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PRINCIPAL CONTENTS.

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BY

WILLIAM SOMERVILLE, M.A., D.Sc.,

Professor of Rural Economy at the University of Oxford.

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The Ministry last year invited Professor Somerville to prepare a new and up-to-date Report covering the whole ground relating to the manuring of pastures for meat and milk. In publishing this Report the Ministry desires to direct the attention of farmers to the important and practical character of the information here summarised for their use. The Ministry and Agriculturists are alike indebted to Professor Somerville.

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No. 32—Rations for Live Stock

BY

T. B. WOOD, C.B.E., M.A., F.I.C., F.R.S.,

Professor of Agriculture at the University of Cambridge.

THIS pamphlet describes a simple general method of working out rations for horses, cattle, sheep and pigs. The method is based on the tables giving the composition and nutritive value of a large number of feeding stuffs, and on the curves showing the relation between live weight and food requirements, which are given at the end of the pamphlet. The meaning of the figures given in the tables, and the method of using them, is explained in the text. Typical rations for all kinds of animals are worked out from the figures and curves.

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CONTENTS.

THE JOURNAL
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MINISTRY OF AGRICULTURE

Vol. XXVIII. No. 1.

APRIL, 1921.

NOTES FOR THE MONTH.

Second Meeting of the Council of Agriculture for England.

THE second meeting of the Council of Agriculture for England was held at Essex Hall, London, on March 4th, when the Earl of Selborne, K.G., G.C.M.G., was elected chairman for the year. During the course of the proceedings the Minister of Agriculture, Lieut.-Col. Sir Arthur Griffith-Boscawen, addressed the Council.

Among the resolutions moved was one in favour of maintaining the existing restrictions upon the importation of live animals from abroad, in order "to ensure the due protection of British livestock against the ravages of serious contagious disease." An amendment to add, as an additional reason for the continuance of the embargo, the words "and to encourage the maintenance of the milk supply of the country" was carried; while an amendment to make an exception in the case of Canada was defeated. Another amendment proposed to refer the whole question of the embargo to a Committee of the Council for enquiry and report. This was defeated, as also was one for a joint inquiry by the Ministry of Agriculture and the Ministry of Health. The original resolution, with the addition agreed to, was then carried by 71 votes against 15. It read as follows:—

> "That to ensure the due protection of British Livestock against the ravages of serious contagious disease, and to encourage the maintenance of the milk supply of the country, this Council of Agriculture for England most earnestly requests His Majesty's Government to maintain the existing restrictions upon the importation of live animals from abroad, without attempting to discriminate between one importing country and another."

(36447) P6/198. 11,250. 3/21. M. & S.

The Council accepted an invitation to send representatives to the National Conference, summoned by the Lord Mayor of London, at the Guildhall on March 9th, to consider the question of the embargo on Canadian store cattle, and Mr. Langford, Mr. Strutt and Mr. Rea were chosen to attend.

A resolution was moved in favour of the compulsory registration, by County Agricultural Committees, of all bulls kept for service—except pedigree bulls used solely in the owners' herds—if and when certified suitable for breeding purposes. At the request of the chairman, a brief statement on this subject was made by Sir Daniel Hall, Chief Scientific Adviser to the Ministry. After explaining the difficulties of implementing the resolution, he suggested that the matter be referred to the Livestock Committee of the Ministry. This was agreed to, and the resolution was withdrawn.

The Summer Time Act was the subject of a resolution which recommended that " in the interest of the agricultural industry the proposed Summer Time Act for 1921 should operate from May 1st till September 3rd." An amendment in favour of abolishing " Summer Time " was carried, and by 39 votes to 18 the following resolution was adopted :—

> " This Council recommends that, in the interests of the agricultural industry, summer time be abolished."

The provision of telephone call offices in rural areas was then discussed, and after Mr. F. L. C. Floud, C.B., Permanent Secretary to the Ministry, had read a statement on the subject which had been received from the General Post Office, a resolution in the following terms was carried *nem con* :—

> " That in view of the proposed heavy increase in charges for telephones, and the failure of the ' Party Line ' system, the Government be requested to make all telegraph offices in rural areas public telephone call offices as well."

A resolution in favour of amending the Agriculture Act in relation to the method of fixing payments arising out of the guaranteed prices for wheat and oats was moved in the following terms:—

> " That, in the opinion of this Council, the statutory provision whereby payments arising out of the guaranteed prices for wheat and oats under the Agriculture Act are based on an average yield for the whole country, is unfair to the more productive and highly rented areas; and that a separate average yield for each county should be adopted, such average yields to be determined by the Minister on the

recommendations of the Agricultural Committee for each administrative county, and that the Act be amended accordingly."

On being put to the meeting it was defeated. The following resolution in favour of re-introducing the payment of rewards for the destruction of rats was also defeated:—

"That the Ministry of Agriculture and Fisheries be asked to press for the amendment of the Rats and Mice (Destruction) Act, 1919, in such a manner as to allow of rewards for the destruction of rats being paid from the County Fund."

* * * * * *

The Supply of Store Cattle.

In the recent controversy on the question of store cattle in the United Kingdom, certain important facts have been overlooked. For example, few people appear to realise that the decline revealed by the Agricultural Returns collected on the 4th June, 1920, was confined almost entirely to the herds of England and Wales. The decrease in Scotland, if compared with that of England and Wales, is seen to be very small, while in Ireland, whence Great Britain derives a large part of the total number of stores required for feeding, there was practically no change; indeed, the total number of cattle in Ireland last year was very little short of the highest number recorded. It follows that there was in Ireland a heavy surplus of store cattle, from which the decline in Great Britain could be made up, and the number of fattening stores shipped from Ireland in the seven months June to December, 1920, was, in fact, 281,000, as against an average of 163,000 in the corresponding period of 1917, 1918 and 1919.

It will be remembered that in January last there was an outbreak of Foot-and-Mouth Disease in Ireland, and it became necessary to place an embargo on importation into Great Britain, with the result that the number of Irish stores received in the first two months of this year in Great Britain has declined sensibly. It has now been possible to relax the restrictions, and there is no reason to doubt that Irish stores will appear again in large number in the English and Welsh markets. The considerable increase in the importation of Irish stores last year was reflected in the total number of store cattle returned as having been offered at those markets in England and Wales which are included in the Ministry's "Return of Market Prices." The figure for the period June 3rd to Decem-

ber 29th, 1920, was 372,000, which compares very favourably with the average of 281,000 in the corresponding period of the years 1917-1919. Since the beginning of the present year there has been a slight diminution, consequent upon the outbreak of disease already mentioned.

The decline in the total stock of cattle in England and Wales last year occurred under each of the three main heads, which are "dairy cattle," "other cattle" and "calves," but was most marked in the case of the last named. Since animals classed as calves in June last would now be described for the most part as yearlings, there may possibly be a moderate shortage of that class of store cattle this year. There is, however, ample evidence that calves are being kept or purchased for rearing in considerably larger numbers than in the same period in 1919 and 1920. The total of 4,368,000 head of dairy cattle in the United Kingdom recorded in 1920 was the lowest since 1913. In that year the number was 4,300,000, but during the next three years the total number of cattle in the United Kingdom increased by no less than half a million. With a larger dairy herd as breeding stock in 1920 and a keen demand for good class store cattle and calves there is no reason why the total stock of the country should not increase again as it did after 1913.

* * * * * *

Employment in Agriculture: An Inquiry.

FOR some time past it has been suggested that employment on the farms in this country is decreasing. In order to ascertain the facts, members of the District Wages Committees in England and Wales have been invited by the Agricultural Wages Board to give information from personal knowledge of conditions in their respective districts, and to this end schedules of inquiry were sent out. The greater number of these schedules have been completed and returned and the contents may be summarised as follows:—

(*a*) That among men employed in connection with the care of animals, referred to as "Special classes," there is little unemployment.

(*b*) That among ordinary farm labourers unemployment is not much in excess of that which existed in January, 1920, and that it affects mostly the unskilled and inefficient workmen.

(*c*) That among boys unemployment to an unusual extent is not general although it is anticipated that the increase in

their minimum rates of wages coming into operation in March will cause more unemployment.

(*d*) That few women are regularly employed in agriculture, and only in some districts are any appreciable number unable to obtain work on the land.

Briefly put, unusual unemployment is to be found in the north of England (Cumberland, Westmorland, parts of Lancashire and Yorkshire); in the Midlands, Herefordshire and Warwickshire are affected; in the South, Hampshire and Wiltshire; in the Home Counties, Berkshire; in Wales, Anglesey, Carnarvon and Merioneth. It is agreed generally that farmers show a tendency to keep the minimum of workers necessary, and to suspend all work that may possibly prove unproductive. The grounds for their action are stated to be (*a*) the high wages for unskilled workmen; (*b*) difficulty in getting permits of exemption for inexperienced or inefficient workmen; (*c*) the shorter hours of labour; (*d*) the low yield of the 1920 harvest; (*e*) the general decline in prices of farm produce; and (*f*) high rates and taxes. The representatives of the workers contend that land is not being cultivated properly, and that if "good" cultivation were enforced there would be no unemployment. They find in the increasing use of modern machinery another contributory factor to present conditions.

It is satisfactory to learn that with few exceptions all ex-Service men formerly employed in agriculture have found re-employment on the land if they have so desired. At the same time cases are given of men who have passed to other industries owing to the higher wages prevailing.

* * * * * *

The International Institute of Agriculture at Rome.

FROM time to time the Press of this country publishes statements of the condition of cereal and other crops throughout the world, stating that these emanate from the Imperial Institute at Rome, but very few people are aware of the origin or constitution of this Institute, or of the important work that it carries through in the interests of international agriculture. The origin of the Institute dates back to 1905 when it was founded in accordance with the terms of the Convention signed by the representatives of some forty different states. Since the year of its foundation other Governments have signed the Convention, and to-day it may be said that the whole civilised world contributes to the only agricultural organisation of an official character established by a formal treaty between different states, managed and controlled by

representatives of those states and supported by their joint contributions.

As an international organisation of an official character the International Institute of Agriculture may indeed be said to have been the first of its kind in the world; it existed prior to the formation of the League of Nations, and indeed it has the universal support that the League has not yet obtained. The origin of the Institute is interesting. The late Mr. David Lubin of the United States realised that the farmers of the world could not combine to adjust their cultivation to world needs so long as they remained isolated and did not know what those needs were. He therefore proposed to the King of Italy the establishment of an International Institute to study the conditions of universal agriculture, publish returns, collect and disseminate information on economic and technical agricultural questions, and so facilitate production and aid agriculture throughout the world. The King not only took up the idea with great enthusiasm but helped to erect the magnificent building that houses the Institute in Rome, and transferred to it revenues worth £12,000 a year.

The chief object of the Institute is to prepare reliable reports of the estimated production of crops and available supplies throughout the world, and it was hoped that this information would prevent the cornering of crops on the one hand and violent fluctuation in price on the other. Bearing in mind the extent of international trade in foods and the essential unity of agricultural science the importance of the information that the Institute circulates will be understood. It is managed by a permanent Committee composed of representatives of the various signatory Governments resident in Rome. From time to time a General Assembly of delegates appointed by their Governments reviews the main principles of policy. Before the War this General Assembly met every two years, while the Permanent Committee meets at least once a month and several of its members devote themselves entirely to the Institute's work.

At present the International Institute of Agriculture is organised under three sections: (*a*) Statistics, (*b*) Agricultural Intelligence and Plant Diseases, and (*c*) Economic and Social Intelligence. Each issues a bulletin in several parts, as well as occasional leaflets and notices to the Press. The Institute also publishes an annual statistical review of the world's agriculture and an annual summary of agricultural legislation. Other publications also are issued from time to time. A meet-

ing of the General Assembly was held in November last and this was the first for seven years, the operations of the Institute having been curtailed by the War.

* * * * * *

The Ministry of Agriculture's Exhibits during 1920: Proposals for 1921.

DURING the War it was impossible for the Ministry of Agriculture to be represented at Agricultural Shows, but last year the long suspended effort was resumed and an agricultural exhibit was staged at thirteen of the leading Agricultural Shows in England and Wales. Wherever the Ministry was able to secure adequate representation, the public response was very definite. Not only were farmers present in large numbers in search of information, but they took full advantage of the leaflets and other publications that were on offer.

In addition to a purely agricultural exhibit, the Ministry extended its interest to the horticultural side of food production, and was represented on forty-five occasions by an exhibit either at Horticultural Shows or in leading country markets. This new departure was designed in the first instance for the benefit of the smallholder, whose methods do not keep pace with his enthusiasms and whose opportunities for acquiring wider knowledge of sound method are few. This exhibit has now been enlarged and its scope broadened, and it is sufficiently comprehensive to provide a good deal of help and guidance, even for the advanced fruit grower. Among the subjects on which information is given through this medium are reliable fruit stocks, pollination and "reversion" of black currants, the preservation, grading, packing and storage of fruit, the history of insect pests and fungoid diseases, and the value and methods of apiculture. In addition to the ordinary exhibit, a special one has been provided to show the results of investigations of Wart Disease as carried out at the Potato Testing Station at Ormskirk. Not only have specimens of diseased potatoes been on view, but there have been specimens of those immune varieties that may, when fully accepted by the industry, enable this country to show a clean bill of health. It is proposed during the season now about to open to provide an exhibit at thirty Agricultural, Fat Stock and Horticultural Shows.

MINIMUM PRICES OF WHEAT AND OATS OF THE 1921 CROP.

THE Ministry of Agriculture and Fisheries thinks it desirable to explain the procedure in regard to the minimum prices guaranteed by the Agriculture Act, 1920, in respect of wheat and oats produced in 1921. These minimum prices will not affect the marketing of wheat and oats. Every grower will be free to dispose of his wheat or oats in any manner he may desire, and at the best prices he can obtain.

Calculation of Minimum Prices.—The Act provides that the minimum prices for any year are to be such prices for a statutory quarter as correspond to the following minimum prices for 1919, which is to be taken as the standard year:—

Wheat ... 68s. per customary quarter of 504 lb.
Oats ... 46s. ,, ,, ,, 336 lb.

The minimum prices for 1921 will be ascertained and certified by three Commissioners appointed in accordance with the provisions of the Agriculture Act. As soon as possible after the completion of the harvest, the Commissioners will ascertain the percentage by which the costs of production of the wheat and oats respectively of 1921 are greater or less than the costs of production of the wheat and oats of 1919.

The minimum prices for 1919 set out above will then be increased or decreased by the same percentage as the cost of production in 1921 has increased or decreased, and the equivalents for a statutory quarter of the prices calculated in this way will be the minimum prices per statutory quarter of wheat (480 lb.) and oats (312 lb.) respectively for the year 1921. As soon as the minimum prices are certified by the Commissioners, they will be published by the Ministry of Agriculture and Fisheries.

Payment to Growers of Wheat and Oats.—No payments will be due to producers of wheat or oats unless the minimum price for wheat or oats as fixed by the Commissioners for 1921 is greater than the average price for wheat or oats for the seven months from 1st September, 1921, to 31st March, 1922, as calculated from the weekly returns made under the Corn Returns Act, 1882. These average prices will be published in the London Gazette as soon as possible after 31st March, 1922.

If the average price for wheat as so ascertained is less than the minimum price as fixed by the Commissioners, each

grower will be entitled to four times the difference for each acre on which wheat was produced, and if the average price for oats is less than the minimum price each grower will be entitled to five times the difference for each acre on which oats were produced.

It is to be observed that if the average prices for wheat or oats are greater than the minimum prices no payments will be due, even though an individual grower may have sold his wheat or oats at less than the minimum price. It is the average price over the whole country which decides whether any payment has to be made to the grower and not the actual price realised by him.

The amount payable to any individual grower will thus depend on the area on which he produced wheat or oats. The yield per acre which he obtained, or the price at which he sold his crop, will not affect the amount payable.

It will be seen that it will not be known until after the end of March, 1922, whether any payment and, if so, how much is due in respect of wheat or oats produced in 1921. Any payments then due will be made by the Ministry of Agriculture and Fisheries as soon as possible.

Claims.—No payment will be made unless a claim is made in respect of the area on which the wheat or oats have been produced. Forms of claim for 1921 will be issued along with the forms on which the Agricultural Returns have to be made on 4th June, 1921. The claims must be forwarded direct to the Ministry of Agriculture and Fisheries not later than the 30th June, unless the claimant can show that he became the occupier of the land after that date, in which case the Minister may accept a claim made not later than the 1st September, 1921.

The claimant will be required to enter on the form of claim particulars of each separate field of wheat or oats. The number of each field as shown on the 25-inch Ordnance Survey Map, and the ploughed area of wheat or oats in each field, will have to be stated. These detailed particulars are necessary to enable the Ministry and the County Agricultural Committee to verify the accuracy of the claim.

Copies of the Ordnance Survey Map on the 25-inch scale can be purchased through any bookseller, price 5s. per sheet. In most districts copies of the map of the district can be inspected at the office of the County Agricultural Committee. Information as to the number of fields can also be obtained

at the local office of the District Valuer of the Board of Inland Revenue. The Assistant Overseer may also possess a copy of the map of his parish. In case of difficulty, inquiry should be made of the Cultivation Officer of the County Agricultural Committee. Farmers are advised to take steps forthwith to ascertain the numbers of the fields sown or intended to be sown with wheat or oats as shown on the 25-inch Ordnance Survey Map.

Mixed Corn.—Where wheat or oats have been produced intermixed with another crop, the amount payable in respect of the area of wheat or oats will be adjusted in such manner as may appear proper, but the claimant will be required to state in his claim the quantity of each kind of seed sown per acre in the mixed crop.

Persons entitled to Claim.—The person to make a claim is the person who on the 1st September, 1921, is the occupier of the land on which the wheat or oats have been produced. Where, however, there has been a change in the occupation of the land and the outgoing tenant is under custom or otherwise entitled to harvest the wheat or oats, he will be the person entitled to claim.

Land Negligently Cultivated.—In any case where it appears that land in respect of which a claim is made has been negligently cultivated, the payment to which the claimant would otherwise be entitled may either be altogether withheld or may be reduced to such extent as may be thought proper to meet the circumstances of the case.

Penalties under the Act for False Statements.—The attention of farmers is drawn to the importance of filling up their claim forms accurately and carefully.

Section 3 (3) of the Corn Production Act, 1917, provides that:—

> If for the purpose of obtaining a payment under this part of the Act, either for himself or for any other person, any person makes any false statement or false representation, he shall be liable on summary conviction to imprisonment with or without hard labour for a term not exceeding six months, or to a fine not exceeding fifty pounds, unless he proves that he did not know and could not with reasonable diligence have ascertained that the statement or representation was false.

Amounts improperly obtained are recoverable by the Ministry.

RESEARCH IN ANIMAL BREEDING.

I.

R. C. PUNNETT, F.R.S.,

Professor of Genetics, University of Cambridge.

WHEN Mendel's discovery in heredity, made over 50 years ago, was unearthed in 1900, it was at once clear to a few scientific men that a new era in the breeding of animals and plants had commenced. What the breeder requires is "certainty" in so far as it is possible to attain it. When a given mating is made he wishes to know what is likely to result, and further, as he is generally of an intelligent and inquiring mind, why the result is obtained.

Through Mendel's work and its recent development the breeder is at last being placed in a sound position to answer these questions. Plant breeders have not been slow to take advantage of the new knowledge. Realizing early the immensely greater powers of control over the living thing conferred upon them by Mendel, they set to work to build up new strains of cereals and other valuable plants. It is unnecessary to detail here the remarkable success which has already attended their efforts, nor to forecast the enormous economic gain that must come to the world when the methods are applied to the produce of vast tropical areas. The rapidity with which plant breeding stations are springing up in both hemispheres is evidence of the service which Mendel rendered to mankind.

While, however, the plant breeder is now fairly embarked upon his career of conquest, the breeder of animals tends to lag behind. Nor is this difficult to understand. The majority of plants are self-fertilized. It is an easy matter to obtain the pure strains essential for purposes of Mendelian analysis, to keep them pure, and to purify any desirable new strain that may be built up. Animals with their bi-sexual mode of reproduction are far more complicated things to deal with, and as we shall see later, the separation of the sexes may in itself introduce complications peculiar to this mode of reproduction. Then again, plants are cheap owing to their great powers of multiplication. Thousands of wheat plants may be grown for the cost of a pig. This rapid multiplication of plants renders more easy the process of Mendelian analysis, and in consequence, man's power of control over them is enhanced.

It was proved years ago that Mendel's principles of heredity apply equally to animals and plants, and the importance of the subject led the Board of Agriculture some years ago to set aside a small grant from the Development Fund for research in animal breeding. The sum allotted, less than £200 per annum, only allowed of work being undertaken with small animals such as poultry and rabbits, but this in itself was no disadvantage, for the object of the work was not to improve the breeds of rabbits and poultry, but to acquire knowledge of the laws which underlie inheritance in animals generally. In this series of brief articles an attempt will be made to indicate the drift of these experiments, and their possible bearing upon economic problems. Before doing so, however, some account must be given of the nature of Mendel's discovery itself; this is the corner stone of our present knowledge, and unless it is clearly understood, later developments must prove unintelligible.

The essence of Mendel's discovery may best be made clear by a simple example, from cattle. The breeder knows, perhaps only too well, that red calves are apt to appear occasionally even in the most highly pedigreed breeds of Aberdeen Angus or Holstein. They are rarely welcomed, and in most cases the breeder would go to a great deal of trouble to ensure that they never appeared in his herd. He tries to get rid of the taint by vealing the red calves, but still they come from time to time. He may try to explain their appearance as a throw-back to some remote ancestor, and though this may ease his conscience it does not help to purify the herd. Mendelism enables the breeder to understand why these red calves appear, and provides the knowledge which can be used to prevent their ever appearing again.

Let us suppose a Mendelian analysis of this case to be made in the usual way. The first step is to cross the red with the black, and it will be found that the pure black bull crossed with red cows will produce black calves only (see Fig. 1). For this reason, black is said to be *dominant* to red, which is *recessive*. The next step is to mate together these first crosses, or F1* animals as they are termed. It will be found that their progeny, the F2 generation, consists of both blacks and reds, but not mixtures of the two colours, and if a sufficient number

* For the sake of clearness in experimental work the cross is taken as the point of departure. The first cross animals belong to the first filial = F1 generation. When F1 animals are mated together they produce the 2nd filial or F2 generation, F2 animals mated together give a 3rd filial or F3 generation, and so on. Similarly in the other direction the parents are labelled as the P1 generation, the grandparents as the P2 generation, and so on.

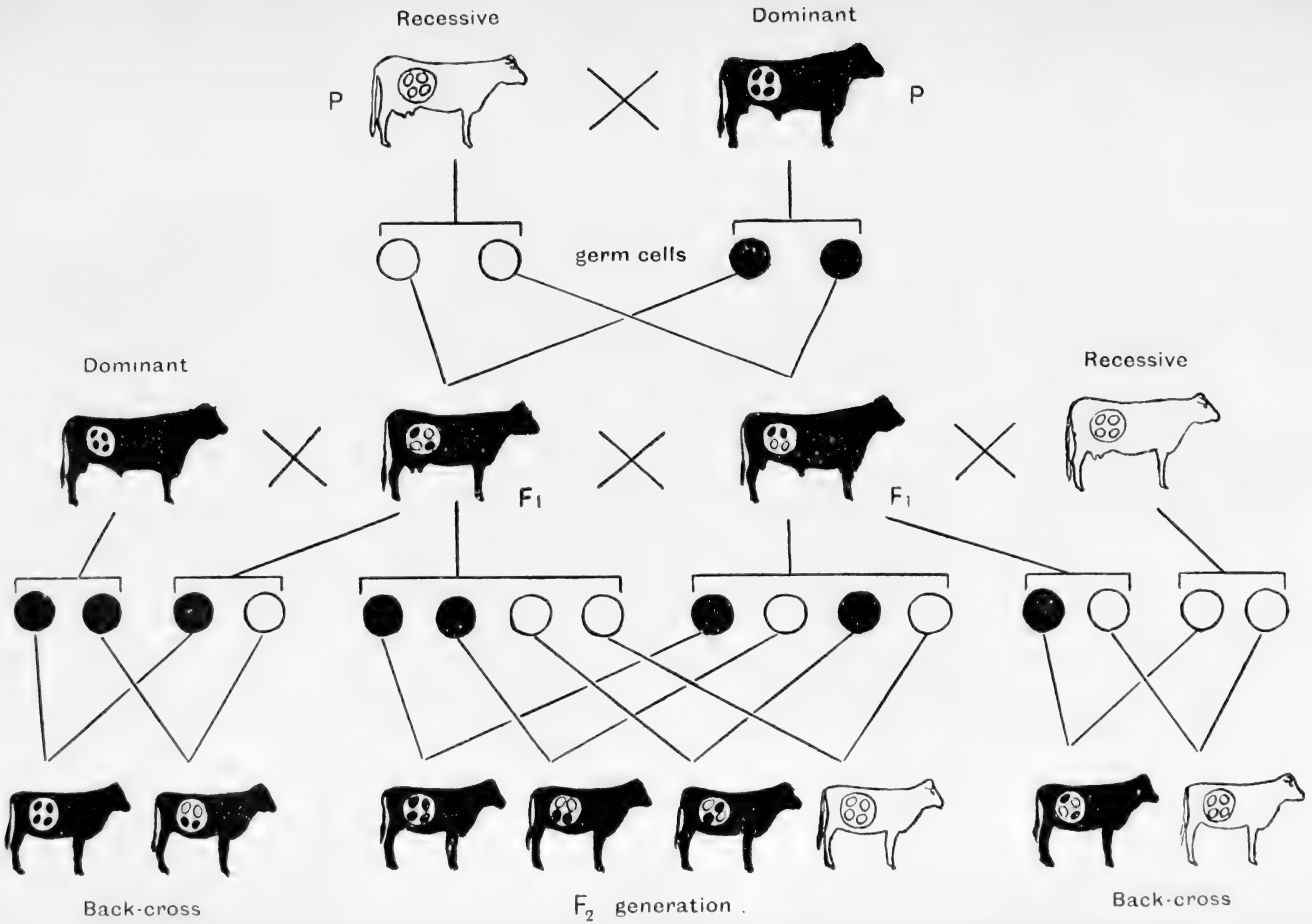

FIG. 1.—Illustrating simple Mendelian Inheritance in a Cross between Red (recessive) and Black (dominant) Cattle. The nature of the Germ Cells carried by each animal is indicated inside the circle on its body.

have been reared, it will be found that the blacks are about 3 times as numerous as the reds. To cover such facts Mendel devised a simple explanation in terms of germ cells. Red and black are alternative in heredity because they are alternative in the germ cells. A germ cell contains *either* that which causes the development of black pigment *or* something which causes the development of red pigment; but it is in the order of nature that it cannot contain both. It is not known at present what these contents are, but as their existence is recognised a name must be given to them, and they are usually spoken of as *factors*. A germ cell, in our cattle then, contains either the factor for black or the factor for red. When an animal breeds true to a given character it means that all its germ cells carry the factor for producing that character. All the germ cells of a true breeding black contain the factor for black, and all the germ cells of a true breeding red contain the factor for red.

Let us refer again to the diagram (Fig. 1). If a red cow is crossed with a black bull a " red " germ cell from the cow is being united with a " black " germ cell from the bull. The resultant animal will be black because black is completely dominant over red, but although it is black it is not a true breeding black. When such an animal reaches maturity it produces germ cells corresponding to the germ cells by which it was produced itself. In their formation the red and the black factors separate cleanly from one another, and in consequence half of its germ cells contain the black factor and the other half contain the red factor. The F1 animals, therefore, whether bulls or cows, produce " red " and " black " germ cells in equal numbers, but owing to the complete dominance of black, they are indistinguishable from true-breeding blacks in appearance. Their genetical constitution, as indicated by the output of germ cells, is very different. The nature of the germ cells produced is diagrammatically represented in Fig. 1 by the contents of the white circles on each animal. When two F1 animals are mated, two similar series of germ cells, each consisting of equal numbers of " red " and " black," are brought together.

Normally only a single ovum of the series produced by any individual cow will be fertilised, but the probabilities are equal of this being a " red " or a " black " ovum. If it is a " black " ovum it is equally likely to be fertilised by a " black " or a " red " sperm. In the former case it will give a true-breeding black: in the latter it will give a black of similar nature to the

F1 animals. If it is a " red " ovum it is also equally likely to be fertilised by a " black " or a " red " sperm. In the former case it will give a black of similar nature to the F1 animal; in the latter case it will produce a red. In considering the calf thrown by an F1 cow mated to an F1 bull, the possibility of its being red is 1 in 4, of its being a true-breeding black 1 in 4, and of its being an impure black (*i.e.*, a black that produces both " black " and " red " germ cells) is 2 in 4. If a large F2 generation from a number of F1 cows mated to F1 bulls were raised, we should expect the F2 generation to consist of blacks and reds in the proportion 3 : 1; further, of the blacks, only 1 out of 3 would breed true to black in the sense of producing only black germ cells. The others would act like the F1 parents and throw about 25 per cent. of reds if mated together.

The truth of Mendel's interpretation can be further tested by mating what are called " back-crosses," *i.e.*, by mating the F1 animals back to the parents. Suppose, as is shown on the left of Fig. 1 that the F1 cow is mated to the pure black bull. As the cow's germ cells are of 2 kinds, " red " and " black," and those of the bull are all black, we can obtain only two sorts of animals, viz., those formed by the union of a " black " ovum with a " black " sperm, and those formed by the union of a " red " ovum with a " black " sperm. The progeny will be all black in appearance, but while half of them are true-breeding blacks the other half will be capable of throwing reds when suitably mated. Again, if the F1 animal is mated with the recessive red as shown on the right side of Fig. 1, the germ cells of the F1 being " black " and " red " in equal numbers, and the germ cells of the recessive being " red," red and black among the calves would be obtained in equal proportion. Moreover, all the blacks so produced would be of the same constitution, *i.e.*, they would have the same output of germ cells as the F parent. No true-breeding black would come from such mating.

For the information of the breeder, the substance of the matter is that when a definite pair of alternative characters is being dealt with, of which one is dominant and the other recessive, only three classes of animals are possible: (*1*) the animal produced by the two *like* germ cells, both carrying the factor for the dominant character; (*2*) the animal produced by two *like* germ cells, both carrying the factor for the recessive character; and (*3*) the animal produced by two *unlike* germ cells, one of which carries the factor for the dominant, and the other for the recessive character. (*1*) is the true-breeding dominant, (*2*) the true-breeding recessive, and (*3*) the impure dominant,

which, though like the pure dominant in appearance, differs constitutionally from it in producing both "dominant" and "recessive" germ cells in equal numbers. The true test of the pure bred animal is that it breeds true, and this we cannot tell from its appearance, but only from the nature of the germ cells that it produces. Mendel's advice to the breeder is: "Think in terms of germ cells."

If the breeder wishes to prevent the appearance of reds in his herd he must eliminate the red germ cells, as these may be carried by blacks as well as by reds. The impure dominant blacks must be weeded out in order to be sure that red calves will not appear. Through Mendelism there is now a definite test that can be applied to determine whether the black is pure or not, and that test is to mate with the recessive; so mated, the true-breeding black will produce only blacks, while the impure dominant will produce an equal number of blacks and reds. This of course is a policy of perfection, and unlikely to be put into practice. Cows in a pedigree herd are too valuable to devote an appreciable proportion of their progeny to testing operations. But since red calves are never born of blacks, unless both parents are impure dominants, it is clear that the use of a bull which had been tested by mating to red cows, and shown to produce only black progeny, would be sufficient to prevent the appearance of red calves in a herd, whatever the proportion of impure dominants among the cows. In practice, therefore, the breeder would be well advised to make sure of the bulls by testing them, even though he did not trouble about the cows. But although nothing but blacks will be produced, the red germ cells will still be scattered about in some of the cows. He cannot be sure, without testing, that an animal sold out of the herd will be a pure black. Nevertheless if he makes use only of tested bulls the proportion of impure dominants among the cows will gradually decrease, and the possibilities of any beast sold being a true black will increase correspondingly. If, however, he uses a new bull without testing it, and it happens to be an impure dominant, a considerable increase must be expected in the number of red calves in later generations, for such a bull introduces as many "red" germ cells as "black," and must necessarily increase the proportion of impure dominants in the herd.

The breeder may reason that, provided the animal brought into the herd had a good pedigree, why should further trouble be taken? If its ancestry shows an unbroken line of blacks for, say, the last 10 generations, is it not practically certain that none but black calves will be thrown? The answer is that pedi-

gree is certainly *some* guide to breeding capacity. An animal with a line of black ancestry is more likely to be a true-breeding black than one that has a strain of red in its pedigree, but it is not a sure guide. The " red " germ plasm may be carried on by blacks for many generations, without coming into the open in the form of a red calf. This is illustrated by the imaginary pedigree shown in Fig. 2. The impure dominant cow in Gen. I carried " red " germ cells, and the " red " germ plasm passes down to her daughter, grandson and great-granddaughters.

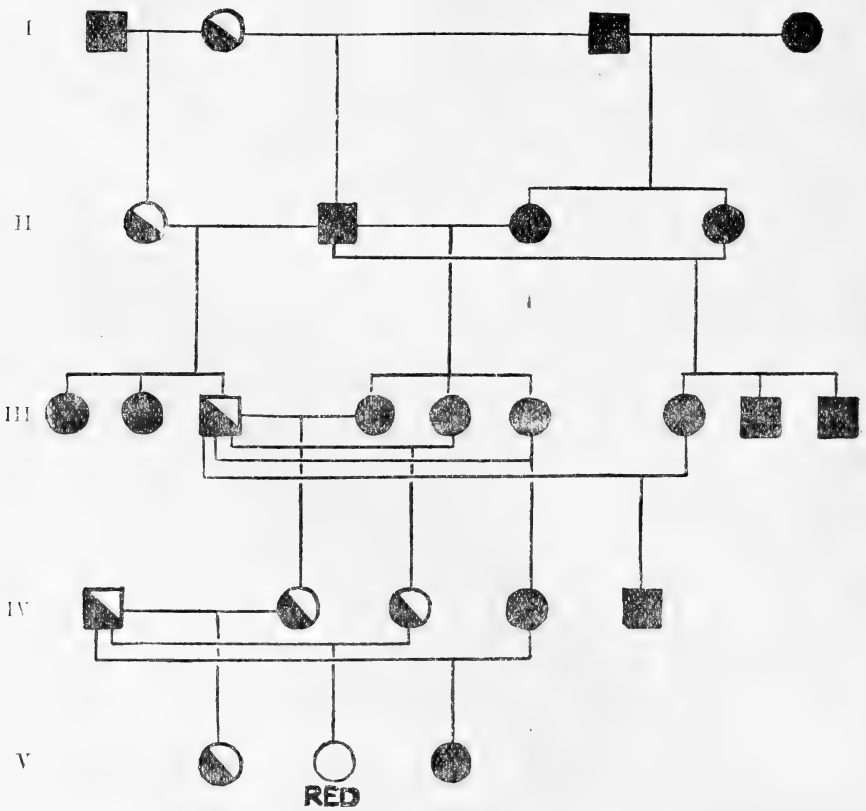

FIG. 2. Illustrating an imaginary Pedigree of Black Cattle. Bulls represented by Squares: Cows by Circles. True-breeding Blacks represented by full black: impure Dominants, carrying Red, represented half Black and half White.

No red calf appears because all of these animals, except the last, have been mated with pure dominants. But at Gen. IV a new bull is introduced which turns out to be an impure dominant, though it may have had only black in its pedigree for generations. If one of the great-granddaughters of the original cow is mated to this bull, it will produce a red calf in Gen. V. Had the breeder tested the bulls used in Gen. III and Gen. IV by mating them with red cows a proportion of red calves would have been

thrown. Had he then substituted for these animals bulls which threw only black calves to red cows he would have broken the sequence of the "red" germ plasm and established a true-breeding strain of blacks. Pedigree is a rough guide in estimating the possibilities as to whether the black belongs to the class of true-breeding blacks, or to that of the impure dominant blacks, but *certainty* as to the nature of the animal can only be arrived at by the direct test of mating to the recessive red. By using only tested bulls the breeder can be sure that none but blacks will appear in his herd. The true test of the purity of a given animal for a given character is not in its pedigree, but the nature of the germ cells that it produces. We now have a reasonable explanation as to why the "pure bred" beast may be nevertheless in reality an impure dominant.

The relation between the animal and the germ cells that it produces is the essence of Mendel's discovery, and must in future form the basis of the breeder's operations where purity of breed and character is desired. Where the character depends upon a single pair of factors, as in the black-red cattle case, the procedure for ensuring purity is simple; and there are a number of such simple cases in connection with farm live stock. Many of these concern coat colours because they are evident and easily worked out. The polled and horned characters in cattle form such an alternative pair, the latter condition being recessive.* Horned animals appear in polled breeds in precisely the same way that reds appear in black breeds, and the procedure for ensuring a herd true to the polled condition is the same as that for obtaining a herd of blacks which throws no reds. Further. Suffolk sheep are liable to throw inferior lambs with brownish markings in place of black. Records suggest that this character behaves as a simple recessive, and could be eliminated by the usual procedure.

The characters that breeders are concerned with are rarely so simple and distinct as the black-red case in cattle, for the possibilities rarely form a simple alternative pair as already described. Usually they are far more complicated, and all kinds of gradations are possible. Hence arises the question whether such complicated cases can be resolved in terms of a few definite factors showing a similar scheme of transmission. Will the general principle of heredity outlined above serve to cover the more complicated cases? Is Mendelism heredity, or is there any other kind of inheritance? These questions will be dealt with in the next article.

* Polled animals carrying the horned character sometimes show small "scurs."

NOTES ON FORAGE CROPS.

JAS. C. BROWN,

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A CONSIDERABLE range of forage crops is available to the farmers of this country, and several of these are well tried and have been grown for many years. There also exists a much more extensive array of forage crops, which, while obviously having great future possibilities, are at present debarred from being grown generally, through suffering from one or more weaknesses which make them uncertain in productiveness, or unsuitable in use. An extensive field awaits the improver of crops, but the importance of the opportunity has not yet been fully realised.

Lucerne.—Lucerne may be taken as an example of the need for improvement in fodder crops, as it seems certain that this plant could be made suitable to the varying conditions of soil and climate existing in this country. This crop has a habitat almost as wide as the wheat crop, and where it succeeds is unrivalled in productiveness. All attempts to render soil suitable by manurial treatment seem to have failed, and inoculation by bacterial cultures has not given very hopeful results, however effective in America. Throughout the world varieties of this plant are being developed suitable to particular regions, but in England no variety of this crop has as yet been raised which is adapted to the general conditions of agriculture of the country. In the United States Grimm's Alfalfa, has proved its superiority over the common varieties, while a most interesting series of hybrids of *Medicago sativa* and *Medicago lupulina* have been obtained in Canada. It may be hoped that some of the types obtained by the above crossing may be suitable for cultivation in Britain, and that they may possess the hardiness and suitability to the climatic and soil conditions of this country.

Bush Vetch.—Other examples of plants which admit of improvement are Prickly Comfrey, the Flat Pea and the Bush Vetch (*Vicia sepium*) particularly the last. This plant is, without doubt, one of the most valuable fodder plants indigenous to this country: herbage containing it is sought by cattle in preference to almost all other kinds, and greedily consumed. It possesses

a combination of qualities not found in any other pasture plant. It is extremely hardy, has a penetrating root, spreads rapidly, and produces heavy crops of high quality. If it could be developed as an agricultural crop it would solve the problem of clover-sick land, and further add to our pastures a crop equal in quality to wild white clover, and in productiveness to the ephemeral red clover. Sir John Sinclair speaks of a field in Scotland growing a crop of this vetch, and giving yields equal to Lucerne. In its wild state it is a far superior plant to the wild ancestor of the cultivated vetch, and but for a single weakness, would have been to-day one of our most prized farm plants.

The writer's attention was drawn to the plant many years ago by the preference cows showed for its herbage. Seeds were collected with a view to sowing a trial plot for grazing or mowing, but none of the seeds sown germinated. This failure was experienced by others, some of whom suggest insect attack as the cause, but it is more probable that the seeds resemble hard clover seeds.

It is only necessary to picture a field of the ordinary vetch with a permanent character to estimate the possibilities of this plant if it could be brought into cultivation. The writer tried for several years to obtain hybrids of this vetch with the cultivated vetch but failed.

Siberian Vetch.—Siberian Vetch (*Vicia villosa*) is another neglected species of vetch. It is largely grown in America, especially on very poor light soils, where it is known as the Hairy Vetch, and to a considerable extent in Russia and other continental countries. During the 18th century it was grown to some extent in England, and its chief characteristics were noted accurately.

Mills' Practical Husbandry published in 1762 says:—"Another species of Vetch, viz., The Siberian, hardly known I believe to the generality of farmers in this country, bids fair to become perhaps the most useful of all fodder: for its stalks grow to a great length, and are well furnished with leaves which do not decay in the autumn like those of the other sorts, but continue green all winter in defiance of the hardest frost."

The Siberian Vetch is semi-biennial in character, and should be sown after midsummer and before September; if sown in the spring it produces seed in August and afterwards makes a second heavy growth which continues until cut down by frost. At the

Harper Adams College it has often been growing luxuriantly, and flowering profusely in November. It is more hardy than the Common Vetch, makes an earlier growth in spring, and is more productive of foliage and flower, but the stems are harder and covered with hairs: also the plant appears to have a less watery composition. It yields seed abundantly in England, and owing to the small size of the seed a large number of plants are produced per bushel. Further, the plants branch profusely and fill up open spaces in the crop. Like the Bush Vetch, it will not hybridise with the Common Vetch.

Vetches.—From the earliest times the Common Vetch has been a favourite forage crop, and at the present time is one of the best of British fodder crops. It is especially valuable for providing keep for sheep, and it makes an excellent food for horses after the watery period of growth is past. For cattle and pigs, however, it is inferior to pea forage, and it has no significance as a seed crop. Vetches need more support than peas and are more difficult to harvest in good condition. A very heavy crop of vetch and cereal forage is liable, especially in wet weather, to rot near the ground, sometimes to the extent of a third of the crop, and to be laid flat. Makers of silage should consider the Harper Adams Soiling Crop No. VI, which does not lodge, and can be cut and carried without difficulty. The writer has not the experience to offer an opinion as to whether peas and beans are as suitable for this purpose as vetches, but in America oats and peas are commonly used.

Another member of the *Vicia* family which is worthy of the attention of the plant improver is the Narbonne vetch which has erect stems and does not require the support of other plants. In appearance it resembles the bean plant more closely than the other members of the vetch family: it is fairly productive, but somewhat delicate.

Vetches are not well suited for making into hay owing to their rapid deterioration under adverse weather conditions, the slow rate at which drying takes place, and their tendency to be over-run with mould in the stack. Well made vetch hay is good fodder, but pea hay is much superior. Vetches pulverise the soil but to a less extent than peas. Two British varieties are marketed, winter and spring, but the writer cannot distinguish between them. In 1916 the winter vetches sown in September were killed by frost, those sown in

November survived. Two new varieties have been placed on the market by the Svalof Plant Breeding Station, and for spring sowing they appear to be more productive than the common kind. They produce more leaf, and there is a difference in the character of the flower.

The Pea.—The pea has considerable claims to be regarded as the most important forage crop for feeding to cows and pigs. For sheep, in the green state, it is less suitable than vetches, and if fed in too large quantities will cause stomach trouble, but the dried haulm is prized by flockmasters for feeding to sheep folded on roots. At all stages of growth the pea plant is a suitable food for pigs, a fact which was well understood in byegone times, as the following statement from Mills' Practical Husbandry shows :—

" The farmers of Staffordshire frequently sow on poor light shallow land, a small white pea, which they never reap but turn in as many hogs as they think the crop will fatten, and let them lie upon it day and night."

Peas succeed on a wide range of soils, and can be grown successfully in all parts of the United Kingdom. They give the highest yields of forage on land containing a considerable percentage of clay, and they prefer a lumpy tilth to a finely prepared soil. Field peas may be sown for forage at any time from the beginning of November until the middle of June, and a succession of pea forage can be obtained by sowing at intervals. The pea is a useful crop for reclaiming very light soils if sown early in the spring, while it can be cultivated successfully in many districts on the New Red Sandstone, where satisfactory crops of oats cannot be obtained. This land is poor in lime and rich in magnesia and overrun with the weeds fumitory and mayweed.

Experiments with Field Peas.—In the soiling experiments, the garden pea was first used, but failed entirely owing to an insufficient root system for field conditions. Experiments were carried out later to test the relative value of field peas, with the following varieties:—Svalof Grinding pea, Svalöf Concordia, Svalof Capitol, Svalof Solo, Golden Vine, Bangalia, Kaiser, Wisconsin Green, English Gray, Dun, and the Maple pea.

Of these the English Gray, Dun and the Maple proved the most luxuriant growers, but the Golden Vine also gave good results. All field peas have succulent stems until the flowering period, but after that time the stems harden rapidly, whereas those of the garden pea do not become so woody. Infinite pains

have been taken to improve the garden pea, because of its value as a human vegetable food, but comparatively little has been attempted in the way of improving the field pea in England, although new varieties have been introduced by the Svalöf Plant Breeding Station, and by the experiment stations of the Department of Agriculture of the Dominion of Canada. If, however, the wild pea which Mr. Sutton brought from Palestine is the ancestor of the field pea, unrecorded but very successful efforts must have been made in the past to improve it. As in the case of the common vetch, the cultivated varieties of peas are immeasurably more productive than the wild ancestor.

Mendelian Experiments.—In the tests made at the Harper Adams College it was shown that the varieties in general cultivation in England are the best at present obtainable, and as these leave much to be desired as fodder crops, a series of hybrids was made with the most luxuriant growers among the garden peas. A Mendelian scheme was planned but the F2 generation was too complex for the original scheme to be followed up with any hope of immediate success. The results are interesting. To give an example, a cross of the Gladstone garden pea with the maple field pea yielded green, blue and yellow seeded peas, both round and wrinkled in each case, all of which have been fixed. As regards vegetative characters, both the parents being tall, the appearance of a considerable percentage of dwarf plants was a surprise. The object of the experiment, was, however, to breed an improved Soiling Pea in the shortest possible time, and for this purpose fourteen of the most luxuriant plants were selected, and tested, those possessing unstable characters or showing weaknesses were eliminated. The type finally selected has much more foliage and stem, is a more rapid grower, and is less woody than the field pea. Attempts made to improve the pea as a soiling crop revealed the possibility of improving the plant as a seed crop. Owing to long and persistent efforts the pods of the garden pea have been increased in size, while those of the field pea have remained comparatively small. By crossing with the garden pea, and making selections, it has been found quite easy to increase the size of the pod without reducing the number of pods per plant, and types have been established especially suited to growing in mixture with oats to be harvested for seed.

Mixed Pea and Oat Crops.—It has for long been a practice in the neighbourhood of Market Drayton to mix peas with the

oat crop to be harvested for thrashing, but the difficulty has always been to prevent the crop becoming laid. The only precaution possible is to keep the proportion of peas small. If the mixture is to be harvested in sheaves, it is necessary that the pea should ripen in advance of the oats. A mixed crop of peas and oats is one of the means by which the grain yield of weak soils can be raised. It is possible to grow the mixture successfully on soils which will not give a profitable crop of oats. The presence of peas in a crop of oats seems to increase the growth of the oats, and particularly in respect of the size and yield of the ear. The chief drawback to the crop is the risk of its lodging as a result of the heavy load of grain it carries.

It is hoped that the new peas, with light foliage, comparatively short stem, and early ripening, will help to make this mixture popular, especially on soils where the oat yield is below 40 bush. per acre. On really first-class oat soils the mixture would not be satisfactory. In combination with Duns oats a mixture of peas and oats gives the heaviest hay crop obtainable.

Cereals.—All the cereals, when cut green, are good fodder for all kinds of live stock, and there appears to be little to choose between them; the oat, however, is considered the most suitable.

Rye is important because of its earliness, and its ability to grow during the winter months, but unfortunately its period of usefulness is short, as the stems become hard much more rapidly than in the case of the other cereals. It is rejected by live stock after seed formation has commenced. Three varieties are known in England, Common Rye, Giant Rye, and St. John's Day Rye. Giant rye gives the earliest and heaviest crops. Many other varieties exist throughout the rye growing districts of the world, but these have not yet been tested in this country.

Barley, in its early stages of growth, is preferred to all other cereals by sheep which will pick out this plant first in grazing. For feeding to cattle, however, the awns are a drawback and are disliked. Barley can be sown later than oats with the certainty of securing a satisfactory crop. The winter barleys are most suited for the purpose of fodder cropping. A recent introduction is Manchurian barley, which owing to its leafy and rapid growth, appears to have superior possibilities as a forage crop.

Wheat, cut green, is excellent fodder, and a mixture of wheat and vetches stands much better than mixtures of barley and vetches, or oats and vetches. In districts which lie at too high an altitude to ripen wheat, and where it grows luxuriantly, it is worth while considering the growing of wheat for dry fodder to be cut in the milk stage, tied into sheaves, and dried in the stook. Cattle thrive remarkably well on wheat straw harvested in the green stage. Browick Grey Chaff wheat, owing to its hardiness, is recommended, but it is hoped shortly to put into cultivation varieties specially raised for the purpose of giving large yields of stem and leaf.

The oat has always been recognised as one of the best of the cereals for fodder, particularly the old varieties such as Clemrotheray, the seed of which can be obtained in quantity. The modern seed oats are unsuited to the purpose, because of their habit of growing thinly on the ground, and their want of hardiness. By far the best of all oats for forage is the variety known as Duns, which unfortunately is not in general cultivation. It is the ideal forage oat, it grows densely on the ground, is leafy, succulent, tall, and stands well, and it is difficult to imagine how it could be improved. At the Harper Adams College, during a year of badly laid corn, a field of Duns oats, although six feet high, remained erect at harvest time. The ears are light but large, and the grains long and lean, in consequence of which it does not give yields of grain on good land equal to those of the grain oats. A great point in its favour as a fodder crop is its lateness, and its slow ripening; it remains green and succulent for a long period. It consists of many types, and could be made more uniform by selection.

Buckwheat.—Buckwheat has long been known as a useful forage crop. Mills among other writers speaks well of it. He says:—

"Milch cows fed on buckwheat will yield an extraordinary quantity of milk, remarkably good for making into butter and cheese, and another advantage attending this pasture is that it will continue green in the driest time of summer when other grass is burnt up."

Buckwheat has been grown and fed successfully at the Harper Adams College in conjunction with peas and rape, and the writer urges a trial of this mixture by those who have poor light soil. Buckwheat will grow on the poorest soils, and if the crop were eaten off by sheep the land would be in a con-

dition to carry a crop of winter barley, even on soils too poor to give a profitable crop under ordinary methods of cultivation.

Beans.—The bean plant is quite good forage, and is readily eaten by cattle, even the thick hard stems. Sheep do not eat the bean plant if other fresh green food is available. The bean has a special value in forage cropping, as it is the only forage plant which can be trusted to remain erect under all conditions, and which can be sown at any season of the year. For cutting green, the common winter horse bean is the most suitable. For spring sowing for seed production, the Mazagan is the most satisfactory. As in the case of the pea the roots of the bean pulverise the soil and leave it enriched for the following crops. In making mixtures containing beans it is necessary to sow at least one bushel per acre to obtain the strength necessary to support a heavy crop of trailing plants.

THE HUMAN MACHINE ON THE LAND.

W. J. MALDEN.

IT is not necessarily the strongest labourer who does the most work or who is the least tired at the end of the day. Much labour at the present time employed in arable farming is inefficient, and consequently energy is misdirected. Assuming that 100 per cent. represents the efficiency of a labourer of all-round skill, the average for the whole country to-day is not more than 60 per cent. Something like £100,000,000 is paid yearly in wages. Forty per cent. wasted through inefficiency is a big charge on the land and the country. When several millions of acres went from the plough in the 'eighties and 'nineties of the last century, and the rural population largely drifted into the towns and industries, the farmers lost a big portion of the highly skilled men, and many of their more promising sons. Roughly £1,000,000,000 was estimated to have gone out of farms and land capital in those years, and a proper wage reward could not be paid to the labourers.

The War made a heavy call on the men of the land, and many skilled labourers have, as a result, been lost to the industry. Without skilled labour full farming cannot be carried on, but what signs are there that anything is being done to train men to a higher efficiency? Yet the time must come when much of the land will go out of cultivation, unless workmen be endowed with more skill. We are in a fairly mechanical stage on the land, and doubtless invention will come further to our aid, but though a percentage of trained mechanics will be required, it seems perfectly safe to state that in a few years a highly skilled farm worker will command very high wages. The skilled man on the land, able to turn to any kind of live stock, good in the hay time and harvest, a skilled hedger, in fact not lost anywhere, has become a very rare man. If he can do a few of these things really well, he can pretty well make his own terms, and he will be in greater demand as years go on.

In many districts labour has so fallen in skill that farmers have accepted a very low standard, being in fact glad of anything that will see them through at all. The farm worker has descended very much from a farm artisan to a farm labourer; he is often possessed of little skill, and having little joy in his

work cannot take the pleasure in it that his fathers did. Work done in that way becomes drudgery. In saying this one makes many exceptions. In all ways something is needed to bring about better conditions, to give the farm workers a greater interest in their occupation, and to make their lives more valuable to themselves and to others. Interest must be aroused in their work. They should be made skilled so that they may feel an honest pride in their work just as they should in their play.

Farm Labour as Farm Athletics.—I have always regarded physical work on the land as farm athletics. This is probably due to the fact that I was reared in a district where work was exceptionally skilled, and where competitions in the arts of husbandry excited as much interest as a local football match does to-day. As a native of Bedfordshire, I was brought up under the direct influence and outcome of those remarkable historic Woburn Sheep Shearings which began towards the end of the 18th and continued into the 19th century. It was in them that the great effort of the Dukes of Bedford, Coke of Holkham, Ellman of Glynde, and other giants of those days set themselves to wake up farming from the sleep in which it had slumbered for some centuries. These gatherings were notable in that they instituted in a broad manner competitions by workmen in acts of husbandry. These farm workmen's competitions acquired world wide repute, and before the 19th century opened a few county agricultural societies were founded, mainly to further skill in farm labour. Naturally from immediate association Bedfordshire inaugurated a Society; and until quite late in the century when hard times in farming stopped them for a few years the competitions aroused the greatest enthusiasm, and exercised a big influence. Farmers and workmen shared equally in the spirit of emulation aroused, and the county ploughing matches even sixty years ago were the hunting ground where the large agricultural machinery firms sought men of skill and resource to be taken to demonstrate the value of their implements and machines throughout the world. Further, the market gardens and the seed growing areas in the Biggleswade and Potton district developed men of skill in the handling of tillage tools. Thus, in that and the surrounding counties, arose an all round skill hard to excel. Skill made work easy to the men, competitions aroused enthusiasm, and enthusiasm led men to work with a will. It was not a question of one man being set apart

to do a particular job; every man expected to be an all-round hand.

Suggested Inter-County Competitions.—There are many men farming successfully to-day who owe their success mainly to taking up farms where their predecessors had trained the men to skilled work. Had they not found them they could not have trained them. It is of little use to find fault with bad work if one cannot show the man the right way. In rather a widely varied life on the land I have found nothing so valuable to me as those few years when I took part in and learned farm work from the skilled artisans amongst whom fate threw me, and every youth going on to the land should make as much study of it as of any other section. I should like to see teams of young farmers of one county challenging those of other counties in a wide range of acts of husbandry; inter-county contests between the farm workmen, with a challenge shield for the best county; and inter-school contests between schools in different districts. It would be far more exhilarating than seeing two parishes playing indifferent football! Few have thought what a lot may be learned in farm work in a village school playground; and how a simple training may teach much that is useful. All sports and physical work should be learnt when one is young.

Training in Farm Labour is Easy.—However, training in farm labour is a very simple thing; and is capable of being taught easily and systematically. That amongst older men, there would be opposition to this there is no doubt, and many who have tried to inculcate fresh methods have met a resistance which has caused them to discontinue their efforts, as they have found that sometimes it is better to carry out a bad method well than a good method badly.

In systematising work I have followed closely the practices in the more strenuous sports. No matter what the physical work or sport, no one commences to do it in the right way, whether it is handling a golf club or a scythe, and unless the proper way is shown little skill is obtained. It has to be remembered that a man is a machine—the most wonderful machine in the world—capable of doing any work performed by the most intricate machinery. He is superior to farm animals because they are horizontal machines capable of doing work only in a straight line forward or backward. Man is a hinged vertical machine not only doing this, but able to stoop and lift heavy weights vertically, which a horse cannot do.

Also he has lateral action; by a heave from his hips and a shoulder jerk, he can pitch a sack of wheat sideways some feet clear of himself. He also has linked action through the arms by which he gets arm swing in association with body swing, and so can use a scythe or an axe, and throw heavy bodies from side to side by hand grip. Again, when using a tool he can get an up and down action from arms and body, as in pumping or threshing with a flail. He can also pull with the arms, using body weight. He can utilise the back swing over the hips, together with the leg drive, as in rowing, hoeing, or tug-of-war. He can lift upwards as in digging, or pitch sheaves, or swing a long hedging bill. In fact there is practically no action or combined action he cannot perform. His hinges at the ankle, knee, hips, shoulders, wrists and fingers are under the influence of muscles and tendons, which flex and give rise to powerful actions, which are often assisted by dead weight, and their proper use takes advantage of leverages; moreover, with tools in hand a man finds leverage from these as well as from outside conditions. We do not think of ourselves as machines until we go in for sports; yet a skilled athlete is but an expert artisan in an unproductive calling. A man with skilled training takes little out of himself as compared with one untrained. It is the same in all farm work; brute strength is helpful, but a weaker man who has got the knack can beat the unskilled any and every time, just as an old man who is skilled is worth more on a farm than a young one unskilled.

"Putting one's back into work" means much more than mere exertion, it means using one's force and dead weight to the best advantage. The greater part of all heavy work should be done by the back and legs through leverage and momentum obtained through the joints or hinges, and to a large extent these are obtained merely by skill in actuating them, viz., learning how to apply them to the best advantage. The arms and hands are convenient means through which the power is transmitted to tools, they give "finish" of work, and add to celerity. Knack is merely a proper co-ordination of mind and muscle brought to the position where effort is not needed to work them together; but one may have a bad knack so it is necessary to learn the correct method of working.

When the best method of working is decided upon, it will be found that it comprises a certain number of actions to complete an operation; and these actions will be repeated in the same sequence in each operation. I have analysed the various

operations into individual actions, eliminated the wasteful ones, and taught the others separately. Next they are run together and operation is linked to operation. As these are repeated there must be an easy connection between them making a series of smooth movements each similar, but necessary for continuous work. We see it in mowing, hoeing (when done in the proper manner), digging, axe work, planting cabbages, &c. Finally, the human machine tunes itself up to a speed compatible with endurance through an average working day.

Need for Intelligent Observation.—However, the human machine should be made to bring its intelligence to bear, to realise its powers, and the mechanical forces within it. The simplest laws of mechanics must be followed. These can be taught very simply and quickly by simple illustration. It may be mentioned that little effective work can be done with the legs straight and rigid. The body and legs must relax, otherwise the rocking and rolling actions obtainable about the hinges or joints at the hips, knee and ankle, so necessary to give effect to body swing, either fore and aft or laterally, cannot be obtained. They give an opportunity to take advantage of good footwork and stance—two of the first essentials, as they afford the opportunity to make use of momentum, and to regain equilibrium, without which rythmical actions will not be maintained.

Then again relaxation is needed to allow the body to go down to the squat or crouch to do any work where stooping is required, and to do it without a backache—as in cabbage planting. The body must always have an easy balance or poise, or it will be overbalanced, so that power is lost and a proper sequence of actions cannot be taken. It is not necessary to go near to a man to see if he is working properly; it is shown as soon as he can be clearly seen. Sufficient proof is afforded by the fact that a man keeps time with himself throughout his work. It may be clearly seen whether a man works inside his work, or uses a tight grip where he should use the running hand, or uses the ham knuckle jerk in lifting a sheaf on to a wagon or rick, or is using his body leverage and not merely an arm lift or swing. Whether he understands the simple laws of levers as applied to the mechanism of his own body, has some knowledge of a suitable line of draught, realises the advantage of using his reach, has a notion of timing an action or values the effect of wrist work and other points, is discernible to anyone who has a proper knowledge of skilled workmanship.

Simple Instruction.—By simple demonstration all these are easy to teach to the old or young. It is so simple that it can be taught to children of almost any age, and could be taught in any village school playground; moreover, a boy leaving school at fourteen could be trained thus in many necessary forms of work, and be skilled in work, whereas otherwise he would go on to a farm without skill, and often by working where poor skill prevails, even after a lifetime on it would remain inefficient.

That strength is not the ruling influence in effective working I recently demonstrated through a cinematograph film showing girls after three months' training doing very varied work, including most of the heaviest done on the farm. By the proper application of their powers they were able to work without undue fatigue, they got the knack of doing the work in the most effective manner, and they worked with perfect rhythm.

It may be taken as a pretty safe axiom that if dung is loaded and spread by long handled forks, if hoeing is done by dub-headed hoes instead of swan necks, and if hedges are trimmed back with short (one handed) swaps or fagging hooks, then the standard of work generally is a low one, whilst the absence of cabbages in a stock raising district is pretty good evidence that the men have not learned to stoop without making their backs ache. Yet nothing is easier than transplanting done skilfully. With a proper stoop there is no need for back ache. In many districts there is not a man who can plant 2,000 cabbages a day, yet after short training they are able to do it, and find it easy to plant 5,000. Where this is done the crop is cheaper and more reliable than any other form of root growing.

In view of the large number of persons who have come on to the land wholly unskilled, with little likelihood of training whereby they will become skilled, whether they come as workmen, small holders, men from the services, allotment holders, who are spending energy with small results, one cannot fail to see the low efficiency on the land. Boys come to the land as stop gaps with no knowledge, skill, or incentive to work. They think that a fixed wage now will see them through life, but without skill it will not. Any training or incentive to skill is sorely needed to restore and maintain craftsmanship in agricultural labour. It is necessary if the land is to be kept under cultivation. The significance of this is obvious.

THE IMPROVEMENT OF PEATY SOILS.

PART II.—THE SILTY AND SANDY PEATS.

E. J. RUSSELL, D.Sc., F.R.S.,
Director of the Rothamsted Experimental Station.

In Part I of this article, published in the March issue of the JOURNAL, *p.* 1104, *Dr. Russell gave an account of the "True Peats" in low-lying and high-lying districts, and the method of reclamation.*

THESE soils form a transition between the true peats and true soils; they arise in conditions where bacterial action goes on more slowly than in ordinary soils, but more quickly than in true peats; organic matter, therefore, accumulates but without forming a separate vegetable layer. They may also arise when a true peat, after drainage, shrinks and finally disappears, again exposing the old surface on which it had rested.

In general these soils present greater possibilities of reclamation than the peats. They usually have the same defects as the peats, viz., wetness, acidity and lack of phosphates, but in a less intense form; it was through these defects that the soil bacteria were unable to complete their work, and until they are remedied crops cannot make proper growth.

Silty Peats.—An interesting example of the silty peats is found in Bodmin moor, Cornwall. The elevation is 800 to 1,000 ft. and the rainfall probably about 40 to 50 in.; both are high enough to interfere with ordinary agricultural processes and with the decomposition of plant residues in the soil, but the conditions are more favourable than on the higher lying Dartmoor, and in consequence there is considerably less deposit of layers of peat. The composition of much of the moor soil is different from normal agricultural soil in its higher content of organic matter, but it is by no means as far removed from normal soil as is peat.

It is possible also that peat may have occurred on some of these areas, but if so it has been denuded subsequently faster than it could be reformed. Some of these soils have the composition shown in the table on the next page.

In all cases except Laneast the surface soil was black, underlain by a band of broken stone; lower down was a reddish yellow subsoil. Where drainage is possible there is no insuperable

	Surface Soils					*Subsoils*		
	Wilsey Down		Laneast Down	Davidstow Moor	Cardinham Down	Wilsey Down	Laneast Down	Davidstow Moor
	Cultivated	Wild	Wild	Wild	Wild	Wild	Wild	Wild
Fine gravel ...	3·2	2·5	3·9	1·6	10·4	2·1	6·1	2·7
Coarse sand ...	9·5	6·3	1·8	1·5	17·8	6·3	3·9	1·7
Fine sand ...	26·3	31·5	20·2	15·4	16·4	32·4	19·2	14·1
Silt	18·1	20·5	21·3	33·9	13·6	17·0	18·2	34·1
Fine silt ...	25·8	19·1	25·2	17·0	11·0	24·0	28·4	18·8
Clay	2·4	1·8	4·5	3·1	3·5	6·0	9·1	11·2
Stones		12·5	12·4					
Organic matter	9·1	11·9	15·1	19·5	17·0	6·2	8·6	12·1
Nitrogen ...	0·31	0·35	0·46	0·63	0·48	0·15	0·23	0·29
Carbonates ...	nil	nil	nil	trace	nil	nil	trace	trace
Acidity ...		present	present					
Lime requirement		0·48	0·67					
Total potash (K_2O) ...		0·21	0·53					
Phosphoric acid (P_2O_5) ...		0·04	0·10					

difficulty about reclamation; some has been carried out already on Wilsey Down. The first ploughing is heavy because of the broken stones, sometimes the work proves even dangerous when done with a horse plough; there is less difficulty with a tractor. More important perhaps than anything else in these high districts is the selection of suitable varieties of crops. The Cornish oat—"American"—is still grown on the old moorland farms as it has been for 40 years past. Preliminary trials indicate, however, that some of the newer sorts such as "Yielder" and "Golden Rain" may prove distinctly better. Phosphates (superphosphate or perhaps basic slag) should be liberally used to hasten ripening of the cereals and to improve the feeding value of the rape and seeds grown for sheep feeding. Nitrogenous fertilisers and lime are also likely to be effective. There is much room for carefully considered experiments on the improvement of these soils.

Another group lies at lower altitudes and under a smaller rainfall; it offers even better prospects of reclamation; examples are found in the Staddon grits of the Lower Devonian series at Newlyn Downs and St. Brioch's, Cornwall. Analysis of the soils gave the results shown in the next table (there are no important differences between the waste and the cultivated soils). An example of reclamation of this type of land is seen on Tremollet Down where a tract of 280 acres was taken into

	Newlyn Downs.		*St. Breock's.*		*St. Breock' Subsoils.*	
	Waste.	Cultivated.	Waste.	Cultivated.	Waste.	Cultivated.
Laboratory number ...			10	11	10	11
Fine gravel	8·7	7·4	2·4	4·7	3·9	3·5
Coarse sand	9·2	5·5	6·1	8·5	7·4	7·2
Fine sand	20·3	18·3	28·9	22·8	29·4	21·3
Silt	24·2	27·8	17·8	30·3	16·2	33·9
Fine silt	17·5	15·3	20·8	12·9	21·0	11·0
Clay	6·6	10·0	9·3	6·6	9·2	11·5
Stones			20	15	17	24
Organic matter ...	7·6	9·2	9·6	9·0	6·1	6·9
Nitrogen	0·21	0·27	0·23	0·30	0·10	0·15
Carbonates	nil	nil	nil	0·02	nil	nil
Acidity	present	present	present	present	present	present
Lime requirement ...			0·06	0·23	0·37	0·21
Total potash (K_2O) ...			0·35	0·55	0·48	0·32
Total phosphates (P_2O_5)			0·03	0·07	0·01	

cultivation by the Duchy of Cornwall in 1909-10 at a cost of approximately £11 per acre. Since the land readily lets at £1 per acre the project has been profitable. The gorse and heather were burnt, and the land was ploughed; no further treatment was needed. The chief expense was incurred in making the road through the land and in setting out and enclosing the fields. These are of 8 acres each and fenced in with the usual Cornish earth wall faced with stone, on the top of which hazel and other bushes will grow; substantial fences are needed to shelter the live stock. The main feature of the farming is stock raising, and the farmers usually adopt the following rotation—oats, roots, barley, seeds mixture—which is then left as long as possible; some of it has been down too long and is beginning to be weedy. The land obviously needs lime which was not applied as part of the reclamation; spurry, sorrel and polygonium are all common on the stubbles, but the reclamation has been a complete success.

Sandy Peats.—Numerous instances of these soils occur in Cornwall, and they are commonly in bad repute. Few people who know them speak well of the black granite, or as they are locally called "growan," soils of Cornwall, yet there seems no reason why they should not be cultivated. Some of them are very acid—one indeed is the most acid soil the writer has found in England—but this could be overcome by a sufficient dressing of lime.

The following analyses of soils are taken from the St. Buryan's district, between Penzance and Land's End; for purposes of comparison the values for a highly fertile potato soil near Penzance are also given:—

	Trevidder Moor.	Near Boscawen.		Ludgvan, Penzance.	
	Waste.	Waste.	Cultivated	Highly fertile potato soil.	
				Surface.	Subsoil.
Fine gravel	21·0	9·3	8·0	2·8	4·6
Coarse sand	40·9	18·1	16·4	9·7	11·6
Fine sand	6·6	20·5	30·8	57·6	46·9
Silt	8·1	21·1	17·2	2·9	9·4
Fine silt	4·7	8·8	9·2	7·4	9·2
Clay	1·1	2·2	1·5	1·4	1·3
Stones	32	15	10	23	
Organic matter (loss on ignition)	11·8	13·2	10·0	8·8	9·4
Nitrogen	0·34	0·39	0·37	0·19	0·19
Carbonate (as calcium carbonate)	nil	nil	nil	3·2	2·6
Acidity	present	high	present	absent	absent
PH value*	4·8	4·6	5·2		
Lime requirement for neutralisation † ...	0·40	0·73	0·44	none	none
Phosphoric Acid (P_2O_5) Total ...	0·10		0·08	0·25	
Potash (K_2O) Total ...	0·52	0·28	0·54	0·44	

*This measures the intensity of the acidity but not the quantity; 7·2 is the neutral point and the lower the PH figure the greater the intensity.

†This measures the quantity of acidity and also the amount of lime absorbed in other ways. The Hutchinson–McLennan method is used.

The soils were all deep, and the subsoils, both at Boscawen and Trevidder, closely resemble the surface soils; the figures are omitted for the sake of brevity. Other waste areas in the district were similar in character to the Boscawen area; the analytical details need not, therefore, be given.

All that these waste soils need is clearing to remove gorse and bracken, then deep ploughing, finally a good dressing of lime and phosphates. The smallness of the difference between Boscawen waste and cultivated land shows that there is nothing in the soil to prevent cultivation. There are, of course, marked differences from the fertile potato soils of Penzance, both in the soil and even more in the position, but these could be used for several types of farming and for either small or large holders.

NOTE.—References to the literature on this subject may be obtained on application to the Ministry.

POTATO GROWING IN ESSEX.

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THE potato is one of our most important farm crops, and can be cultivated successfully and profitably on all soils in this country with the exception of the heaviest clays. In order, however, that the best results may be obtained, it requires "good farming" both as regards cultivation and manuring.

In an ordinary farming rotation, potatoes are taken between two corn crops, and are a very good cleaning crop.

Cultivations.—The great mistake made by so many potato growers is to give too little cultivation. They manure their land well with farmyard manure in the autumn, and also apply a liberal dressing of artificial manures in the spring. They then keep their land reasonably clean, and of course are disappointed if they do not get the maximum yield; but the first, last, and all-important thing in potato growing is deep cultivation and plenty of it, up to the time when the tubers are forming, when of course all cultivations should cease.

Useful Hints on Cultivation.—Ploughing should take place as soon after harvest as possible, to a depth of at least six or seven inches. A subsoiling plough should come directly behind the ordinary plough, subsoiling an additional eight or nine inches. The subsoiling plough should not bring any soil to the top, but only break the subsoil, getting it into a good mulch below. The land should then lie open until the spring, and then, if the soil and weather will permit, it should be cultivated deeply, preferably by steam tackle, but if steam tackle is not available, a strong tractor will do the work. This cultivating should be at least seven or eight inches deep. The land should then be well harrowed until a level top is obtained. To economise in labour it should then be ridged with a ridging machine which makes two ridges (baulks or drills) at each operation, at the same time sowing the artificial manure. This is a good way to apply artificial manure, as a little of the mould rolls on top of the manure, and the seed tuber does not come into direct touch with it. The baulks should be about 27 inches wide.

Methods of Planting and subsequent Cultivations.—The seed potatoes should be planted directly behind the ridging machine, the tubers being covered in with a double-breasted or moulding plough. One horse should always walk on the top of the ridge so as not to displace any of the tubers in the furrow.

About a week after the planting the ridges should be harrowed down with light harrows, care being taken not to harrow the baulks too flat, otherwise the tubers may be disturbed. After the harrowing they should be horse-hoed (with two horses) to a depth of six or seven inches between the rows, and then moulded up with a moulding plough. About ten days or a fortnight later a shim should be run under the potatoes, taking one baulk at a time, and shimming to a depth of four inches below the seed tuber. An implement, commonly known as a potato shim, is used for this operation. This will put the whole of the land into a proper mould or mulch. In some cases the results are very beneficial, but in others when the weather is very dry, and the ground very rough, shimming would result in a loss of moisture, and the farmer must therefore use his own discretion. In a case such as is mentioned above the ridges ought to be harrowed down again with saddle-back harrows, and horse-hoed again. The land should then be left until the potatoes are three or four inches through the ground, when they should be hand-hoed, all the top soil being moved, whether there are weeds or not. This should be followed by another horse-hoeing, and when the potatoes are high enough they should be well moulded up. This should finish all cultivations.

Manuring.—This is a matter on which there is considerable difference of opinion, but after many years of practical experience the writer has no hesitation in recommending the following methods.

As soon as possible after harvest, 15 tons of good, well-rotted farmyard manure should be applied to the stubbles and ploughed in. In the spring, just before planting, there should be applied a mixture of:—

$$\left.\begin{array}{l} 1\frac{1}{2} \text{ cwt. Sulphate of Ammonia} \\ 5 \text{ cwt. 30 per cent. Superphosphate} \\ 1 \text{ cwt. Sulphate of Potash.} \end{array}\right\} \text{per acre.}$$

If farmyard manure is not available for the potato crop, a liberal dressing of organic manure should be given, which will to a certain extent take the place of farmyard manure. This organic manure should be either bone and meat meal, hoof and horn manure, or fish guano, and should be applied at the rate of about 8 cwt. per acre, while a mixture of $1\frac{1}{2}$ cwt. sulphate of ammonia and $1\frac{1}{2}$ cwt. sulphate of potash per acre should also be applied. The application of sulphate of potash to light land will be specially beneficial.

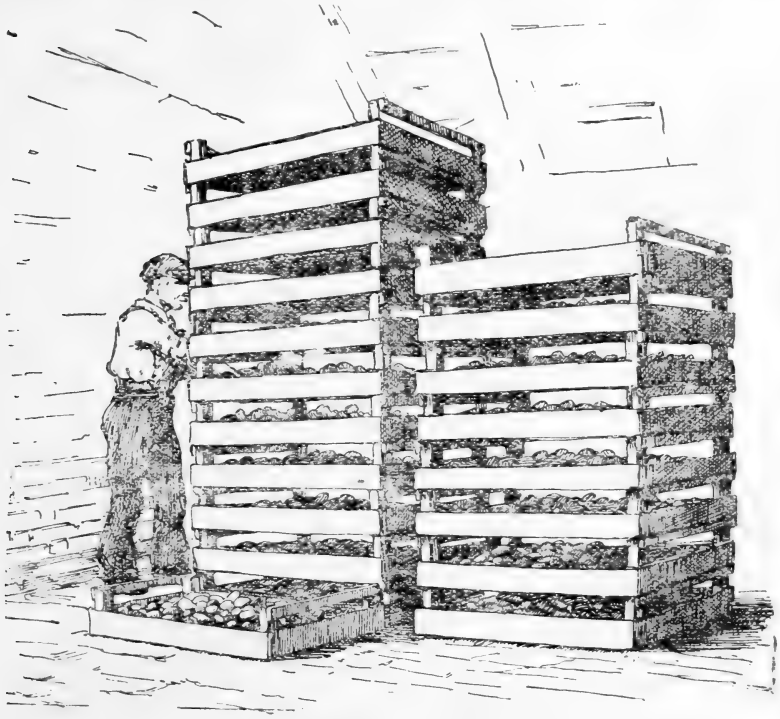
Planting.—Planting is an operation which requires more

attention than is usually devoted to it. Early varieties for the early market should be planted about ten inches apart, and main crop varieties should be planted from fifteen to sixteen inches apart. Care should be taken to see that the seed tubers are planted with equal spaces between them, as if they are planted too closely together the plants will be crowded and the result will be a large proportion of small potatoes. If too much space is left between the tubers ground will be wasted and weeds will have a better chance. Some farmers use a marker, consisting of a wheel with movable spikes which are set to the required distance and the wheel is then pushed along the furrows making small holes at even distances for the seed tubers. Where such a marker is not available it is a good practice for the man in charge of the planting to have a stick cut to the length of the required distance between each potato, and he can then measure the distance at which the workers are dropping the potatoes, and give them a clear idea as to exactly how much space is to be left between each tuber. Some farmers plant potatoes at a distance of twelve inches apart, believing that they will get a larger crop, but while they may get a larger number of tubers, the total yield of good marketable ware potatoes will be less; and a good crop of ware potatoes is what we should aim at.

Boxing.—The boxing of early varieties should be done in September or October, and the boxes stored in a house or barn suitable for the purpose. A suitable house must have plenty of light, with a window or large loop, which can be opened every day when the weather is open, on each side of the house, in order to get a proper current of air through. Under these conditions the potatoes will give hardy, stubby, purple shoots. Care should always be taken to pack the boxes correctly; if they are packed too closely, long, white spindly shoots will be found on the potatoes in the centre of each box, and this should be avoided (see sketch). The boxes should be moved at least twice during the period, the top boxes being put below and the bottom boxes on top.

The boxing of late varieties is a very debatable point. If the date of planting is to be very late—say the end of April or the beginning of May—the potatoes ought to be boxed; but if planting, particularly with late-sprouting fresh Scotch seed, is to take place between the end of March and the middle of April, so that the first sprouts are formed in the soil, little advantage is to be gained by boxing.

Seed.—It pays the farmer to sow good seed for all crops, but the seed is of special importance in growing potatoes. The benefits derived from change of " seed " are now generally admitted, but some growers are not sufficiently particular as to the source of their new " seed " potatoes.



Boxes for Sprouting Potatoes.

It is generally admitted that Scotch seed potatoes yield the best crops, but still a large number of farmers cling to the belief that " once-grown " seeds (*i.e.*, potatoes grown in England from Scotch seed) will yield crops equally as good as those grown from seed direct from Scotland. Satisfactory results are undoubtedly obtained from " once-grown " seed potatoes in those parts of the country which have a fairly heavy rainfall, but in the drier parts (the south-eastern and home counties) far heavier crops are obtained from Scotch seed than from " once-grown " seed potatoes, although in a year with a heavy rainfall during the growing season occasionally the latter will yield crops almost equal to those obtained from the Scotch seed. These, however, are the exceptions which prove the rule, that in the dry eastern counties fresh Scotch seed should be planted every season. Not only in the weight of the crop is the advantage of the new seed

to be reckoned, but the crop grown from new seed is generally more sound and marketable than a crop grown from "once-grown" seed. Some farmers, while admitting that larger total crops are obtained from new seed, incline to the opinion that a larger percentage of ware (large size tubers) is obtained from "once-grown" seed, but experiments conducted by the East Anglian Institute of Agriculture (see Report on Field Experiments for 1914) do not confirm this.

Considerable differences of opinion exist as to the best seed size, but generally speaking it is found that seed dressed through a 2-inch and over a $1\frac{1}{4}$-inch riddle, although taking a fair weight per acre, give more satisfactory results than those obtained from smaller seed, with the exception of the first-early variety, Epicure, which seems to grow equally vigorously from very small tubers.

Varieties.—Local conditions largely influence the varieties which should be planted, but, speaking generally, one may say that for the production of potatoes for the very early market Epicure is a prime favourite, followed by Eclipse, which, although of better quality and shape, and a heavier cropper, is a little later than Epicure.

It is interesting to note that some growers have reported very favourably on King George as a first early, and claim that, if boxed and sprouted and planted at the same time as Epicure, it gives a large crop of potatoes of good quality equally as early. Usually, however, King George is grown as a second early, and should be lifted, as a general rule, not later than the end of August.

Main crop varieties are always changing, but of late years King Edward has been a great favourite at most markets in England, though unfortunately this variety does not seem to possess enough vigour to grow a really heavy crop, except under favourable soil conditions and with a fairly heavy rainfall. Arran Chief is a very good potato, giving a good yield on nearly all soils, even in a dry season. Unfortunately neither of these varieties is immune from wart disease, which has become so prevalent during the last year or two, and growers are turning their attention to several of the new immune varieties. These are too numerous to mention in detail, but Great Scot and The Ally have proved very vigorous potatoes, giving big yields of good quality tubers. Kerr's Pink is also being grown to some extent, and has given some very heavy yields. Majestic, although a heavy cropper, is inclined to be coarse.

Spraying.—Although the practice of spraying potatoes is getting more popular, very few farmers realise that, apart from preventing potato disease, spraying increases the crop very considerably by extending the growing period.

Spraying should be carried out at least twice in the season. The best times for spraying vary in different parts of the country, but, speaking generally, the first spraying should take place during the first fortnight in July, and the second about three weeks later. In a wet season it may be necessary to give a third spraying.

Two types of horse-drawn spraying machines are in use—one for dry spraying and another for wet spraying.

It is claimed that the application of liquid spray (either Bordeaux or Burgundy mixture) is more effective than a dry spraying, but the writer has always used dry spray and found it very effective. Dry spraying should be done late at night or early morning, when the dew is on the leaf.

Harvesting.—If the ground is very hard and dry, the best way to lift potatoes is by means of a potato plough. By this method the tubers are not bruised, but care must be taken to have the share of the plough well below the potatoes.

If the ground is reasonably soft, the method of using a potato digger is preferable. The digger must not be driven too fast, otherwise the potatoes will be thrown too far, thereby making extra work for the pickers, and to use a screen damages the potatoes. In this case also, care should be taken to have the broadshare of the digger an inch or so below the lowest tubers. If this is not done, the result will be a lot of split and damaged potatoes. All damaged tubers should be taken out when dressing for market, as the market prices naturally depend largely upon well dressed samples.

Probably the cheapest method of picking potatoes is as follows. If the crop is good, nine pickers will be required on each side, but if very heavy, ten will be necessary—in other words, eighteen or twenty pickers respectively. The length of ridges should be measured and divided into ninths or tenths as the case may be, and stakes should be inserted in the middle of the work, so that each picker will have his or her equal share. Then each picker should be supplied with five bushel or potato baskets, and three carts should follow round at regular intervals, the potatoes being emptied into the carts and taken loose to the clamp.

Clamping.—This is work that requires careful attention. The bottom of the clamp should be about four feet wide and not more than from three to four inches deep. The side of a potato clamp should be made as steep as possible, and the clamp brought to a sharp point at the top. As the clamp is formed it should be covered with dry wheat straw, well straightened out, and packed tightly about six inches deep. The clamp should be earthed up at once if possible—while the straw is dry. If this is done, with about seven inches of earth, there will be little risk from frost, always taking care that the trench outside the clamp is about six inches deeper than the bottom of the potato clamp in order that the potatoes will lie quite dry. It is essential when earthing up the clamp to place a straw ventilation on the top, at least every six feet. This will let any heat out of the clamp and the potatoes will keep very much better.

THE INFLUENCE OF SIZE AND CHARACTER OF SEED ON THE YIELD OF POTATOES.

Redcliffe N. Salaman, M.A., M.D.

In 1920 a preliminary investigation of the above problem was begun. For this purpose a stock of a new variety* was employed, which had been grown in Barley, Herts, the previous year; the tubers had been clamped during the winter and sprouted in the spring. This main crop variety is well adapted to this type of experiment for two reasons: it is an exceptionally heavy cropper and it is extremely resistant to leaf-roll and mosaic. The tubers are white kidneys, and are immune to wart disease. This stock was raised in 1911 by the writer in Barley.

Selections of the seed tubers were made by the writer according to various grades, and the number of tubers in every pound weight of seed was carefully checked. The tubers were selected both for size and weight so that each class was as uniform as possible.

The classes selected were :—

	Weight of tuber sets.	
1.	0·4 oz.	i.e., 36 tubers to 1 lb.
2.	1·3 „	„ 12 „ „ „
3.	2·0 „	„ 8 „ „ „
4.	2·6 „	„ 6 „ „ „
5.	4· „	„ 4 „ „ „
6.	5·3 „	„ 3 „ „ „
7.	5·6 „	„ 12 „ „ 4¼ lb.
8.	6·0 „	„ 12 „ „ 4½ „
9.	Mixed seed of all sizes.	

Class No. 8 was not chosen with the idea of differentiating the crop obtained from seed so very similar, both in size and weight, to those used in Classes 6 and 7, but to discover whether seed tubers which carried much secondary growth influenced the resulting yield. In fact Class 8 differs merely as to the presence of secondary growth on all the seed tubers used, from Classes 6 and 7. The tubers were planted in rows in the midst of a farm crop of potatoes of the same variety. The part of the field selected, the soil of which is a medium clayey loam, is as nearly uniform in quality as it is possible to find in this part of the country, and was chosen for that reason. Manuring was the same for the entire potato crop, viz., 15 tons per acre laid in the furrows on which the potatoes were planted. The

* This potato is not, as yet, on the market.

distance between the sets was 15 in. and between rows 30 in. Tubers were not cut.

It is realised that in order to obtain reliable and accurate results in respect to cropping, it is rightly accepted that each plot should be repeated several times and the probable error calculated; this has not been done. Notwithstanding, there is evidence that a very considerable degree of accuracy may be ascribed to the results obtained. Thus when the ware sized tubers were used as seed, Classes 5-7, the resulting crops are 12.0, 11.2, 11.8 tons per acre respectively, which is not only a closely similar result, but one which previous experience would suggest. The very striking similarity between the average of the analysed results of the eight crops with that derived from mixed unselected seed of the same variety (Table II), would further suggest that the crops as shown in each of the eight classes cannot vary much from their true modes. Without therefore, wishing to stress unduly the results arrived at, the writer feels considerable confidence that the outstanding features which will be shortly detailed may be accepted as a general guide to the solution of the problem in hand.

In Table I the actual weight and number of seed of each of the eight classes employed are shown. In addition the weight of the crop returned; the ratio of yield to seed weight; the yield per acre; the weight of seed used per acre; the weight of ware tubers of 4 oz. weight and over, and the net crop after deducting the weight of seed used are shown.

TABLE I.

	Class of Seed Tuber.	Weight of Set.	Weight of Seed Used.	Number of Sets.	Weight of Yield.	Ratio Seed to Yield.	Yield per Set.	Yield per Acre.	Weight of Seed per Acre.	Ware per Acre 4 oz. and over.	Yield per Acre less Seed.
		oz.	lb.		lb.		lb.	tons	tons	tons	tons
1.	36 : 1 lb. ...	·44	8·5	304	280	1 : 33	·92	5·7	·17	2·15	5·53
2.	12 : 1 lb. ...	1·33	29	348	504	1 : 17·4	1·45	9·0	·51	2·45	8·49
3.	12 : 1½ lb. ...	2·	31	248	553	1 : 18	2·23	13·8	·77	4·36	13·0
4.	12 : 2 lb. ...	2·66	73	438	756	1 : 10·3	1·73	10·7	1·	3·67	9·7
5.	12 : 3 lb. ...	4·	16·5	66	128	1 : 7·8	1·95	12·0	1·5	2·64	10·5
6.	12 : 4 lb. ...	5·33	47·5	142	256	1 : 5·4	1·8	11·2	2·1	3·55	9·1
7.	12 : 4¼ lb.	5·66	50	141	264	1 : 5·3	1·9	11·8	2·2	2·82	9·6
8.	12 : 4½ lb. Secondary growths	6·	20	53	123	1 : 6·1	2·35	14·6	2·4	3·8	12·2

From this table two facts are evident :—(1) That it is tubers of 2 oz. weight which give the best return of crop, excepting the large tuber sets with secondary growths. When, however, the

weight of seed is taken into consideration with the yield, then the crop from the 2 oz. set is the heaviest of all. (2) That the crop from the sets with secondary growth is very much greater than any of the others, which is a fact of considerable interest. It is hoped that experiments will be continued to ascertain whether such tuber sets, cut into pieces of 2 oz. weight, would yield equally good crops. If such is the case, as is very probable, then there would be great advantage in using such, especially in view of the fact, as we shall see later, that the tendency to secondary growth is in no way conveyed by the tuber.

That the sets with secondary growths should have proved such successful seed is, however, not surprising; a secondary outgrowth indicates a high vegetative activity on the part of the parent tuber, and the outgrowth itself is in the nature of an immature tuber, which experience has long shown to be the best type of tuber seed.

Samples taken at random from the crops derived from the eight classes were analysed into the following groups of tubers :—

Class *a*.—Tubers under 1 oz. in weight.
„ *b*.— „ of 1–1¼ oz.
„ *c*.— „ „ 1½–2·6 oz.
„ *d*.— „ „ 3–4½ „
„ *e*.— „ „ 5 oz. and upwards.

The results are set out in Table II.

TABLE II.

Seed Class.		Weight of Sample.	Percentage of Total in each Crop Class.					Heavy Ware *d.* and *e.* combined
			a.	*b.*	*c.*	*d.*	*e.*	
		lb.						
1.	Under 1 oz.	32	4·0	5·0	18·0	37·0	36·0	73·0
2.	1·33 oz.	30·5	5·4	9·7	29·5	19·6	35·0	54·6
3.	2 oz.	29·25	3·45	2·55	30·7	24·0	39·2	63·2
4.	2·66 oz.	30	5·8	2·33	23·3	26·6	41·7	68·3
5.	4 oz.	29·35	9·4	8·9	37·5	20·5	23·9	44·4
6.	5·33 oz.	30	5·0	8·6	28·3	18·3	40·0	58·3
7.	5·66 oz.	30·5	4·92	10·6	36·0	23·3	24·5	47·8
8.	6 oz. with outgrowths	36·5	5·45	8·2	34·3	24·5	27·5	52·0
	Average of 8 classes	31·0	5·43	7·22	29·7	24·2	33·6	57·8
9.	Mixed seed	27·6	4·55	4·93	25·6	32·5	32·5	65·0

The percentages of weights of each group in each sample varied within relatively small limits from each other, or from the control sample derived from mixed seed of the same variety.

The crop from the small chat tubers produced a greater percentage of large ware than those from the heavy seed.

As the value of a potato crop is concentrated in the main on the quantity of the large ware size tubers formed, it is of interest to refer to the last column in Table II where the percentage of the entire crop represented by the tuber of 4 oz. and over is shown. The highest value, viz., 73 per cent. of the total crop is given by seed tubers of less than 1 oz. in weight, *i.e.*, by chats, so that it would appear the larger the set the smaller the quantity of big ware. When, however, the fact is taken into account of the bigger crop thrown by the 2 oz. sets the total yield per acre of large ware is considerably greater in this than in any other class. If, however, cut tubers with secondary growth will yield in the same manner as the large ones of Class 8, then the advantage of such sets might at least equal that of the 2 oz. set in the production of heavy ware.

A further analysis was made of the crops from the 8 different sized sets, as well as one from mixed sets in respect to the number of tubers in each weight group. Table III shows the result as well as the weight of the sample, and the total number of tubers contained in it.

TABLE III.

				Percentage of Number of Tubers in each Class of Yield.				
	Seed Class.	Weight of Sample.	No. of Tubers in Sample.	Under 1 oz.	1–1¼ oz.	1½–2·6 oz.	3–4½ oz.	5 oz. and over.
		lb.						
1.	0·44 oz.	32·12	156	12·8	15·4	24·3	30·7	16·7
2.	1·33 oz.	30·5	204	24·5	19·6	31·0	11·8	13·3
3.	2·0 oz.	29·25	159	14·5	7·55	43·5	17·6	17·0
4.	2·66 oz.	30	160	25·0	6·9	28·8	20·0	18·8
5.	4·0 oz.	29·35	207	28·8	16·9	34·8	11·2	8·2
6.	5·33 oz.	30	166	19·3	15·7	35·5	13·2	16·3
7.	5·66 oz.	30·5	205	18·5	21·5	37·0	13·7	9·3
8.	6 oz. with outgrowths	36·5	263	23·5	18·3	34·3	13·7	9·6
	Average of 8 Classes	31	190	20·8	15·2	34·3	16·5	13·7
9.	Mixed Seed	27·6	154	19·5	11·6	30·5	23·5	15·0

It does not appear that any inference can be drawn from these figures, except that small sets do not tend to produce any undue proportion of their like, nor large sets of theirs. There is far less conformity between the numbers of tubers in the same groups of the yields from each of the 8 crops than there was in the case of the corresponding weights of the tubers. This

result is in harmony with a long series of unpublished experiments, which, amongst other things, show that the crop of a potato plant must be expressed in the quantity of tuber material produced, its subdivision into tubers depends on other factors and is probably influenced by environment. The general approximation of the numbers of tubers in the classes of the crop from mixed seed, with that of the average of the eight seed classes, is a fact of considerable interest.

It will be remembered that seed class No. 8 consisted of large tubers with secondary growths. A close scrutiny was made throughout the crops of the 8 classes for tubers exhibiting any tendency to similar outgrowths. In Table IV the percentage of tubers thus affected in each class is shown. It will be noted that so far from the crop of seed class No. 8 showing any excess, it actually has by far the least of such tubers. It is, moreover, the bigger tubers in each case which tend to exhibit secondary growth at all. That the tendency to secondary growth formation should not be conveyed is in full accord with a number of more critical experiments the results of which will shortly be published by the writer and Mr. J. W. Lesley.

TABLE IV.

	Seed Class.	Percentages of Secondary Growth in each class of Tuber.				
		Under 1 oz.	1–1¼ oz.	1½–2·6 oz.	3–4½ oz.	oz and over
1.	0·44 oz.	0	8·6	0	10·2	15·4
2.	1·33 oz.	2	5	4·75	16·35	33·3
3.	2·0 oz.	0	0	8·7	28·5	37·0
4.	2·66 oz.	2·5	0	4·35	6·25	23·5
5.	4·0 oz.	0	2·85	1·4	8·3	35·2
6.	5·33 oz.	0	3·55	5·1	0	33·3
7.	5·66 oz.	0	0	3·95	14·3	21·0
8.	6 oz. with outgrowths..	0	0	0	2·75	8·0
	Average	·5	2·5	3·53	10·83	25·8
9.	Mixed Seed ...	0	0	15·0	13·9	43·5

It will be seen also, that there is no relation between the amount of tubers with outgrowths in the same weight groups in the crops from the different seed classes, excepting that in the small weight classes the proportion is uniformly low, whilst in the higher ones it is very variable, but generally high. There is here no such close relation between the values for the average of the crops from the eight seed classes, and those of the groups in the crop from the mixed seed as was found in respect of both

weights and numbers of tubers—see Tables II and III. It appears that neither size, weight, nor external character of a tuber set, influences the phenomenon of secondary outgrowths in the potato crop.

Although the tendency to produce secondary growth is obviously not carried on by the tuber seed, nor influenced in any way by the size of the set, it is, however, clearly a property of larger, rather than smaller tubers of the crop.

The results of the experiment so far as this first year allows of conclusions are :—

1. That although small chats give a great return in proportion to their weight as seed, and produce as much, in this experiment more, big ware as any class of seed, yet they are decidedly uneconomical.

2. The best seed class are tubers of 2 oz. in weight.

3. Seed tubers over 2 oz. in weight give smaller crops whilst the amount of seed used is progressively greater. The amount of heavy ware is progressively less both actually and relatively.

4. The tendency to secondary growth formation is not conveyed to the crop from the seed tuber. It is a peculiarity of big tubers and is not directly influenced by the size of the seed tuber.

5. Seed tubers with secondary growth make exceedingly good seed, and, apart from the fact that they are large and wasteful without cutting, the evidence would tend to show that their use as seed is strongly indicated.

In conclusion it may be noted that the experimental results as regards the best weight of tuber sets being 2 oz. merely confirms general experience. As to the value of tubers exhibiting secondary growth as seed, it is the custom amongst the allotment holders and others in this district to use, when cut as seed, those tubers they exhibited in the local Flower Show for " largest size " class, and which almost invariably are deformed by prominent outgrowths, in the firm belief that they yield the biggest crops and earliest crops of the particular variety.

COMMON SCAB OF POTATOES.

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EVERY farmer and gardener knows the uncertainty with which, despite every precaution, he looks forward to the harvesting of a sound potato crop. So many are the fungoid diseases which attack the potato that it often seems barely possible for the plants to escape infection from one or more of them. It is true, that, in the case of some of the worst diseases, certain protective measures may be taken which give a fair guarantee of immunity, but in the case of many others, which, though perhaps less generally destructive, are often very serious, escape from attack is very much a matter of luck with the majority of growers.

Two of the most harmful diseases which come into this category are Corky and Common Scab. Both are widely distributed, to a large degree seasonal in their outbreaks, and each is frequently responsible for great loss in many potato crops, which, before lifting, appeared free from disease.

A certain amount of experimental work has already been carried out on Corky Scab, and the results of this together with the treatment recommended are embodied in Leaflet No. 232. A detailed description of the two diseases, which bear a certain superficial resemblance to each other is given in the same leaflet.

In the case of Common Scab, little information has been available, and no treatment could be recommended with any certainty of success. An investigation of the disease, extending over a number of years has, therefore, been carried out at the University of Leeds, and it is hoped that the results obtained may be of service to those growers, who up to the present have been practically at its mercy.

A report[1] of the experiments has been recently published by the University of Leeds and the Yorkshire Council for Agricultural Education, and the present article is therefore intended to give a short account only of the disease with especial reference to the remedial measures found effective for it.

Common Scab is found in its most virulent form on light sandy or sharp gravelly soils, and a photograph of the disease as it occurs on such soils is given herewith (Fig. 1); it appears to a lesser extent on heavier soils and is practically unknown on peat soil. It is frequently associated with the presence of ashes in the soil.

On these grounds, the idea arose that Scabbing was due to the wounds inflicted on the swelling tubers by sharp soil particles with which they came into contact during their growth, and the disease was thus long known as "Mechanical Scab."

In America, however, so long ago as 1890, the work of Thaxter[2] had shown that Common Scab—or Deep Scab, as he then called it—was due to the attack of a fungoid organism now known as Actinomyces scabies (Thaxter) Güssow. Although during recent years it had been assumed that English and American Scab were identical, Thaxter's work had never been confirmed in this country, and certain text books, still in common use, even averred that "American Scab," *i.e.*, that produced by Thaxter's organism, was almost unknown here. Pethybridge, however, carried out experiments in Ireland in 1914 and came to the conclusion that there could be practically no doubt that Scab was due to an organism.[3]

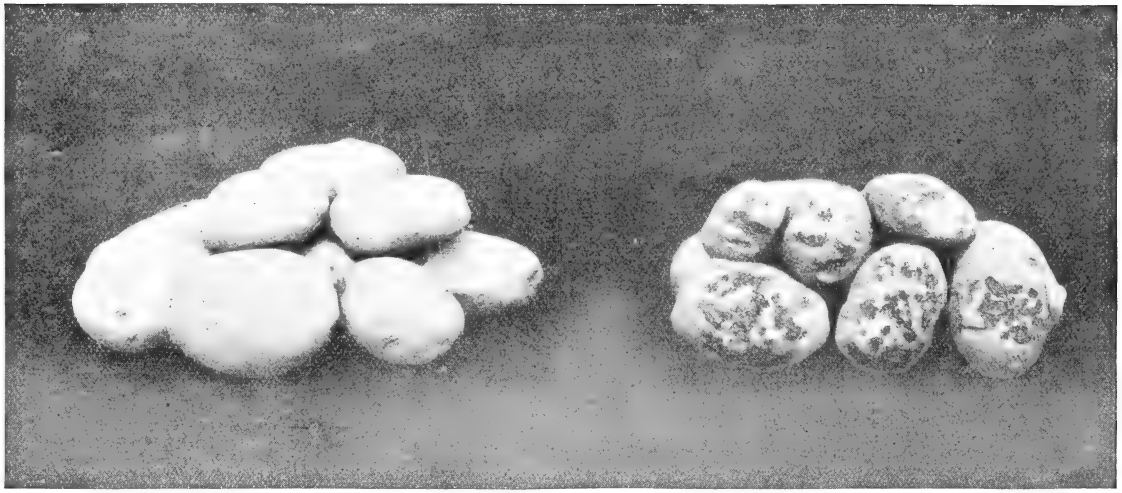
It thus appeared very necessary to repeat the American work for Common Scab as we know it in England, and this has formed one section of the Leeds investigation. The details of the work are not included in the Report above mentioned, but it is hoped they will be published shortly.

The results showed *Actinomyces scabies* to be the cause of Common Scab, and thus proved the American and English diseases to be one and the same. From other experiments, it was also shown that Scab was not produced by mechanical injury from sharp soil particles and, with the combination of these results, the problem of controlling the disease reduced itself to the simpler one of fighting a fungoid pest, whose characteristics could be studied at will in the laboratory.

Remedial Measures.—The discovery of a remedy for the disease formed the second section of the investigation. Experiments in America on the prevention of Scab appear to have consisted mainly of attempts to sterilise the soil by means of fungicides such as copper sulphate, corrosive sublimate, &c. but, these have not given any results of practical value. Sulphur has also been tried by various investigators but with indifferent success.

The only previous English work on the subject is that of Seton and Stewart,[4] who carried out a series of experiments at the University of Leeds in the years 1904-7 and came to the conclusion that "whatever the cause of Scab may be, it would seem that there is some relationship between the virulence of the disease and the moisture holding capacity of the soil."

FIG. 1.—Common Scab of Potatoes.



Green-manured. Untreated.

FIG. 2.—The effect of Green-manuring on Scab. Experiment in 1919.

Later, Professor Seton conceived the idea of increasing the moisture holding capacity of the soil by green-manuring, and the present series of experiments is the natural outcome of this suggestion. Subsequent experiments have shown that the hypothesis put forward could not be maintained, but the treatment to which it gave rise, has, for some other reason which will be discussed later, given excellent results.

The first experiment in which it was put to the test was carried out in 1914 as follows :—

Two plots, No. 1 and 2, were selected on soil known to produce Scab. On Plot 1 a quantity of fresh grass lawn mowings was spread at the rate of 30 tons to the acre, and when this had withered somewhat, it was forked in. No dung was used but a mixture of artificials was applied to each plot.

Two-thirds of each plot was then planted with clean "sets" and the remaining third with badly scabbed "sets" of "Dalhousie" potatoes. The plots were then cultivated in the usual way.

When harvesting, a great contrast was shown between the respective crops. That from Plot 1, both from the clean and scabbed "sets" was almost entirely free from Scab and the skin of the tubers showed the smooth glossy appearance rarely seen except on Potatoes raised on peaty soil.

That from Plot 2 was badly scabbed as usual, the tubers from the scabbed "sets" being slightly worse in this respect than those from the clean.

The respective yields from the two plots and from the different parts of the same plot were as follows :—

	From Clean "sets." Per acre.		From Scabbed "sets." Per acre.	
	tons	cwt.	tons	cwt.
Plot 1, Green Manured ...	18	5	10	15
Plot 2, untreated	12	10	8	0

In addition therefore to the main object of the experiment, it is clear that grass provides an excellent manure for the potato crop and materially increases the yield. It should also be noted that the yield given by the scabbed seed fell considerably lower than that from the clean seed on both plots and on these grounds, the use of clean seed is to be advocated.* Scab on the seed does not, however, appear to have much effect on the amount of Scab

* The scabbed seed was from the same sample as that shown in Figure 1 but was not obtained from the same source as the clean seed. It is apparently only where the scab has attacked the eyes of the tubers, that the yield is affected so adversely by it.

produced in the crop. This experiment with slight variations in the amount of grass applied, and in the manner in which it was introduced into the soil, was repeated on the same plots in 1915, 1917 and 1919 and on some other plots in addition in 1915 and 1919. In every case similar results were obtained.

The dry year of 1919 was the worst season for Common Scab known in Yorkshire for some time past and the photograph of that year's results is thus selected for reproduction here (Fig. 2). In the Report mentioned, however, photographs of the four years' results are given.

Conclusion.—There appears to be no doubt that the introduction of green organic matter into the soil may be regarded as a means of securing a clean crop. The amount necessary to secure the best result will naturally depend on the scab producing propensity of the soil. Very good results have been obtained with 10 tons to the acre of fresh material on soil where the control plot gave a badly scabbed crop.

In estimating the quantity to apply, it should be remembered that green plants contain approximately 75 per cent. water and thus the amount of half dry or withered grass required will be considerably less than that of fresh material. No trials have been made with hay but there seems no reason to suppose that this would not act in the same beneficial manner. The secret of success appears to lie in securing such an intimate admixture of the vegetable matter with the soil that the young potatoes form in a compost consisting largely of the decaying organic matter. On a small scale, where the land is cultivated by hand, this is not a difficult condition to secure. The grass may be applied in different ways. It may be spread on the surface and forked in before planting or, a part may be strewn in the trenches at planting time, a further portion added with the soil in filling in the trenches and the remainder strewn lightly over the surface and worked into the soil on earthing up.

On a larger scale, where green manuring can only be carried out by ploughing in a green crop growing on the soil, it is difficult as yet to suggest by what method it would be possible to secure an intimate incorporation of the green crop with the top spit of soil, and at the same time to allow of subsequent cultivations. It is not too much to hope, however, that the ingenuity of the practical agriculturist will find some way in which this difficulty may be overcome and the treatment applied.

In the experiments recorded in the Report, grass was the only vegetable substance tested. In another experiment, good

results were obtained by digging in a crop of Rye and planting the potatoes soon after the operation. There appears to be no reason, however, why other sources of organic matter of vegetable origin should not be used with equally good effect. Leaf mould is used by some gardeners with good results, and since carrying out this work the writer has been informed that spent hops are employed in some localities for the same purpose.

How Grass Inhibits Scab.—Various theories were formulated during the course of the investigation to account for the prevention of Scab by grass and plant residues, and this part of the work proved far the most difficult. Experiments on it were carried out concurrently with the repetition trials of the treatment, but, for a full account, the reader must be referred to the Departmental Report. The conclusion there drawn is that the fungoid organisms responsible for the Common Scab are primarily saprophytic, that is to say, they feed on dead organic matter in the soil, where they thrive mainly on plant residues and aid in the early stages of its decomposition. Only when these natural supplies of food are exhausted do they become parasitic on the potato tubers.

It is not difficult to see that this deduction will account for many of the observations made in regard to Common Scab. Two of those made earlier in this article may be recalled. Scab is most prevalent on light sandy or gravelly soils and is practically unknown on peat soils. In soils of the first type, especially where these have been liberally supplied with lime, organic remains tend to disappear rapidly and the scab organisms being left with a deficiency of food, attack the potato. The introduction of fresh supplies of plant residues remedies this defect, and may be considered to act as a decoy for the fungus. The potato crop in this way escapes attack. In a peat soil, however, large reserves of organic matter are present naturally, and there is consequently no fear of the crop being attacked.

Other phenomena relating to Scab, in particular the influence of lime and ashes on the disease, may be accounted for in a similar way. More work is being carried out on the subject, and it is hoped to publish a further report of the experiments in due course.

(1) "*Common Scab of Potatoes*," *University of Leeds and Yorkshire Council for Agricultural Education*, Report 118.

(2) *Connecticut Agric. Expt. Station*, Report for 1890.

(3) *Investigations on Potato Diseases*, 6th Report, *Journ. Dept. of Agric. and Tech. Instruction for Ireland*, Vol. XV., pp. 491–526.

(4) *University of Leeds and Yorkshire Council for Agricultural Education*, Reports 55, 63, 70.

DUCKS AS EGG-PRODUCERS.

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WITH the high cost of labour and the general depreciation in the saleable value of their principal products, farmers are finding it increasingly necessary to look around for every possible source of income, and to concentrate on those branches of the farm which require the minimum of labour. In these circumstances it is thought that farmers and all occupiers of grass or orchard land might profitably consider the possibilities of ducks as egg producers. With proper management the labour expenses are small and the returns are regular. There is likely to be an increased demand for well bred stock birds of the best laying strains, and duck egg production can be easily made the source of a regular weekly income.

Considerable advance has been made lately in the science and practice of egg production. Many farmers, realising the increased economic value of poultry, now recognise them as a distinct branch of the farm, and give proper attention to their management. This advance, however, has been made with one section only, for whilst hens have received greatly increased attention, ducks have been neglected. It is not suggested that ducks should in any way replace hens, but that both can be kept so long as separate sleeping accommodation is provided.

Swimming water is not necessary; in some circumstances it may be a disadvantage; the best laying breeds lay quite as well without it, and their eggs are as fertile. The general dislike of the strong, green duck egg is sometimes quoted as an objection to ducks as egg producers; this is immaterial, as well bred ducks of suitable breeds lay pearly white eggs which have a ready sale. There is also a doubt whether the market can absorb a large number of duck eggs; this remains to be proved, but at present there appears to be no reason for anticipating a greater difficulty in disposing of the fresh, clean, white duck egg than of the hen egg. There will of course be seasonal gluts just as with hen eggs.

Advantages of Ducks as Egg-producers.

Management.—Ducks require less attention than hens: feeding is less frequent and more simple. This is especially the case where grass range is available.

Housing.—There is no need for an expensive house or scratching shed. If a house is provided it can be of the simplest

kind and very cheaply made. Glass windows, perches and nest boxes are not required, and although bedding is necessary if a duck-house is used, there are no expenses in purchasing scratching litter.

The writer prefers leaving the ducks absolutely in the open as soon as they are large enough to be safe from rats.

Feeding.—Feeding is less frequent than with hens. A wet mash given late in the day is the essential meal, and only simple ingredients like ground oats, bran and fishmeal are necessary. Hard corn is only required if the ducks have not free range or if their eggs are to be used for incubation. Variety, which a duck does not appear to relish, hinders rather than helps egg production.

Fencing.—The fencing, which is very expensive for poultry runs, costs much less in the case of ducks, as wire netting 3 ft. or 4 ft. high will keep most kinds within bounds.

Depreciation.—Whilst hens are rarely worth keeping after their second season except for breeding purposes, and are less productive in their second season than in their first, well bred ducks often lay as well in their second as in their first season, and are usually profitable in their third and sometimes in their fourth. Being also less subject to infectious diseases, and generally more healthy, they are less likely to die young than hens, so that replacement charges are less.

Laying Capacity.—The writer does not wish to support the extravagant claims of egg laying which are sometimes made on behalf of ducks, as there have been very few real tests of comparison between hens and ducks. He is of opinion that pullets and ducklets of the best laying breeds average about the same number of eggs per bird per year, but that the best ducklets will probably produce more than the best pullets. Second, third and fourth season ducks undoubtedly average more than hens of the same age.

Size of Eggs.—Practically all duck eggs are large, being well over the 2 oz. standard.

Consistent Laying.—Well bred ducks often lay continuously for very long periods.

Good Autumn Production.—Ducks lay a large proportion of their eggs when prices are high; if properly managed, their production after the moult in the autumn may be quite as good as in the spring. The writer's best records with Khaki Campbells were made in the autumn by second season ducks after their moult.

Foraging Capabilities.—Given a good range, ducks will travel far and wide and pick up a large proportion of their food.

Small Liability to Disease.—Ducks are more healthy and at the present time less subject to disease than hens. They seem to be more or less immune from most of the commoner fowl ailments.

Hardiness.—Ducks are less affected by rain, snow and frost than hens, so that they can profitably sleep out of doors.

Damage to Crops.—Ducks do much less damage to farm and orchard crops than hens, as they are unable to scratch with their webbed feet and their bills are too blunt to do much damage by pecking. They are of great value in orchards for destroying insect pests.

General Remarks.—On partly arable farms ducks are a source of income which is helped by the wet unsettled weather which so often damages arable crops in this country in summer time. Nearly all duck eggs are laid early in the morning before about 9.30 a.m. This simplifies gathering and makes individual recording much easier. The colour of the egg shell of the best strains of ducks is a pearly white. These eggs find a ready market and usually make about the same price as hen eggs: sometimes in the spring they command a little more. The green duck egg, however, is less easily marketed, especially in summer time, and should be eliminated. The flavour of duck eggs from the best laying breeds is not strong unless unsuitable feeding is allowed. They are like large white hen eggs except that the shell is rather more pearly white and the membrane lining is slightly thicker and stronger.

Disadvantages of Ducks as Egg-producers.

(1) Ducks are more nervous then hens, and easily harassed. Handling or any change of feeding or treatment are liable to disturb them, with consequent loss of eggs. Moulting out of season is also more liable to occur in ducks.

(2) Duck houses are more difficult to keep clean than hen houses.

(3) When ducks are so disturbed that they cease laying, it is sometimes very difficult to get them to commence to lay again.

(4) Ducks are not so suitable for the back garden as hens. They lay well in confined runs, but the ground is difficult to keep clean and the amount of food required is much greater than when the birds have free range. They are also more likely to disturb neighbouring households by their quacking.

The Best Laying Breeds of Ducks.—There are very few first class laying breeds, but it is probable that the increased interest taken in ducks will soon lead to the production of several new ones. Fawn and White and White Indian Runners, Khaki Campbells and Buff Orpingtons are the best and the most popular at present. The entries in the Stapleford Duck Test, and in the Test which the National Utility Poultry Society and the Utility Duck Club are carrying out in conjunction with the Great Eastern Railway Company at Bentley, seem to show that White and Fawn and White Indian Runners have been considered the best layers and are, therefore, much the most widely distributed. The final results at Stapleford, however, and the early reports of the Test at Bentley, show that Khaki Campbells are making a strong bid for the premier position. It is probable, therefore, that this breed in particular will meet with an increased demand in the near future.

Indian Runners, Fawn and White or White, have a very upright carriage, and clean, well marked flocks are very attractive. They are good layers of white eggs, but being very small birds are not of high value for table purposes, though if killed when 9 or 10 weeks old they make excellent eating. Birds of the best strains are very good layers; some strains have been rather spoilt because a few breeders have given too much attention to their show points, and have practised too close breeding. Indian Runners, especially the white variety, are liable to look very dirty and disreputable in muddy situations unless they have clean swimming water.

Khaki Campbells are larger and less upright in carriage than Indian Runners. Owing to recent crossing with the wild duck they are considered hardier birds, and more suitable for an open air life. The colour more or less resembles mud, and in wet weather it has not the dirty appearance of the white duck; they are, therefore, a more suitable breed for muddy situations and where there is no swimming water or only limited accommodation. They average about a pound heavier than Runner ducks, are better table birds, and are equally as good and possibly better layers of white eggs. They have been exhibited very seldom and are bred principally for egg production. The best strains of Indian Runners and Khaki Campbells are about equally good as egg producers, but there appears to be a smaller proportion of poor layers among the Khaki Campbells.

Buff Orpingtons are also good layers, but on the average it is probable they are not quite so good as Indian Runners and

Khaki Campbells. They cannot be considered first-class egg producers until the green egg, now all too frequent, has been eliminated entirely. This breed of duck is larger and heavier than either of the above-mentioned birds and serves the dual purpose of egg production and table use.

Pedigree Breeding of Ducks.—Chiefly owing to the supposed difficulties of keeping individual records of production, very little pedigree breeding of ducks has been undertaken, except by a small number of specialist breeders. More attention is now being given to this branch of the subject and various methods of obtaining individual duck egg laying records have been evoked.

Type of Duck Required.—Primarily it is essential to obtain birds of a strain which has been developed for egg production by a skilful specialist breeder. The anatomical points of a good layer seem to be the same with ducks as with hens. The bird should be so built that plenty of room is available for the digestive and reproductive organs; breadth and depth of body, width across the back and between the legs are therefore desirable. Small boned active birds with sharp, snaky, fine looking heads and necks, seem to give the best results, especially those with bright prominent eyes set high up in the skull. The thick clumsy head and short thick neck are undesirable features. Large, coarse boned, heavy birds should be avoided.

Housing: Open-air Methods.—There is a great difference of opinion as to the best methods of housing ducks. The primary object is to keep them healthy, contented and productive as economically as possible. Few duck houses comply with these conditions. It is almost impossible to keep them clean without a large expenditure in labour and bedding material; the ducks rarely approve of being shut in at night, and if left alone will usually remain outside. Most authorities insist that a dry bed at night is essential for ducks; the writer, however, considers that the natural clothing of feathers in waterfowl is so arranged that their bodies remain dry and warm in wet surroundings. He prefers, therefore, to keep ducks without a house as soon as they are large enough to escape from rats. An open-air sleeping pen surrounded by wire netting, is provided instead of a house, and ducks kept in this manner appear to be more contented and less disturbed at night. In consequence, the air they breathe is fresher, they are hardier, healthier and better breeders. These open-air methods have proved extremely successful in the case of Khaki Campbells at Appleby, in North Lincolnshire. When severe wintry weather comes on, the egg

production of ducks which are housed at night, falls quite as much as those which are in the open all the time.

Feeding Ducks for Egg Production.—Ducks should be induced to obtain as much of their food as possible by foraging. Foraging is good for their health, increases egg production, and in consequence a smaller proportion of artificial food is required. It is most economical to feed, as far as it is possible, on home-grown and home-prepared foods. Fancy and proprietary laying meals are not recommended. The bulk of the food should be given in the form of a wet mash consisting principally of ground oats, wheat bran, and a reliable fish meal of low salt and oil content. If free range is available the only other necessities are some shell forming material such as cockle or oyster shell and drinking water. If the birds are confined in pens a small feed of heavy white oats or small wheat should be given in the morning and some vegetable food supplied. Flint grit is very seldom needed. Barley and barley meal are not recommended for egg production and maize is unnecessary.

Time of Feeding.—When free range is available, one feed of wet mash each day just before dusk seems to give the best results. It is a mistake to feed laying ducks in the morning or at mid-day except when foraging is for any reason either impossible or insufficiently productive. A morning feed removes the natural hunger, and the ducks no longer have any incentive to forage for themselves.

Amount of Food.—The weight required per bird per day, depends on so many factors, and is so extremely variable that it is unwise to give any figures. It will be found that the rate of laying, nature and extent of foraging range, warmth and moisture of atmosphere, and numerous other factors exercise a great influence on a duck's appetite and requirements.

It is a sound rule to give laying ducks on open range as much as they will eat when they return in the evening, but nothing at any other time of the day.

Training of Ducks.—Much depends on the way in which the young ducklets are trained. To give the best results it is essential that they should feel thoroughly at home and settled by the time they are old enough to commence production. They should, therefore, be taught when still young what to do and what treatment they must expect later on. The ducklets should be placed in their permanent laying quarters as soon as possible after they can be distinguished from the drakerels. They should then remain there, having the same sleeping accom-

modation and the same range for the rest of their lives, if the best egg returns are desired. Changes made at a later date are almost certain to result in a serious loss of eggs.

Immediately the ducklets have been put in their permanent laying quarters, they must be taught when and where to expect their food. They must be made to realise that they will not be given anything until just before dark. They must learn from experience that they can only obtain food by running about and looking for it, and that quacking has no effect on their attendant, who must be firm. It is wise to spend some time teaching ducklets where to forage. They should first be attracted from their permanent quarters by scattering a little corn on to their range in the direction in which it is desired they should go. They must not be allowed to remain in or around their sleeping quarters. If there are two or more flocks it is worth while trying to teach one to go in a particular direction and the other in the opposition direction. In this way a larger area of ground is covered and a bigger harvest of worms and insects is obtained.

Farm Duck Management.—Farmers and occupiers of grass land will find the following plan worthy of trial. It has proved very successful in the case of Khaki Campbells on a farm at Appleby in North Lincolnshire.

Two flocks of about twenty layers each may be kept at each farmyard or feeding centre. One flock should consist of ducklets and the other of second season ducks. The two flocks must be fed separately and must sleep separately. Two open-air sleeping pens should be arranged some distance apart, about 12 to 15 yd. square. They should be situated if possible in a quiet unused part of the farmyard where they will be safe from horses and cattle, and if possible they should be on thick-growing grass. Each pen should be surrounded with strong wire netting, hung on strong posts, the ends of which have been dipped in tar. In a fox country the wire should be 8 ft. high and let into the ground at the bottom; 6 ft. wire will be sufficient if there are no foxes. Fix a simple gate in the middle of the wire on whichever side of the sleeping pen is approached most conveniently from the food store. Place in the pen a sufficiently long feeding trough of simple make to enable all the birds to feed at the same time. Drinking water should be placed outside only, not inside the sleeping pen, and a liberal supply of cockle shell or other shell forming material should always be available. Arrangements should be made for a supply of about

twenty well bred April or May hatched ducklets. Preferably these should have been bred and reared on the same farm. If it is desired to stock a larger number of layers, each flock may consist of 25 to 30 layers, and 4, 6, 8, or more flocks may be undertaken. If it is decided to keep the ducks a third laying season, three sleeping pens should be provided instead of two, for each group of three flocks.

Anyone beginning in 1921 with the idea of keeping two small flocks would then proceed as follows :—

September 1,	1921.	20 ducklets (Flock A) put in Pen 1.
September 1,	1922.	20 ducklets (Flock B) put in Pen 2.
September 1,	1923.	20 ducklets (Flock C) put in Pen 1.
November,	1923.	Flock A sold out of Pen 1 when their autumn production of eggs ceases.
September 1,	1924.	20 ducklets (Flock 1) put in Pen 2 and Flock B sold in November.

Thus each season a new flock is introduced early in September to replace an old flock which is sold in November. Each flock is kept for two whole laying seasons and an extra autumn period. Two flocks inhabit one pen for two or three months each autumn until the older one is sold. If desired an extra sleeping pen may be provided, in which case the new flock goes into a clean empty pen, and the old flock is not disturbed by the appearance of the new one.

The following is the daily routine of work in connection with each flock :—

9.30 a.m. Open gate, count ducks out, collect eggs, shut gate. Towards dusk, open gate, put mash in trough, count ducks in, shut gate. See that cockle shell in abundance, and drinking water are available. At regular intervals clean the sleeping pens as thoroughly as it is possible and give them a good dressing of lime.

It is convenient to mix two or three weeks' supply of mash at one time so that it is only necessary at the time of feeding to wet sufficient for that meal. 12 to 15 per cent. by weight of the standard mash mixture should consist of good fishmeal, the bulk of the remainder can be ground oats with about 10 per cent. of bran. Other foods can be used but these are satisfactory, simple and are obtained easily. The attendant should also have a supply of fishmeal which may be used to encourage egg production if suitable care is taken. If the ducks are not laying sufficiently well, or if there is less natural food available than usual, a little more fishmeal should be added to the mash.

If the weather is warm and moist and there is an abundance of worms, or if the eggs are required for incubation, the amount of fishmeal should be reduced. If eggs are being freely produced in April and May in moist weather, it is a good plan to reduce the amount of fishmeal considerably, so that it is possible to increase it when the weather gets hotter and drier and less natural food is available. When the moult commences in July and August, fishmeal should not be given but introduced again as a strong incentive to egg production after the moult.

It is advisable to breed and rear at home the young ducklets which are to become a new laying flock in September. Four drakerels should be run with each flock of 20 ducks. Whole oats should be largely fed and less mash and fishmeal given as stock birds should not be forced. It is easier to hatch duck eggs under hens than incubators, and April and May are the best months for hatching laying ducks.

SIZE OF EGG IN RELATION TO AVERAGE PRODUCTION.

Edward Brown, F.L.S.

Complaints have been made during recent years of the increasing number of home eggs below the recognised standard in size and weight which are placed upon the market. The advent of the commercial poultry farmer, whose main object is table egg production, and the increased practice of pedigree breeding for high fecundity may largely account for this decrease in the size of eggs, although farm eggs have also undergone a decrease, but in lesser degree. It is the general practice to use medium-sized or large eggs for table purposes, and to reserve the smaller ones for cooking or manufacturing purposes. Before the War large quantities of eggs were imported into this country, but these were mainly full sized, the "smalls" being retained for home consumption. The import trade has not yet regained its former dimensions, and home producers are not, therefore, faced with foreign competition to the same extent as formerly. It may be anticipated, however, that former conditions will gradually reassert themselves, and with the increased number of full-sized eggs which will find their way on the market, poultry keepers will be obliged to give closer attention to the question of the production of eggs of reasonable size.

Pullets of all breeds usually produce smaller eggs than do older birds, especially at the beginning of the laying period. This tendency is increased the earlier they commence to lay. Among the distinctive breeds there are great differences in the size of egg produced. The Minorca hen and Wyandotte hen are relatively about the same weight, yet the egg of the former is consistently larger than that of the latter. A similar difference is observed in the case of the smaller bodied types such as the Campine and Hamburgh; although both breeds are of the same ancestry, Campine eggs are larger than those of the Hamburgh. Many other instances could be given. A further point of importance is that the egg produced by improved races of poultry as the result of selection and better feeding is larger than that from the original stocks. The constant tendency to reversion can only be counteracted by careful breeding with a view to maintaining size of egg.

The influences which tend to the production of a greater number of small eggs may be briefly summarised:—

(1) When eggs are laid by pullets at a much earlier period than the normal, and before the body has attained maturity; such early laying checks the growth of the body, so that in process of time, in the absence of selective breeding, the size of the egg is reduced.

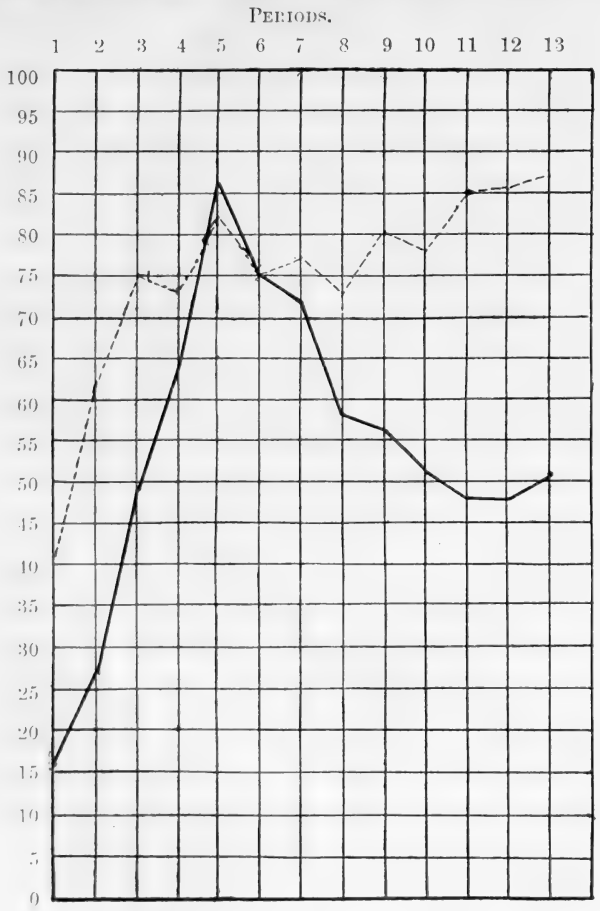
(2) When an increased number of eggs is laid within a given period there is a tendency towards reduction in weight; investigations and observations both in this country and America have shown that in a cycle of continuous laying each egg is slightly lighter than its predecessor, and that the maximum is not regained until a break in laying has taken place.

(3) There are periods when, in certain breeds, over entire flocks, a marked reduction in the size of egg takes place. The accompanying graphs illustrate this in the case of White Wyandottes, Leghorns, Rhode Island Reds and Plymouth Rocks. Periodical variations occur which differ according to breeds, but which, nevertheless, seem to follow a definite rule of variation within a breed.

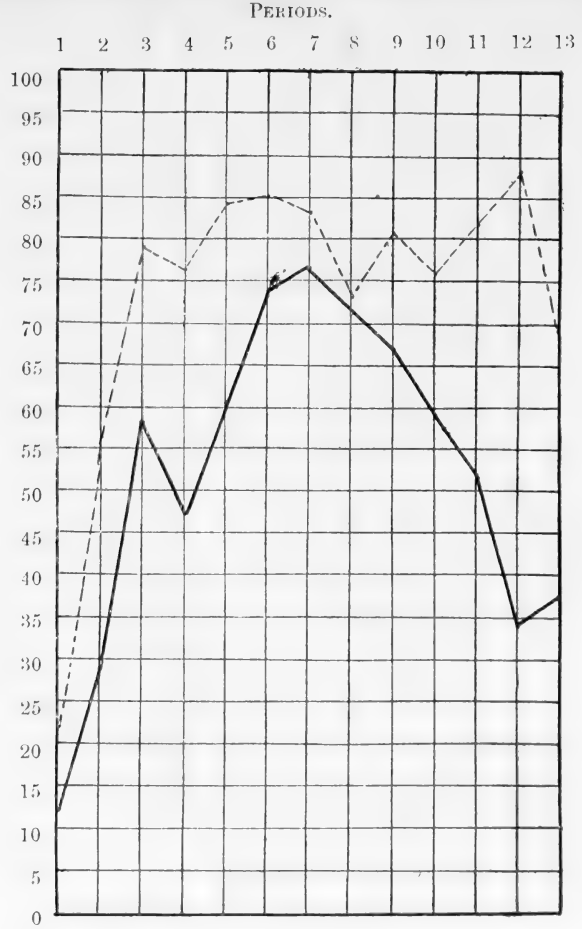
(4) The use of breeding stock before maturity has been reached; birds hatched from eggs smaller than the full size tend to smaller eggs.

At the Harper Adams Poultry Conference, held in August, 1920, it was advocated by some breeders that market standards for eggs should be reduced. There seems no reason, however, for any change from the present 2 oz. to $2\frac{1}{4}$ oz. standard.

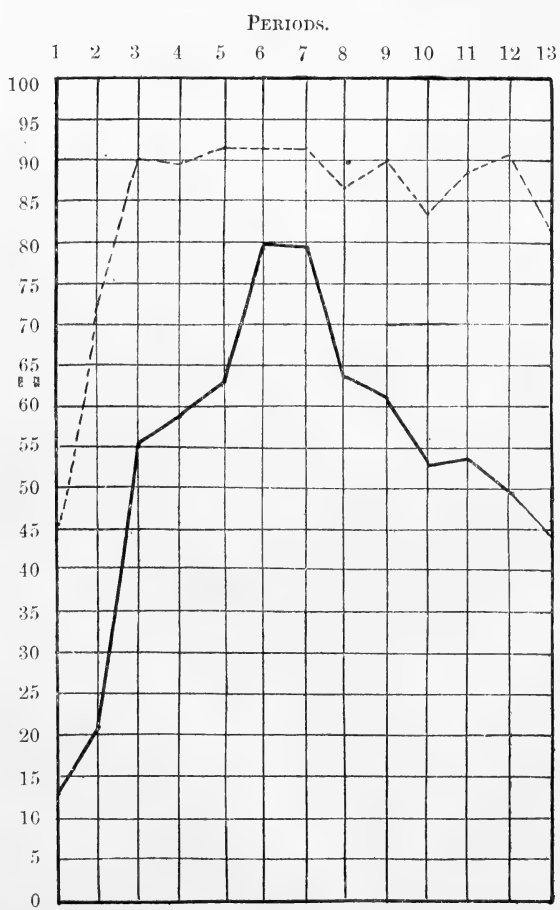
A study has been made of records presented in the Report of the 1918-19 Small Flocks Laying Trials at the Harper Adams Agricultural College, with a view to obtaining data as to (1) the relative proportion of undersized eggs to the total production; (2) the extent to which there was an increase in size during the whole year; (3) whether heavy winter laying has an appreciable influence upon the size of egg during the remaining periods of the year; and (4) the relation between total annual production and the size of the eggs laid. The breeds selected for observation were White Wyandottes (33 pens); White Leghorns (32 pens); Rhode Island Reds (8 pens); and Plymouth Rocks (8 pens). Each pen contained six pullets. These birds were carefully selected from much larger flocks, which had been bred with a view to early laying,



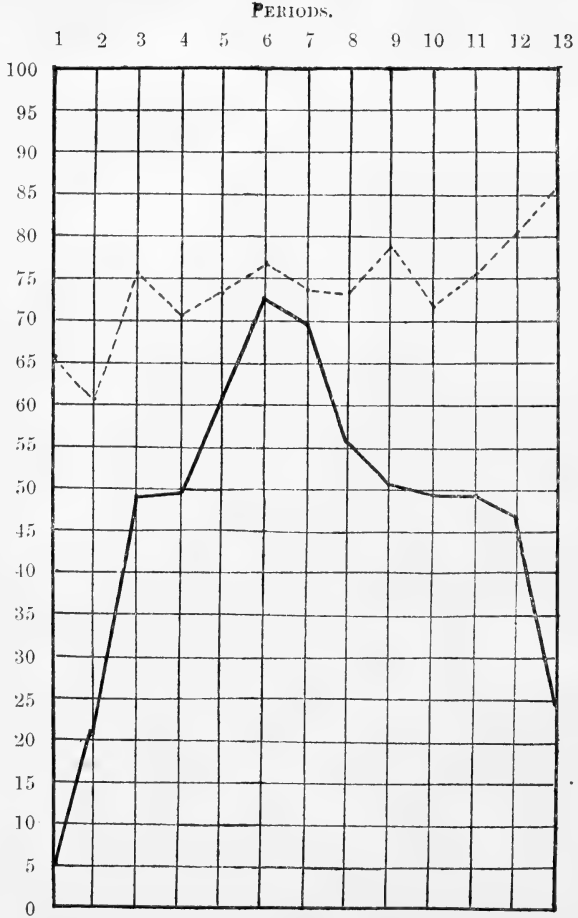
White Wyandotte (33 pens, 198 birds).
Percentage of Production ——————
First Grade Eggs ----------



Leghorn (32 pens. 192 birds).
Percentage of Production ——————
First Grade Eggs ----------



Rhode Island Red (8 pens, 48 birds).
Percentage of Production ————
,, ,, First Grade Eggs ----------



Plymouth Rock (8 pens, 48 birds).
Percentage of Production ————
,, ,, Grade Eggs ----------

and were from stock which had been reared for several generations for high numerical production. It was expected, therefore, that a tendency to lay small eggs would be noticed.

Table I gives the percentage of production in each period of four weeks. An egg per day per pullet is reckoned as 100 per cent. production, and an egg every alternate day 50 per cent. Table II shows the percentages of first grade eggs (2 oz. and over) and of second grade eggs (all eggs under 2 oz. during the first sixteen weeks and under 2 oz., but not less than $1\frac{3}{4}$ oz., thereafter).

Table I.—*Percentages of Production.*

	Periods.	*Wyandottes.*	*Leghorns.*	*R.I. Reds.*	*Plymouth Rocks.*
1.	Nov. 3—30	16·4	12·9	12·4	5·2
2.	Dec. 1—28	27·6	28·9	21·2	21·1
3.	Dec. 29—Jan. 25 ...	49·7	58·4	55·8	49·4
4.	Jan. 26—Feb. 22 ...	64·1	47·2	58·5	49·5
5.	Feb. 23—Mar. 22 ..	86·7	60·9	62·9	61·0
6.	Mar. 23—Apl. 19 ...	75·0	73·2	79·8	72·5
7.	Apl. 20—May 17 ...	72·5	76·3	79·2	69·6
8.	May 18—Jun. 14 ...	58·8	71·3	63·8	55·7
9.	Jun. 15—Jul. 12 ...	56·8	66·8	60·9	50·8
10.	Jul. 13—Aug. 9 ...	51·1	59·0	53·0	49·5
11.	Aug. 10—Sep. 6 ...	48·7	51·9	53·2	49·8
12.	Sep. 7—Oct. 4 ...	48·7	34·4	49·2	46·4
13.	Oct. 5—Nov. 2. ...	51·3	37·5	43·9	24·4

Table II.—*Percentages of First Grade* (A) *and Second Grade* (B) *Eggs.*

	Periods.	*Wyandottes.*		*Leghorns.*		*R.I. Reds.*		*Plymouth Rocks.*	
		A.	B.	A.	B.	A.	B.	A.	B.
1.	Nov. 3—30	41	59	22	88	45	55	66	34
2.	Dec. 1—28	62	38	57	43	72	28	61	39
3.	Dec. 29—Jan. 25 ...	75	25	79	21	90	10	75	25
4.	Jan. 26—Feb. 22 ...	73	25	77	23	90	10	71	29
5.	Feb. 23—Mar. 22 ...	82	18	84	16	91	9	73	27
6.	Mar. 23—Apl. 19 ...	75	24	85	13	91	9	77	23
7.	Apl. 20—May 17 ...	77	23	83	17	91	9	73	27
8.	May 18—Jun. 14 ...	73	27	73	27	86	14	73	27
9.	Jun. 15—Jul. 12 ...	81	19	81	19	90	10	79	21
10.	Jul. 13—Aug. 9 ...	79	21	76	24	89	14	71	29
11.	Aug. 10—Sep. 6 ...	86	14	82	18	88	12	76	24
12.	Sep. 7—Oct. 4 ...	85	15	88	12	91	9	80	20
13.	Oct. 5—Nov. 2 ...	87	13	69	31	82	18	86	14

The accompanying graphs indicate the relation between size of egg and production in the thirteen periods of the year.

Selecting the 33 pens of Wyandottes for further study, remarkable variations are apparent in each period. The figures for these pens are given in Table III below. Two of the pens laid only second grade eggs during the first four weeks. In one pen the eggs steadily increased in size with the exception of two recessions, and in the last recorded period (the twelfth) produced 90 per cent. of first grade eggs; the other pen varied

to a much greater extent, and in the last period the birds laid only 26 per cent. of first grade eggs. A third pen, which in the first period produced 17 per cent. of second grade eggs, lost heavily, and in the fifth period had produced 64 per cent. of second grades; thereafter it slowly improved, and in the final month produced 78 per cent. of first grade eggs.

TABLE III.—*Relation of Size of Egg in the First Two Periods to Average Annual Production and Grade of Eggs (Wyandottes).*

Pen No.	*Percentage of 2nd Grade Eggs in first 56 days.*	*Yearly Average.*	*Yearly Percentage of 2nd Grade Eggs.*
33	28·6	201	33·2
34	53·7	220	30·0
35	57·6	191	39·0
36	56·6	231	39·5
37	No eggs laid	179	6·9
38	38·5	161	13·8
39	54·0	209	13·8
40	83·3	170	11·6
41	67·8	208	11·6
42	11·3	187	8·9
43	80·0	195	35·2
44	66·7	206	28·7
45	63·5	235	51·5
46	52·0	183	23·2
47	54·8	176	20·5
48	40·0	181	17·4
49	No eggs laid	151	10·4
50	49·2	217	19·6
51	15·9	194	12·9
52	30·6	158	6·8
53	11·8	185	12·3
54	76·5	184	46·5
55	22·8	173	15·6
56	44·0	217	20·9
57	50·0	204	28·5
58	69·1	204	48·5
59	29·7	205	4·0
60	55·7	191	7·3
61	11·5	185	39·6
62	27·3	199	2·8
63	85·2	163	51·8
64	44·4	204	5·5
65	31·5	261	7·5

TABLE IV.—*Winter Laying (3rd November—28th December) in Relation to Annual Production and Size of Eggs (Wyandottes).*

	First and Second Periods.		*Yearly Averages.*	
No. of Eggs.	*No. of Birds.*	*Average No. of Eggs.*	*No. of Eggs.*	*Percentages of 2nd Grade Eggs.*
0	12	0	165	8·5
1 to 10	66	5	190	28·2
11 ,, 20	78	13	192	22·0
21 ,, 30	30	22	206	26·7
Over 30	12	33	230	18·2

As it is unsafe to draw conclusions from the performances of single pens, results have been collected of the number of eggs laid by groups of pens during the first two periods (November and December), in order to determine the extent

to which the size of eggs over the whole year is related to winter production. The results are given in Table IV.

The relation between the total annual egg production and the size of egg is shown in Table V.

Table V.—*Average Egg Production in Relation to Size of Egg.*

Group. No. of Eggs.	*No. of Birds.*	*Average Production.*	*Percentage of 2nd Grade Eggs.*
151 to 160	12	155	8·6
161 ,, 170	18	164	25·6
171 ,, 180	18	176	14·3
181 ,, 190	36	183	24·6
191 ,, 200	30	191	19·7
201 ,, 210	48	205	24·7
211 ,, 220	12	217	20·2
221 ,, 230	6	220	30·0
Over 230	18	235	32·6

The percentages of production as given in Table I indicate that, by selection and efficient management, a steady output of eggs can be maintained throughout the entire year. While the maximum is attained during the spring cycle (February-May), the variations at other periods are less than might have been expected. It will be noticed that Leghorns did not compare favourably with Wyandottes, Rhode Island Reds and Plymouth Rocks, a matter of surprise, considering that Leghorns are non-sitters, whereas the others are usually sitters during the fifth, sixth and seventh periods.

Table II is worthy of study. It will be noticed that while there are considerable variations in accordance with the season, yet the variations seem to follow a consistent rule. The proportion of eggs failing to reach market standards is considerable. In this respect the Rhode Island Reds show the most marked improvement from the first period.

The graphs show that size of egg increases with greater production, although not in relative proportion, during the earlier periods of laying, and that during the later periods, when production declines, the size of the egg is maintained.

It is further shown that all breeds lay smaller eggs in the first two periods, and that the increase therefore takes place after the first eight weeks.

From Table IV it would appear that, with the exception of the two pens which produced no eggs in the first and second periods, and gave the lowest annual averages of second grade eggs, there is no affinity between winter laying and the percentage of second grade eggs. The eleven pens of Wyandottes which laid an average of 5.1 eggs in the first and second periods, gave over the whole year an average of

28.2 per cent. second grade eggs, and the two pens which produced 33.2 eggs in first two periods laid 18.2 per cent. of second grade eggs.

On the other hand, with notable differences, it would seem (Table V) that the number of second grade eggs laid is influenced by the total annual egg-laying capacity; the larger the annual production the greater is the percentage of second grade eggs.

Further evidence is obtained by a study of the details from records of pens of White Wyandottes given below.

Four Pens producing an Annual Average of 220 Eggs and over.

Pen No.	First Period. Average Production.	First Period. No. of 2nd Grade Eggs.	Percentage of 2nd Grade Eggs in Last Period.	Whole Year. Total Eggs laid.	Whole Year. Percentage of 2nd Grade Eggs.
23	17·8	64	1·6	220	30·0
36	7·5	80	26·0	231	39·5
45	3·2	89	73·0	235	51·5
65*	15·3	51	12·6	261	7·5

* This flock quickly improved, and maintained a higher proportion of 1st grade eggs.

Five Pens producing an Annual Average of 180 to 190 Eggs.

42*	8·83	18·9	57·1	187	8·9
46	3·5	42·8	17·2	183	23·2
53†	0·0	0·0	3·1	185	12·3
54	3·0	72·2	40·4	184	46·5
61‡	3·0	16·7	21·8	185	39·6

* Until the last period the percentage of 2nd grade eggs was very low.
† 11·76 per cent. 2nd grade eggs in second period.
‡ Average of 2nd grade eggs greatly increased, being 64·4 per cent. in fifth period.

In only thirteen instances were all the eggs produced within any one period of first grade standard. Of these, one was in the third period, one in the fourth, one in the fifth, two in the seventh, three in the ninth, two in the eleventh, one in the twelfth, and two in the thirteenth period. In the large proportion of cases, where small eggs are laid during the first and second months, the size of the egg is below standard during the remainder of the year.

The figures submitted, so far as the four breeds dealt with are concerned, would clearly show that, while early laying has, in the majority of cases, an influence upon the size of eggs throughout the year, and also on total productivity, yet there are enough exceptions to indicate that size of egg is largely a matter of breed or strain. In order, therefore, to obtain a standard sized egg throughout the year, attention should be devoted to the production of a larger egg during the winter. Size should not be entirely sacrificed to numbers.

GOVERNMENT ASSISTANCE TO HORTICULTURE:

ITS LIMITS AND ITS POSSIBILITIES.

Wm. J. Lobjoit, O.B.E.,
Controller of Horticulture, Ministry of Agriculture.

Expectations as to Government assistance to horticulture are not infrequently based on a failure to appreciate what are and what are not the functions of a Government Department. In the demands and criticisms which one hears and reads there is evidence of two distinct and divergent lines of thought among growers as to what the Ministry should do and what relationship it should maintain to the industry.

There are those whose conception of the whole duty of Government is expressed in three words: "Let us alone." The persistent neglect of agriculture, which in past days was the occasion of almost universal grumbling, is now looked back upon with wistful regret as a paradise lost. Most people, however, have come to realise that modern society has grown too complex for Government to adopt the role of merely keeping the ring while competing interests tear each other according to the law of the jungle; the community in general looking on and taking its chance, whether of benefit or suffering. You cannot bring back the water that has flowed under the bridge, nor can you put back the hands of the clock. During the years 1914 to 1918 civilization sailed into a new latitude and it has had to set its chronometers to a new Meridian. There is a changed atmosphere; there is an expanded outlook; there is a new philosophy of life, affecting those who think and those who exist without thinking. You cannot go back to the untrammelled individualism of the isolated country-side. The functions of Government are extended and extending by force of a world-wide impulse. On all hands there is the regulation of liberty in order that the essence of liberty may be preserved. There are, however, those who expect Government to do almost everything for them: a mental condition begotten of the nightmare of the war period when Government invaded the very altar places of home and in the manifest impotence of individual effort men looked to Government for deliverance. Just as there is the call so there are the limits to what a Government can do for Horticulture.

It can neither supply capital, nor individual initiative. It

cannot find judgment nor give financial prudence. It can make knowledge available but the acquirement must rest with the individual. Nor can it—and this seems to be the chief note in much criticism that has been passed on the Ministry—deliver growers from the necessity of facing up to the competition of produce from overseas. The fiscal policy is for the country through Parliament to settle.

Association of Growers.—There is a range of subjects in which growers in combination can do what the individual acting alone cannot.

Among these are questions of railway and other transport, markets, matters requiring agreement upon a common policy for the industry. Growers, in co-operation with the Ministry, can combine for conducting experiment and research as is done at Lea Valley and Malling. Last but not least, growers can always participate in the exhilarating sport of criticising and even of fighting the Government. There is still left a wide territory which can only be occupied by Government action.

Government Action.—But Government action does not necessarily mean—though it is generally taken to mean—action of the policeman type coming with a summons in his pocket. There is that wider and much more general police action of protection against the aggressor, of safeguarding interests menaced by the evil doer, and there is action of the " fire engine " type which comes to preserve property threatened by destruction. Whatever in the past may have given occasion for suspicion of Government action and given rise to resentment of the visit of an inspector as an invasion of the liberty of the subject, it is the anxious desire of the Ministry to dispel suspicion and to prove itself to be the friend of every section of the industry, the co-operator in every useful development, the protector of its interests against every assailant—its eyes in the investigation of problems and its intelligence wing in research.

To secure that this shall be so, elaborate arrangements have been made for frequent consultation between the Ministry and representatives from all branches of the industry. There is the Horticultural Advisory Council with its Sub-Committees of Nursery, Fruit and Vegetable Growing, Glass House, Marketing and Distribution, Bee Keeping and Willow Growing.

At the foundation of a horticultural policy is the question of statistics. Probably no industry in the country stands in such an unfurnished condition in this respect as does that of horticulture. That the industry is important— that it represents the

investment of much capital, and gives employment to large numbers, everyone knows—but who can fix precise figures to the general statements? Yet to know the dimensions of the industry is surely a reasonable pre-requisite to defining a policy in regard to it. It has been said that the value of statistics to a Government Department is patent, but what benefit can they be to the grower? It is very much like stating that anyone can see the value of diagnosis to a physician; but what benefit can it be to the patient? In the recent inquiry as to railway rates the absence of accurate statistics has weakened the case for the industry. There are violent fluctuations of prices for vegetables. Is the cause over production or lack of transport or faulty distribution? Statistics alone can prove it. In times of glut, too, is importation the cause or is it a question of reorganising transport? Statistics are necessary before an answer can be given.

No doubt at the mention of statistics the grower sighs and says "More forms." But here his fears are groundless—for though there must be the filling of schedules, expert assistance for this purpose can be given from Committees comprised of representatives of growers' organisations, the County Horticultural Staff and the inspectorate of the Ministry. The schedules are the product of conference between the national organisations of growers, the Horticultural Advisory Council and the Ministry. They are designed to obtain an accurate, detailed record, in the first instance, of fruit growing of all types in the country and of the nursery and glass house industry, with provisions for building up a system of reliable forecasts of the fruit crop, obtained in time to give warning to growers overseas when there is a large crop in this country.

The collection of statistics on the lines above indicated has been deferred for the present in view of the need for economy.

Plant Hygiene.—If an accurate diagnosis of the conditions of the industry is the foundation for a Horticultural policy, the next step will be to take measures to defend the horticultural stocks of the country against the attacks of diseases and pests. These can either be brought into the country upon imported produce or can be spread by the distribution of home grown stock as carriers. In the first case dealing with imported produce is necessary, and here it is evident the industry is dependent upon sympathetic Government action. The matter is not an easy one in any case, and is made more difficult by the disagreement among experts of how best to do it. The provision made and the powers taken to protect the live-stock herds against infection.

form some analogy of the course that may be taken. Inspection and certification by the authorities of the exporting country, where an effective system for this purpose exists, and where it does not, inspection at the port of landing before distribution in this country, form the basis of the plan with, in the background, the power to prohibit importation altogether, where such a drastic measure becomes necessary.

Next in importance is the health of the home stocks. Growers can be assisted in this matter by means of inspection of nurseries so that in all cases where it is possible to do so a certificate of health can be given, which the holder may use and quote to his clients, and powers to secure punishment of those who, reckless of the damage they may do to the industry and the community at large, send out plants seriously affected with diseases or pests.

This fight for health has become a vital matter to the industry. With the relative position attained by costs of production and the wholesale price obtained for produce, the saving of the waste seems to be the only way of escape for the grower.

Purity of Stock.—Next to health comes purity of stock and fidelity to type. Notwithstanding the laudable and costly efforts made by our nurserymen and seedsmen to improve and to fix standard types, the battle has yet been scarcely more than an affair of outposts, but the lines have been pretty clearly laid down and much useful ground covered at Malling. Experiments with regard to Strawberries, Raspberries and other fruits are now being conducted at Long Ashton, but there is scarcely a form of fruit or vegetable produce in which the field for investigation, in this respect, is not almost unlimited. Then there is the matter of production of new types which has hardly yet been attacked in a comprehensive and scientific manner. In all these matters the Ministry so far as its resources permit is ready to lead the way for the industry, so that the problems that are constantly arising may be effectually tackled.

Value of Fruit Shows.—All this is in the production line. The more efficient and successful you make production the greater the obligations imposed upon you to find an outlet for the consumer. Here again you come into almost uncharted territory and the Ministry can offer to the industry services that cannot be substituted. It is proposed to make a beginning with apples—it is safe to assert that the general public is ignorant of what the home commercial grower can produce of this fruit.

The series of commercial fruit shows which began with Kent and has gradually been extended to other fruit growing centres has already served to quicken the interest and stimulate the spirit of emulation among fruit growers. These shows serve to afford information of what the more progressive and scientific growers are accomplishing. They are dispersing the old idea that any grower can gain by a policy of selfish seclusion; they serve the purpose of education by bringing the growers together for mutual counsel, and for the discussion of topics of general interest; they afford stimulus from the sporting spirit of competition; they serve to enlighten the public of what home growers are striving for, and they demonstrate what with skill, courage and persistency the most advanced have accomplished; they serve also to concentrate attention on those varieties of fruit which are best calculated to meet the public taste. But shows in fruit growing centres are insufficient. It is necessary to have a crowning edifice in London where entries which have obtained a prize in the Provincial Shows may be brought together and re-staged in competition with one another—if possible for some substantially attractive prizes for the best among the best.

The home grower has hidden his candle under the bushel too long. Too long has he neglected advertisement. It is a modesty which is not convenient, and it has given long measure to the illusion that if fruit that is attractive for the table is desired, one must get it from overseas supplies. The undoubted excellency which home grown fruit has attained, has yet to be brought home to the citizens of the metropolis and the provincial capitals of industry. This is a matter in which Government support can be helpful to the carrying out of any extended enterprise. It is satisfactory to note that arrangements are well under way for the organisation of a show of commercial fruit in London in the forthcoming summer on a scale such as has never been attempted before.

The commercial fruit show in the fruit growing area may be called " educational "—this to be held in London may be called a " demonstration " show. It is fitting that the first demonstration show should be held in London—the hub of our Empire. It is well to enlighten the citizens of the metropolis first—but it is not enough to do this and stay. The teeming populations of our commercial and industrial centres are equally unenlightened in this respect, and it is part of the proposed plan in subsequent years, to hold a demonstration show in each of the principal provincial cities.

When the home grower has by these means demonstrated to the British public that he can produce fruit of the finest quality and present it in a manner to suit the most refined taste, there must be set on foot a campaign of propaganda to secure that the home grown fruit shall have its full and rightful place in the dietary of the people. It must strike anyone who gives the matter a moment's thought that this is most assuredly not the case at present. Without referring to ordinary domestic uses, it is sufficient for the moment to ask the question: at how many dinners or banquets, even of the highest class, does one see a provision for dessert of such a nature as to encourage the consumption of home grown fruit? The order of events must be first the demonstration of what the home grower is accomplishing and then the propaganda to extend the use.

Grading and Packing of Fruit.—The encouragement of an extended culture of fruit must have its counterpart in the propaganda to encourage the extended use of fruit, which, if it can be attained, will justify itself not only upon economic grounds, but on the higher plane of health. These considerations involve the form of package to be used, the lines on which fruit should be graded and the methods of packing to be recognised, the standard of quality, and any possible limitation of the varieties to be recognised. As a beginning has to be made, it will be well in the first instance to confine attention to the apple, which is the most widely used of any form of fruit capable of being grown at home. It is common knowledge among growers and all who deal with apples that the popularity which the imported apple has attained in this country is due to the use of a standardised package selected because of its suitability for shipment purposes, the adoption of a consistent system of grading which has been imposed by Government action, to scientific methods of packing, and to a high condition of soundness in quality, while the continuity of supply which results from concentration upon a comparatively few varieties of ascertained quality has added to these other advantages and given to the imported apple a distinct lead.

The Ministry does not wish to impose upon the trade the use of any form of package, but would rather that the trade (and, by the term "trade" in this connection the Ministry understands not only the growers, but wholesale salesmen and retail distributors), should come together and arrive at an agreement as to what packages should be standardised. The same system will apply to the other items of grading, packing, standard of quality, and of recognised sorts. Upon each of these matters

the industry is asked to come to an agreement. When this measure of agreement is obtained, the next step to consider is how to put it into practical operation for the benefit of the industry and the country in general. There are those who favour legislation, giving to the agreement arrived at by the trade, the force of law, but this would not necessarily be the best method of securing the willing co-operation of the growers, and the popularity of the method. A far better method would be to make use of the motive of self interest and by the voluntary co-operation of the growers themselves, demonstrating the advantages of the system. To effect this an authorised label to be used only for apples which are packed in the manner agreed to by the trade and authorised by the Ministry might be adopted. The label could be issued by the Ministry to organised growers under a guarantee to observe certain conditions.

These conditions would be (1) An authorised system of grading; (2) An authorised system of packing; (3) An authorised standard of quality; and (4) A recognised commercial variety. The label would bear, distinctly marked on it, the grade, the number of weight of the contents, the variety of the apple, and some distinction mark to identify the grower. The label would thus be a symbol to all buyers of honest fruit.

The apples of any one variety whether grown in the North, South, East or West of England, packed according to these conditions and of the same grade would be so similar that they could be stacked together in the market and sold in bulk. A buyer would thus have the advantage of continuity of supply, which at present unfortunately only goes with fruit grown overseas. The saving of labour and space to the salesmen in busy markets is evident, and some might be reflected to the grower in reduced salesmen's charges. The main advantages to the grower, however, would be that ruinous slumps would be avoided. As all sales would be from standard samples no individual consignment need be neglected. An auxiliary to this policy would be the taking off the market of all scabby and misshapen apples which now tend to lower the price and to spoil the home grown apples, and the use of such fruit in manufacture.

It may be mentioned, in conclusion, that by the Agriculture Act, by the legalising of what is known as the "Evesham custom" and by other provisions, long-standing grievances of which commercial horticulturists complained, are removed, and to the encouragements to the extension of intensive cultivation described above is now added that of a larger measure of security for capital invested in improvements of the holding.

"ISLE OF WIGHT" DISEASE OF BEES.

The disease of bees called "Isle of Wight" disease has recently come into prominence on account of some interesting papers that were read before the Royal Society of Edinburgh on 1st November, 1920, by Dr. J. Rennie, and his collaborators, Miss Elsie J. Harvey, and Mr. P. Bruce White, B.Sc., on their recent discovery in connection with this malady. Before dealing with these papers, however, it will perhaps be as well to give a rapid survey of the history and progress of this disease, and the investigations that have been made into its cause since it first appeared.

The name "Isle of Wight" was given to the disease because the first serious outbreak occurred in that Island in 1904, since when it has engaged the continuous attention both of the Ministry and practical and scientific bee-keepers. From 1904 to 1906 the disease spread slowly, but in the latter year its progress became more rapid, until in 1907 practically the whole Island was affected and bee-keeping there became an unprofitable industry.

The symptoms of the disease are as follows:—Listlessness of the bees; dislocation of one or both posterior wings, and distension of the abdomen; the staining of the alighting board and combs with excreta of the consistency of putty; crowding of the bees on the outside of the hive, and, in severe cases, owing to their inability to fly, crawling about in thousands on the ground or ascending upright objects, and at times collecting in small clusters eventually to die.

Many theories in earlier times have been advanced as to the cause of the disease, including infection from poisonous plants, from tar spraying of the roads, from spraying fruit trees and potatoes, from damaged pollen collected and eaten by the bees, inbreeding, want of ventilation, fungi, yeasts, artificial feeding, and modern methods of bee-keeping. In 1907, at the request of the Board, Mr. A. D. Imms, B.A., Cambridge University, carried out an investigation of the disease in the Isle of Wight itself. He came to the conclusion that it was due to digestive trouble, and gave an account of his investigations in this Journal in June, 1907. Shortly afterwards Mr. Imms went to India, and his work of investigation was continued by Dr. Graham Smith, in conjunction with the late Dr. Malden, of Cambridge University. They reported that all the

affected stocks in the Island had by that time died off, and that the disease remained in abeyance until the middle of June, when it broke out again with greater virulence. They formed the opinion that the conditions described by Mr. Imms were the result and not the cause of the disease. They also shared the opinion of the practical bee-keepers on the Island, that the disease was highly infectious and that the drinking places visited by the bees were a source of contamination.

In 1911, the disease made its appearance in England and Scotland. Dr. Malden continued his work and was assisted by Dr. Fantham, Dr. Annie Porter, and Mr. Bullamore. The general conclusion which these investigators arrived at was that the disease appeared to be caused by a parasitic organism, "Nosema Apis," a member of the group known as "Microsporidia," which carried out its life cycle in the intestines of the bee. The name "Microsporidiosis" was accordingly given to the disease. Investigators in other countries, Zander and Massen in Germany, and Nussbaumer in Switzerland, also came to the conclusion that "Nosema Apis" was the cause of the disease.

Attention was now devoted to finding a cure for it. Several drugs were tried with varying results, but no definite and certain remedy could be found. Investigations were then carried out at the University of Aberdeen and the Aberdeen College of Agriculture by Dr. Rennie and Mr. Anderson, the latter eventually questioning whether "Nosema Apis" was, in fact, the cause of the disease. Dr. Rennie was later assisted by Miss Elsie J. Harvey and Mr. P. Bruce White, B.Sc. Their investigation led to the discovery, early last year, of a parasite of a remarkable kind, belonging to the genus "*Tarsonemus*," hitherto unknown in bees. The *Tarsonemes* include several species destructive to plants, and there are some which have been found in malignant growths in man and in animals; in structure the bee *Tarsoneme* appears to be most closely allied to these last. This creature, which is specialised in structure, is bred within the bee and is confined to an extremely limited, but very important region of its breathing system. Within the space of a few cubic millimetres scores of these creatures may be found in all stages of development, sometimes so densely packed as to cut off effectively the air supply from the surrounding organs. The detailed pathology described in Mr. White's paper proved the destructive character of the parasite's habits. Thousands of bees have been examined from large numbers of stocks throughout the

country, and it was found that every stock reported by reliable bee-keepers, or certified by the investigators themselves, as suffering from the disease, harboured this parasite, while " Nosema Apis " was not always present. Similarly, every individual bee known to be suffering from this disease from its stock history and individual symptoms, was also found to contain these parasites, and to exhibit the internal disorders which caused the disabling symptoms. The investigators stated that they were now able to diagnose the disease in its earliest stages, while the bees were capable of flying and foraging. Infection appeared to occur mainly in the hive, the conditions of the cluster making this comparatively easy. In support of this theory, mites have been obtained from the outside of the bee apparently on their migratory passage.

In the light of this discovery much that was puzzling in the symptoms of the disease appears to be cleared up. The mite infests the trachea of the thorax only, entering by the spiracles, and breeding takes place here, until eventually the trachea becomes partially or wholly obstructed. In the latter case the bee dies at once, while in the former, being unable to fill the air sacs which permit of flight, it is reduced to crawling. In such cases the fæces are not evacuated, as normally this is accomplished when the bee is on the wing, and hence arises the congested condition of the bowels, and the consequent staining of the combs, hive front, and alighting board.

Interesting experiments were carried out by blocking up the thoracical spiracles of the bee with wax, and by this means all the usual symptoms of " Isle of Wight " disease were produced. Tests were also made on young bees which were hatched from combs in an incubator and from which all the adult bees had been previously removed. Out of the 157 young bees that were examined only one was found to be affected with " Tarsoneme "; this may have remained on the comb, and entered the bee after it had emerged from the cell, so that it is reasonable to suppose that young bees are not affected. This supposition is further strengthened by the fact that in the past, stocks apparently have been cured, and have given surplus honey by making an artificial swarm from the affected stock; the swarm, consisting of all the old infected bees being destroyed, and the young and hatching bees allowed to carry on the work of the hive.

Many bees from different countries outside Great Britain have been examined, and so far " *Tarsonemus* " has not been found in them. All the evidence obtained points to this parasite in bees being peculiar to this country.

As some recognition of the interest taken by Mr. A. H. E. Wood, the director of the research proposes to designate the new species "*Tarsonemus woodi*." The investigators also recorded their high appreciation of the support of bee-keepers throughout Great Britain, and also of the Ministry of Agriculture and Fisheries in supplying bees, and rendering other assistance so essential for the successful conduct of the research.

In conclusion it may be said that the discovery appears to be an important one for the bee-keeping industry, and there seems little doubt that the causal agent of "Isle of Wight" Disease has at last been traced. It remains, however, for other investigators to corroborate or refute the conclusions arrived at by Dr. Rennie before the discovery can be wholly confirmed and accepted. Dr. Rennie, to whom great credit in the matter is due, will now devote his time to finding a means of combating this pest. He suggests that the name "Isle of Wight" disease, which is unsatisfactory, might be changed to "*Acarine*" disease.

NOTES ON MANURES FOR APRIL.

E. J. RUSSELL, D.Sc.,
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Manures for Potatoes.—This is the season when manures must be applied for potatoes. The best preparation is a good dressing of farmyard manure in the previous autumn in England, or in spring where the winter rainfall is heavy as, probably, in Wales. Where sufficient dung was not available in autumn the remainder is applied in the drills.

Artificials must always be added. Satisfactory results have been obtained by the application at the time of planting of 1 cwt. of sulphate of ammonia, 4 cwt. of superphosphate, and 1 cwt. of sulphate or muriate of potash per acre. If, however, the soil and climatic conditions are such that 9 or 10 tons of potatoes per acre may be expected then the following mixture would be justified: 1½ cwt. of sulphate of ammonia, 4 cwt. of superphosphate, and 1½ cwt. of sulphate or muriate of potash.

In special cases even higher dressings can be used, but only when direct experience shows a definite advantage. Cases are on record when a shortage of dung was satisfactorily counterbalanced by increasing the sulphate of ammonia to 2½ cwt., with corresponding increases in the superphosphate to 6 cwt. and in the sulphate of potash to 2 cwt. per acre.

Some farmers have asked whether anything is gained by adding magnesium compounds to a potato manure. Certain Scotch farmers have used magnesium in the form of oxide or carbonate, and claim to have obtained satisfactory results. One of the successful Scotch growers in Hertfordshire has applied magnesium compounds. The writer was unable to find, however, that any advantage was gained thereby, but precise evidence is lacking. Magnesium sulphate or chloride could be more readily obtained: the effect is being tested during the present season at Rothamsted.

Sulphate of ammonia is generally found better for potatoes than nitrate of soda, nitrate of lime or nitrolim, and should therefore be used unless there is evidence that the nitrate would be more effective. Whenever there is any reason to fear scab sulphate of ammonia and superphosphate would be necessary, but in soils where scab does not generally give trouble, and in certain other cases also, a mixture of basic slag

and superphosphate can be used instead of superphosphate. As a general rule, however, the mixture given above has worked satisfactorily.

Manures for Mangolds.—As in the case of potatoes, the best preparation for mangolds is a dressing of farmyard manure, applied in the previous autumn if possible in the case of most of England, but in spring in districts where the winter is very wet. Many dairy farmers in the Home Counties have used little else, but this is not a satisfactory method of treatment unless dung is very cheap. Better results are obtained by the use of not more than 20 loads of dung, supplemented by artificials.

The following mixture has proved satisfactory: 1 cwt. of sulphate of ammonia, 3 cwt. of superphosphate, 4 cwt. of kainit or sylvinite, and 2 to 4 cwt. of salt in the drills, and 1½ cwt. nitrate of soda as a top dressing when the plants are singled and hoed.

The dressing seems heavy, but owing to the importance of the crop liberal manuring is quite justified. In the case of mangolds nitrate of soda gives better results as a top dressing than sulphate of ammonia: experiments show that nitrate of lime is also effective.

Kainit or sylvinite are suggested in preference to other potash manures because the salt present is of value to the mangold crop. Even when 4 cwt. of these fertilisers are used, however, mangolds would often respond to further dressings of salt.

Swedes and Turnips.—These crops require altogether different manurial treatment from the preceding. If grown without dung they need large quantities of phosphate, and sufficient, but not excess, of nitrogen. A useful dressing in this case would be, in the southern part of England: 4 cwt. of superphosphate or 6 cwt. of basic slag, and 1 cwt. of sulphate of ammonia. If, however, climatic and soil conditions favour a yield of 18 tons or more per acre, the following could be used: 6 cwt. of superphosphate or 8 cwt. of basic slag, 1 cwt. of sulphate of ammonia, and 1 cwt. of sulphate of potash in the drills, followed by 1 cwt. of nitrate of soda as a top dressing at the time of singling.

Where, however, dung is applied it is very doubtful whether artificials are required at all. In numerous careful experiments there has been no response to the additional artificials. The phosphate and potash would of course remain in the soil for future crops, but the ammonia would be lost.

Examine Clover Leys now.—Now that the winter is over careful inspection of the clover leys is desirable to ascertain whether the general soil conditions are suitable or whether there is a need of lime and of phosphates. The writer is convinced that many farmers suffer unnecessary loss of this most valuable crop simply through lack of lime and phosphates. The best time for applying these is at or before the sowing of the clover seed, when, as pointed out last month, there is a marked response in the growth of the young plant. The advantage of inspection now is that it affords guidance for the treatment of seeds to be sown this year: if last year's crop is patchy and the plants are not as healthy as they should be, the newly sown seeds should be well dressed with basic slag.

Difference between Kainit, Sylvinite, Muriate of Potash and Sulphate of Potash.—Our correspondence shows that there is some confusion in the minds of farmers between these substances.

Sulphate of potash is well known, and being a single substance is always of the same composition so long as it remains of the same degree of purity. It can be used on all crops needing potash, and is free from harmful effects on quality.

Muriate of potash is also well known to farmers, and in most cases can be used as freely as sulphate of potash, with the certainty that it will supply the requirements of crops needing potash. There have been statements that it sometimes injures quality, but the writer has found no direct evidence that this is the case. Careful trials are being made this year.

Kainit is a mixture of substances graded so as to contain about $12\frac{1}{2}$ per cent. of pure potash (K_2O), most of which appears to be in the form of muriate. Before the War it consisted of about one-third of its weight of common salt (sodium chloride), about one-third of magnesium salts (apparently chiefly as sulphates), while the remaining third was muriate of potash with water of crystallisation. It is known to be of great value on mangolds and grassland, where probably all its constituents help the crop.

Sylvinite is a newcomer among fertilisers and is being vigorously handled by the Company responsible for the development of Alsace and Lorraine, where it is found. One grade is sold to contain 12 to 14 per cent. of pure potash (K_2O), and this is comparable with kainit; a higher grade contains 20 to 22 per cent. of potash. Both differ from kainit in containing no sulphate of magnesia but only muriate of potash and

muriate of soda (common salt). The lower grade contains approximately 19 to 25 per cent. of muriate of potash, 60 to 66 per cent. of muriate of soda, 2 to 5 per cent. of sulphate of lime, and 10 to 12 per cent. of insoluble matter; the higher grade contains approximately 32 to 35 per cent. of muriate of potash, 50 to 55 per cent. of muriate of soda, 2 to 5 per cent. of sulphate of lime, and 9 to 10 per cent. of insoluble matter. Either grade would be worth trying on mangolds or grassland. The effect on potatoes is being carefully tested this year at Rothamsted.

Confusion between Chalk, Lime and Limestone.—Instances have been brought to the writer's notice of a confusion between lime and limestone or chalk, which is adversely affecting some of the farmers in whose minds it exists. It is unfortunate that these words are all used in rather a loose way, as if they meant the same thing. They do not, and there is really a considerable difference between them. In buying lime the farmer should be perfectly certain as to what the analysis means, and if he is in any doubt should communicate with the County Organiser. If one invoice guarantees 90 per cent. of pure chalk or pure limestone or pure calcium carbonate, and another guarantees 50.4 per cent. of pure lime *or* pure oxide of lime, these two quantities are not different but the same. There being no legal form of guarantee a dealer is fully justified in describing the material in whatever way he thinks most attractive, but the farmer who is buying should be perfectly clear in his mind what it is he is getting.

FEEDING STUFFS IN APRIL.

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IN last month's notes it was stated that eggs contained all the vitamines considered essential to the well being of the young growing animal. It should have been stated that eggs, like most animal products, are deficient in the anti-scorbutic factor. Although our present knowledge does not enable us to state whether this factor is indispensable as a component of a normal growth dietary, it is well to mention its absence in order to remove any misapprehension which may arise through the statement made. The anti-scorbutic factor is of course abundant in most fresh vegetable foods, such as cabbage, swedes and carrots.

Farm and Consuming Values.—It will be noted that the expression " consuming value " as applied to potatoes, swedes, mangolds and silage, has been replaced in the table by the term " farm value." The object of this is to avoid the possibility of confusing the value given with the value assigned to farm goods by valuers. The " consuming value " of a food, as given by valuers, is arrived at generally by taking two-thirds of the market value of the food, after allowing for costs of marketing and residual manurial value. The figures given in the table, however, represent the actual value to the farmer for feeding purposes on the farm, together with the manurial value, and do not allow for cost of marketing. The value assigned by a valuer to potatoes on a farm will, as a general rule, have quite a different value to that given in the table.

Maize and Maize Products.—An average sample of maize contains approximately 1.5 per cent. ash, 2.2 per cent. crude fibre, 4.5 per cent. oil, 10 per cent. protein and 70 per cent. starchy material. It is relatively high in oil and starch, medium in protein, and low in fibre, and is, therefore, pre-eminently a fattening foodstuff. The protein of maize by itself is unsuitable for young growing animals, so that if maize is used it must be supplemented with foods rich in protein and mineral matter. In the case of growing and breeding stock, maize or maize meal should in no case exceed one-half of the ration, about one-third being the best proportion. Oats or bran with linseed meal, lucerne or clover hay, and pasture are suitable additions to a maize dietary.

In the case of fattening stock, particularly pigs, maize or maize meal may form with advantage the bulk of the food. Whether the maize should be given whole or crushed, or in the

form of meal, depends on the class of stock and the judgment of the feeder. In the case of cattle a proportion of the whole grain passes through the digestive system unchanged, and it may be an advantage in this case to run pigs with the cattle. In the case of lambs, the maize should be finely crushed, but it is considered best to feed sheep with whole maize. In the case of pigs the maize is best fed in the form of meal, and it is advisable to soak the meal well before feeding.

Maize By-products.—The use of maize and maize products for human food gives rise to a large number of by-products, including maize bran, gluten feed, gluten meal, maize germ meal, corn oil cake, hominy chop, hominy feed, and brewery by-products such as distillers' grains.

Maize bran consists of the whole of the maize and has a low feeding value. *Gluten feed* consists of a mixture of all the by-products obtained in the manufacture of maize starch, and can be regarded as the maize grain with most of the starch removed. It is rich in oil and protein and is well suited for dairy and fattening stock. *Gluten meal* does not contain the whole bran or the embryo, and differs from gluten feed in this respect. It is a concentrated feeding stuff, and may be used in the same way as gluten feed.

Maize germ meal or cake consists of the embryo or maize germ from which the oil has been extracted. It is a very concentrated food and should be used in conjunction with other grain feeds. *Corn oil cake* consists of the pressed embryos, contains a considerable quantity of oil, and, like maize germ meal, is a highly concentrated feeding stuff. *Hominy chop* and *hominy feed* consist of the whole grain and starchy refuse from the hominy factory. They resemble maize itself from a feeding standpoint, and are of about equivalent value lb. for lb. They are valuable for fattening animals and milch cows. *Distillers' grains* obtained from maize are valuable as a feed for dairy cows, and may replace part of the oat ration for working horses, but owing to their fibrous nature are not suitable for pigs.

The following table shows the chemical composition of the various by-products:—

	Water.	*Crude Protein.*	*Oil.*	*Nitrogen free extract.*	*Crude fibre.*	*Ash.*
Gluten meal ...	9·2	36·9	3·9	46·7	2·2	1·1
Gluten feed ...	8·5	25·7	4·4	53·5	6·7	1·2
Germ meal ...	9·1	23·0	10·7	45·6	9·0	2·6
Hominy feed ...	9·3	11·2	8·6	63·7	4·5	2·7
Distillers' grains	8·8	35·0	11·3	30·4	12·1	3·4
Maize bran ...	9·1	9·9	5·6	62·0	12·1	3·1

NAME.	Price per Qr. s.	lb.	Price per Ton. £ s.	Manurial Value per Ton. £ s.	Food Value per Ton. £ s.	Starch Equiv. per 100 lb.	Price per Unit, Starch Equiv. s.	Price per lb. Starch Equiv. d.
Barley, English Feeding	40/3	400	11 5	1 6	9 19	71	2/10	1·52
„ Foreign „	46/6	400	13 0	1 6	11 14	71	3/3	1·74
Oats, English „	41/6	336	13 17	1 9	12 8	59·5	4/2	2·23
„ Foreign „	33/-	320	11 11	1 9	10 2	59·5	3/5	1·83
Maize	55/9	480	13 0	1 5	11 15	81	2/11	1·56
Beans, English spring	—	—	—	—	—	—	—	—
„ „ winter	57/-	532	12 0	3 1	8 19	66	2/8	1·43
„ Chinese	14/6	112	14 10	3 1	11 9	66	3/6	1·87
Peas, English blue	60/-	504	13 7	2 13	10 14	69	3/1	1·65
„ „ dun	70/-	504	15 11	2 13	12 18	69	3/9	2·01
„ „ maple	70/-	504	15 11	2 13	12 18	69	3/9	2·01
„ Japanese*	137/6	504	30 11	2 13	27 18	69	8/1	4·33
Buckwheat	72/-	392	20 11	1 9	19 2	53	7/2	3·84
Rye, English	54/3	480	12 13	1 8	11 5	72	3/1	1·65
Millers' offals—Coarse	—	—	9 10	2 10	7 0	45	3/1	1·65
„ „ Fine	—	—	10 10	2 10	8 0	64	2/6	1·34
Barley meal	—	—	16 5	1 6	14 19	71	4/2	2·23
Maize „	—	—	12 10	1 5	11 5	81	2/9	1·47
Bean „	—	—	16 10	3 1	13 9	66	4/1	2·19
Fish „	—	—	21 0	7 12	13 8	53	5/1	2·72
Linseed	—	—	19 0	2 16	16 4	119	2/9	1·47
Cakes, Linseed	—	—	17 12	3 12	14 0	74	3/9	2·01
„ Soya	—	—	—	—	—	—	—	—
„ Cotton seed	—	—	10 0	3 5	6 15	42	3/2	1·70
„ Cotton seed decorticated*	—	—	18 0	5 6	12 14	71	3/7	1·92
„ „ decorticated meal	—	—	14 0	5 6	8 14	71	2/5	1·29
Coconut cake	—	—	10 10	3 0	7 10	79	1/11	1·03
Groundnut cake	—	—	—	—	—	—	—	—
„ decorticated	—	—	15 0	5 5	9 15	73	2/8	1·43
Palm kernel cake	—	—	7 10	2 1	5 9	75	1/5	0·76
„ „ meal	—	—	—	—	—	—	—	—
Brewers' grains, dry	—	—	8 10	2 7	6 3	49	2/6	1·34
„ „ wet	—	—	1 15	0 12	1 3	15	1/6	0·80
Distillers' „ dry	—	—	11 5	2 16	8 9	57	3/-	1·61
„ „ wet	—	—	—	—	—	—	—	—
Malt culms	—	—	7 10	3 6	4 4	43	1/11	1·03
Potatoes†	—	—	3 0	0 8	2 12	18	2/11	1·56
Swedes†	—	—	1 6	0 5	1 1	7	2/11	1·56
Mangolds†	—	—	1 3	0 6	0 17	6	2/11	1·56
Vetch and oat silage†	—	—	2 16	0 15	2 1	14	2/11	1·56

* Prices at Liverpool. † Farm value.

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 February 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 £2 1s. per ton. The food value per ton is therefore £7 19s. 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. 1d. Dividing this again by 22·4, the number of pounds of starch equivalent in 1 unit, the cost per lb. of starch equivalent is 1·11d. 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.

AGRICULTURE ABROAD.

PICKERING SPRAYS—WHEAT IMPROVEMENT IN CANADA.

THE United States Bureau of Chemistry has completed an investigation into the comparative efficacy of Pickering Sprays and of the standard Bordeaux Mixture, and the results are given in Bulletin No. 866 of the United States Department of Agriculture. Plant pathologists will remember that Spencer Pickering did considerable work on Bordeaux Mixture, made by treating dilute copper-sulphate solution with lime water. It was obvious that, if the results obtained by Pickering in the laboratory in England held good under field conditions in America, a great saving of copper might be effected. The investigation, therefore, sought to determine the amount of copper necessary, for a given quantity of spray, to ensure effective control of fungus diseases, while a comparison of the adherence of the sprays was also made. As a result of tests on potatoes, extending over three seasons, it was found that sprays made after Pickering's method, containing 7 per cent. of copper-sulphate, were as effective as ordinary Bordeaux Mixture containing 1.25 per cent. of copper-sulphate. Pickering's claim that the copper of his wash was 10 to 12 times more effective than the copper in standard Bordeaux Mixture was, however, not substantiated. Its adhesive property was, however, satisfactory, while no injurious effects on the plants were noted. Curiously enough, the Pickering Spray was not so effective on apples and grapes, and it also burned the foliage. Barium hydrate solution substituted for lime water also gave satisfactory results on potatoes.

Pickering Sprays and Fungus Diseases.

* * * * * *

ACCORDING to *The Agricultural Gazette of Canada* for May last, the first serious effort made by the Federal Government to improve the wheat crop of Canada dates from 1886, when the Experimental Farms System was inaugurated. The objects were to improve existing grains and to introduce from abroad varieties that were hardy, high yielding, and capable of maturing in districts in which the season was somewhat short. Owing to Canada's geographical position and to the great climatic differences prevailing in the various Provinces, no single variety of either fall or spring wheat gives uniform results throughout

Wheat Improvement in Canada.

the Dominion. By breeding and selection, therefore, each Province is endeavouring to produce varieties of wheat that will not only give optimum results to the grower, but will also possess satisfactory milling qualities. Improvement of the wheat crop is also encouraged by the Canadian Seed Growers' Association* and by private individuals. That their united efforts have been attended with success there is no doubt. The result is demonstrated in two directions. First, doubtless in part owing to war conditions, the wheat acreage has been greatly increased: in 1918, it was approximately two million acres above the average acreage of the three preceding years, while in 1919 there was a further increase of another two million acres. Secondly, the value in increased wheat production owing to the specially selected cars of wheat which were recleaned and distributed at cost for seeding purposes throughout Canada can scarcely be estimated.

At first, twenty-eight varieties representing the produce of the chief grain-growing countries of the world were selected by the Dominion Department of Agriculture from grain offered for sale on the London Corn Exchange. Among these were four varieties of wheat from India, namely, Kurrachee, Hard Calcutta, Red Calcutta, and Club Calcutta, some of which proved valuable for breeding strains of high quality. Another was Bobs, a yellow branned wheat from Australia, from which the present Red Bobs is a selection. Practically the only variety of the earlier introductions grown to-day is Kubanka, a Durum wheat, which was tested out by the Experimental Farms in 1903-4. Among the first crosses made by a Fife wheat on those from Northern Russia were Preston, Stanley and Huron. Of these, Huron is the best; it is a red, bearded wheat well suited to the Eastern Provinces and parts of Alberta and Saskatchewan. In Northern Alberta, the Bishop variety has made a noticeable stand; it is comparatively early, it gives an excellent crop and yields a very good grade of flour. Then there is Marquis, the leading wheat of Canada, which has added enormously to the value of the Canadian wheat crop. Introduced by Dr. Chas. E. Saunders, Dominion Cerealist, Marquis is from three to twelve days earlier in maturing than some other varieties, and is very productive, especially on rich soils and in rather dry climates. It yields excellent flour, it does not readily shell out before cutting, the kernels are hard, and the straw is rather short, but stiff.

* See this *Journal*, January, 1912, p. 855.

Another cross-bred variety is Ruby, which ripens at Ottawa in about 93 days from the date of sowing, and is thus even earlier than Marquis. It yields well and is specially valuable in districts where Marquis is too late or where there is a moderate rainfall. Ruby wheat has helped to make profitable the growing of wheat in districts where grain crops were formerly ruined by frost. Prelude is also an early variety, ripening about 87 days from the date of sowing; it yields flour of very high baking strength, but it is not pale enough to be given the highest rank for colour. One of the most noteworthy strains of wheat produced by selection from commercial varieties is Early Red Fife. It is obtained from ordinary Red Fife, but is several days earlier and has a higher yield. Among other sorts are White Russian and White Fife. By the free distribution of 5-lb. samples of wheat, through the agency of the Experimental Farms, the Dominion Government is encouraging the growing of high-yielding, good flour-making wheats suitable to the wide variety of conditions found in Canada.

Private growers also aid in the work of producing new or improved varieties. The foundation stock resulting from selection of individual plants of outstanding merit is maintained and multiplied in its purity by farmers who specialise in seed growing. About three hundred such farmers are members of the Canadian Seed Growers' Association. The Association receives a grant from the Government and charges fees for registration of inspected seed, which is marketed as such. In localities well adapted to the production of wheat, growers of registered seed work in co-operation in what are known as seed centres. Registered seed provides the stock for field crop competitions, seed fairs and provincial seed exhibitions. These receive subventions from the Seed Branch of the Canadian Ministry of Agriculture, which also inspects and tests seed for farmers and seed merchants, besides supplying seed wheat through the Government Seed Purchasing Commission. Thus, when farmers or seed merchants are in doubt, samples are sent to the seed laboratories for germination tests.

Seed wheat exposed for sale must comply with the requirements of the Seed Control Act. It must be either free from noxious weed seeds or be labelled to indicate those present, and must be capable of germinating 63 per cent. or be labelled to show the exact percentage of germination. If sold according to grades, the standards must be maintained for those indicated.

namely, Extra No. 1, No. 1, or No. 2 seed. The Seed Purchasing Commission was established in 1916, primarily to provide emergency seed for the drought-stricken areas in the Prairie Provinces, but gradually it extended its operations until at the present time the quantity supplied to Western Canada alone runs into millions of bushels a year. Car samples of wheat in transit to Government elevators are sorted by Dominion seed inspectors, and those which can be cleaned to seed grade without serious dockage are treated accordingly. The seed inspectors also supervise the re-cleaning and issue seed certificates ex-elevator. Every car is sampled for germination tests to be made at the Dominion seed laboratories, while purity tests are made by the inspectors. The policy of providing an abundant supply of superior seed wheat will, it is anticipated, result in increasing the demand for the best quality only.

The Warble Fly Pest : An Appeal to Farmers.

EVERY farmer is familiar with the barrel-shaped maggots often to be found in large numbers just under the skin on the backs of cattle. These maggots are the grubs of the Warble Fly, and are the cause of enormous loss to farmers. The subject of this pest in cattle is engaging the attention of a Scientific Committee appointed by the Ministry. Experiments are in progress with a view to discover a remedy which must be cheap, safe and easily obtainable to combat the ravages of the Fly, and eventually to destroy the pest altogether. The only reliable process which has been recommended hitherto is that of " squeezing out " the warble maggots from the backs of cattle during the season of greatest growth, but this method of destruction is both lengthy and troublesome. The Committee have devoted their time to the finding of a satisfactory " dressing " which might be applied with safety to affected cattle, and one has given results so promising that it has been decided to invite farmers to try it as extensively as possible, with a view to its recommendation for general use.

The dressing is a wash, the principal ingredient of which is a tobacco powder. This powder is steeped in water for 24 hours, the liquid strained through coarse muslin, and applied with a cloth or brush to the backs of the cattle. The wash should be pressed into the warbles.

An infusion of 3 to 4 lb. of the powder, with 4 lb. of lime added, in one gallon of water gives the best results. With a wash compounded in this way it has been found possible to kill

from 80 to 96 per cent. of the maggots present in cattle subjected to experiment. A single application was in some cases sufficient to do this, but more certain results may be expected from dressing twice at an interval of 2 days.

The Committee wish, therefore, strongly to urge upon farmers the desirability of carrying out for themselves trials with the above-mentioned dressing during the Warble season. An admirable arrangement would be to apply the dressing to the cattle once a fortnight until May; in this way farmers will not only advance their own interest by rendering their stock immune to an objectionable and costly pest, but they will also assist the Ministry in a very practical manner. The great desideratum is that a result reached by patient experiment should receive repeated tests by practical men working under normal conditions. There is reason to believe that if this campaign is followed up and the experimental side of the Ministry's researches is carried from the Laboratory to the farm, the grievous trouble to cattle and the heavy loss to the farmer may come to an end within two or three years.

The Committee would welcome at the Ministry's Offices any communication from farmers interested in this matter, and would be glad to receive in due course reports as to the progress they may have made and the results obtained.

* * * * * *

The First World Congress on Poultry.

The first "World Poultry Congress," to be held at The Hague and Scheveningen, in Holland, from September 6th to 13th, 1921, will be an event of international significance to poultry-keepers. This Congress will be an assembly of delegates from Governments, Teaching and Experimental Institutions, Poultry and other Societies, and persons interested in the development of poultry husbandry.

The Congress has been organised by the International Association of Poultry Instructors and Investigators. It was intended originally to hold the first Congress at The Hague in 1916, but the war made it necessary to postpone the meeting until 1921. The programme is remarkable in its range, including as it does papers and discussions relating to education, research, poultry hygiene and diseases, production, distribution, co-operation and standardisation. The exhibits will include the breeds and varieties of the world, the latest inventions in poultry equipment and appliances, educa-

tional methods, results of research, and the special literature of various countries. The main purposes of the Congress are to stimulate interest in poultry-keeping, and all matters relating thereto, to co-ordinate education and research in poultry-keeping in all countries, and to educate poultry-keepers in the most efficient and practical methods.

The titles of the sections and sub-sections afford sufficient indication of the exhaustive nature of the discussions and demonstrations to be held during the sittings of the Congress. There are four main sections, the *first* dealing with experiments, investigations, the science of breeding and its practical application, systems of incubation, brooding, general management and rearing. The *second* section will be concerned with State and official action, including reconstruction, together with opportunities for women in the poultry industry. It will consider also international and national trade in eggs, co-operation and the organisation of poultry societies. The *third* section is concerned with hygiene and diseases, and the *fourth* section will discuss the training and the necessary qualifications of instructors, and deal generally with education and demonstration work, as well as with the organisation and influence of Exhibition and Laying Trials. Nearly 100 different papers have been projected and these will be read by men and women of the highest authority in the poultry world. From the titles of these papers it will be seen into what an extraordinary number of subsidiary, although important, departments this industry is divided. Among readers in the first section occurs the name of Professor Punnett, who will lecture on his own subject—"Mendelism: the Poultry Industry and the Fancy." Professor Graham, from Guelph, Canada, will discuss the science of breeding and its practical application. Professor Chas. Voitellier, Professor of Poultry Husbandry, Paris, will be heard on the scientific bases of balanced feeding of fowls, with a discussion of variations in weight and composition of eggs, (*1*) in different periods during the time of laying of the same hen, and (*2*) on hens of different breeds.

In the Women's Section some interesting papers will be given upon woman's sphere as an instructor in poultry-keeping, and the charge of small animals. This will be considered as a home industry for women. Among papers dealing with breeding, visitors will hear an account of American methods of packing and marketing. In the section of hygiene, matters

relating to diseases of poultry will be discussed, American methods of combating disease, French investigations in tuberculosis of poultry, and the infection of eggs dead in the shell. In the educational section, administration of agricultural clubs and farm schools will be treated exhaustively.

The Congress can be attended by delegates representing any Government, Teaching and Research Institution or Organisation engaged in some phase of poultry breeding, production or distribution. Private individuals interested in these subjects may also attend. Inquiries should be addressed to the Hon. Secy. of the British Congress Committee, 3, Vincent Square, Westminster, London, S.W. 1.

* * * * * *

The Use of Fish Meal for Pigs: A Warning Note.

FISH meal, rightly used, forms a palatable food for stock, but the Ministry is receiving evidence that farmers are not using this material with proper discretion. Pork butchers and bacon curers are complaining bitterly that many pigs bought by them are tainted with a fishy taste and odour, and the carcasses from such pigs are worthless for human food. In all these cases, when the trouble is traced back, it appears that the feeders have used either the wrong brand of fish meal, or have used it in excess, or, in certain cases, have used a proprietary pig meal containing a large quantity of fish meal. It cannot be too strongly emphasised that fish meal is a dangerous food for pigs unless the right grade is used and unless this meal does not form more than one-eighth of the dry food fed. An error in this direction is very difficult to correct, since the fishy taint once acquired by the pig is very difficult to get rid of subsequently. It is certain that butchers will not face the possibility of loss through acquiring tainted carcasses, and the inevitable result of misuse of fish meal for pigs will be that butchers may refuse to buy pigs which have been fed on fish meal. The Ministry's Leaflet No. 333 gives particulars of the kind of fish meal that is safe and the quantity that can be used; unless a farmer can ensure that instructions of the kind are followed he had better let fish meal alone.

Note for Compound Meal Manufacturers.—The Ministry has recently been advised of a case of tainting of pig meat which occurred in the Birmingham area. The case concerned a lot of 500 pigs, the carcasses of which were yellow and oily in appearance and had a strong fishy odour. On tracing this case back to its source, it appeared that the tainting was due to the

presence of considerable quantities of fish meal in a patent pig meal fed to the pigs. The Ministry wishes to call the attention of manufacturers to the danger of putting large quantities of fish meal into meals or cakes; "white fish meal" only should be used for this purpose, and the quantity fed should not exceed one-eighth by dry weight of the total meal. In all such cases, when a meal contains fish meal, it is advisable to state the proportion by weight of fish meal present to obviate the danger of the pig feeder using fish meal in excess by feeding fish meal in conjunction with such pig meals.

The danger of taint from such sources is a real one, and misuse of fish meal is liable to discredit the value of fish meal as a feeding stuff. It is obvious that the retail meat trade will take as strong action as possible to avoid losses in the future from such a source if such cases occur in any frequency.

Foot-and-Mouth Disease.—*Gloucestershire, Herefordshire, the Midland Counties Group, and Lincolnshire (Ormsby and Grimsby Districts).*—All restrictions imposed in connection with the outbreaks in these districts have now been withdrawn.

Yorkshire (East Riding).—Six outbreaks, in all, have been confirmed in the Halsham district, the most recent being on the 1st March on premises in close proximity to those concerned in earlier outbreaks. The restrictions on movement are applicable only to ten parishes, in the immediate neighbourhood of Halsham, and the parish of Hollym alone remains a prohibited area, that is, an area in which movement is entirely prohibited except by licence.

Rabies.—*Wiltshire, Dorset and Hampshire.*—One further case of Rabies has occurred in this district since the issue of the March *Journal*, namely, on the 12th March at Southampton.

The limits of the Inner Controlled Area around Salisbury have been contracted by the issue of an Order which operated on the 15th February. That Area now includes only the Borough of Salisbury and 7 parishes immediately surrounding the Borough.

Glamorgan.—No further outbreak has occurred in this district.

Berkshire District.—A case was confirmed at High Wycombe on the first of March in a puppy which died and was buried early in January.

London.—The suspected case of Rabies in the Borough of Woolwich having been found, as the result of inoculation experiments, not to be one of Rabies, the restrictions on the movement of dogs out of a portion of that Borough were withdrawn as from the 4th March. No further outbreak of Rabies having occurred in the Acton District since that which necessitated the imposition of restrictions on the 8th December last, the requirement of leading was, therefore, withdrawn as from the 4th March.

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Articles or reports on the following subjects have appeared in the *Journal* each month or from time to time, and are not separately indexed:—Notes on Feeding Stuffs, Notes on Manures, Notes on Crop Prospects and Live Stock Abroad, Notes on Agriculture Abroad, Notes on the Weather, Notes on Agricultural Labour in England and Wales, Notes on Agricultural Conditions in England and Wales, Prices of Agricultural Produce, Outbreaks under the Diseases of Animals Acts, Lists of Additions to the Ministry's Library, and Selected Contents of Periodicals.

Editorial Notes are indexed under the subjects to which they refer.

To avoid confusion in reference the term "Ministry" is used throughout, with a very few necessary exceptions, although the word "Board" may appear in the text.

BREEDERS' ANNOUNCEMENTS.

CATTLE.

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