wheat for flour, the process consists essentially of cracking and grinding the wheat kernels by passing them through series of steel or stone rollers and sifting out the finest particles by means of a fine silk sieve which has 130 meshes to the linear inch. The particles that pass through this sieve form the flour, and the remainder constitutes the "wheat offals." The subsequent history and separation of the constituents of the wheat offals depends to a large extent on the local milling practice and the nature of the machinery available for separation. The coarser part of the offals, known under the name of "bran" is extracted by passing the offals over a wire sieve having 16 meshes to the linear inch. The bran is that portion which fails to pass through the sieve. The greatest variation in milling practice occurs in the separation of the finer particles of offals. As with bran, the separation is a mechanical one, the offals being graded according to whether or not they pass through sieves of a given mesh. Where separation is most complete, the intermediate offals are graded into three fractions, known respectively as pollards, coarse middlings, and fine middlings. Where separation is not so complete, the separate fractions above may be combined, so that a mixture of coarse

DESCRIPTION.	Price per Qr. s.	Price per Qr. lb.	Price per Ton. £ s.	Manurial Value per Ton. £ s.	Cost of Food Value per Ton. £ s.	Starch Equiv. per 100 lb.	Price per Unit, Starch Equiv. s.	Price per lb. Starch Equiv. d.
Wheat, British - -	53/6	504	11 18	1 0	10 18	71·6	3/5	1·83
Barley, English Feeding	38/–	400	10 13	0 18	9 15	71	2/9	1·47
„ Canadian No.2 Feed	34/–	400	9 10	0 18	8 12	71	2/5	1·29
Oats, English White -	34/6	336	11 10	0 19	10 11	59·5	3/7	1·92
„ „ Black & Grey	32/–	336	10 13	0 19	9 14	59·5	3/3	1·74
„ Canadian No.2 Feed	29/6	320	10 6	0 19	9 7	59·5	3/2	1·70
„ Argentine - -	26/3	320	9 4	0 19	8 5	59·5	2/9	1·47
Maize, „ - -	43/6	480	10 3	0 17	9 6	81	2/4	1·25
„ South African -	38/–	480	8 17	0 17	8 0	81	2/–	1·07
Beans, English Winter -	63/3*	532	13 6*	1 15	11 11	67	3/5	1·83
„ Rangoon - -	—	—	8 0	1 15	6 5	67	1/10	0·98
Buckwheat, Manchurian	59/–	392	16 17	1 6	15 11	53·4	5/10	3·12
Millers' offals—								
Bran - - -	—	—	7 10	1 16	5 14	45	2/6	1·34
Broad Bran - -	—	—	8 15	1 16	6 19	45	3/1	1·65
Fine middlings (Imported) - -	—	—	10 0	1 7	8 13	72	2/5	1·29
Coarse middlings -	—	—	7 15	1 7	6 8	64	2/–	1·07
Pollards (Imported)	—	—	7 0	1 15	5 5	60	1/9	0·94
Barley Meal - - -	—	—	11 10	0 18	10 12	71	3/–	1·61
Maize „ - - -	—	—	8 12*	0 17	7 15	81	1/11	1·03
„ Germ Meal - -	—	—	8 10	1 5	7 5	85·3	1/8	0·89
„ Gluten-feed -	—	—	9 10	1 11	7 19	75·6	2/1	1·12
Locust Bean Meal -	—	—	9 10	0 9	9 1	71·4	2/6	1·34
Bean Meal - - -	—	—	14 0	1 15	12 5	67	3/8	1·96
Fish „ - - -	—	—	16 10	5 10	11 0	53	4/2	2·23
Linseed - - -	—	—	19 10	1 16	17 14	119	3/–	1·61
„ Cake, English (9°/₀ oil)	—	—	14 5	2 6	11 19	74	3/3	1·74
Cottonseed „ English (5°/₀ oil)	—	—	8 12	2 6	6 6	42	3/–	1·61
„ „ Egyptian (5°/₀ oil)	—	—	8 2	2 6	5 16	42	2/9	1·47
„ „ decorticated (7°/₀ oil)	—	—	14 0*	3 11	10 9	71	2/11	1·56
Coconut Cake (6°/₀ oil)	—	—	9 0	1 19	7 1	73	2/–	1·07
Groundnut „ (6°/₀ oil) (undecorticated)	—	—	8 15	3 5	5 10	47	2/4	1·25
Palm kernel Cake (6°/₀ oil)	—	—	7 10*	1 9	6 1	75	1/7	0·84
„ „ Meal (2°/₀ oil)	—	—	6 10	1 9	5 1	71·3	1/5	0·76
Feeding Treacle - -	—	—	5 15	1 1	4 14	51	1/10	0·98
Brewers' grains, dried, ale	—	—	10 5	1 11	8 14	49	3/6	1·87
„ „ „ porter	—	—	9 5	1 11	7 14	49	3/2	1·70
„ „ wet, ale	—	—	2 10	0 8	2 2	15	2/10	1·52
„ „ wet, porter	—	—	2 6	0 8	1 18	15	2/6	1·34
Malt culms - - -	—	—	8 0*	2 3	5 17	43	2/9	1·47
Whole Milk (3°/₀ fat) -	8d. per gal.†		7 9†	0 7	7 2	15	9/6	5·09

* Prices at Liverpool. † Specially included—not market price.

FARM VALUES.	—	—	Value per Ton on Farm. £ s.	Manurial Value per Ton. £ s.	Food Value per Ton. £ s	S.E. per 100 lbs.	Value per unit S.E. s.	Market Value per lb. S.E. d.
Potatoes - - -	—	—	2 7	0 5	2 2	18	2/4	1·25
Swedes - - -	—	—	0 19	0 3	0 16	7	2/3	1·20
Mangolds - - -	—	—	0 18	0 4	0 14	6	2/4	1·25
Good Meadow Hay .	—	—	6 6	0 18	5 8	31	3/6	1·87
Good Oat Straw - .	—	—	3 9	0 10	2 19	17	3/6	1·87
Good Clover Hay -	—	—	6 16	1 4	5 12	32	3/6	1·87
Vetch and Oat Silage -	—	—	1 19	0 8	1 11	14	2/3	1·10

NOTE.—The prices quoted above represent the average prices at which actual wholesale transactions have taken place in London, unless otherwise stated, and refer to the price ex mill or store. The prices were current at the end of March and are, as a rule, considerably lower than the prices at local country markets, the difference being due to carriage and dealers' commission. Buyers can, however, easily compare the relative prices of the feeding stuffs on offer at their local market by the method of calculation used in these notes. Thus, suppose palm kernel cake is offered locally at £10 per ton. Its manurial value is £1 9s. per ton. The food value per ton is therefore £8 11s. per ton. Dividing this figure by 75, the starch equivalent of palm kernel cake as given in the table, the cost per unit of starch equivalent is 2s. 3d. Dividing this again by 22·4, the number of pounds of starch equivalent in 1 unit, the cost per lb. of starch equivalent is 1·21d. A similar calculation will show the relative cost per lb. of starch equivalent of other feeding stuffs on the same local market. From the results of such calculations a buyer can determine which feeding stuff gives him the best value at the prices quoted on his own market.

middlings and fine middlings constitutes the grade known as straight run middlings. A mixture of coarse middlings and pollards is similarly known as straight run pollards. The three fractions combined would constitute straight run offals. Given in the form of a diagram the results obtained are as follows :—

Wheat kernel is separated into 5 fractions.	1. Flour		Straight run offals.
	2. Fine middlings	Straight run middlings	
	3. Coarse middlings		
	4. Pollards	Straight run pollards	
	5. Bran		

The investigation also showed that fine middlings, coarse middlings, pollards and bran had a fairly definite chemical composition and each could be placed in its proper grade on its chemical composition. From the investigation it was also possible to group the local names into their proper grades. Thus fine middlings is identical with seconds, fine thirds and biscuit middlings.

Coarse middlings is identical with sharps, thirds, parings and boxings.

Pollards is identical with randans, coarse sharps and gurgeons.

The composition and digestibility of the four important grades of wheat offals are given in the Ministry's Miscellaneous Publication No. 32* (*Rations for Farm Stock*), and by comparing the analysis of any given sample of offals bought locally with these standard analyses it should be possible for the buyer

* Obtainable from the offices of the Ministry, 10 Whitehall Place, S.W. 1. Price 6d. post free.

to place with a fair degree of accuracy the nature of the offals sold. It is hoped eventually that millers will agree to classify their offals on a standard basis, as this will give the farmer an accurate idea of the feeding value of any wheat offal whatever its local name may be.

The Feeding Value of Whole Milk.—A correspondent has written asking that the value of milk based on a price of 8d. a gallon, and a fat content of 3 per cent., may be given in the table. It has therefore been included.

It will be seen that, at 8d. a gallon, milk is a dear feeding stuff. Its use could only be justified for feeding in special circumstances, as in the case of very young stock, or where local conditions preclude its sale. In the latter case, it would be more profitable to manufacture cheese or butter for sale and to feed the residues rather than to feed the whole milk itself.

* * * * * *

Effect of Coal Smoke on Plants.

COAL smoke and the presence of sulphurous acid in the atmosphere have for long been two of the greatest trials with which the Royal Botanic Gardens, Kew, have to contend, and the winter conditions are so bad that it is almost impossible to cultivate certain evergreen trees. Winds from the north and north-east almost invariably carry coal smoke to Kew. In summer the smoke may only be noticeable as a slight haze, but in winter it takes the form of dense fog. A fog of a few hours' duration causes the flowers and leaves of many indoor plants to fail, owing to the sulphurous acid in the atmosphere, whilst out of doors everything is covered with a thick deposit of fine greasy soot. This deposit is very noticeable upon water, glass, and the leaves of plants. The breathing pores of leaves become clogged and the plants are enfeebled; in fact, so disastrous is the dirt to health that it has become impossible to cultivate many of the firs and spruces.

A temporary exhibit has been arranged in Museum III at Kew, consisting of leaf specimens showing the difference between clean foliage and smoke or soot-laden foliage, and of glass from a greenhouse showing the effect of fog.

In order to increase the educational value of the Gardens, it is proposed from time to time to arrange other small exhibits at Kew, of objects of particular interest at the moment.

* * * * * *

Grants for Agricultural Research.

THE Ministry of Agriculture and Fisheries is prepared to receive, not later than the 15th May next, applications for grants in aid of scientific investigations bearing on agriculture to be carried out in England and Wales during the academic year commencing 1st October, 1922. The conditions on which these grants are offered are set out on the prescribed form of application (A230/I), of which copies may be obtained from the Secretary, Ministry of Agriculture and Fisheries, Whitehall Place, London, S.W.1.

* * * * * *

Wart Disease of Potatoes Regulations.

THE proposed new regulations for the control of Wart Disease, which were to have been brought into operation by the Ministry of Agriculture and Fisheries at the conclusion of the 1922 planting season, are still under consideration by the Minister's Advisory Committees. The Ministry can, however, inform potato growers that no restrictions additional to those operating in 1921 will be imposed which will affect the distribution of the 1922 potato crop, or of the entry into England and Wales of seed potatoes produced during 1922 in Scotland or Ireland.

* * * * * *

Horticulture in the Penzance Area of Cornwall.

THE Great Western Railway Company have drawn the Ministry's attention to certain statements which appeared in an article in this *Journal* for November, 1921, entitled *Horticulture in the Penzance Area of Cornwall.*

The Company point out that the present arrangements for the receiving and forwarding of the Cornish broccoli and vegetable traffic had been already the subject of discussion between the Railway Company and the Cornish Branch of the National Farmers' Union, and had been agreed to by the latter.

The whole question has recently been under discussion between the Ministry and the Railway Company, who are anxious to provide every facility for the transport of these commodities under the most favourable conditions.

The Ministry is glad to recognise the progressive and liberal attitude adopted by the Great Western Railway Company,

especially as regards their willingness to give immediate attention to any specific complaint by a grower, and to ensure the best possible transport of all perishable produce.

* * * * * *

How to Produce Clean Milk.

With reference to the article entitled "How to Produce Clean Milk," by James Mackintosh, O.B.E., N.D.A., which appeared in the April issue of the *Journal*, in view of recent experiments conducted at the University College, Reading, the writer wishes to make the following amendments to his article:—

Methods of Washing.—Scalding is really an attempt to sterilize, and will do much to lessen the contamination from the utensils; efficient steaming, however, will actually sterilize utensils with less labour and is therefore to be preferred. Where steam is not available utensils should be immersed in boiling water and boiled for 10 minutes; in the case of a large cooler or churns which cannot be placed in an ordinary copper, boiling water should be poured over or into them until they become unbearably hot.

Steaming.—Utensils may be enclosed in a box or tank into which steam is passed from a boiler. The steaming period will vary from 10 minutes upwards according to the supply of steam and the size of the box. If a thermometer is inserted through a small hole in the lid or side, a temperature of 210 degrees F. is sufficient evidence that the utensils are being satisfactorily treated; steaming should be prolonged to allow the contents of the box to reach this temperature. Vessels inverted over a steam jet should be kept in position until every part of the vessel becomes too hot to touch with the hand and left for at least one minute thereafter.

Strainers and Straining.—Strainers containing a layer of cotton wool which must be renewed at each milking, are the best, particularly those where the milk falls on a metal plate first instead of directly on to the straining material. The metal plate then bears the direct weight of the falling milk, and there is less chance of particles of dirt being forced through the strainer. Cloths of a fine mesh are also in common use, but the difficulty of keeping such cloths clean, and the certainty that a dirty cloth will contaminate milk indicates clearly that cotton wool strainers are much to be preferred. Where cloths are used, two should be provided—one, used in the evening,

should be soaked in cold water overnight; the other, used next morning, should be soaked as soon as the morning milking is finished. Both should be rinsed repeatedly, then washed, boiled (or steamed) and hung in a clean place till again required.

* * * * * *

Acarine Disease: Examination of Bees.

THE Ministry of Agriculture and Fisheries wishes to inform beekeepers that bees can now be examined for the presence of Acarine Disease, on payment of a fee of 2s. for each sample submitted. The following instructions should be carefully observed :—

(1) Specimens should be *live* bees, of not less than 30 in number, taken from off the combs and not collected from outside the hive. It is in this way only that the true condition of the colony can be diagnosed. *Dead* bees will not normally be accepted as they are unreliable for microscopic examination.

(2) The bees should be placed in a small cage or box, preferably of wood, provided with ventilation holes, and having a piece of muslin fastened across the inside for the bees to cling to during transit.

(3) A supply of candy sufficient to last for a few days, or a lump of sugar moistened with water, should be wrapped in muslin and firmly fixed to the inside of the box.

(4) The box should be secured with string and a label attached addressed to the Secretary, Ministry of Agriculture and Fisheries, 4, Whitehall Place, S.W.1, with the name and address of the sender written on the reverse side, but crossed through to prevent an error in the post.

(5) Not more than three samples may be submitted by a beekeeper at any one time, but further samples may be sent at intervals of four days. In all cases where more than one sample is sent at a time, these should be numbered 1, 2 and 3 as the case may be.

(6) At the same time as the bees are despatched, a remittance at the rate of 2s. for each sample submitted should be forwarded under separate cover. No bees will be examined unless or until this remittance has been received. Payment should be made by cheque or Postal Order, payable to the order of the Ministry of Agriculture and Fisheries and not to any individual by name, and crossed "Bank of England." Postage Stamps will not be accepted. The Ministry will not be responsible for any loss occasioned by inattention to these instructions.

(7) In the letter forwarding the remittance, as much information as possible should be given with regard to the past history and present condition of the stocks from which the bees were taken. This may help the Ministry in giving advice when furnishing a report of the examination, and will assist in general bee-disease research.

* * * * * *

Brompton Agricultural Discussion Society.

A NOVEL method of organising a series of agricultural lectures was adopted with success last winter by the Yorkshire Council for Agricultural Education. In the previous winter a course of twelve weekly lectures was given at Brompton, near Northallerton, which was only moderately attended. In order to stimulate interest in the proposed educational courses in the subsequent season, the prominent members of the previous class formed themselves into the Brompton Agricultural Discussion Society. They elected a Treasurer, Secretary and a committee. The subscription for membership was 1s., a printed programme was drawn up, and a lecture was arranged for each week from December to the end of March. The subjects were chosen by the members, and the County Agricultural Organiser was then asked to assist in obtaining the services of specialists in the particular subjects, the result being a well constructed programme of which the scientific side was presented by the staff of Leeds University, while practice was preached by prominent agriculturists who freely gave their services.

The lectures were followed by discussions and it was interesting to see in this small village a company of thirty to forty farmers on a miserably wet night firing questions at the lecturer as quickly as possible during the three-quarters of an hour which was open for discussion. Not least important is the fact that full reports of these lectures appeared in the local press, which devoted one or two columns per week to the society's work. The hearers therefore had an opportunity of reading the lecture again at their leisure.

Another result of this work is shown in the keenness with which those who are members of the society are taking up the question of plot and variety trials, usually at their own expense. Their results form material which is periodically brought up in the discussions following certain lectures.

* * * * * *

THE following communication has been received from a correspondent :—

Milking by Contract.

"The principle of paying piece-work rates for many agricultural operations is very old-standing, but its adoption in the tending of livestock is a comparatively new departure, and in certain cases is impracticable. For a considerable time it has been customary for small bonuses to be paid to stockmen, shepherds, etc., for each animal successfully reared or fattened, and in some localities milking cows have been let out on a hiring system.

Recently a large firm of dairymen, with over 400 cows on the outskirts of London, have contracted for the care and milking of their herd. Owing to the general fall in the price of agricultural products, this firm was faced with the alternative of reducing individual wages or obtaining a greater output per man. Methods were therefore sought for placing their business on a sound economic basis, and it was finally agreed between the firm and their employees that piece-work rates for milking and tending the cows should be paid. The rate agreed to is 4s. per cow per week, and each man is now milking 16 cows against 12 before the agreement. In addition each man has a cottage or 3s. per week in lieu, and milk. The day's work is done in two periods; the first commences at 4.30 a.m. and finishes at 9.30 a.m. During this period the cows are fed, milked, the sheds and mangers are cleaned and the animals are again fed. The second period commences about 12.30 p.m. The cows are milked at 4 p.m., after which the milk pails and churns are scalded ready for use the next morning, and the day is finished about 6.30 p.m. The farm steward supervises the head cowman. Milk records are taken weekly and thus careless milking is quickly detected.

It is stated that the men appear satisfied with the arrangement and no falling off in the milk supply or condition of the cows has occurred.

The dairy is run on town lines, *i.e.*, the cows are always housed, and when yielding below 6 quarts of milk per day they are sold for slaughter. Under the above conditions it is comparatively easy to adopt factory methods, but in country herds it would be much more difficult to arrange an efficient system."

* * * * * *

Leaflets issued by the Ministry.—Since the date of the list given on page 1051 of the February issue of the *Journal*, the following five new leaflets, of which the one marked with an asterisk will, provisionally, be supplied free, have been issued :—

No. 363.—Insecticides and Fungicides.
,, 382.—Liquid Manure Tanks.
,, 384.—Pig Breeding.
,, 385.—Lime and Its Uses on the Land.*
,, 389.—Distribution of Sittings of Eggs and Day-old Chicks for Improving the Breed of Poultry.

The following have been revised or amended :—

No. 180.—Dodder.
,, 201.—The Marketing of Poultry.
,, 222.—Meadow Saffron.
,, 326.—Injurious Weed Seeds in Grasses and Clovers Harvested for Seed in Great Britain.
,, 229.—The Breeding and Rearing of Turkeys.
,, 349.—Methods of Obtaining Strong Stocks of Bees for Wintering.
,, 368.—The Cultivation of Flax for Fibre.

The following Leaflets have been re-written :—

No. 128.—Advice to Beginners in Bee-Keeping.
,, 157.—The Sale of Day-old Chickens.
,, 176.—The Fattening of Poultry for the Table.
,, 224.—Narcissus Cultivation.

The following Leaflets have been withdrawn :—

No. 289.—A Disease of Wheat.
,, 171.—Rhizoctonia Diseases.

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NOTICES OF BOOKS.

Farming Costs.—(C. S. Orwin. London : Oxford University Press. Price 8s. 6d. net.) During the War the subject of farming costs received much attention, particularly in connection with the controversy surrounding the Corn Production Acts, and it still occupies a prominent position the in Agricultural Press. A revised edition of Mr. C. S. Orwin's well-known book on the subject must, therefore, be welcomed, for the author, as Director of the Institute of Agricultural Economics at Oxford, is in a position to speak with authority. The first edition (entitled "The Determination of Farming Costs") was published in 1917 and was in great demand as the only authoritative work on the subject. Since that date further experience has enabled the author to speak with even greater authority as well as to make such modifications as extended observation and criticism have shown to be desirable. Certain matters still remain, however, in regard to which Mr. Orwin, in the absence of further experience, is not prepared to give firm directions. It may be permissible to suggest that the time has come when general agreement between experts is necessary, if it were only on a conventional basis. Not the least benefit of the keeping of costing accounts is the material which they provide for comparative study, whether from year to year on the same farm, or in

relation to other farms similarly situated. For this purpose it is more important that the systems of costing pursued should be uniform than that they should be defensible in every detail on purely theoretical grounds.

One of the matters as to which further experience has led the author to modify his views, relates to the trouble and expense involved in keeping cost accounts. "There is, however," he states, "a degree of exactness required in cost determinations which may be so troublesome and so expensive of time and labour . . . . that it would not be profitable for the ordinary farmer." "But," as he properly goes on to say, "this . . . . does not affect the importance of having . . . . an exhaustive and scientific analysis of farming costs . . . . on a number of typical farms." In this connection attention may also be drawn to Appendix I, which suggests an "Alternative Basis for Cost Determination." The system outlined therein, if successful, goes far to meet the objection that costing on the approved principles described in the body of the treatise is too expensive for adoption by the "ordinary farmer." One misses, it may be said, the refreshingly pungent criticisms of other writers on the subject of costs with which the first edition closed. A.B.B.

Fruit Farming: Practical and Scientific.—(Cecil H. Hooper. London: The Lockwood Press. Price 6s. net.) The Second Edition of this book which has now been published covers a wide field by including articles on most subjects of importance to the commercial fruit grower. Many of the articles have been written by Mr. Cecil Hooper, who has had experience of fruit growing in this country and Canada, while others have been written by well-known practical growers.

The information, which is essentially of a practical nature, has been given in a condensed form readily understood by the average grower to whom this little book should appeal. H.V.T.

Agricultural Geology.—(Frederick V. Emerson, Ph.D., late Professor of Geology and Geologist for the State Experimental Station, Louisiana State University: pp. 319, 16s. 6d. net: Chapman and Hall.) This volume is suitable for University students of agriculture, but is too wide in scope and too advanced in character for those attending Farm Institutes. It should, however, find a place in the library of the latter. Obviously intended for the American student, it deals with soils and conditions which, in many cases, are unfamiliar to the British agriculturist. The portion dealing with the residual soils of various rocks, and with inherited soils, is very interesting, giving the causes of their agricultural value, and explaining many phenomena puzzling to the observer who is more agriculturist than geologist. Further, the chapter on the part played by wind in geological formations is as attractive as the account of the methods employed in binding the shifty soils most affected. Mention must be made of the discussion on "ground water," the facts in connection with which are perhaps not generally realised, while the account of alluvial terraces and the alluvial deposits of flowing water are also of interest. Glaciation and glacial soils are subjects very well illustrated; indeed, the photographs and diagrams throughout the volume arrest the eye and make particularly valuable those portions which the British student can read with advantage. A chapter on the mineral fertilisers, and their occurrence in nature, adds to the value and interest of the volume.

Insect Pests of Farm, Garden and Orchard.—(E. Dwight Sanderson. Second revised and enlarged edition by L. M. Peairs. London: Chapman Hall, 1921. Price 26s. net.) As indicated in the title, this book deals concisely with the insects east of the Rocky Mountains, except insects attacking citrus fruits. Material relating to some pests occurring also in Britain will be found in its pages, while some other American pests, familiar to us by evil repute, are absent, probably owing to the geographical range of consideration, the pests of the Pacific Coast and the irrigated country of the Far West not coming under review. The work goes further than its title, and includes insects injurious in the household, to domestic animals and to man directly, and should be distinctly useful to those whose interests lie also outside the British Isles.

The statistics as to damage, and the popular names with which many of the insects are labelled combine to strike a strong and characteristic transatlantic note, carrying inspiration by their vigour. The book is profusely illustrated by half tone and line blocks; these leave something to be desired, not on account of their lack of soundness, but, more particularly as regards many of the former, from poor production.

For those who desire to explore literature additional to British works on plant pests, this American book may be recommended.

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ADDITIONS TO THE LIBRARY.

Agriculture, General and Miscellaneous.

Ernle, Lord.—English Farming Past and Present. (3rd Edition.) (504 pp.) London: Longmans, Green & Co., 1922, 12s. 6d. net. [63(09).]

Geological Survey Memoirs. England and Wales.—The Water Supply of Cambridgeshire, Huntingdon and Rutland. (157 pp.) London: H.M. Stationery Office, 1922, 1s. net. [628.7.]

Woodhouse, T.—The Handicraft Art of Weaving. (162 pp.) (Oxford Technical Manuals.) London: Henry Frowde, Hodder & Stoughton, 1921, 6s. net. [63.193.]

Field Crops.

Hayes, H. K. and *Garber, R. J.*—Breeding Crop Plants (328 pp.) New York and London: McGraw-Hill Book Co., Inc., 1921, 21s. [575-4.]

University of Leeds and Yorkshire Council for Agricultural Education.—No. 121:—Results of Experiments with Cereals, Swedes, Turnips and Potatoes in Yorkshire, 1921. (8 pp.) Leeds, 1922. [63.31(04); 63.332; 63.512(04).]

University College of North Wales, Department of Agriculture.—College Farm: Varieties of Oats, 1920 and 1921. (11 pp.) Bangor, 1922. [63.314(04).]

Horticulture.

Royal Horticultural Society.—Report of the International Potato Conference, Nov., 1921. (182 pp.) London: Office of the Society, 1922, 3s. [63.512(02).]

National Institute of Agricultural Botany.—Report of the Potato Synonym Committee, 1921, and Resolutions of the Potato Industry Conference. (23 pp.) Cambridge, 1922, 1s. 6d. [63.512(04); 63.512-194.]

U.S. Department of Agriculture.—Bull. 1006:—Accounting Records for Sampling Apples by Weight. (13 pp.) Washington, 1921. [63.41-198; 63.41(a).]

Fletcher, F. J.—Market Nursery Work Series. Vol. III :—Roses for Market (70 pp.). Vol. IV :—Carnations and Pinks (66 pp.). London : Benn Bros., 1922, 4s. 6d. net each. [63.52(02).]

Plant Diseases.

Ralfs, E. Marguerite.—An Abstract of the Legislation in Force in the British Empire dealing with Plant Pests and Diseases up to the Year 1920. (65 pp.) London : Imperial Bureau of Entomology, 1921, 2s. 6d. net.

Royal Society.—Reports of the Grain Pests (War) Committee. No. 9. (52 pp.) London : Harrison & Sons, Ltd., 1921, 1s. 6d. [63.27-31.]

U.S. Department of Agriculture.—Bull. 1023 :—The Relative Toxicity of Strychnine to the Rat. (19 pp.) Washington, 1922. [63.269.]

Veterinary Science.

Archer, A. H.—The Stockowner's Veterinary Aid : Containing Elementary Principles and Outlines of Treatment of Diseases and Injuries for General and Army Requirements. (136 pp.) London : Crosby Lockwood & Son, 1921, 7s. 6d. net. [619(02).]

University College of North Wales, Department of Agriculture.—Notes on the Liver Rot Epidemic of 1920-21 in North Wales. (8 pp.) Bangor, 1922. [59.169; 619.3.]

Dairying.

West of Scotland Agricultural College.—Bull. 98 :—Butter-making on the Farm. (62 pp. + 8 plates.) Glasgow, 1921, 2s. [63.72(02).]

Poultry.

Toovey, T. W.—Commercial Poultry Farming : A Description of the King's Langley Poultry Farm and its Modus Operandi. (2nd Edition.) (139 pp.) London : Crosby Lockwood & Son, 1922, 6s. net. [63.65(02).]

Engineering.

Society of Motor Manufacturers and Traders.—Report on the Tractor Trials held at Shrawardine, near Shrewsbury, Sept. 20th-24th, 1921. (100 pp.) London : Offices of the Society, 1921, 2s. 6d. [63.175(04).]

Gougis, A.—Manuel du Conducteur de Machines Agricoles. (350 pp.) Paris : Librairie Agricole de la Maison Rustique, 1921, 12 fr. [63.17(02).]

U.S. Department of Agriculture.—Bull. 997 :—The Cost and Utilization of Power on Farms where Tractors are Owned. (61 pp.) Washington, 1921. [63.175.]

Economics.

U.S. Department of Agriculture.—Bull. 987 :—Handbook of Foreign Agricultural Statistics. (69 pp.) Washington, 1921. [31(04).]

U.S. Department of Agriculture.—Bull. 1043 :—Crop Insurance : Risks, Losses and Principles of Protection. (27 pp.) Washington, 1922. [368.5.]

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SELECTED CONTENTS OF PERIODICALS.

Agriculture, General and Miscellaneous.

The Progress of British Agriculture, *Sir R. Henry Rew.* (Jour. Roy. Stat. Soc., Vol. 85, Part I, 1922.) [63(09); 31(42).]

Weather and Harvest Cycles, *W. H. Beveridge.* (Econ. Jour., Vol. 31, No. 124, Dec., 1921.) [551.5.]

The Evaporation of Water from Soil: Influence of Soil Type and Manurial Treatment. *B. A. Keen.* (Jour. Agric. Sci., Vol. xi., No. 4, Oct., 1921.) [63.112.]

Field Crops.

The Improvement of Poor Pasture, *W. Somerville.* (Jour. Farmers' Club, 1922, Part 2.) [63.33-16.]

The Latest Results of the Enquiry into the Spontaneous Combustion of Hay. (Int. Rev. Sci. and Prac. Agric., xii., No. 4, April, 1921.) [63.1982.]

Horticulture.

Genetic Studies in Potatoes; Sterility, *R. N. Salaman* and *J. W. Lesley.* (Jour. Agric. Sci., Vol. 12, Part I, Jan., 1922.) [575.1]

Pollination in Orchards (v. and vi.), *A. N. Rawes* and *G. F. Wilson.* (Jour. Roy. Hort. Soc., Vol. 47, Part I, Jan., 1922.) [63.41(08).]

The Winter Study of Fruit Trees, *E. A. Bunyard.* (Jour. Roy. Hort. Soc., Vol. 47, Part I, Jan., 1922.) [64.41(04).]

Live Stock.

Some Aspects of Beef Production, *T. B. Wood.* (Scottish Jour. Agric., Vol. v., No. 1, Jan., 1922.) [63.625.]

On the Relative Growth and Development of Various Breeds and Crosses of Sheep, *John Hammond.* (Jour. Agric. Sci., Vol. xi., Part 4, Oct., 1921.) [63.63(04).]

Scientific Pig Keeping with its relation to Vitamine, *M. J. Rowlands.* (Jour. Farmers' Club, Dec., 1921.) [63.64(04).]

War-Time Substitute Fodders. (Live Stock Jour., March 24th, 1922.) [63.604(a).]

Experiments with "War Forages" in Germany, Hungary, Switzerland and France. (Int. Rev. Sci. and Prac. Agric., xii., No. 4, April, 1921.) [63.604(a).]

Dairying.

Milk Recording Societies and their Effect upon the Dairy Farming Industry, *James Mackintosh.* (Jour. Farmers' Club, 1922, pp. 1-22.) [63.6(06): 63.711(b).]

Outline for a Study of the Cost of Milk Production, *J. A. Hopkins.* (Jour. Dairy Sci., Vol. 5, No. 1, Jan., 1922.) [63.714.]

The Possibility of Increasing Milk and Butter Fat Production by the Administration of Drugs, *A. C. McCandlish* and *T. M. Olson.* (Jour. Dairy Sci., Vol. 4, No. 6, Nov., 1921.) [63.711(a).]

Engineering.

The Planning and Construction of Farm Buildings, *J. B. Mendham.* (Specification, 1922, pp. 21-32.) [69(04).]

Economics.

The Cost of Tractor and Horse Labour, *C. S. Orwin.* (Scottish Jour. Agric., Vol. 5, No. 1, Jan., 1922.) [63.19; 338.58.]

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Net Sale Certificate.

I hereby certify that the average monthly net sales of *The Journal of the Ministry of Agriculture*, all editions carrying advertisements, after deducting all free vouchers, complimentary and advertising copies, and all returns, for the half year ending 30th September, 1921, were 9,687 copies per issue.

In addition to sales, the average number of copies distributed to Officials of the Ministry, County Inspectors, Agricultural Committees, Agricultural Societies, and agricultural experts and writers, was 1,187 monthly, which, while not being a sale circulation, is nevertheless effective and guaranteed.

(Signed) F. L. C. Floud,
Secretary and Accounting Officer.

7th November, 1921.

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