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THE JOURNAL
OF THE
MINISTRY OF AGRICULTURE

Vol. XXIX. No. 4.

JULY, 1922.

NOTES FOR THE MONTH.

Prices and Supplies of Agricultural Produce in 1921.

THE Report on the Prices and Supplies of Agricultural Produce in 1921, which has now been issued by the Ministry, forms the Third and concluding Part of the Ministry's Agricultural Statistics for 1921. Part I of these Statistics dealt with the acreage under crops and the number of live stock in England and Wales, and Part II with the estimated production of the principal crops. The three parts taken together represent an endeavour to give information on the main points of economic interest affecting agriculture, and those who wish to take a comparative view of the changes in agricultural prices during 1921 will find much to interest them in the Report now issued. It also gives particulars of the work done by the Ministry in connection with the payment of claims under the Corn Production Acts. The total number of claims accepted was 187,000 and the area on which payment was made was 1,896,620 acres of wheat, 2,007,875 acres of oats, and 123,814 acres of mixed corn. The Report is published by H.M. Stationery Office and can be ordered through any bookseller.

* * * * * *

International Institute of Agriculture.

A MEETING of the General Assembly of the International Agricultural Institute was held at Rome in May last and was attended by representatives of 51 different countries. The questions discussed at this Meeting were largely of domestic interest, relating as they did to the financial position of the Institute, and the possibility of effecting certain improvements in its work, which without increasing the total expenditure would give the greatest result for the funds available. With this object a number of

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proposals were agreed to which will, it is hoped, tend to popularise the publications of the Institute.

Of the various Sections into which the work of the Institute is divided, the one which attracts most attention and is the most valuable is the Statistical Bureau. Briefly its work consists in publishing a monthly Bulletin, a Statistical Year Book, and special Reports on the Statistics of particular products, such as oilseeds. The work of this Bureau is remarkably well done and reflects the greatest credit on Professor Ricci, the Head of the Bureau, and on his staff. The Monthly Bulletin has for the past year or 18 months been issued in three parts, (a) Prices, (b) Production and (c) Imports and Exports, and the desire to make each of these parts as complete and perfect as possible has resulted in a very considerable increase in the size of the Bulletin. Whilst this enlargement enabled the Bureau to issue in a summarised form a complete statement of the available statistics received from all parts of the world, it necessarily involved considerable expense in printing. The Bulletin contained, moreover, two distinct classes of information. In the first place the section relating to production comprised the latest reports on crop prospects and crop yields in the different countries of the world, and included the best available information as to the supplies which were likely to be available in exporting countries and the probable requirements of importing countries. This section was therefore of direct and immediate value to the grain trade of the world by helping producers and distributors to form an accurate estimate of probable supply and demand. Notices are also issued at frequent intervals to the Press, and by this means the available information is spread broadcast throughout the world and is available for a very much larger public than is reached by the mere distribution of the Bulletin itself. The value of this side of the work is clear and is admitted on all hands.

In addition, however, the Bulletin contains records of prices ruling in the principal markets of the world, and also gives the latest available particulars of imports and exports with a view to showing how far the supplies of exporting countries are becoming exhausted, and the demands of importing countries are being met. These details whilst valuable for purposes of record and comparison are necessarily retrospective, and do not possess the same practical and current interest as those relating to crop production. It was felt that the Bulletin would gain in the estimation of the special public for whom it was intended by removing

from it everything that was not of immediate practical value and current interest, while at the same time this would enable it to be sold more cheaply. This does not mean that the information would cease to be issued but merely that it could without loss be included either in the Statistical Year Book or in a half-yearly publication. In the same way it was decided that the Bulletin of Technical and Economic Information now issued monthly could advantageously be altered in form and published as a quarterly review.

The satisfactory working out of the suggestions made at this Meeting in regard to the form of the publications is of vital importance to the future well-being of the Institute as it is in practice only through its publications that the Institute can appeal to the world and hence to the Governments by which it is supported. A development in the sale and popularity of its publications will be the strongest ground on which to base that demand for a permanent increase in its revenue which is a consequence of the decreased purchasing power of money.

It should, however, be borne in mind that much of the Institute's work must necessarily be gratuitous. The most striking example is found in the Statistical Bureau where the essential information obtained in the form of crop forecasts and crop yields is and must be distributed free through the Press. While in this way one of the main purposes for which the Institute was established is fulfilled, the benefits achieved cannot be precisely traced and are certainly not indicated by measuring the sale of the Bulletins or other publications.

That the Institute is well worth the small contributions made by the adhering Governments can hardly be questioned. At the present rate of exchange, the total cost expressed in English money is less than £40,000 per annum, towards which the British Government contributes only £3,200. In return, apart from the general and specialised information placed at the disposal of the agricultural and commercial public, the Institute actually provides much information, particularly in the direction of international statistics, which would otherwise have to be prepared by each Government separately at a far greater cost.

One decision reached at this Meeting which is of interest to English speaking countries was the adoption of English as one of the official languages of the Institute. There can be little doubt that this will tend to improve the position of the Institute in the eyes of the Anglo-Saxon world.

* * * * * *

International Year-Book of Agricultural Statistics.

THE International Institute of Agriculture at Rome has just issued a publication of 700 pages entitled the "International Year-Book of Agricultural Statistics for the years 1909 to 1921." It gives complete information as to the crop areas and yields in all the countries of the world, number of live stock, imports and exports, prices, freights, and the output and trade in fertilisers. It can be obtained direct from the International Institute of Agriculture, Rome, price 8s. post free. The money can be sent in the form of a British Postal Order. Copies will also be on sale shortly at the offices of the Ministry.

* * * * * *

Conciliation Committees in Agriculture.

THE total number of Conciliation Committee agreements at present in operation is 44, of which all but 3 are for periods extending over the corn harvest. Three agreements have been reached recently. The Committee for Cumberland and Westmorland have reached an agreement to operate up to 11th November providing for the payment of skilled men at the rate of 40s. for a week of "customary" hours (*i.e.*, 63 hours) and other adult male workers at 30s. for a week of 54 hours in summer (*i.e.*, up to the end of October) and 48 hours in winter. The Isle of Ely Committee have decided to extend their agreement which expired on 31st May up to 11th October, and in accordance with the Committee's application the agreement as extended has been confirmed by the Minister under Section 4 (3) of the Corn Production Acts (Repeal) Act. The Cambridgeshire Committee have now submitted the agreement which they reached last March to the Minister for confirmation. Particulars of these two confirmed agreements are given below. The effect of confirmation of an agreement by the Minister is to make the rates specified in the agreement an implied term of the contract of employment of every worker of the class to which the agreement applies. It will be noticed in the case of Cambridgeshire that the Committee have refrained from putting a definite period to the operation of the agreement, but have agreed that it shall stand until such time as either side of the Committee gives 21 days' notice of termination.

Isle of Ely Agreement:—

1. During the period up to 11th October, 1922, no male worker employed in agriculture shall be paid wages at less than the following rates :—

(a) Male Workers aged 18 and over employed as horsemen or milkmen.

Age.	s.	d.
21 and over	40	6
20 and under 21	37	9
19 „ „ 20	35	6
18 „ „ 19	34	3

for a week comprising the hours necessary for the performance of the customary duties of these classes of workers.

(b) All other male workers employed in agriculture.

Age.	Weekly wages for a week of 51 hours. s.	d.	Overtime rates, for all time in excess of 51 hours per week. d.
21 and over	31	0	8½
20 and under 21	28	9	8
19 „ „ 20	27	0	7½
18 „ „ 19	25	9	7
17 „ „ 18	20	6	5½
16 „ „ 17	16	3	5
15 „ „ 16	13	3	4½
14 „ „ 15	10	3	3
Under 14	7	3	2½

2. That the working week for summer months (*i.e.*, from the first Monday in March to the last Saturday in October) shall consist of 51 hours, and for next winter (*i.e.*, for the period other than the summer months) shall consist of 48 hours.

3. While no definite agreement is made regarding Saturday half-day, the employers will not put any obstacles in the way of farmers arranging with their workmen for a Saturday half-day after 51 hours have been worked, and this clause is to be carried out in a reasonable spirit.

Cambridgeshire Agreement:—

(*a*) A wage rate for all able-bodied male workers of 21 years of age and over of 7¼d. per hour for a week of 50 hours.

(*b*) A wage rate of 8d. per hour for all time worked between 50 and 54 hours per week.

(*c*) All work performed on Sunday to be paid for at the rate of 10d. per hour.

(*d*) All the rates specified to operate until twenty-one days after notice of any proposal to cancel is received by the Minister from either section of the Conciliation Committee.

(*e*) The Conciliation Committee strongly recommends farmers to offer facilities for one short day per week, the Workers' Side undertaking that workers shall not refuse to work on the short day for full time, in cases of necessity.

Information with regard to the position in any of the Conciliation Committee areas can be obtained on application to the Ministry, 10, Whitehall Place, S.W.1.

* * * * * *

The Agricultural Index Number.

THE index number of prices of agricultural produce in England and Wales shows a slight rise for May as compared with the previous month, prices on the average being about 70 per cent. above the pre-war level as against 68 per cent. in April and 112 per cent. in May, 1921.

The percentage increase each month since the beginning of 1919 as compared with the average of the years 1911-13, is shown in the following table :—

Month.	Percentage Increase. 1919.	1920.	1921.	1922.
	Per cent.	*Per cent.*	*Per cent.*	*Per cent.*
January	148	213	186	77
February	150	205	172	83
March	150	199	158	82
April	153	199	141	68
May	132	169	112	70
June	128	164	102	—
July	141	174	100	—
August	138	177	116	—
September... ...	148	181	105	—
October	166	191	90	—
November... ...	182	197	84	—
December	207	194	82	—

Wheat and oats were dearer during May than in April, the average prices during the month being the highest since last autumn. Barley continued the downward movement which has been in evidence since September last. A further slight advance was recorded for fat cattle, but sheep and pigs were slightly cheaper. The price of sheep after rising steadily throughout the year, reached the highest point at the beginning of the month and subsequently experienced an appreciable decline.

Among the principal alterations in prices as compared with the previous month were those in connection with milk and potatoes. The seasonal fall in milk prices from April to May reduced the average to 9½d. per gallon or only ¾d. per gallon higher than the average of the years 1911-13, although, as compared with summer prices in pre-war years, current rates show an increase of 2d. per gallon or about 27 per cent. Potatoes experienced a sharp rise from the latter part of April, and this was shown in the index figures for that month. This advance continued into the first half of May, and although prices subsequently fell considerably, the average of prices for May was about 170 per cent. above the pre-war level, as against 126 per cent. in April.

Among other produce, butter was again cheaper, while cheese showed little alteration. Eggs also fell in value but the decline was fully counter-balanced by the increase in the market value of poultry.

Feeding stuffs on the whole were inclined to be dearer in May than in April, except brewers' grains, which experienced a sharp decline; with this exception there was little difference between prices in April and in May. No material alteration in fertiliser prices was recorded, nitrate of soda again advancing slightly, while the lower grades of basic slag were somewhat reduced. On the average, prices for feeding stuffs and fertilisers during May were between 50 and 60 per cent. above the pre-war level.

* * * * * *

Distribution of Leaflets.

In order to reduce expenditure on printing, the Ministry has been compelled to discontinue the free distribution of leaflets, and the small registration fees shown below will in future be payable by persons who wish to receive the leaflets as issued.

The leaflets are divided into four main groups dealing with the following subjects:—

I. Farm Live Stock (including Dairying, Feeding Stuffs, Pests and Diseases of Farm Animals).

II. Small Domestic Live Stock (Poultry, Rabbits, Bees, Goats, etc.)

III. Farm Crops (including Manures, Weeds, Pests and Diseases of Farm Crops).

IV. Garden Crops and Fruit Growing (including Manures, Weeds, Pests and Diseases of Garden Crops and Fruit Trees.

To receive NEW *Leaflets only.*

1. Of any one or two of the above groups - 1s. per annum.
2. Of any three groups or of all four groups 2s. ,,

To receive both NEW *and* REVISED *Leaflets.*

1. Of any one or two groups - - - 3s. ,,
2. Of any three or of all four groups - - 6s. ,,

* * * * * *

THE SCHOOL OF AGRICULTURE OF THE UNIVERSITY OF CAMBRIDGE.

PART II.

T. B. WOOD, C.B.E., M.A., F.I.C., F.R.S.,
Drapers' Professor of Agriculture and Fellow of Gonville and Caius College, Cambridge.

THE completion of the School of Agriculture opened a new era for agriculture in Cambridge. Until the end of 1909 the staff had been without a home of their own, and although they had received the greatest possible kindness and consideration from the heads of other scientific Departments, notably the Professors of Chemistry and Botany, the agricultural staff had undoubtedly been severely handicapped by deficient accommodation.

In January, 1910, the staff moved into their new building with a class of about 40 students. Immediately the number of students began to increase at the rate of about 25 additional students per annum, and in the academic year 1913-14 the total number of students receiving instruction in the School had reached 117, including about 30 candidates for the Diploma who had already taken the National Science Tripos, but exclusive of research students of whom there were about a dozen. Meantime other notable events had occurred. In 1910 the lease of the farm at Impington expired and it was decided to secure a farm nearer to the laboratories and the colleges so that the practical side of the teaching as well as the experimental work might be developed with less effort both to the staff and to the increasing number of students. Through the good offices of Trinity College the University was able to lease from the College for 10 years Gravel Hill Farm, consisting of about 200 acres of land situated between the Huntingdon and Madingley Roads within 1½ miles of the laboratory and not more than 1 mile from many of the colleges. To this area were added several adjoining fields hired from Clare College. The convenience of access of this farm has undoubtedly enabled Mr. Mackenzie and Mr. Amos, who have had charge of the teaching of husbandry, to develop the practical side of their teaching to a remarkable extent.

Unfortunately the demand for building sites on this side of the town makes it unlikely that the University will be able to retain the occupation of this farm, or to buy it from the College, at a price which would admit of its continued occupation as an agricultural holding. It is probable, therefore, that the agricul-

tural staff may shortly be compelled to seek another farm, and as continuity is the essence of field experiments, it is most desirable that funds should be available to enable the University to purchase a suitable farm and to equip it as a permanent station for teaching and research in plant and animal husbandry.

During the University's occupation of Gravel Hill Farm, Mr. K. J. J. Mackenzie has held the position of Director of the farm, an onerous and difficult office which he has filled with great success. His policy of maintaining pedigree herds of milking Shorthorn cattle, Suffolk sheep and Large White pigs, combined with a consistently high standard of production, has been justified by the intense interest of the students in the practical side of their work, and by the valuable results he and his assistants have obtained in animal husbandry in general and in swine husbandry in particular. In acknowledgment of the success of his labours he was given the status of University Lecturer in Agriculture in 1910, and was promoted to a Readership in 1915.

His Colleague, Mr. Amos, who has devoted his attention chiefly to crop husbandry, was given the status of University Lecturer in Agriculture in 1916. Mr. Amos has published much valuable work on clover sickness, on the cultivation of hops, and on ensilage.

About the time of the opening of the School, the University had consented to the inclusion of the physiology of farm animals as a compulsory subject in the examination for the diploma in agriculture, and the School was able to secure as lecturer in that subject Dr. F. H. A. Marshall, who had made his mark as an agricultural physiologist by his work on the causes of fertility and sterility among farm animals. Since his return to Cambridge, Dr. Marshall, now Reader in agricultural physiology, has continued his investigations and is now recognised as the leading authority on the physiology of reproduction.

At this stage it may be interesting to record the number of students of agriculture at the important epochs of the development of the School. In 1893, the first informal class numbered 7 students. In 1899, when the University Department of Agriculture was created, the total number of students was 20. In 1910, when the School was opened, the class just exceeded 40. In the spring of 1914, the numbers had risen to 117. Then the War came and the numbers fell rapidly to about 12. Immediately the Armistice was concluded there was a sudden rush of students. In October, 1919, over 200 freshmen joined the School, and by the end of the year the total number had risen to about 320, at

which level it still remains. This great influx of students necessitated a considerable reorganisation of curriculum, staff and buildings. A long range of army huts was hurriedly erected and fitted as lecture rooms and laboratories. Estate management and Horticulture were added to the subjects of instruction, Mr. F. B. Smith, C.M.G., being appointed Reader in Estate Management and Mr. C. W. B. Wright, N.D.H., Lecturer in Horticulture. The Gilbey Lectureship in the History and Economics of Agriculture was made into a full time office, the original endowment being supplemented from other sources. Lecturers were also appointed in agricultural zoology, agricultural law, veterinary science, accountancy, and statistics, the last jointly with the Department of Economics. An endowment collected by Sir Arthur Shipley made possible the appointment of a lecturer in tropical agriculture. These new appointments have increased the number of the teaching staff to 22, including two professors, four readers and four University lecturers.

At the same time the curriculum has been greatly extended, not only by the inclusion of the subjects mentioned above, but by the establishment of a definite three years' course of instruction in agriculture and allied subjects for the B.A. degree. Candidates for this course must become members of the University either by joining a College or by obtaining admission as non-collegiate students. They must also pass or obtain exemption from the previous examination, or Little Go, which comprises ordinary school subjects. The first year's course, which is the same for all students, aims chiefly at giving an all round introduction to agriculture and agricultural science. In the second and third years the subjects of instruction and examination vary according as the student is interested chiefly in agriculture, estate management, forestry, or horticulture. There is an examination at the end of each year. A student who has passed all three examinations is awarded the B.A. degree.

This degree course is designed to give a liberal education to prospective landowners, farmers, estate agents, foresters and horticulturists. It comprises not only agriculture, estate management, forestry or horticulture, and the allied sciences, but includes also lectures on agricultural history and economics, agricultural law and accountancy.

The examinations for the diploma in agriculture were formerly open to anyone. Candidates for the diploma must now be members of the University, and must possess a degree or some equivalent qualification gained either in Cambridge or elsewhere.

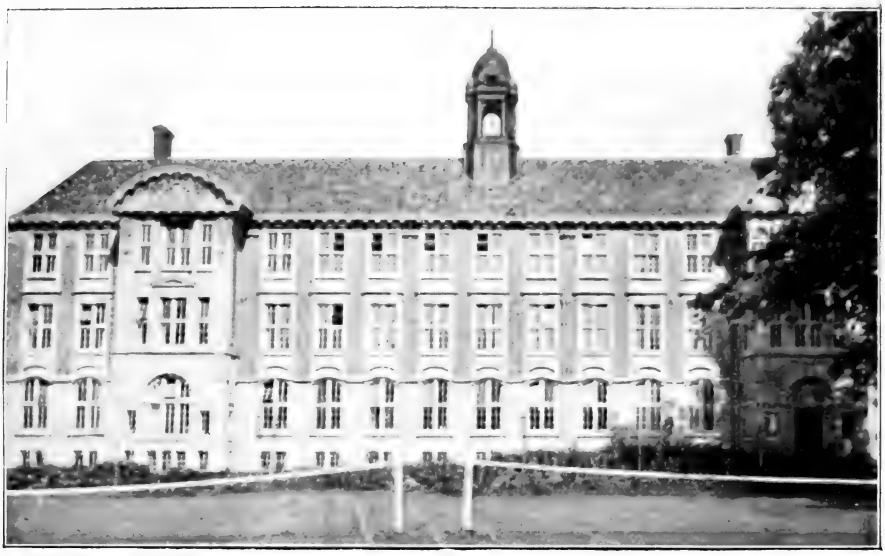


FIG. 1.—The School of Agriculture, South Front.

FIG. 2.—The Chemical Laboratory.

FIG. 3.—The Biological Laboratory.

FIG. 4.—Part of the Library.

The course of instruction for the diploma extends over two years, with an examination at the end of each. The first examination for the diploma is a difficult technical examination in agriculture and agricultural sciences. In the second year a candidate may specialise in any line, either practical or scientific, and is examined in that line only. Thus, the diploma is a valuable qualification of professional standard. The University gives diplomas also in forestry and horticulture, the instruction and examination for which are on similar lines.

These diplomas are taken for the most part by Cambridge men who have already taken honours degrees in natural science and are intending to become agricultural experts at home or abroad. It is a point worth noting that in Cambridge over 300 men take honours degrees in science every year.

For many years it has been an honoured tradition in Cambridge that every teacher in the science schools should engage in research in his own subject. This tradition has been followed in the case of agriculture. Already in 1910, when the School of Agriculture was opened, members of the staff were well known by their publications. It is only necessary to mention Professor Biffen's work on plant breeding, which has produced Little Joss Wheat, and Dr. Marshall's work on the physiology of reproduction.

When the Development Fund became available for the promotion of research, and the Development Commissioners decided to establish Research Institutes in various branches of agricultural science two of these Institutes were placed at Cambridge—a Plant Breeding Institute under the direction of Professor Biffen, and an Animal Nutrition Institute under the joint direction of the writer and Dr. Marshall. The Plant Breeding Institute has its laboratories in the School of Agriculture. It is also equipped with bird-proof cages for the experimental culture of small plots and with greenhouses and sorting rooms. These are accommodated at Gravel Hill Farm. The larger plots for testing and growing on for seed are situated at How Hill Farm, a mile further out on the Huntingdon Road, opposite Girton College. The staff of the Institute have concentrated their attention chiefly on cereals and potatoes. Up to the present the main practical result of their work has been the production of the two wheats, Little Joss and Yeoman, which are too well known to require description. But perhaps the result which will in future prove still more valuable is Professor Biffen's discovery of the mode of inheritance of immunity to yellow rust

in wheat. This discovery demonstrates the practicability of breeding varieties of crops which resist the attacks of diseases, and opens up a wide field of investigation which promises very valuable results.

The labours of Professor Biffen and his colleagues and of plant breeders generally, will be lightened by the establishment of the National Institute of Agricultural Botany with its headquarters on the Huntingdon Road opposite the University Farm. This Institute manages the national seed testing station, but its main function is to take over, test, grow on, and distribute seed of new and improved varieties of all kinds of agricultural crops, returning to the breeder a fair proportion of the profit derived from their sale.

The Animal Nutrition Institute has investigated and is investigating a variety of problems concerned with meat production. Its earliest efforts were directed to the study of the composition and feeding value of home-grown fodders, and members of the staff have published numerous papers on mangolds, straws, and silage, the latter in collaboration with Mr. Amos. Another line of work has been the investigation of winter beef production, which has been attacked both statistically and experimentally. Many papers have been published, but the investigation is still incomplete.

Dr. Marshall and his colleagues have extended their work on the physiology of reproduction to many problems of meat production, for example, seedy cut in bacon, the effect of spaying on rate of growth, the factors controlling the size of the litter in sows.

Mr. Mackenzie and his colleagues have made a special study of pig feeding under modern conditions, and have demonstrated the importance of vitamines and the value of palm kernel cake in pig feeding. Besides these more immediately practical investigations, several members of the staff have been engaged in the study of fundamental scientific problems of nutrition and have obtained important results. Scientific work of this kind, although its results may have no direct bearing on agricultural practice for perhaps 20 or even 50 years, is none the less important for the progress of agriculture. Just as present-day farmers and consumers of farm produce are to-day reaping the reward of Lawes' and Gilbert's purely scientific work on manures carried out at Rothamsted more than 50 years ago, so we may confidently expect that farmers and consumers of the future will equally benefit from work now in progress which at first sight may appear

to have no direct practical bearing. As examples of the work of the Institute which falls in this category, Mr. Foreman and Dr. Woodman's investigations on the chemistry of the proteins, and Mr. Capstick's experiments with his recording animal calorimeter may be mentioned.

Like the Plant Breeding Institute, the Animal Nutrition Institute has its main laboratories in the School of Agriculture, and in these the fundamental scientific work is concentrated. Its more practical activities are somewhat inconveniently scattered. Mr. Mackenzie's pigs are kept at Gravel Hill Farm. The winter beef production and ensilage investigations are carried out chiefly at How Hill Farm. Dr. Marshall's animals are located mainly in temporary premises at the field laboratories, Milton Road, a new department of the University, which the Institute shares with the medical school, the Quick department of Biology and the Biochemical Department.

The School is also interested in the work on the breeding of small animals, including poultry, in the department of genetics under Professor Punnett. The headquarters of this department adjoin Gravel Hill Farm, and are about to be considerably extended.

Besides the organised work of these Institutes, members of the staff of the School have carried out many independent investigations. Mr. Newman for many years has been engaged on a survey of the soils and agriculture of the eastern counties. Intensive surveys of certain areas have been published already, but the extensive general survey was delayed by the war and is now held up for lack of funds. It is impossible to refer specifically to the work of every member of so large a staff. It must suffice to say that every one maintains the tradition of doing his best to extend the boundaries of knowledge in his own subjects.

Before leaving this subject, it should be mentioned that certain officers of the School took a prominent part in the foundation of the *Journal of Agricultural Science*, which was first published by the University Press in 1905 and has since then formed the chief organ for the publication of the results of agricultural research in this country. This journal has undoubtedly played a very important part in the development throughout the country of an active band of research workers. It was started at the joint financial risk of the Editors and the University Press. During the war financial difficulties arose and it is now the joint property of the Research Institutes at Cambridge and Rothamsted and is edited by the Directors of those Institutes.

The School is recognised by the Ministry of Agriculture as the central institution for education and research in the eastern counties, and in this capacity it has received since 1912 an annual grant from the Ministry for the maintenance of an Advisory Department. The staff of this Department includes Mr. F. R. Petherbridge as biologist, Mr. W. S. Mansfield as agricultural chemist and Mr. Codling as analyst. Mr. Petherbridge and Mr. Mansfield spend a large proportion of their time in the country giving advice to farmers on all kinds of agricultural problems, usually through the county organisers.

The School of Agriculture at present has no endowment for agricultural scholarships or studentships. Among its pupils, however, are many holders of scholarships or studentships of one or other of the Cambridge Colleges which devote part of their endowments to the encouragement of all branches of learning, including the sciences allied to agriculture. The School is also one of the Institutions at which the research scholarships and training scholarships of the Ministry and the agricultural scholarships of the County Councils are tenable. Holders of scholarships of the various categories mentioned above have been among the best students attending the School and the present staff has been largely recruited from them.

The School in its degree courses aims at providing a liberal education for men who wish to spend their lives on the land in any capacity. Its Diploma courses are designed to go further and to give technical instruction of professional standard to post graduates who wish to practice as experts in some branch of agriculture, forestry, horticulture or the allied sciences.

The internal affairs of the School are managed by the Special Board for Agriculture and Forestry which is practically the Executive Committee of a larger body—the Board of Agricultural Studies. This latter body comprises University and County Council members and acts as a permanent agricultural conference for East Anglia.

* * * * * *

PRODUCTION OF MEAT ON PASTURES OF DIFFERENT TYPES.

SIR THOMAS MIDDLETON, K.B.E., C.B., LL.D.,
Development Commissioner.

IN this *Journal* for September, 1915, in a paper on "Systems of Farming and the production of Food," I made a brief reference to the production of meat on pastures of three different types. In the present paper I propose dealing with the same subject in more detail. The estimate then made of the yield from rich pastures has since been supplemented by the estimates of others: and I have also secured some additional figures, bearing on the production of food by poor pastures.

Rich Fattening Pastures.—The former estimate was based on the probable production of the best pastures in the English Midlands that I had had an opportunity of examining carefully. It may be recalled that the yield of this type of pasture was put at 190 lb. meat per acre in an average season, without any assistance from feeding stuffs. The total was made up as follows:—90-100 days' summer grazing, 200 lb. live weight increase, equivalent to 120 lb. fat meat; 70 days' autumn grazing, 100 lb. live weight increase, or 55 lb. moderately fat meat; late autumn and winter grazing for store cattle or sheep—30 lb. live weight increase, or 15 lb. lean meat.

There would, necessarily, be wide departures from these figures in very good or very bad seasons, but I expressed the view that on the average of a term of years the output of the best pastures could not be expected to exceed the figures given.

With the object of ascertaining whether the particular grass land then in view was representative of the best in its particular locality, and also for the purpose of checking the estimates, I applied, in the autumn of 1920, through a mutual friend, to several experienced graziers in the locality, submitting to each the following questions:—

> Assuming a *ten-acre* field of grass of first-rate quality, and *no feeding stuffs of any kind* to be used:—
>
> 1. What number of fattening cattle would the field carry during the summer months and what would be the average gain in live weight per head?
>
> 2. Assuming the first lot of cattle to be cleared off in July and the pasture to be rested, what number of cattle would be carried in the autumn months? Could these be fattened without cake in an average season? What increase per head might be expected in this lot of cattle if no artificial feeding stuffs were used?

3. Would sheep be grazed in addition to cattle in the summer or autumn months? If so, what number and what increase in weight per head would be expected?

4. Would the field carry any stock during the winter months? If so, what class of stock and what numbers?

Seven replies to this schedule of questions were returned. As the inquiry was made through private channels I shall not refer to the correspondents by name, but take this opportunity of acknowledging my indebtedness to them for the care they took in supplying full answers to the questions, and for explaining the particulars in which their own practice did not fit in exactly with the conditions assumed in the questions.

The correspondents were asked to provide estimates of the live increase that would be made by grazing animals and this they did. I am responsible for estimating the quantity of meat which these live weight gains should represent, and in changing from live to carcass increase the percentages used in my original paper have been adhered to. In this connection it may be noted that there is very little evidence available as to the probable percentage of carcass to live gain in the case of bullocks fattened on grass; and, from the percentage of carcass which such cattle yield when slaughtered, some may be disposed to consider that my figure of 60 per cent. for summer increase is too high; it should be observed therefore that the cattle fed on these rich pastures are in very good condition when they are turned out to grass, and that the subsequent live increase represents a much higher percentage of carcass than it would in the case of lean stores.

Reduced to figures the seven estimates were as follows:—

TABLE I.

	Total Live Increase, lb. per acre.	*Carcass Increase, lb. per acre.*
A	372	217
B	340	198
C	310	183
D	297	172
E	280	162
F	271	155
G	263	154
Average A—G	**305**	**177**
Do. A—D	330	192
Do. D—G	278	161
Original Estimate ...	**330**	**190**

The average of all seven estimates works out at 305 lb. live increase per acre, equivalent to about 177 lb. of meat; the

average of the first four—which may be taken as representing the best that can be expected—coincides with my original estimate, while the average of the last four, representing moderate returns from pastures of fine quality, is 16 per cent. less than was estimated.

My original figure for the quantity of beef produced during summer grazing was 120 lb. from 200 lb. live weight increase; the average of the seven estimates A to G works out at 113 lb. from 189 lb. live increase; the average of the four highest at 131 lb. from 218 lb. live increase.

Neglecting the value of the winter grazing, the average of the seven estimates for summer and autumn production works out at 172 lb. of meat from 295 lb. live increase, as against my original estimate of 175 lb. from 300 lb. live increase.

We may take it then that the best pastures in the English Midlands are capable of producing on an average of years about 175 lb. of meat per acre during the summer and autumn without the aid of feeding stuffs, and that if we add the increase from occasional grazing at other seasons of the year, the total production will amount to about 190 lb. of meat, and the total live increase to about 330 lb. per acre.

It is at once obvious how greatly the production of this rich grass land must exceed the average yield of our fattening pastures. The total number of grass-fed cattle marketed annually, from July to November inclusive, is about one million; feeding stuffs are freely used in fattening cattle on grass; but if even one-thirtieth part of the grass-land of the United Kingdom were equal in quality to these Midland pastures, all the beef made in the final fattening period by the home-fed cattle slaughtered from 1st July to 30th November could be produced on this small fraction of our grass land, without recourse to feeding stuffs and without any assistance from roots or other tillage crops.

From the actual numbers of the live stock marketed, it would, indeed, appear to be very unlikely that we could find 250,000 acres of grass land in the whole country capable of producing as much meat as those pastures which are here referred to. There is no doubt a very much larger area capable of producing this quantity of meat in a favourable season, but the particular quality which marks off a very fine from an ordinary good pasture is the certainty of the yield. It is only on the finest grass land that we can rely on securing high production on an average of years without aid from feeding stuffs.

Production on the Poorest Pastures.—Turning to the other end of the scale it may be asked what quantity of meat (or rather of carcass increase, for they do not produce the finished product) our poorest pastures are capable of furnishing on the average of a term of years? In my paper of September, 1915, I referred briefly to some of the manure and mutton experiments, with which Professor Somerville's name is associated, and without discussing the subject, took the figure of 20 lb. meat per acre as being sufficiently near the annual production for my then purpose. But if attention is directed to the yield of the poorest cultivated pastures this figure is, in fact, too high. The yield is likely to vary from about 12 lb. of lean meat in a poor grazing season to 20 lb. in a good season, and 16 lb. per acre represents the best average that can be expected from the poorest of these clay soil pastures, on which the use of basic slag produces so wonderful an improvement. Some figures in support of this view will now be examined.

TABLE II.

Increase in live weight of sheep grazing very poor pastures in five English counties.

County.	*Station.*	*Period.*	*Average Season's Increase per acre.* lb.
Northamptonshire	Cransley	1901–08	44
Cambridgeshire	East Hatley	1900–04	53
Essex	Great Yeldham	1901–03	30
Suffolk	Saxmundham	1905–15	75
Northumberland	Cockle Park	1897–1905	37
Do.	Do.	1906–14	22
Do.	Do.	1915–20	31
Do.	Do.	1897–1920	29

The live weight increase of sheep grazing very poor clay soil pastures is shown in Table II. The periods to which the figures for increase refer are indicated. The influence of a series of good grazing years is brought out by comparing the increase on the same land at Cockle Park for the periods 1906-14 and 1915-20. Although there is some evidence to show that this very poor grass deteriorates slowly under continuous sheep-grazing, it can still respond to very favourable weather and in 1920 there was the surprising increase of 54 lb. per acre on the unimproved land at Cockle Park.

It will be seen from the last column in Table II that of the pastures tested in five counties the grass on the Northumberland farm was the poorest, and as the records in this case are the most

complete we may concentrate attention on it, remarking only that although the actual experimental fields selected in Cambridgeshire, Northamptonshire and Essex were somewhat better than that in Northumberland, there would be little difficulty in matching the poverty of the Cockle Park pastures in most English counties. No statistics indicating the area of land equally poor are available, but the total amount of this poor grass must be at least ten times as great as the area of the very rich pastures to which reference has been made above.

Over a period of twenty-four years, including some very bad and some very good grazing seasons, the sheep on the unimproved land at Cockle Park made gains which average 29 lb. per acre per annum. But what does this increase in the living animal represent in the form of meat? This is a point to which little attention has been directed. It is often assumed that from 48 to 50 per cent. of the increase made by sheep of the class used in these experiments, would consist of carcass. In my opinion the proportion on very poor grazings is very much less.

In an experiment reported by me in 1902* it was shown that in 1901, a bad grazing season, the carcass increase of the best animals on improved land at Cockle Park was equal to 42.6 per cent. of the live weight gain. In 1902 a more extended experiment on the same lines was arranged and certain figures relating to the sheep of that season will be found on page 9 of the Seventh Report on the work at Cockle Park; but as my own connection with the Northumberland Station terminated before the end of the grazing season, the special point now in question was not discussed at the time. Through the courtesy of Professor Gilchrist and the Record Keeper at Cockle Park I have obtained the original figures relating to the sheep of 1902, and will now refer to those results of this old experiment which bear directly on the subject of carcass increase.

It may first be recalled that the grazing season of 1902 was a good one, a marked contrast to its predecessor; on the unimproved land sheep produced 41 lb. live increase per acre as against 23 lb. in 1901. At the end of the year the quality of the sheep grazing on the improved land was favourably reported on by the butcher.

On 20th May, when the experiment began, four typical sheep were selected, and after fasting for 15 hours were weighed and then slaughtered. The live and carcass weights (in brackets) of

* Sixth Annual Report on Experiments with Crops and Stock at the County Demonstration Farm, Cockle Park, Morpeth, p. 34.

the four were, 89 lb. (39 lb.), 80 lb. (35 lb.), 74 lb. (29 lb), 69 lb. (29 lb.). The percentage of carcass in the best sheep was nearly 44, in the poorest, just over 39. The average yield of carcass was 42.3 per cent. The sheep had not been shorn when killed. If slaughtered after clipping the percentage of carcass would have been 46. From sheep with early October fleeces about 44 per cent. of mutton would have been got.

On 8th October at the end of the grazing season, eighteen of the best sheep were selected from the six lots (out of eleven lots under experiment) which could produce three, or more than three, sheep fit for the butcher, and after 15 hours fast were weighed and killed. For one of the eighteen, full figures are not available; a second, the average sheep of the remaining seventeen, may be left out of account; particulars of the others, arranged in four groups, Lot I, those giving the highest, and Lot IV those giving the lowest percentage of mutton to live weight gain, are given in Table III. Lot A refers to the four sheep killed on 20th May.

TABLE III.

Lot.	Weight, 20th May.		Weight, 8th Oct.		Increase.		Percentage of Carcass in Live Increase.
	Live.	*Carcass.*	*Live.*	*Carcass.*	*Live.*	*Carcass.*	
	lb.	lb.	lb.	lb.	lb.	lb.	
A	78	33	—	—	—	—	42
I	78	33	121	59	50	26	52
II	81	34	125	59	51	25	49
III	82	35	124	57	50	22	45
IV	78	33	119	52	47	19	41

With reference to these figures it should be noted that the carcass weights of Lots I to IV on 20th May have been estimated at 42.3 per cent. of the live weight, and that to the figures for live weight increase an addition has been made for the wool removed from each sheep in the first month of the grazing season.

The highest percentage of carcass to live increase given by any one sheep was 55 and the lowest 40.

As contrasted with the slaughtered animals, all of which were in a thriving state on 8th October, the remaining sheep on the unimproved pasture were in very lean condition, and in the butcher's judgment were losing weight; if they had been slaughtered it is not possible that even in the good grazing season of 1902, they would have shown nearly as much as 40 per cent. of carcass; comparing them with the animals selected for slaughter it may be estimated that the percentage of carcass to live increase could not have exceeded 35 or 36. None of the very lean sheep grazed on the unimproved land at Cockle Park

have been slaughtered during the twenty-five seasons for which records are now available; but if figures were available, I am satisfied that the 29 lb. of live increase credited to this grass land in Table II would be found to represent not more than 10 or 12 lb. per acre of carcass increase.

On the other hand when using these experimental figures for the purpose of estimating the yield of meat on our poorest cultivated grazings, it must be remembered that it is very unlikely that the full returns of which such pastures are capable can be obtained by grazing with sheep alone. If store cattle were kept along with sheep a greater increase would almost certainly be secured. It is possible, though not likely, that mixed grazing might increase the output by as much as 50 per cent. If we adopt this figure as a maximum, the average yield of meat by our poorest pastures may be estimated at from 15 to 16 lb. per acre, rising to 20 lb. in good grazing seasons and falling to 12 lb. in poor years.

Production on Grazing Land of Medium Quality.—In my original paper particulars were given of the yield secured at Cockle Park from two ten-acre fields, originally of the very poor quality of the grass-land above referred to, which had been greatly improved as a result of treatment with basic slag. From the figures then available I estimated the yield on the improved land at about 210 lb. live increase and 105 lb. of meat. Several good grazing seasons between 1914 and 1920 have slightly raised the average yield; over the fifteen year period 1906-1920 the figure for the live weight gain has been increased to 215 lb. On the other hand the carcass increase for both sheep and cattle was, in 1915, assumed at 50 per cent. of the live increase, and in view of the above figures for sheep this percentage is too high; the original estimate of 105 lb. meat per acre may therefore be retained for these particular fields.

The effects of good or bad grazing seasons on land of this type are illustrated by the records of these experimental fields. Averaging the results on the two ten-acre enclosures, the following were the live weight yields per acre in the two best and two worst seasons experienced between 1906 and 1920. The figures refer to the summer grazing only.

Season.	*Live Increase, lb. per acre.*	*Per-cent. Increase over* 1914.
1907	250	61
1920	240	55
1910	170	10
1914	152	—

While the influence on production of a good grazing season at Cockle Park is shown by these figures, it must not be assumed that they necessarily represent the gains made by the store stock of the country in good and bad years. The actual differences are much less than the 50 to 60 per cent. found in this case; for these experimental pastures are grazed so as to make the most of the herbage they grow, whereas in actual farm practice it is impossible to secure the full advantages of a first-rate year. We have not stock enough in the country to consume all that grows in a bountiful season, the numbers of our live stock being adjusted to the grazing available in average years.

These ten-acre fields were referred to in my 1915 paper as representing store pastures of ordinary quality; but it may be remarked that the actual yield secured from them is far in excess of the average yield of the grass land of the United Kingdom. From information collected in the course of the War it is estimated that the average yield of meat by all grass land (meadows and pastures) lies between 70 and 75 lb. per acre; for pastures only it is about 7 lb. less.

Scope for Improvement in our Grass Land.—The quantity of meat to be expected from the three types of pasture discussed above, and the low average production of the pastures of the United Kingdom, clearly point to the scope for improvement which our grazings offer; moreover, it is not in quantity only that differences occur in the meat output of rich and of poor land. There is a wide difference in the food value of the prime meat produced by the rich grazings of the English Midlands and the lean meat which forms the carcass increase of cattle and sheep grazing the poorest pastures. Weight for weight the former is worth from three to four times the latter as a source of energy. Thus if both quantity and quality be taken into account, the food value of the produce of an acre of rich grass may equal the food value of the produce of forty acres of the poorest cultivated grazings.

Methods of improving grass land have been fully dealt with in one of the Ministry's recent publications,* and will not be referred to here; but it may be observed that although it is beyond our skill to secure a forty-fold increase, by converting such grass land as that of Cockle Park into pastures having the quality of the rich Midland grazings, it is quite possible to

* Manuring of Pastures for Meat and Milk, by Professor Somerville. Ministry of Agriculture and Fisheries Miscellaneous Publication No. 30, price 6d. post free.

produce on poor clay soils, what may be described as a " colourable imitation " of a rich pasture during a part of the grazing season. On the average of a long term of years it has been shown that suitable manuring and careful grazing may increase the production of such poor land ten-fold, if both quantity and quality be taken into account; and favoured by good seasons, skilful management might even be rewarded by a greater return.

These are the possibilities of improvement offered by certain types of poor pastures on clay land. When we come to the question of the increase that could be expected over a wide area, and in the circumstances and conditions under which the average farmer works, we must be contented with a very different set of ratios. If instead of a ten-fold increase, the occupiers of inferior grazings added even ten per cent. to their output of store cattle and sheep they would do well. Incidentally, too, by remedying the grievances of those farmers who feed cattle in winter, and now complain of the shortage of " stores," they might terminate a current controversy.

* * * * * *

THE PLANNING AND CONSTRUCTION OF COW-SHEDS.

Major H. P. G. Maule, D.S.O., M.C., F.R.I.B.A., and A. Ewart Aston.
Ministry of Agriculture and Fisheries.

The increasing attention being given to the production of clean milk inevitably opens up the question of the modern planning and construction of cow-sheds, and the following article and illustrations may be found interesting to those who contemplate new buildings or the reconstruction of existing buildings in the near future.

The questions of planning to minimise labour in ministration and to maintain the health and cleanliness of stock are well understood, but nevertheless the larger proportion of cowsheds throughout the country are far from being ideal, either in arrangement, construction, or fittings.

It has been pointed out by Mr. Mackintosh of the National Institute for Research in Dairying in his article on " How to

produce clean milk," published in the April issue of this *Journal*, that :—

> "It is desirable, however, to study this question from different points of view and to maintain a due sense of proportion. It is quite correct to say that clean milk of the highest standard can be produced under very primitive conditions, provided attention is given to the cleanliness of the utensils, the cow and the milker, but it may not be a practical proposition to attempt to maintain such a standard of cleanliness, day after day, summer and winter, without taking steps to improve the cowshed or the water supply, and thus lessen the expenditure of time and labour.
>
> The point of view of the cowman or milkers must also be appreciated; if nothing is done by the master to prevent cows wading in filthy mud or lying down amongst manure, one must not be surprised if exhortations to greater cleanliness meet with little response from the men. On the other hand, through carelessness or ignorance as to proper methods, an ideal cowshed and dairy with a complete plant may turn out milk which soon goes sour."

This is a thoroughly commonsense argument based on an understanding of human nature, and it is the human factor which counts most of all in the production of clean milk.

Under the present conditions both of farming and building the main factor in construction will be the question of cost, and unfortunately the equipment of modern cow-houses has too often been carried out on far too lavish a scale. Money has been spent on non-essentials both in construction and fittings, without any corresponding advantages in cheap or clean production.

Obviously an effort should be made to obtain due balance of all the factors—arrangement, construction, fittings, and the human element—so that without needless expenditure upon building the workers may be led to take a pride and interest in their work under stimulating conditions conducive to cleanliness and efficiency.

Broadly speaking no attempt is here made to dogmatise, but rather to illustrate plans and a form of construction which it is believed would be found cheap and convenient, easy to erect and suitable for extension and standardisation.

Again to quote Mr. Mackintosh :—

> "It is unnecessary to attempt to lay down any general rules beyond stating that there should be good light and ventilation, and stalls and floors so constructed that they will assist in keeping cows clean. Regulations as to ventilation, air space, and superficial area have little to do with clean milk production apart from their bearing on the health of the cows."

So far as general arrangement is concerned it may be said that if accommodation is required for more than 12 or 15 cows

the double standing is strongly advocated as being more suitable for extension, economical of labour, and relatively cheaper to construct.

Arable Dairy Farm, Hucknall.—The illustrations given (Fig. 1) are of the Experimental Arable Dairy Farm at Hucknall, Notts., built under the direction of the Ministry of Agriculture in 1921. Its purpose is to demonstrate the intensive production of milk from 30 acres of arable land, the conservation of food stuffs being largely effected by means of a silo.

Conditions.—The conditions laid down by the Dairy Branch of the Ministry included standings for 22 cows placed head to head, with a central feeding passage having a straight run from the mixing floor and silo. The double doors to the former for the delivery of green food, and the convenient position of the shoot from the silo are consequently the essence of the plan and secure the most economical means of service in time and labour. The original intention was to allow sufficient width in the feeding passage to enable a loaded cart to be drawn through in order to feed fresh-cut green fodder direct from cart to cow, but considerations of economy led to a reduction in width, the feeding passage being finally constructed 5 feet wide. Provision had to be made to allow for future extension to accommodate 10 more cows.

It was necessary to balance the cow-house accommodation with other essential farm buildings, such as stabling, boxes, cartshed, and piggeries, which with the open yard, complete the steading. The conservation of liquid manure by means of a large underground tank, suitably placed for convenient access, was also considered an essential feature of the scheme.

Construction.—The decision to have a shed with double standings necessitated a roof of wide span, and under the abnormal building conditions then obtaining it was obvious that special consideration must be given to simple and economical construction, with due regard to a minimum of expense in future maintenance. These conditions and the fact that it was intended to use American Yoke Ties and standard metal stall divisions, one to each cow, led to the use of timber of small scantling, rather than the employment of heavy roof timbers or steel trusses, with a clear span from wall to wall. Reference to the section in Fig. 1 shows that intermediate supports are used, facilitating the use of the metal divisions and the employment of light timber trusses. These supports carrying the roof principals are consequently spaced at 10 ft. 6 in. centres allowing standings for

3 cows per bay on each side, and enabling future extensions to be carried out in sections with the minimum of expense. One advantage of this type of roof with internal supports is that the external containing walls can be reduced to a minimum thickness and constructed without the expense of intermediate piers under each roof principal.

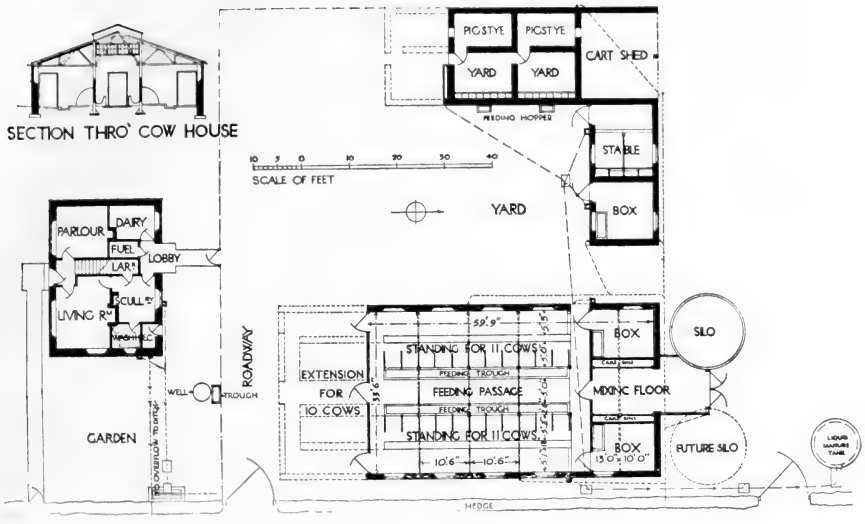
The trusses have double wood members for the rafters and tie beams with single ties and struts inserted between, all simply spiked through at the joints and all being formed from 4 in. × 1½ in. scantlings. The post supports are constructed of three 6 in. × 1½ in. pieces, stiffening the whole structure, and are so placed that they do not interfere with the working or accommodation of the building see Figs. 1 and 2. Incidentally the low tie beam over the dunging passages provides easy and convenient fixing for an overhead trolley should such be required for the removal of dung.

An important feature is the method of top lighting and ventilation, the centre of the roof over the feeding passage being raised at intervals for the purpose of inserting ventilating louvres and skylights, the tops of these raised portions being glazed. Galvanised iron sheets were used for the roof covering and thus all common rafters are eliminated, the sheets being spiked to purlins supported on the trusses at 10 ft. 6 in. centres.

A light matchboard lining secured to the underside of the purlins prevents cold air and condensation from the iron roof descending upon the cows below. It will be noticed from the section that adequate stiffening is given by means of the cross braces, the whole roof being very rigid though formed of such small scantling timber.

Fittings and Details.—The doors are framed and braced, hung in two halves, and the windows are of the hopper type placed on each side for cross ventilation. As before stated the stall divisions are tubular and the American Yoke fitting is used for the ties. The use of these fittings enabled the cow standings to be reduced fully six inches in length and the width of the building is correspondingly reduced, an economy of space and material which partly compensates for the more expensive type of fitting.

The feeding troughs are of concrete, continuous from end to end, as the Yoke fittings restrict "poaching" to a minimum and thus cleaning out is facilitated and the expense of cross divisions in the mangers is avoided. The dung gutters are only

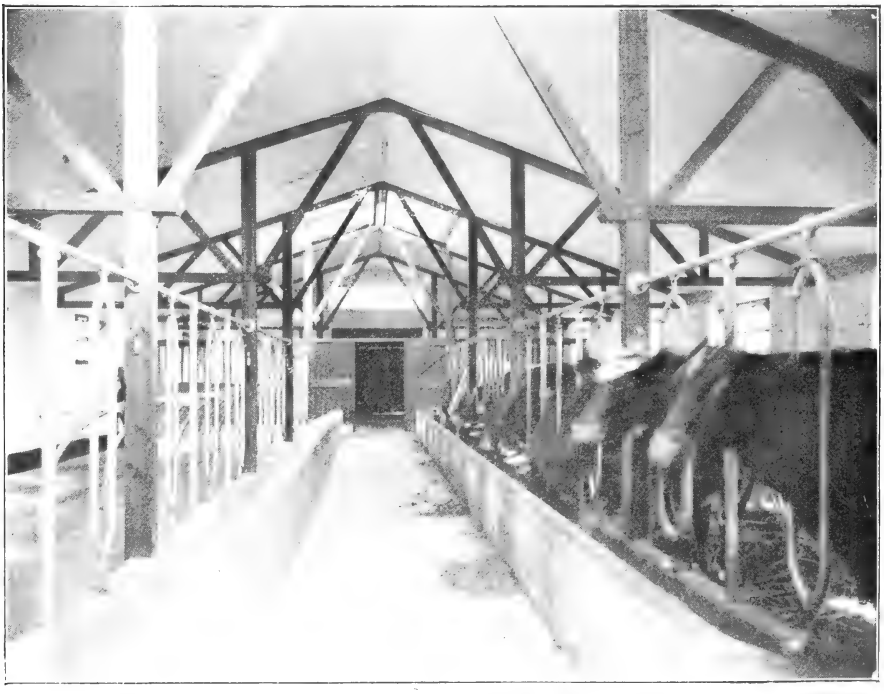


Plan.

General View from South-West.

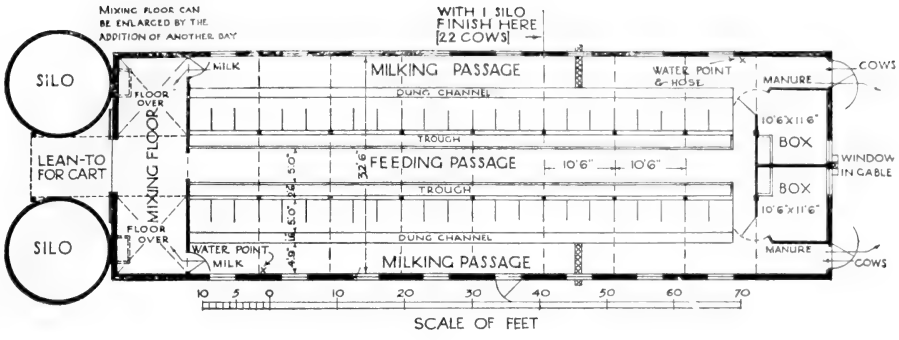
FIG. 1.—The Ministry's Arable Dairy Farm, Hucknall, Notts.

Interior View of Cow-house, showing Milking Passage.

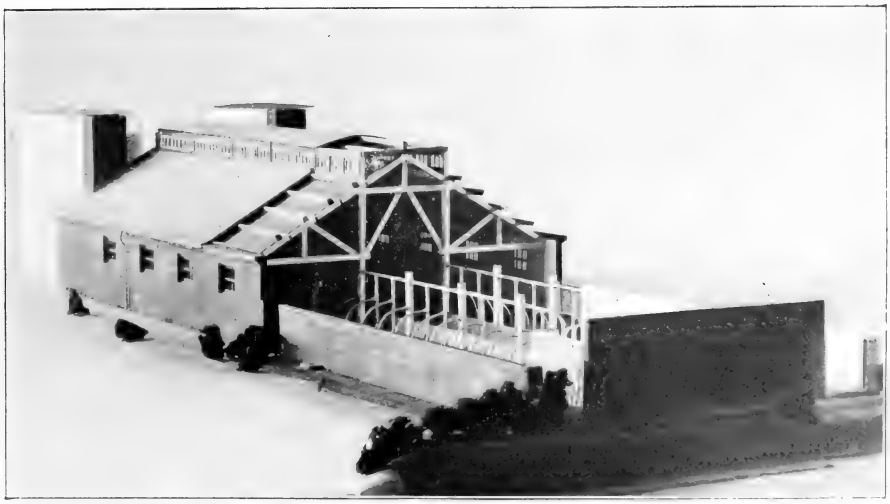


Interior View, showing Feeding Passage and Sky-lights.

FIG. 2.—The Ministry's Arable Dairy Farm, Hucknall, Notts.

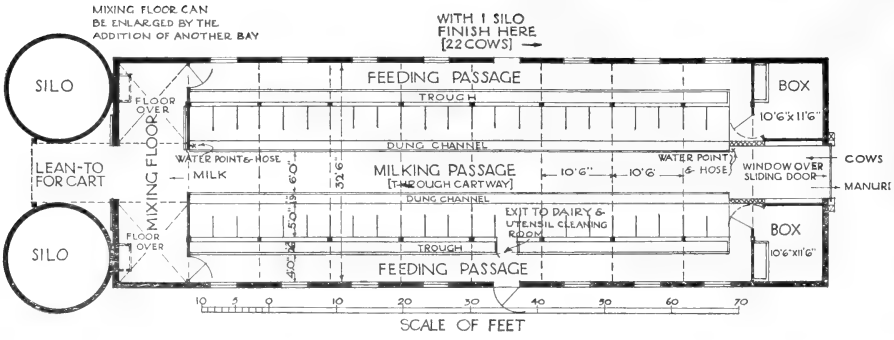


Plan.

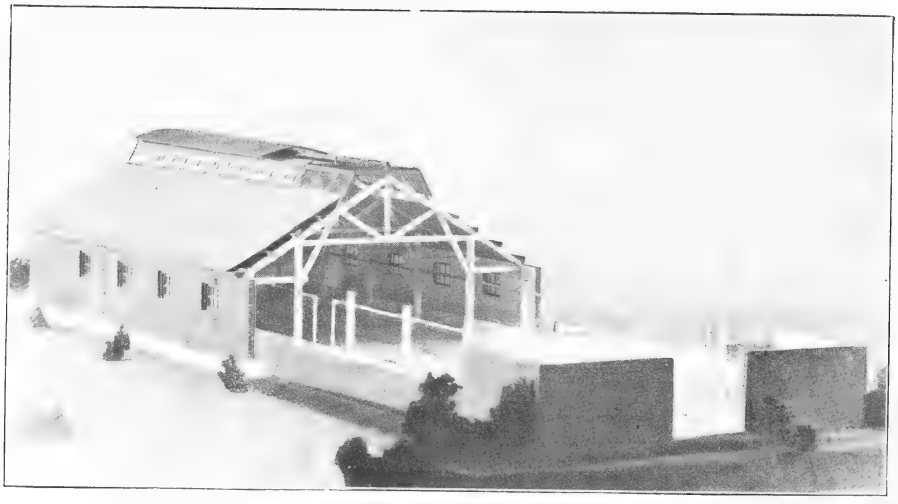


View of Model. (Part of Roof removed to show interior.)

FIG. 3.—Suggested development of Hucknall Cow-house for 40–50 cows, with head to head arrangement (Scheme A).



Plan.



View of Model. (Part of Roof removed to show interior.)

FIG. 4.—Suggested development of Hucknall Cow-house for 40–50 cows, with tail to tail arrangement (Scheme B).

18 in. wide made with a four-inch drop from the gangways and a ten-inch drop from the standings, which are therefore raised 6 in. above the floor of the gangways.

It is found that the provision of the Yoke tie keeps the droppings just about within the limits of the gutter and the writer was particularly struck with the cleanliness of the cows, especially noticeable in the case of the larger cows, although the standing is 5 ft. 2 in. in length on one side and only 5 ft. on the other. The right width for the gutter is a debatable point but if continued observations show that 18 in. is effective instead of the 2 ft. often demanded it is obvious that in a double standing, a reduction of one foot in the width of the building is an effective saving which again assists in compensating for the extra cost of the fittings.

To obviate excessive falls within the depth of the gutters themselves or the provision of cross channels and extra outlets advantage was taken of a natural fall in the ground, the whole floor sloping slightly towards the mixing floor and in the direction of the manure tank. Few sites are absolutely level and if advantage can be taken of a natural slope it is both economical and conducive to efficiency to adopt this method rather than construct a level floor with increased depth in the gutters.

A Suggested Standard Cow-House.—While making no claims to any striking innovations, the Hucknall design certainly offers possibilities of further development along economical structural lines, and its practical success in economic service and cleanliness led to the suggestion that it might prove of service if the same principles of construction and arrangement were applied to a design for a shed to contain a larger herd of some 40 or 50 cows.

Two Schemes were therefore prepared by the Building Branch of the Ministry to show the comparative merits of both head to head and tail to tail planning, and advantage was taken of the practical experience gained at Hucknall to introduce various modifications in detail whereby improvement could be effected.

Diagrams and slides made from these designs were utilised in a course of lectures given to the various University Agricultural Departments in England and Wales last winter, and aroused so much interest that it was thought desirable to prepare a model of each type for exhibition at the Royal Agricultural Show at Cambridge in July. These models have been prepared by Mr. L. C. Powell in the Ministry's drawing office and are constructed

to a scale of half an inch to the foot. For the purpose of showing the construction and interior fittings more clearly only half of each model has been completed.

Plans and photos of the two models are here given in Fig. 3 (Scheme A), and Fig. 4 (Scheme B).

The merits and demerits of the head to head and tail to tail systems are so well known it is hardly necessary to recapitulate them, but it may be mentioned that where the herd is sufficiently large to require the services of two men there are certain advantages in the tail to tail method, in which case each man has the undivided use of a feeding passage, and can work independently of the other, while there must be less disturbance among the cattle when feeding is taking place. While it is realised that the special feeding conditions obtaining at Hucknall may not apply in all cases, and silos may not be required, the arrangement of the mixing floor at one end of the building is adhered to and is equally applicable to either method of arrangement. It has, however, been extended right across the building from wall to wall with storage floors over at each side which can be filled from a loaded cart standing in the centre gangway. The mixing floor shown on the plans is restricted to the width of one bay, but in practice it would probably be found necessary to increase this to two bays for a herd of 40 to 50 cows.

The silos, if required, can be discharged in convenient places and a lean-to is shown in Scheme A, where a cart-load of fodder may be placed over night or at the week end.

A comparison of the photographs shows that the tail to tail method, Scheme B, lends itself to a simpler and more efficacious system of construction, lighting and ventilation; even in the photographs of the models it is clear that this building is better lighted than the other, and it is a noteworthy fact that the roof requires one-third less timber, a material advantage in cost.

General Construction.—The Hucknall principle of construction has been adhered to, namely, the use of small scantling timber, but the pitch of the roof in both schemes has been made to suit slating or corrugated asbestos sheeting. The main variation has been made in the method of top lighting.

In both schemes a continuous clerestory has replaced the separated raised skylights of the Hucknall plan, thus admitting light with better distribution to the whole building. The two Schemes A and B vary somewhat from each other, the variation being due to the different type of roof truss used, this in turn being governed by the different arrangement of the stalls. In Scheme A

the supports being closer together and near the centre the continuous clerestory is placed vertically above the posts and has vertical lights on either side, a proportion of which would be made to open for ventilation and would be controlled from below, but casements would be required for the glazing, a material addition to the cost, and the controls are apt to get out of gear and cause trouble in adjustment.

In Scheme B the central dunging passage admits of the supports being placed nearer the side walls and by carrying up the braces, sloping sides are obtained to the clerestory which admit more light. Alternative suggestions are shown for the lighting and ventilation, viz., either fixed glazed casements, or reinforced glass secured direct to the framing by the same method as in greenhouse roofs. Allowance is made for expansion and contraction by means of galvanised clips, while provision would be made for the escape of condensation.

Ample ventilation is obtained by raising the curved corrugated iron or asbestos top of the clerestory two or three inches above the framing by means of blocks placed at intervals. This space is protected by close mesh wire to keep out birds and insures adequate cross ventilation above the flat ceiling of the clerestory.

To let out the hot and foul air rising from below it is suggested that this flat ceiling could be cheaply formed of battens spaced half an inch apart similar to Yorkshire space boarding and as it is continuous throughout the whole length of the shed the extraction of air would be so distributed as to obviate any possibility of draughts. An alternate method of ventilation panels is shown in the model, one in each roof bay, but the former method is considered by far the better and cheaper and likely to prove the more efficacious in actual working.

It is also suggested that as the top lighting in this scheme would be ample the openings in the side walls immediately in front of the cows should not be glazed but should be fitted with simple adjustable louvre shutters such as are commonly found in the midland counties. Thus fresh air would be admitted and the supply regulated in the feeding passage by means of the adjustable louvres, the openings in the clerestory acting entirely as outlets. The actual inlet ventilation area of the two louvres in each bay would approximately equal the outlet ventilation area between the spaced boarding in the flat ceiling.

It is seriously suggested that the provision of closely spaced louvres in the lower openings would overcome the great diffi-

culty experienced in well lighted cow houses of combating the nuisance of flies. It may not be generally known that in Italy it is possible to keep houses absolutely clear of flies provided the louvre shutters are not opened in the day time. The glazed casements within may stand wide open but flies do not enter unless the louvre casements are opened back as well.

It is admitted that this does not get over the fact that flies also come into the cow-house on the bodies of cows returning from pasture, but it would undoubtedly assist in minimising the nuisance.

In each scheme the total width of the buildings is the same, but in Scheme B, the tail to tail method, it is clear that not only is the construction less costly but it is claimed by the authors that the method of lighting and ventilation is more perfectly suited to the placing of the cows than in the head to head method.

It should be noted that the trusses throughout the whole length of the building are placed, as at Hucknall, at 10 ft. 6 in. centres, and each complete bay provides for 6 cows, admitting of easy extension if it is desired to commence with a smaller herd. In Model B the individual standings have not been shown but would be constructed in the same way as in Scheme A, viz., tubular stall divisions and Yoke ties.

In Scheme B provision is made in the centre of the building for a side entrance to enable milkers to pass quickly from all parts of the building to the dairy and utensil cleaning room which are considered essential and integral parts of a dairy homestead.

Cost and Cubical Contents.—It is difficult to give more than an indication of the probable cost of such buildings as are here illustrated, especially under present conditions, but the following facts may be some guide.

The total cubical content of the entire cowshed excluding the silos is approximately 54,500 cubic feet. Before the war such a shed as this could have been built at about 5d. per foot cube. It is not unreasonable at the present time to put building costs at twice the pre-war rate, say 10d. per foot cube for such work as this, which would give an approximate estimate of £2,227, say *£2,200*, for the complete building. Scheme B would certainly work out at a lower price.

These figures must only be regarded as a rough guide, as obviously there are differences in cost due to site, locality, local materials, etc. The main point is that owing to the character

of the design there should be no difficulty anywhere in obtaining the necessary materials, and there is nothing in the construction of the building demanding more skill than the average village builder has at his command.

In conclusion it should be noted that the air space is approximately 720 cubic feet per cow, a sufficiently ample allowance when the general conditions of the building are taken into consideration.

Space does not permit of the discussion of all the details, but it is hoped that the main essentials have been made clear and that the photographs and plans give a sufficient indication of the principles adopted and the methods of construction employed. Further it is hoped that the exhibition of the models at the various Agricultural Shows this summer will promote criticism and suggestions for improvement or modification of detail.

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LABOUR ORGANIZATION ON AN EAST MIDLANDS FARM.

PART I.

ARCHIBALD BRIDGES, B.A.,
Institute for Research in Agricultural Economics, Oxford.

FROM the point of view of the country as a whole it is highly desirable that all industries should be so organized as to give regular employment throughout the year to their workers. The agricultural industry—the greatest the country possesses—has been a noteworthy exception in the observation of this rule. In the days before machinery was a regular feature of farm equipment the seasonal demand for casual and part-time labour was very large, and though it is not now of so much importance, it is still a prominent feature of the industry in districts where specialised farming is in vogue, and it can easily be understood that unless this employment fits in with idle periods in other industries the worker himself, and the community at large, are bound to suffer. The farmer also loses by the system. The demand for casual labour comes when work which demands immediate attention cannot be overtaken by the

regularly employed hands. Casual labour must be obtained, and the general result is that high rates of wages have to be paid; and moreover a casual worker has not the same interest in the success of the farm as a regular employee, and the combination of high wages and indifferent work often results in costly labour. The farmer is also adversely affected in another way. The supply of skilled and reliable labour flowing to any industry is directly influenced by the regularity or otherwise of the employment offered. It is therefore not to be expected that men, at any rate the most enterprising and efficient of them, will remain in an industry where regular employment cannot be depended on. Speaking of general farming, which so greatly preponderates in this country, this casual labour problem is one which every farmer should endeavour to deal with as far as possible by looking ahead, and so organizing his farm as to ensure that the work at all seasons is more or less uniform and within the powers of the permanent labour. Agriculture is, however, in many respects like warfare—the enemy may upset the best laid plans. The weather, the friend of the agriculturist, is also his worst enemy, and on this account he requires a high standard of efficiency in management to overcome its vagaries.

Of course this question is largely bound up with the progress of invention in agricultural implements and machinery. Manual labour may be the only means of performing certain operations on the farm, and casual labour the most economical way of getting them carried out, but as far as possible, and consistently with getting the operations completed within a reasonable time, they should be accomplished by the permanent staff of the farm, stimulated, if need be, to greater effort by piece-work rates. Against piece-work it is said that the work is not well done, but so long as the farmer keeps a watchful eye on the men this argument against its adoption largely falls.

It is not intended in this paper to discuss the organization of labour under the various types of farming which exist in this country, but to illustrate a few aspects of the economics of farm management which are well worthy of study by all employers of agricultural labour. For this purpose the writer has selected a farm in the East Midlands, and examined the labour records kept for costing purposes from 1st June, 1918, to 31st May, 1919. The period 1st June to 31st May conforms to the accounting period on this farm.

The following statement shows the area of the farm, its crops and stock, the number of persons employed, their equivalents in

men, and the number of work-horses. The figures have been converted to a 100 acres basis for comparison, and the land and stock managing capacity of each man and the area worked by each pair of horses are shown at the foot of the statement.

	Total.		*Per* 100 *acres.*	
1. ACREAGE :—				
(*a*) *Arable*—				
Grain Crops	436		45·2	
Root and Fallow Crops ...	140		14·6	
Pulse	49		5·1	
Seeds for Hay	55		5·5	
Seeds not for Hay ...	85		8·9	
Other Crops	6		·6	
		771		79·9
(*b*) *Grass*—				
Hay	22		2·3	
Pasture	172		17·8	
		194		20·1
		965		100·
2. STOCK :—				
Cows and Heifers in milk and in calf	49		5·1	
Other Cattle—				
2 years and over	24		2·5	
1 year and under 2 ...	37		3·8	
Calves	73		7·6	
		183		19·0
Sheep—				
Ewes	264		27·4	
Shearlings	139		14·4	
Lambs	356		36·9	
		759		78·7
Pigs—				
Sows	11		1·1	
Others	109		11·3	
		120		12·4
Horses—				
Working		24		2·5
Others		12		1·2
3. PERSONS employed		28		2·9
Men equivalents...		24		2·5

	Acres of		All	All	All
	Arable.	Grass.	Cattle.	Sheep.	Pigs.
Per man equivalent	32·09	8·07	7·62	31·62	5·00
Per pair of horses	64·25	16·16			

As will be seen nearly 80 per cent. of the total area is under arable cultivation. The soil is light in character and mostly capable of being worked by two-horse teams. The four-course system of cropping is adopted, with wheat and barley as the principal grain crops. The pasture is grazed by all classes of stock, and only twenty-two acres are made annually into hay. A dairy herd of 21 to 26 milking cows is maintained with a proportionate number of young stock. As the farm is a considerable distance from a railway station the produce of the dairy herd is

made into butter, the separated milk being available for the young stock and the pigs. All young stock are yarded in winter for the purpose of consuming the roots and straw, and to tread the remainder of the latter into manure for the land. The ewes run with their lambs on the pastures and grazing seeds during the summer, and are folded on roots during the winter, the tegs being fattened off and a sufficient number of ewe lambs retained to maintain the flock. As the table shows, a considerable number of pigs are kept. The open air system is not practised, the pigs being maintained wholly indoors and fed for the production of bacon.

The labour supply was regular, except at certain times, casual hands and gangs being employed during busy seasons on carrots and potatoes, but an average of nineteen men, four to five women, and four boys were regularly employed.

Manual Labour.—Fig. 1 showing the distribution of the manual labour on this farm for the year 1918-19, illustrates the nature of the demand for labour on the farm. If the work had been capable of being performed by full-time labour the height of the column in each month would have been alike, but bearing in mind the climatic conditions with which agriculture has to contend, and also the fact that during the War efficient labour was difficult to obtain, the results secured must be regarded as bearing witness to the high degree of skill on the part of the farmer. The maximum variation of employment month by month is 17 per cent., and omitting the busy periods of May, June, October and November, it is less than 10 per cent.

The graph has been split up for the purpose of illustration and discussion into the departments making demands for labour, viz.: (1) Arable; (2) Sheep; (3) Other Stock; (4) Pasture, and (5) Establishment.

(1) *Arable.*—The portion relating to the arable has been subdivided by a dotted line. The upper part shows the time spent in threshing, dressing, and the delivery of the various grain and pulse crops. The lower part combines all the labour on the field operations of ploughing, cultivating, manuring, sowing, harvesting, etc., of all the crops on the farm during the year.

(2) *Sheep.*—This includes the time of a fully-employed shepherd throughout the year, and also of additional assistance required by him when the sheep were being folded on roots, at lambing, and also at shearing and dipping times.

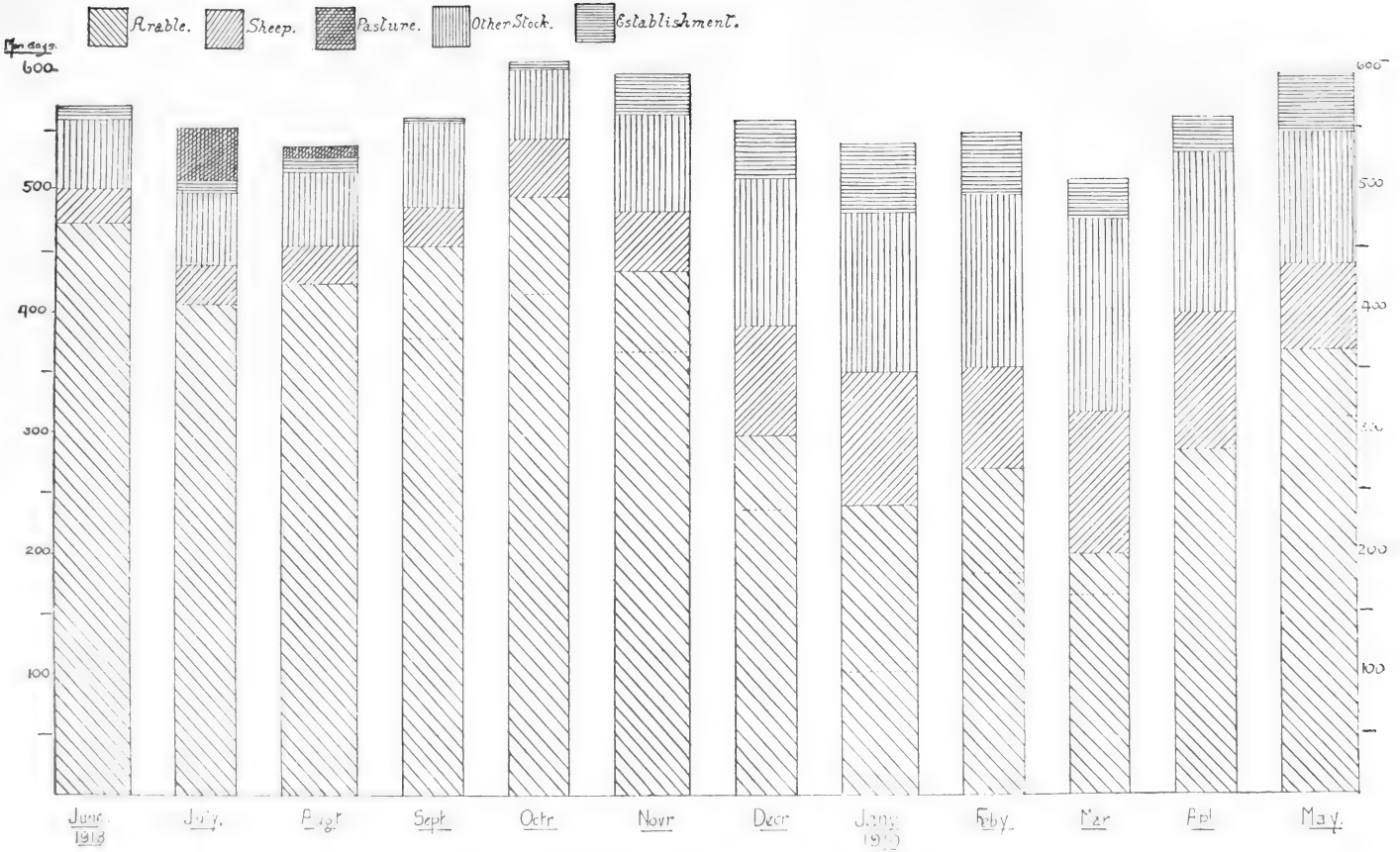

FIG. 1.—Distribution of Manual Labour 1918–1919.

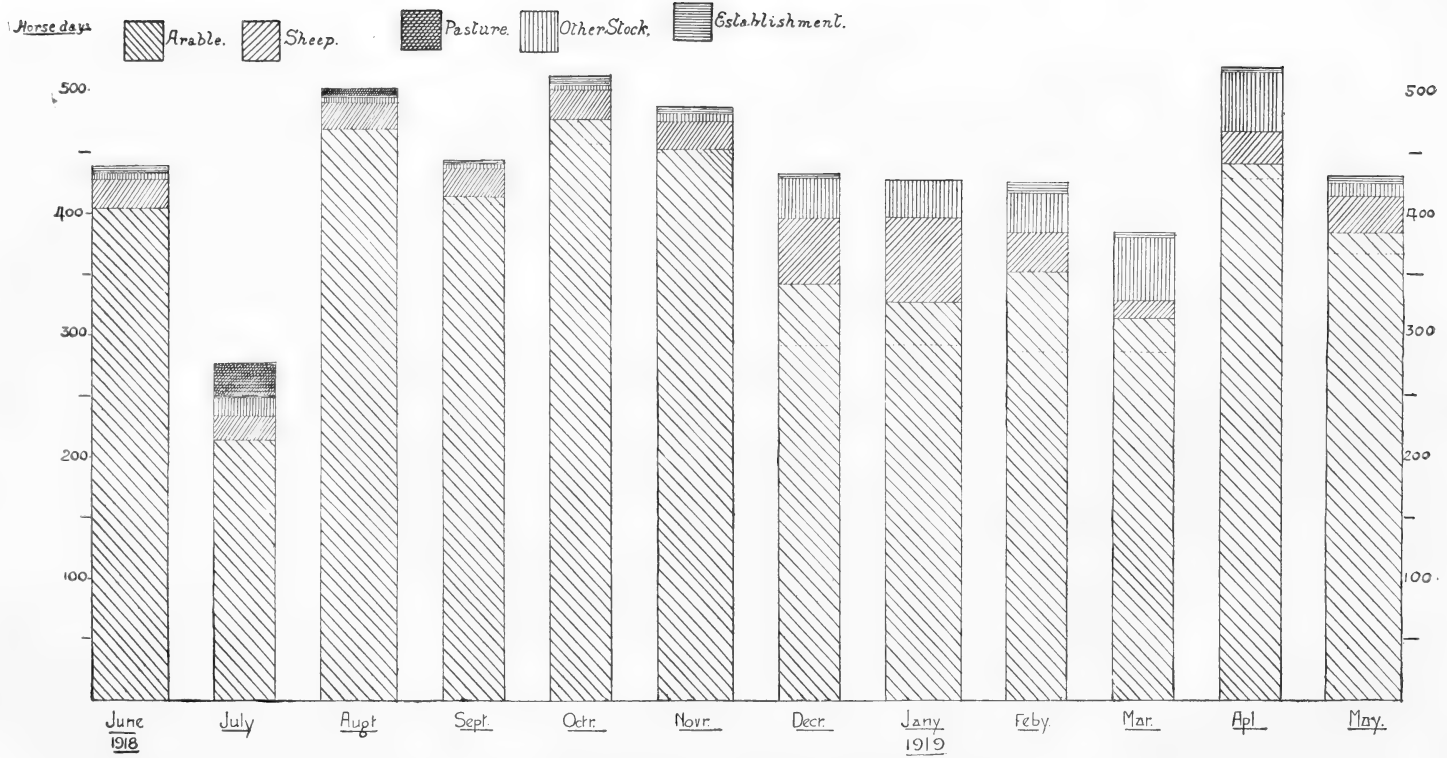

FIG. 2.—Distribution of Horse Labour 1918–1919.

(3) *Other Stock.*—This portion of the graph similarly includes all manual labour in feeding and milking, root carting, and other incidental work directly connected with all the stock on the farm, exclusive of the sheep. Owing to the interchangeable nature of the labour on the stock it was found impossible to divide this labour on any accurate basis between the dairy herd, other cattle, and the pigs.

(4) *Pasture.*—Manual labour in harrowing and rolling the pastures, any manurial operations, and the work involved at hay-making are the only items shown under this head.

(5) *Establishment.*—This portion covers all manual labour which cannot be *directly* charged to any of the productive departments of the farm. In cost accounting such terms as "overhead charges," "general expenses," signify payments for this class of work.

There are many operations on a farm which come under this head. Hedging, fencing, ditching, road repairs, and sundry other items, are examples of this class of work performed by the labour staff of the farm. An allocation of this work to the productive departments is possible, but as it plays an important part in labour organization, it was considered advisable to show it separately.

A misconception of the nature of establishment work is often observed in the minds of farmers and writers on agricultural topics. It is a commonplace to hear it spoken of as entirely unproductive work. It is possible to imagine a state of superfarming, where work of this category is accomplished to keep the farm in a "spick and span" condition without in any sense being productive, or where through lack of organization this work is done in conflict with productive work with the result that the men are idle at less busy periods, or again where, through indifferent work, it has to be done a second time. In this last case the first work was entirely unproductive. A familiar example is gap stopping. Improperly done in the first instance sheep or cattle break out again at the same place, and apart from the waste of time in getting the stock back the gap has again to be repaired, and the time spent in the first instance was of no avail.

But on the whole where the work is well executed establishment operations are conducive to the well-being of the crops and stock of the farm, and if they were left undone for any length of time the farm would suffer severely. The writer has a case in mind where, owing to the failure to clean out a water-course, the outfall of the drainage system was blocked up, with disastrous

results to the state of the fields adjoining. The term " indirectly productive " used by some American agricultural economists is therefore preferred as a definition of establishment work.

In a general way the graph shows the relative importance of the labour requirements of each line of production under this type of farming. Naturally the labour on the arable stands out prominently. What is more important to notice, and this is the main feature of the graph, is how the arable and the two stock departments fulfil the condition of equalizing the labour demands when the work, as here, is efficiently organized. During the busy months in the year on the land, on this farm—May, June, July, August, September, October and November—the stock are on grass and more or less shifting for themselves, thus reducing their labour requirements to a minimum, and the labour on sheep is also comparatively small, while during the winter months and early spring, when arable land operations are curtailed by weather conditions, etc., the labour required for all the classes of stock is considerably increased, and with the " granary " work—threshing, etc.—makes up for the diminished demand on the land. Further, winter is the period of the year when ditching, hedging, fencing, road repairs and other establishment works can be carried out without disturbing the essential work for crops and stock.

In organizing labour, therefore, the unit of organization is the farm itself, not its individual parts. Each line of production must be correlated and linked up with the others. Thus, the efficient manager of farm labour must not only consider the labour for his crop rotation, but what is equally imperative the relation of stock labour to that required for the crops, in order that he may supplement where necessary the work on the land, and so ensure a continuous demand on the labour at his disposal. The graph (Fig. 1) shows fairly conclusively that for this style of farming arable is dependent to a large extent on the stock to regulate the labour requirements.

To enable a farmer to organize labour effectively a thorough knowledge of crops and stock is essential. This phase of farm management is outside the scope of this article. A short discussion of the importance of doing work at the right time will not, however, be out of place. Certain classes of work must have preference over others at any given time. It will be at once recognized that the feeding of stock cannot be put off; the work at seed time and harvest, and the thinning of root crops are all operations which must be completed within a limited period of

time. On the other hand, operations such as ploughing can be spread over longer periods, but that this is not always so will be apparent in the busy period which follows harvest in the preparation of the land for winter corn. Operations of this class must not, however, be delayed so as to crowd the work into too short a period, and thus bring them into the class demanding immediate attention. If, for example, the ploughing of the land for barley be put off until the spring, then the work must be completed within a very limited period, with a corresponding strain on men, horses, and equipment.

On wet days, or where, owing to previous rain, the land is too wet to be worked, the horsemen and other workers in the fields will be affected. The farmer should therefore aim at having a programme of work in readiness in order that no delay should occur in its execution when the time arrives. Many tasks can be performed at these times. Barn-work, repairs to implements and harness, and other tasks are familiar examples of wet day work, and the carting of corn, and of coals for threshing, and also various forms of establishment work out of doors can be performed when the land is too wet to be worked.

The class of work grouped under the head of establishment—the indirectly productive work—should never have preference over productive work. If it can be shown that, owing to weather conditions, a farmer executed some establishment work in July of a given year, when at the same time the self-binder which he expected to use in a few weeks' time was out of repair, it can be readily seen that valuable time will be lost when the grain is ready for cutting.

In this country establishment work is *mainly* carried out during the winter months, when, as shown in the graph (Fig. 1), it plays an important part in the equal distribution of labour. The large quantity of this work which was carried out in March, April and May, on this farm is quite remarkable. The state of the weather may have been partly responsible, but without an accurate knowledge of the weather conditions at this period it cannot be stated whether this was so. Another possibility is that the farmer was anticipating his needs for additional labour in June and July on the root crops, and was possibly carrying a little more labour than he could employ on directly productive work at this time. In the whole year establishment work accounted for a little over 5 per cent. of the men's time.

A striking feature is the little work required for pasture land, which is another way of saying that it is not the pasture but the

stock it carries which makes the demand for labour; only in two months in the year—July and August—during haymaking was any work actually carried out on the grass. Neither harrowing or rolling appears to have been done in the spring of 1919.

A reiteration of the necessity for thorough organization is made here. Every farmer should think ahead and have a programme of the main work to be accomplished on his farm. It is not expected that farm work can altogether be carried out according to schedule, but a good programme will minimize errors and avoid delays. Greater efficiency in the management of the labour should result in obtaining a larger production from a given expenditure, for if men can be kept fully employed on directly productive work the unit cost of production must fall. One expedient of the inefficient manager, in order to reduce labour expenditure, is to get rid of some of the men, when there is little work to be accomplished, thus reducing them to part-time workers. The effect of this action on the farmer, worker, and society at large has already been discussed.

Horse Labour.—Graph No. 2 (Fig. 2) shows the distribution of the horse labour on this farm. The same sub-division has been adopted as in the manual labour graph. The actual number of working days per horse during the year was 243.4 or 77.8 per cent. of the total possible working days. The percentage of the possible working days in each month of the year was as follows:—

	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1918 ...	76·1	48·1	87·1	76·7	88·7	84·4	74·8
	Jan.	Feb.	March.	April.	May.		
1919 ...	73·9	73·7	66·6	90·0	74·6		

It must not be assumed, owing to the small percentage worked in certain months, that this farm was overstocked with work horses, or that the great irregularity shows inefficient management. It has already been demonstrated,* that similar results are obtained by taking the average of five farms of different types. The number of working horses which a farm requires is not determined by the average requirements over the year, but by the number necessary to overtake the work in the busiest months. Therefore, on this farm, although an extremely slack period occurs in July, and comparatively slack periods in June, December, January, February, March and May in the year under review, yet a sufficient number of horses must be retained in these months to accomplish the

* C. S. Orwin, Determination of Farming Costs, 2nd Edition, 1921.

work in the busy seasons. This rule is also applicable when there is a tractor on a farm, unless it can so overtake the work as to keep horse work uniform throughout the year. The test of practice only can show whether this can be done. Some evidence that tractors do not fulfil this condition nor displace horses equivalent to their potential capacity is given by Mr. A. G. Ruston.* He says: "In every case investigated by the writer one effect of the introduction of a tractor on a farm has been without exception to increase the cost of horse labour per working day, because, owing to the fact that at certain times of the year, such as hay-time and harvest, horses are absolutely essential, the introduction of a tractor is rarely accompanied by the selling-off of its equivalent of horses. In consequence there is a decrease in the number of working days per horse per year." This, however, is only one aspect of the various considerations which require investigation when introducing a tractor. The manual labour which a tractor can displace, the running costs and depreciation of the new equipment as compared with the old, the advantages of getting work done quickly and the influence on the yield of the crops, are all factors which require to be measured in order to gauge whether the combination of tractor power with horse power is an economical one.

Returning to the graph, it is well to notice how relatively unimportant are the demands which stock make on horse labour, though the sheep make a fairly steady demand. One horse was definitely allocated to the shepherd during this year for the carting of hay, concentrated foods, shifting of hurdles, etc., yet in December and January this horse was not capable of undertaking the whole of the carting work and the time of two horses in the former month, and nearly the whole time of three horses in the latter were required, principally for the carting of roots. The remainder of the stock only require the services of horses to any particular extent from December to April, again mainly due to the carting of roots when the stock are indoors. On a farm of this type, where the proportion of arable to grass is high, the stock work is mainly supplementary to that on the arable, and generally speaking, if provision is made for working the arable, the same horses will easily do the stock work in addition.

* A. G. Ruston. "The Cost of Horse Labour," Journal of the Ministry of Agriculture, Dec., 1921, p. 810.

On this farm the pasture, as in the case of manual labour, makes little demand for horse labour, and that only at hay time. There seems to be no reason why harrowing and rolling should not have been carried out in March, 1919, when both manual and horse labour graphs show a relatively slack period.

Establishment work requires very little horse labour, as would be expected. The proportion of horse time spent on this class of work was less than 1 per cent. as compared with 5 per cent. for that of manual labour.

One would expect a much higher percentage of days to be worked in June and July, in the height of summer, than is shown. The demand made by turnips for horse labour in these months was remarkable, and the whole of the root crops together required by far the greatest proportion of both manual and horse labour requirements in these two months. Root crops are expensive to grow it will be admitted, but when considered from the standpoint of the use of labour—both men and horses—when it would not be otherwise required, and also having regard to the fact that they are cleaning crops, the expenditure may be an extremely economical one. The substitution of forage crops for silage in place of roots must always be considered in relation to labour utilization, a point which many advocates of silage crops often fail to substantiate.

To account for the small number of horse days worked on the farm in June and July it may be argued that there is very little hay land. Meadow hay accounted for 22 acres only, but there were also 55 acres of mowing seeds, and together these make a considerable amount of horse work. The fact remains that apart from the turnips and the hay no other crop on the farm can be effectively dealt with by horses at this time of the year, or if horses are able to work on them, the ratio of horses to men is not an economical one. Only hand weeding can be carried out on the grain crops; the carrot crop of six acres required only manual labour for weeding and thinning; and the work on the mangolds mainly consists of hand and horse-hoeing, in the last of which the relation of horses to men is 1 to 1, not 2 or 3 to 1 as in the case of ploughing, cultivating, etc. That manual labour is relatively more important at this time of year is borne out from a comparison of the manual and horse labour graphs for these months.

The introduction of root thinners or bunchers, and other labour-saving devices on root crops would provide for a more

extended use of horses at this time of the year, and not only so, but they should also be the means of displacing a certain amount of manual labour and making it available for other work; especially is this desirable where a large amount of casual labour has to be employed at this season of the year.

Where a few mares are kept for breeding purposes a means of reducing the cost of the horse-labour is provided, as the birth of the foals and the subsequent period when they have to run with their mothers coincides with these slack months; the cost of the keep of the mares then becomes a charge on the foals and not on the other enterprises of the farm. Whether this is a profitable way of dealing with the problem is another question and depends largely on the demand for work horses.

The ideal of horse labour management is the same as for manual labour, viz., uniform employment throughout the year on productive work. It will be apparent from the graph that this is difficult to attain, but efficient organization, as far as the weather and other conditions affecting the use of horses will allow, through a well thought out programme of work will make an enormous difference in the proportion of idle days.

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USE OF ELECTRICITY AT GREATER FELCOURT FARM.

R. BORLASE MATTHEWS, A.M.Inst.C.E., M.I.E.E.

IN order to show the possibilities of the use of electricity in farm buildings the writer proposes to explain the extent to which he "takes his own medicine," on his farm of 600 acres at East Grinstead. This method will probably be more interesting at the moment, since the author has read two papers* which summarise very fully the work he has been carrying out during recent years.

* "Electro-Farming, or the Applications of Electricity to Agriculture," read on 30th March, 1922, before the Institution of Electrical Engineers, Savoy Place, Victoria Embankment, S.W.1; also, "The Uses of Electric Power in Agriculture," on 3rd April, 1922, read before The Farmers' Club, 2, Whitehall Court, S.W.1; also, "Electro-Farming," published by the Electrical Development Association, Savoy Street, Strand, W.C.2, price 1s.

Although wide use is made of electricity on the author's farm, it is not yet employed to anything like the extent to which ultimately it will be. It is only after exhaustive investigation, both of methods and equipment, that new applications are introduced. As the whole object of applying electricity to farming is to reduce costs and increase profits, the commercial aspect of each development is very carefully considered beforehand. The actual results are carefully analysed by means of a very detailed application of the author's Auto-Countancy system.

As a result of such investigation, it has been shown beyond all doubt that electricity applied on correct lines to agriculture possesses economic advantages which no other source of power can offer.

Electric Lighting.—The use of electric light not only makes for cleanliness and convenience of working, but owing to the absence of flame, reduces fire risk, a matter of importance where such inflammable materials as hay and straw are concerned. Experience, however, has shown that besides these obvious advantages, electric lighting on the farm can actually be made a source of profit.

To take the simplest case, it has been found that by installing electric light in the poultry houses, and thereby increasing the hours of light during the winter months, an increase in the winter egg production of at least 10 per cent. can be secured. When it is considered that the cost of lighting is only about one penny per bird per annum it will be seen that the return due to this application of electricity is very great.

One interesting result of the installation of electric light in the author's cow byres is that the cost of the current (at 4d. per unit) is paid by the saving resulting from the prevention of milk spillage due to better lighting. Although but little work has yet been done on the subject, there is no doubt that electric lighting will ultimately play a very great part in bringing both animals and plants more quickly to maturity. Recent experience with lambs, and also with flowers, such as tulips, has been very promising.

Where electricity is used for increasing the hours of light, it can be switched on and off by means of very simple automatic devices, known as "time switches." Thus it is not necessary to increase the hours of work on the farm, in order to obtain the advantage of a longer feeding day. In fact, by the provision of suitable hoppers, which can be filled at convenient times during working hours, labour and inconvenience are actually reduced as compared with ordinary methods.

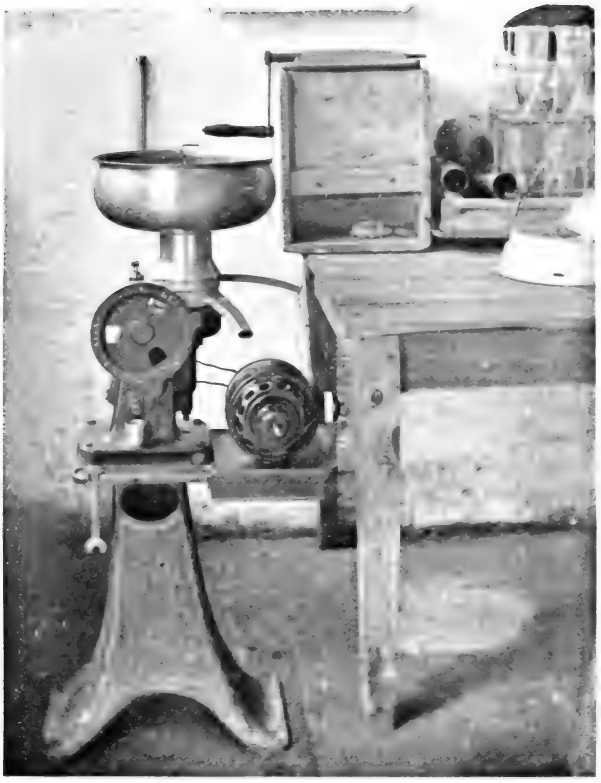

FIG. 1.—An electrically-driven Cream Separator at Greater Felcourt Farm.

FIG. 2.—A combined Root Cleaner and Slicer at Greater Felcourt Farm.

It must not be supposed, however, that the mere provision of artificial light will give satisfactory results. What is required is "illumination." The same specialised experience and technical knowledge, which is required for the satisfactory illumination of a works, is required to obtain a satisfactory result even in the lighting of a poultry house.

Electric Power.—The advantages of electricity for power purposes have been found to be equally great. One of the most successful adaptations of electric power, on the author's farm, is for driving the liquid manure pump. By its aid, liquid manure carts are now quickly and cleanly filled, with the result that labour is better employed, and the land better treated. In the farm buildings electric power is used for driving the food-preparing machinery, as well as for milking. A special feature of the electric motor is its practically constant speed under varying loads, and its ability to deal with heavy overloads. It is, therefore, the ideal method of driving food-preparing machines such as chaff-cutters, cake-breakers, root-slicers, and crushing and grinding machines, all of which require a steady speed, irrespective of the wide fluctuations in the power which take place from second to second during operation.

The author's experience with electrically driven Hinman milking machines shows that by running the pumps at 42 pulsations per minute, instead of the higher speeds usually employed, the necessity for hand stripping is reduced (although some hand stripping is done in all cases). It should be noted that the milking machine does not milk quicker than by hand. As, however, one man can supervise six or more milking machines, the milking time is greatly reduced, so that both time and labour are saved. The cream separator, and a bottle-washing machine, are also driven by electric motors. The cardboard covers used to seal the bottles of Grade A (Certified) Milk, are hermetically attached by means of a specially designed electric heater, which enables 25 to 30 bottles to be sealed per minute.

Milk is delivered to the railway station, two miles distant, by an electric van. The cost of running has been found to be about one-halfpenny per mile, which compares most favourably with that of petrol lorries or horse vans.

Electric power is also used for driving the incubator fans, for the threshing, cleaning and grading of cereals, and for sheep-shearing and horse-clipping. Owing to the adequate supply of water under pressure which already exists, electric water pumping is not employed. On many farms, however, this would prove

a very useful and necessary application of electric power. The superiority of electricity for this purpose is well shown by the fact that in Denmark (which is a country of windmills) electric pumping is displacing wind pumping: the same thing is also happening in Holland. It is found that the electric motor is much more reliable, and pumps when it is needed to do so.

In order to show clearly what can be done for the expenditure of one unit* of electricity, in terms of farm work, the following table has been prepared, based upon results actually obtained on the author's farm. One unit of electricity will perform any one of the following operations:—

Operation.	*Average time taken.*
Chaff 1,000 lb. of hay or straw	10 min.
Cut 6 tons of mangolds	60 „
Crush 22 bushels of oats	25 „
Grind 3½ bushels of corn	5 „
Milk 52 cows	35 „
Separate 260 gal. of milk	—
Churn and work 165 lb. of butter	60 „
Drive the fans of a 2240 egg incubator for 15 hours	—
Thresh 8 bushels of wheat	11 „

One unit of electricity will do the work stated irrespective of the time taken. Average times are given merely to emphasise the added advantage of rapid working which results from the adoption of electrical methods.

Apart from the advantages referred to above, the ease with which the electric motor can be started makes it particularly valuable for farm work. By simply closing a switch, without any physical exertion, the motor will start instantly and with certainty under all conditions.

The author advocates the use of individual electric motors for the more important machines. Where this is not considered possible it will be found that the use of a portable electric motor (for which the author has devised a very cheap and simple arrangement) will be preferable to the use of counter-shafting. It is supposed by many that the use of a single motor and a counter-shaft gives the most economical results. This view, however, is quite mistaken. At Greater Felcourt Farm the food-preparing machinery is at present driven from a counter-shaft (originally installed for an oil engine drive) driven by the electric

* One unit is 1,000 watts expended for one hour. Watts represent the product of volts by amperes. Thus 10 amps. on a 100-volt circuit gives 1,000 watts, and if used for one hour means a consumption of one unit. Similarly, 60 amps. taken for 10 min., from a 100 volt circuit represents 1 unit because it is 6,000 watts used for $\frac{1}{6}$ of an hour.

motor. Exact measurements (which of course are only possible where electricity is used) have proved that for every 6s. spent in useful work 5s. has to be wasted in useless effort merely in turning the shafting, belts, and loose pulleys. With electricity at 4d. per unit the yearly cost of the power wasted by the shafting is sufficient to buy a new electric motor of 3 to 4 h.p. capacity. Since the use of a counter-shaft increases the amount of current taken by one to four times that necessary for the useful load, the size of cables used in the wiring must be at least doubled. Again, if storage batteries are used to supply the load, their ampère-hour capacity must also be doubled. Not only is the cost of using electric power unnecessarily increased by the counter-shaft, but the capital cost of installing the plant is also much increased.

It is commonly supposed that the advantages of electricity can only be obtained by the large farmer, but the writer is convinced that this view is entirely wrong. While the big farmer uses electricity to supplement the efforts of his labourers, and thereby increase profits, the small-holder, who is usually unable to employ labour, stands in the greatest need of some simple means to increase his productive capacity. Electricity, properly applied, relieves the small-holder of much of the more monotonous work, leaving him free to concentrate on those things which require manual skill and knowledge. The first cost of the electrical equipment is not great. Its earning capacity is much greater than that of any other part of the farm equipment. Every year small-holders quite cheerfully pay large sums for new types of poultry houses and similar plant, in the hope of obtaining increased returns. It is very probable that by making their old houses weather-proof, and installing electric light, they would secure much greater returns at a much lower cost.

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WHEAT PRICES AND RAINFALL.

It is obvious that crops are dependent upon the weather, and perhaps the most important question to which the farmer wants an answer is, "what will be the effect of the weather upon the harvest?" Of scarcely less importance to the farmer is the further question: "What is the weather going to be next year?" Students of the weather have for many years past been endeavouring, by analysis of past records, to find answers to these

questions, particularly by trying to find out whether abnormal temperature or rainfall recurs at regular intervals; *i.e.*, whether there is a regular sequence of weather, or *cycle*, as it is called.

Various astronomers and meteorologists have in recent years thus discovered cycles, some of which may now be regarded as well established. Of those that may conceivably produce a direct or indirect effect upon our crops the two best known are probably the sun-spot cycle and the Brückner cycle. It has for long been known that the number of spots occurring on the sun varies in a regular manner, a maximum and minimum occurring at intervals of about 11 years; also that certain terrestrial phenomena are influenced in the same way, indicating that sun-spots affect the conditions on the earth, or perhaps it should be said that both are due to the same cause. Dr. Brückner found some thirty years ago that a period of relatively warm and dry years recurred on the Continent about every 35 years, and similarly that the intervening years tended to be wet and cold. Although we are altogether in the dark as to the causes of such fluctuations in the weather, their influence must nevertheless make itself felt upon the growth of vegetation, and thus it becomes a very important matter to detect them.

It is conceivable that the weather of different parts of the earth may be differently affected by a large number of cycles, each of them due, maybe, to different causes. This makes it exceedingly difficult to discover any regular sequence in the weather or in the produce of agriculture by mere inspection of records. Since the periods of these cycles are not of the same duration, their beneficial or harmful influence does not recur at the same moment of time: it will thus happen that the maximum effect of one cycle will sometimes coincide with an opposite effect of some of the other cycles, and so its effect may be nullified. It is therefore only when the maximum or minimum effects of several influential cycles coincide in point of time, that their combined result will show itself in a big crop or severe shortage; and this can only be expected to recur at comparatively long intervals. Agricultural records have not been kept for a sufficient number of years to exhibit a sequence of good or bad harvests that can be relied on as a guide to the future, as an event known to have recurred only three or four times cannot be accepted as sufficient evidence of a regular cycle.

There is, however, one class of observations that is sufficiently long to be of use for this purpose, and that is the price of wheat,

of which records exist, in more or less complete form, for nearly 400 years, for a large number of places in western Europe. Now it is well known that, at least before the development of an overseas trade in corn, the price at a given locality was high when the harvest in that neighbourhood was scanty, and low when the crop was abundant. Sir William Beveridge has examined these data, and being struck by the appearance at regular intervals of abnormally high prices—which may be assumed to follow immediately on bad harvests—has conducted an exhaustive investigation into the whole material.*

Now although it is simple enough to combine several cycles to form, so to speak, one compound cycle, and find out when their cumulative influence is greatest or least, it is not so easy to decompose the resultant compound cycle, which is all that we have to work upon. Yet there are mathematical processes which enable us to unravel the threads and disentangle the constituent cycles. The arithmetical calculations are very heavy, but by the use of methods known as "harmonic analysis" and the "periodogram," Sir William Beveridge has succeeded in detecting a large number of cycles. He finds, in fact, no less than 19 (possibly there may be more), with periods of revolution ranging from $2\frac{3}{4}$ to 68 years. The probability of their real existence is in a large number of cases confirmed by the periods agreeing, with quite reasonable accuracy, with cycles detected by various meteorologists.

The most striking of these cycles, *i.e.*, the one emerging most prominently from the calculations, is one of about 15 years; and it is the more remarkable because an independent period of this duration is not known to meteorologists. Sir William Beveridge suggests, however, that it may be really a combination of shorter cycles, the maximum intensity of all of which would coincide about every fifteenth or every thirtieth year.

He also finds a cycle of 11 years, corresponding to the sun-spot cycle. This one, however, does not persist throughout the whole 300 years, and the author thinks that the real period (also emerging from his calculations) is one of not quite $5\frac{1}{2}$ years, or almost half 11. A cycle found with a period of $35\frac{1}{2}$ years also corresponds well with that discovered by Brückner as causing a regular alternation of dry, warm periods with wet, cold ones.

Sufficient records do not exist to enable the author to use data prior to 1550, but the records of historical famines show that

* "Wheat Prices and Rainfall in Western Europe," a paper read before the Royal Statistical Society on 25th April, 1922. This is in substance a sequel to an article by the same author on "Weather and Harvest Cycles," in the *Economic Journal* for December, 1921.

most of these occurred at dates which might be calculated by carrying back some of the cycles found.

The material actually used covers only the three centuries 1550 to 1850, the later years being entirely ignored in the investigation, for the reason indicated above, viz., that European prices of wheat since then (or at least since 1870) depend far more upon the harvests of the entire world than of the locality where the price is paid, and thus—as cycles probably affect different parts of the world differently — high prices would not necessarily indicate scarcity in western Europe. This precaution enables him to test the continuance of the phenomena since 1850, as well as their utility for prophecy, by comparing a calculated curve with actual results. He accordingly adds together the theoretical effects of the eleven best established cycles in each year, and constructs a "synthetic" curve—as he calls it—of wheat prices. Upon the assumption that, if we are looking for a single factor which is uniformly adverse to a good harvest, we shall get nearest to finding it in rainfall, the "synthetic" curve between 1850 and 1920 is compared with the curve of rainfall in western Europe during the same years, and the main peaks in the two are seen to correspond very closely.

Reference may be made to the deduction drawn by Sir William Beveridge some year or two ago as to the probability of heavy rain and bad harvests in 1923. This was taken by many people as a prophecy, but his later inquiries do not lead to the same conclusion as to the general meteorological condition of the near future, and such an interpretation is now to be regarded as withdrawn. He fully believes that trustworthy prophecy of the weather will, in due course, become possible, but that it is not yet possible on the facts as he has given them. Prophecy will become possible, if at all, only after detailed investigation has shown the nature, shape, relative importance, and, above all, local variations of each cycle. At present little more can be said than that such cycles exist and are noticeable as periodic changes in the rainfall. As his examination shows, these cycles do not necessarily persist indefinitely: many of them have persisted for centuries, but others have died away, or their periods have become modified. Such considerations render it dangerous to forecast the weather of any given year; and, in fact, the "synthetic" curve above referred to shows several discrepancies in certain years with the actual rainfall records, although

the most prominent peaks duly appear in both. While, therefore, the results obtained up to the present make it risky to assert that, because there was a particularly bad harvest in a certain year, there will be another bad one fifteen, or thirty, years later, continued investigations on the same lines should result in our being able to make such prophecies with a more reasonable expectation of their fulfilment.

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TRIALS OF NEW VARIETIES OF CEREALS.

PART I.

E. S. BEAVEN,
Member of Council, National Institute of Agricultural Botany.

THE paper deals generally with the subject of Variety Trials of cereals and specially with the methods which have been used by the writer with a view to securing comparative accuracy in the results of field tests of new varieties.

Terminology.—Wheat, barley and oats have each been divided by systematic botanists into several "species" and "sub-species," and each of these again into a greater or less number of "varieties." The number of varieties recognised 20 years ago was about 200 for the three cereals together. The number has now been greatly increased by the artificial production of hybrids. Varieties are again divided into "sub-varieties," "strains," "sorts" or "forms," signifying aggregates differing in respect of either minor structural characters or characters not always discernible to the eye but often of agricultural value, as, for instance, length of growing period, hardiness, stiffness of straw, root-range, ratio of grain to straw, disease resistance, etc.

It will be convenient to use some one word for the aggregates which are dealt with in variety trials. New productions are generally aggregates of plants the individuals of which have a common ancestry, and in variety trials we are concerned only with the inherited characters of the aggregates. The most descriptive term to apply to any aggregate under trial therefore appears to be *race*.

Some aggregates originating from selected individual plants having a hybrid ancestry, although apparently uniform in all their inherited characters, ultimately prove to be more or less variable. This fact must be recognised in interpreting results of variety trials but is too complex for discussion in this Paper.

Racial Characters.—The most valuable characters of any cereal race are those which affect its relative *productivity* in respect of grain as compared with other races of the same species. The measure of productivity is the weight of dry grain harvested and threshed from some unit of area.

Next in value to the grower is the *quality* of the grain in relation to the purpose for which it is most likely to be used.

Morphological or physiological characters and combinations of characters of any kind will be of value in proportion as they contribute to yield or to quality. The quantity and quality of the *straw* as feeding material or for other uses must also be taken into account.

From the above it is evident that variety trials of cereals are complex affairs. Moreover, the problem has many limitations and is beset by difficulties and sources of error especially in estimates of productivity, both in execution and in the interpretation of the results obtained. It is desirable to set forth some of these limitations and difficulties before describing in detail the methods which have been designed to deal with the problems involved.

Limitations of Yield Testing.—It is very improbable that with our present knowledge any new race of cereal will be produced which will give a higher yield of grain per acre than any and every already existing race of the same species under every condition of soil, season and cultivation. The same applies, although perhaps to a less extent, to quality of grain. The problem of the plant breeder is that of adaptation of the plant to external conditions, and all that can be expected from him is that he will produce new races better adapted to definite sets of external conditions than existing races in average seasons and under the best methods of cultivation.

In Great Britain there are no wide areas of uniform soil. The "lay of the land" and the dip of the strata combine to make uniformity impossible. There are doubtless many farms of 500 acres in Great Britain on which the soil is so variable that no one race of any species of agricultural plant is the best race for all parts of the farm. This may seem a hard saying, but let any critic try to find two adjacent pastures showing equal pro-

portions of different races of grasses. This results from the combined effects of artificial and natural selection and of adaptation, and there is no apparent reason why cereal races should not show a similar range of adaptability.

The plant breeder is limited in the early stages of the production of new races by the type of soil of his breeding plots and by the average climatic conditions of his station. The comparative yields and qualities of a particular race obtained at a station in the West of England, say on the upper greensand with an average rainfall of 36 in., may be quite different from those obtained, say on the "boulder clays" of East Anglia with a 24 in. rainfall. It therefore does not necessarily follow that the plant breeder's original determinations of relative productivity, however correct for his own conditions, will always be applicable to other localities.

Seasonal effects, even in a limited area, are very diverse. These together with the necessarily variable methods of manuring, crop rotation, and tillage may suit one race of a species better than another. Moreover, in some localities a quick-growing race may be necessary in the average of a series of years, as for instance the quickly maturing "Scotch Common" barley in Aberdeenshire. As a general rule, the more slowly maturing races will be the most productive, but superior yield may have to be sacrificed, if in, say one season out of three, there is a chance that the crop would fail to ripen.

It follows that all that can usefully be accomplished in any one year in the way of variety testing is to make accurate comparisons of races in respect of respective economic value, taking both quantity and quality into account, at different stations, selected for typical differences both of soil and of average climatic conditions.

Is the task of the cereal breeder then a hopeless one? Is an organization for testing new cereal races equally hopeless? It is by no means necessary to accept "counsels of despair," but in interpreting results of trials it is necessary to keep fully in mind the limitations and qualifications set forth above. These ar ein fact instinctively present to the minds of most growers, and it is because the practical farmer is aware of them that he frequently pays scant respect to variety trials and prefers to rely on his own experiences.

If it were desired to obtain systematic knowledge of the suitability of existing races to localities, no better plan could be adopted than for some representative body, like the Farmers'

Union, to organise a voluntary census of yields of varieties of cereals in different districts on the same principle and with similar objects as in the collection of milk records.

In the case of new races, however, the prospective grower will always have to rely on the experience and testimony of those who produce, multiply and distribute the original stock. He must expect to pay for this in the form of a high price for a few bushels of seed, which is all that he needs at the start in order to stock his farm within a few years, and even so he will sometimes be disappointed and find that the new race does not suit his land. On the other hand, if he gets a substantially increased return, due either to yield or to quality, or still better to both, the increase may easily be equal to the rent of the land and he may make much more than this for a few years by the sale of some of his produce for seed.

Now the position of the plant breeder is that unless he is very lucky the cost of producing a new race which appears to have some definite advantage in its favour is many hundreds of pounds, quite apart from any systematic series of field trials such as have now been inaugurated by the National Institute of Agricultural Botany, and if he proceeds at his own cost to field trials in different localities one of two things happens—either the new race gets into other hands than his and he gets no return, or he must establish an extensive organization for both multiplication and control. In the latter case he runs the risk of having to incur these costs and then find that his new race is after all "not good enough"—in which case it ought to be "scrapped," because the spreading of inferior races is a disservice to agriculture.

The above appear to the writer to be considerations which justify the efforts of the National Institute of Agricultural Botany to organise a system of variety trials for new races in the joint interest of plant breeders and purchasers of seed-corn, and generally in the interest of increased production of grain in the country.

Does what has been said above make it necessary to test great numbers of new races in a great number of localities and over a long series of years? It certainly shows the need for more systematic methods than have hitherto been adopted; but there are some comforting considerations. It is becoming evident that there are some valuable racial qualities, the presence or absence of which can be demonstrated by plant breeders themselves in a few years in one or a few localities on small areas, and which

may reasonably be expected to hold good under a wide range of external conditions. Illustrations may be given both with regard to yield and quality.

1. It is fairly clear that a race with a long growing period is likely to give a better yield than one with a short growing period, and therefore it is probably desirable to select for any locality a race with as long a growing period as the ordinary climate and farming conditions of that locality permit.*

2. The writer has shown that with some races of cereals (given complete ripening) a greater proportion of the total dry matter of the plant is accumulated in the grain than with others, and there is consequently a better proportion of grain to straw—an obvious advantage, because grain is more valuable than straw.†

3. Comparative "strength" in wheat appears to be quite definitely a racial character to a great extent independent of external conditions.‡

4. Immunity from certain diseases is also a racial character more or less independent of external conditions.§

The above are examples of characters which can be tested in the plant breeding stage. Further investigations of the factors of productivity and of quality together with elaborated nursery testing methods will probably tend to lessen the number of new races which are worth carrying forward to the stage of variety testing in the field.

Whatever may be the improved characters which the plant breeder has aimed at and hopes that he has obtained, the first essential in systematic comparisons on the field scale is that each comparison shall be, as far as is reasonably and practically possible, free from errors of experiment, and the next essential is that some reliable estimate should be made of the probable extent of the errors that are unavoidable. Unless these conditions are fulfilled it is not possible to proceed with any advantage to that interpretation of the results which will still be necessary and which should accompany the publication of them, if they are to be of service to future growers.

Errors of Experiment.—It is admitted that every separate field experiment is subject to unavoidable errors. If in a comparison of yields on different plots at any station in the same year the errors of experiment exceed the observed differences between the yields of the races under comparison, the results of that particular trial are valueless as yield trials. In variety

* Pedigree Seed Corn. Beaven. *Jnl. Royal Agr. Soc. of England.* Vol. 70, 1909.

† Breeding Cereals for Increased Production. Beaven. *Jnl. Farmers' Club*, Nov., 1920.

‡ Inheritance of Strength in Wheat. Biffen. *Jnl. Agr. Science*, iii, 86, 1908.

§ Inheritance of Disease Resistance. Biffen. *Jnl. Agr. Science*, ii, 109, 1907; iv, 421, 1912.

trials as hitherto carried out, the *probable errors** of the weights of grain have often been greater than the observed differences. Also, unfortunately, the existence of these probable errors has generally been ignored in published reports. Sufficient evidence of the universality and extent of probable errors in field trials may be found in the publications of (1) Wood and Stratton*; (2) Mercer and Hall†; (3) of the present writer.‡ It may at least be partly due to ineffective methods employed in variety trials and to consequent misleading reports of them in the past, that there has been so little increase in the average yields of cereals in Great Britain; for according to agricultural statistics the average yields of grain in Great Britain are still only about the same as they were 40 years ago. This record compares badly with what has been done with other agricultural plants and still worse with that of the horticulturists. The marked improvement in barley yields in Ireland is, however, an example of success directly due to systematic yield trials.

It has sometimes been tacitly assumed that if a set of trials of the same varieties are carried out at a number of different stations on different soils, the average results obtained give figures which are more useful than those obtained at any one station. If, as rarely happens, one variety gives better results than all the others at a number of stations there is no doubt a probability that it would have given comparatively good results under still other sets of conditions in the same season. What generally happens is that the order of merit varies at different stations in the same season and in different seasons at the same station. For this reason the averaging of results obtained at a number of stations, whilst useful, is at best of limited value. For example:—It is not of much use to a grower in Norfolk to be told that a certain variety of wheat grown in, say, Shropshire or even at several other stations, has given comparatively high yields if the external conditions at all the stations are different from his own.

Errors of experiment in variety trials are of two orders:—(1) Systematic, and generally avoidable; (2) Casual, and not generally avoidable. To the first class belong:—

* For the use and meaning of the term "probable error" as applied to agricultural experiments see "Interpretation of Experimental Results" by Wood and Stratton, *Jnl. Agr. Science*, Dec., 1910, also Supplement to *Jour. of the Board of Agriculture*, Nov., 1911.

† Experimental Error of Field Trials. *Jnl. of Agr. Science*, Vol. 4, Part II, Oct., 1911.

‡ Breeding Cereals for Increased Production. *Jnl. Farmers' Club*, Nov., 1920.

Character of Seed.—A necessary precaution which has often been neglected in variety trials is to make sure that the parcels of seed of the different races under comparison are equally representative. Very considerable differences in yield arise from differences in the physical, germinative, and other non-racial characters of the parcels of seed sown. These should not be neglected, just as for other reasons in a variety trial of potatoes we should not think of comparing Scotch grown "Arran Chief" with Fen grown "Up-to-date."

The function of a seed, as of a tuber, is to give the individual plant a start. Much depends on a good start, and varieties should not be irregularly handicapped in this respect.

The only practicable method of eliminating this probable source of error is to use seed of all the races under trial which has been grown and harvested the previous year under uniform conditions, and in case there is any substantial difference in moisture content it would be preferable that all the parcels of seed should be kiln-dried to an equal moisture content.

A very good parcel of seed of an inferior race of a cereal will sometimes give a better crop than an inferior parcel of seed of a better race, but there is no evidence that this accidental quality of the seed would be transmitted to the next generation.

Admixtures.—Another systematic error arises if any substantial admixture occurs in the seed of any race under trial. A very small percentage of admixture may be regarded as negligible. One per cent. of "rogues," if of an obviously different race of the same species will show quite forcibly when the crop is ripe, but if the "rogue" plants are only 10 per cent. less or more prolific than the rest, the difference in yield due to them will only amount to one-tenth of 1 per cent., which is negligible. If, however, the crop is to be used for sowing again, even such a percentage is very undesirable.

Casual Sources of Errors.—These are very numerous. They include soil variations due to a multitude of causes and extending over large or small areas, such as those due to previous cropping and manuring, soil bacteria, etc.; variations in sub-soil and in natural or artificial drainage; contour variations, such as slopes or furrows; irregular shading or uneven exposure to wind; patches of weeds of all sizes; inroads of insects, vermin, birds, etc., in patches. It is quite impossible to exclude these sources of casual errors and they may occur in either small or large patches. Their occurrence may be regarded as chance events and they may be all lumped together, because there is only one

way of discounting them, viz., to arrange and multiply the plots of each race at each station in such a manner as to give an approximately even chance of getting the same proportion of good and bad patches, and at the same time to keep the races to be compared as close together as possible in order to secure general similarity of soil conditions.

On account of these unavoidable casual errors the yields of cereals cannot at present be compared with the accuracy obtainable in physical experiments in the laboratory. With the help of the statistician, however, we may make steady approaches in this direction. The value of reliable results when they can be obtained is sufficiently great to justify the attempt.

Probable Error of Yield Trials.—Every farmer knows that he cannot obtain a fair sample of the grain threshed from a stack by taking a handful out of one bag. Neither is it possible to find the yielding capacity of a parcel of seed by sowing it on any one patch of ground, large or small. Still less is it possible to estimate the difference in the yielding capacity of two parcels of seed by sowing each of them on a single plot, even if the plots are side by side. To obtain sound comparisons, at any one station, it is necessary to average the results of a number of plots of each race. Having done this, if we have excluded systematic errors, we can calculate, by an arithmetical device based on the laws of probability applicable to chance events, the probable error* of the average result. Obviously the probable error of an average is likely to be less than that of any one plot, and the greater the number of plots the smaller is likely to be the probable error of the average.

Briefly stated, probable error is an average error computed in a particular manner in order to afford a measure of the unreliability attaching to any average of results by reason of the operation of chance conditions.

The degree of unreliability indicated by any probable error depends on the size of the probable error in proportion to the quantity to which it refers. For instance:—If the probable error of a difference between two averages of say 5 per cent. is as much as 3 per cent. it is an indication that the difference of 5 per cent. is one that might easily be due to chance conditions. If, however, the probable error of the same difference is only 1 per cent. it would be extremely improbable that such a difference (5 per cent.) arose entirely from chance conditions. If in com-

* For a full discussion of the theory involved see "An Introduction to the Theory of Statistics" by C. Udny Yule. 5th Edition.

paring the produce of a series of "control" plots of an established race "C" with a corresponding series of a new race "A" the result was:—

"C" = 100. "A" = 105 ± 1·0 per cent.

(where ± 1.0 stands for the calculated probable error as a percentage of "C") we could be practically certain that the difference in favour of "A" was not a chance occurrence.

The following may be taken as a rough standard of the reliability of any comparison such as we are considering:—If an observed difference between two averages, each of a considerable number of cases, is more than four times the probable error of the difference, the difference may be regarded as *significant* in the sense that it is extremely unlikely to have arisen from the operation of chance events.

Since it is useless to expect a very rapid rate of advance in the yield of cereals from the breeding of new races, and since it is highly desirable that published conclusions should have a high degree of reliability, a "fine sieve" is required through which to sift results of yield trials. It is therefore suggested that a probable error of 1 per cent. or less in weight of grain should be aimed at in the difference between any two races at any station in any one year.

Before considering whether there is any practical arrangement of plots which will give this degree of accuracy it will be as well to see how this compares with the kind of results at present obtained in field trials. Before doing so it will be instructive to refer briefly to the probable errors which occur in the plant breeding stage.

The plant breeder usually proceeds year by year somewhat as follows:—

1. *Single plants of different races with equal soil space per plant.* The writer finds that with 12 sq. in. soil space per plant, and with all the plants of the same race and comparing adjoining plants the differences run from zero up to a quite indefinite maximum; the probable error of the percentage difference is somewhere about 80 per cent. of the average weight of two adjoining plants. A difference of 300 per cent. between two adjoining plants is therefore not conclusive evidence of any racial difference, but may be due to conditions external to the plant. The probable error is much greater even than this for single plants under field conditions with necessarily wide differences in soil space per plant. It follows, although the argument cannot be developed here, that it is practically impossible to select single plants for racial productivity. Incidentally also it shows the great difficulty, if not impossibility, of adapting pot-culture methods to estimates of productivity, except in respect of very great differences.

2. *Rows of* 12 *plants with equal soil space per plant.* The probable error of the difference between two averages of say 12 *row* weights is likely to be

about 10 per cent., and comparisons at this stage may afford the plant breeder some slight but very uncertain indication of racial productivity.

3. *A chessboard of plots—each planted with the same number of seeds with equal soil space per seed.* This method has been followed by the writer since 1910 in nursery cultivations at Warminster, and has been adopted also by the Irish Department of Agriculture and the Cambridge Plant-breeding Station.

Where the plots are 16 sq. ft. at seeding time reduced to 9 sq. ft. for harvesting by eliminating margins; the plot of each race repeated 20 times (giving about 2,000 plants of each race); the whole area protected from birds; the produce of each plot weighed; the water-content determined and the dry weight computed; the probable error of the difference between the total dry weights of any two races is found to be about 4 per cent. By this method eight different races can be compared to this degree of accuracy on less than ten perches of ground, when half a pound of seed of each race is available. Estimates of comparative yield based on these nursery chessboards are generally, but not always quite closely, confirmed by field trials of the same races on similar soils in the same season. The results obtained on 12 such chessboards since 1910 are now being summarised for publication. This method undoubtedly provides a means of sifting out those races which are worth carrying on to the field trial stage.

Proceeding now to systematic attempts to estimate the magnitude of the probable error to be expected in field trials, Wood and Stratton, in the paper already referred to, from a very large number of published results estimate that the probable error of single plots of any size over 1/40th of an acre is generally about 5 per cent. of the produce of the plot. This gives a probable error of 7 per cent. as that which may be expected when comparing any two adjacent single plots.

This is fully confirmed by Mercer and Hall in the paper already referred to, and in addition there is described in this paper the most elaborate experiment of which there is any record in this country with the object of determining the number of plots required to be averaged to produce a prescribed probable error.

An acre of wheat of one variety selected for apparent uniformity was divided at harvest into 500 equal rectangular plots and the grain and straw from each plot was weighed. This was a great undertaking—only possible at such a station as Rothamsted. The mass of figures was very thoroughly investigated on statistical lines, not only by Mercer and Hall, but also by "Student" in an Appendix in which a still more elaborate statistical method was devised and shown quite clearly to lead to a further reduction in the probable error.

In this experiment the actual difference in the weight of grain between the two half-acres on the east and west of the acre was 8.3 per cent. If, therefore, this acre of ground had been used for a trial of *two* varieties—one single half-acre on the east and one single half-acre on the west side—there would obviously

have been an actual error of about 8.3 per cent. in the comparison between the two races due, not to racial characters, but to soil and other conditions external to the plant. In other words, the experiment would have been (as most variety trials in the past have been) a combined trial of soil fertility and race productivity, and it would have been impossible to disentangle the two. When, however, comparison was made of the weights grown on the 250 pairs of adjacent plots, it was found that the probable error of the average difference between all adjacent plots taken in pairs was reduced to less than half of 1 per cent. If therefore 250 plots of each of *two* races had been planted in alternating strips of plots across the field, it may be assumed that whatever was the difference in the total weight of grain of the two races, the probable error of this difference due to soil conditions would have been only about half of 1 per cent. and that if the actual difference amounted to 2 per cent., viz., four times the probable error, it might safely have been regarded as significant.

It becomes a problem in statistical inference to estimate the number of comparisons necessary with plots of any specified area in order that the probable error under any fairly normal external conditions shall not exceed, say, 1 per cent., and also to find the best way of splitting up any available area into such plots.

Consideration of the above results, and more especially of the contribution by "Student," suggested to the writer a method of yield testing for barley which after some early preliminary experiments was commenced at Warminster in 1920 for field tests of two different races.

The method appears after two years' full trial to be practical, and also economical of area, and furthermore to be adapted to reduce the probable error of yield trials of cereals to a very small percentage of the observed weight of the crop.

This method may be called the "half-drill-strip" method and will be described in Part II of this paper with a summary of the results so far obtained. It is in course of trial by the National Institute of Agricultural Botany this year for oats and barley. Whilst it presents distinct advantages there are still difficulties to overcome and it can probably be further improved on.

(To be concluded.)

THE REVIVAL OF VILLAGE INDUSTRIES:

THE WORK OF THE RURAL INDUSTRIES INTELLIGENCE BUREAU.

MAJOR L. SHOETEN SACK, O.B.E.

THE decline of rural non-agricultural industries as an important factor in the economic life of this country dates from the introduction of machinery. With the gradual supersession of handicraft by mechanical means of production, there began a steady transfer of nearly every form of manufacture to the towns, with a consequent withdrawal from the countryside to the urban areas of the workers required to man the newly erected town factories.

The tendency continued unceasingly until the centralization in towns of every form of factory and workshop came to be regarded as the natural direction of all industrial development. The countryside was considered as being suited only to agricultural work, and the towns claimed control of all manufacturing industries, even of those where the element of handicraft continued to predominate over the partial mechanical processes.

As a result of this policy, the break up of the hitherto prosperous village industries was as inevitable as the steady depopulation of the countryside. To-day, with isolated exceptions, the few rural industries which have survived are carrying on a precarious and languishing existence. Too frequently they are managed by enthusiastic but insufficiently experienced amateurs; often their policy is directed by local sentiment rather than by business principles; usually they are out of touch with the rapidly changing market conditions and are, therefore, unable to face the keen competition of their urban competitors.

The outcome of the social revolution consequent on the introduction of machinery has, therefore, been (*a*) to depopulate the countryside to such an extent that at present only 15 per cent. of the working population are country dwellers, and (*b*) to make the livelihood of even that proportion dependent almost solely on agricultural work by withdrawing the stabilizing effect of a successful non-agricultural industry suited to local conditions and seasons.

In most continental countries, the retention of profitably worked village industries has been encouraged by carefully planned schemes of Government action, having for their object

the relatively even distribution of population and industries throughout the country. Germany, more than any other continental country, has worked out its distribution of industrial activities on a considered plan, but other countries have not neglected the problem; for example, the French rural industries employ more than $1\frac{1}{2}$ million persons, and in Switzerland the prosperity of rural industries is closely associated with agricultural life.

So disproportionate has the rural population of this country become and so serious is its threatened effect on agriculture, that the problem of improving the conditions of life of the rural worker has for several years received the serious thought of the Government and of leading agriculturists and economists. The more closely the matter is explored, the more definite appears the conclusion that the revival of rural industries must form an essential factor in the stabilizing and revitalizing of the countryside.

Already in pre-war days the rural worker was being influenced to a larger and broader outlook on life by improved education and the more frequent reading of the daily press. The War has here, as in so many other directions, had a decisive effect. The rural soldier returned to his village with new experiences and greater ambitions and his ideas rapidly spread to his fellow inhabitants. The countryman now demands for himself and his family greater security and wider prospects for the future than the exclusive dependence on agriculture can offer. Disregarding even the seasonal nature of much agricultural work, the farm worker can gain a livelihood only when he is strong and able-bodied. Purely agricultural work offers but rare chances of employment to his wife, to any of his children whose health is failing or to himself should he become physically weakened. Inevitably, therefore, the more progressive villagers are attracted to the towns where the greater variety of openings seems to offer a better future for himself and his family.

Again, on grounds of high economic policy, it is desirable that the continued centralization of all industries in the towns should be checked and that a process of decentralization should be begun by transferring to the countryside some of those industries which are still largely dependent on handiwork and in which the use of modern mechanical processes is subsidiary. The increasing congestion in towns is clearly undesirable on social grounds. But further, in many industries cheaper production should result owing to the reduction of numerous "overhead" charges which are frequently much inflated in towns.

The importance of rural industries in meeting the pressing problem of the disabled soldier cannot be overlooked. There are probably 100,000 or more ex-soldiers whose state of health unfits them both for the conditions of work in town factories and for the arduous routine of the agricultural labourer. To such men, capable often of only part time work, the village workshop seems to offer the employment most likely to encourage their ultimate return to health.

The pressing importance of these and other aspects of rural industries development had for some time engaged the attention of the Development Commissioners. After calling for expert reports on the matter and thoroughly exploring the whole subject, the Commissioners approached the Treasury for a grant to enable some central organization to be established with a view to providing a recognized centre for the distribution of authoritative advice and reliable data affecting the revival or establishment of rural industries. The Treasury sanctioned the grant, and accordingly the "Rural Industries Intelligence Bureau"* was formed under a Trust Deed with the following trustees appointed by the Ministry of Agriculture:—Major-General Sir Gerard M. Heath, K.C.M.G., C.B., D.S.O.; Sir Charles McLeod; Sir Basil Mayhew, K.B.E., F.C.A.; Sir Douglas Newton, K.B.E., M.P.; The Hon. Edward G. Strutt, C.H.

The Committee has as its Chairman the Right Hon. Lord Ernle, P.C., M.V.O., and is composed of the trustees in association with representatives of the Board of Trade, the Ministry of Health, the Board of Education, the Ministry of Agriculture and Fisheries, the Ministry of Labour, the Board of Agriculture for Scotland, the Ministry of Pensions, the Forestry Commission, the Labour Party, the British Legion and all other interested associations.

The Director of the Bureau is Mr. E. Cecil Kny, who has devoted much time to a practical first-hand study of the rural industries in most European countries and combines with this intimate knowledge of rural organization a wide technical knowledge of the industries mainly affected.

The Bureau is thus controlled by a body equally representative of social interests and of technical and business experience. It is essentially an organization set up for practical purposes. The constitution of the Committee seems to indicate that in dealing with the many important questions that await settlement, the wider national outlook will be associated with the parochial

* 258/262, Westminster Bridge Road, S.E.1.

standpoint, and modern business methods will have due regard to practical local sentiment.

The primary purpose of the Bureau is to offer skilled advice to those who are engaged in, or contemplate, the establishment of commercially profitable rural industries. The following may be quoted as typical subjects on which the Bureau will be able to offer the considerable assistance of their wide investigations and complete reference data :—

(*a*) The revival of lapsed, and the extension of existing rural industries on sound economic lines.

(*b*) The economic possibilities of establishing, in any particular locality, industries hitherto carried on exclusively abroad.

(*c*) Commercial organization, *e.g.*, questions of costing, designing, training, and choice of processes.

(*d*) Market intelligence, including reports on home and foreign markets, freights, etc.

(*e*) The decentralization of urban industries which could be better carried out in rural areas.

The policy of the Bureau will not be restricted by any rigid rules or formulæ. It is recognized that no hard and fast system is suitable for, and still less can be imposed upon, every part of the country. Normally, it will rest with the local inhabitants to take the initiative by considering what form of industry is most suited to the particular local conditions, having regard to such considerations as the natural sources of power, the railway service, the facilities for obtaining the requisite raw materials, etc. The Bureau will where desired give preliminary advice as to the general principles which will probably be necessary to ensure the commercial success of any scheme; when the preliminary scheme has been worked out, the Bureau will be in a position to go into the commercial possibilities of the proposals more closely.

While the initial purpose of the Bureau is, as has been explained, to act as an expert adviser, it is recognized that in many cases the successful management of newly established industries may require further practical assistance in obtaining reliable material at reasonable prices and in securing a good market for the manufactured articles. In conjunction with the Bureau, therefore, a co-operative trading society, known as the Country Industries Co-operative Society, has been established also at 258/262, Westminster Bridge Road. The working scheme of this Society will be explained in an article in a later issue of this *Journal*.

THE LINCOLNSHIRE CURLY COATED PIG.

SANDERS SPENCER.

THERE appears to be little doubt as to the locality in which the Lincolnshire Curly Coated Pig originated, since in no other county than Lincolnshire is there found a breed of pig of a similar type and character. It is true that some forty or fifty years ago there was to be found in County Cork an occasional pig with very curly hair, but this was of quite a different character to the curly hair of the Lincolnshire pig as it was much softer and more like wool than hair. Further, the County Cork type of pig did not seem to possess that robust constitution which is so characteristic of the Lincolnshire pig. It had more the appearance of a pig which had been so interbred as to lose its constitution and which had entered on its last stage. The subject of these notes is in every respect the exact opposite, as it certainly appears to have been vastly improved, not only in constitution but in form and substance since classes for the breed were included in the prize schedule of the county agricultural society. The writer's first experience of the North Lincolnshire pig was in the fifties of the past century when the curliness of the hair was not so generally noticeable, nor did the pigs of that period possess in so marked a degree the quality of early maturity. Then, as now, the sows were prolific and good mothers, whilst the pigs were very hardy, but they required to be of considerable age before they responded readily to the fattening process. This resulted in fat pigs of a size and degree of fatness which would not find favour in the eye of the consumer of the present day, even in Lincolnshire where the average fat pig killed for consumption on the farm would scarcely pass muster at any market outside the particular county.

The probable reason for the very heavy and fat type of pig finding favour in the county of Lincoln was that, in the northern part of the county especially, a considerable proportion of the horsemen, cattle men, and shepherds used to live in the farm houses or in the houses of the ground keepers or foremen, the latter receiving from the farmer a certain weight of bacon annually in part payment of the cost of keep of the men. Both in the farm house and in the ground keeper's house bacon formed the chief meat consumed by the men, whose appetites had not been pampered, so that they made no objection to fat bacon made

FIG. 1.—Lincolnshire Curly-Coated Boar.

FIG. 2.—Lincolnshire Curly-Coated Sow.

from old and matured pigs which was neither so delicate in flavour nor so tender as is the most highly priced bacon of to-day. It has, however, the desired qualities of satisfying at little cost the appetites of the men and of enabling them to perform their somewhat arduous duties on the farm, or in other words, the Lincolnshire Curly Coated pig has been most successfully bred to meet the requirements of the farmer. It fulfils in the most complete manner its duty of supplying at a fair cost a large carcass of fat pork within a reasonable time. Indeed we think that its breeders are justified in making the claim that no other breed is more suitable, if so suitable, for the special purpose for which the curly coated pig is mainly kept.

It might not be so great a favourite when transported from its native county to the southern portion of this country, but there can be no doubt that a considerable proportion of the common country pigs would be more readily fattened and at less cost did they possess an infusion of the blood of the curly coated pig.

The vast improvement in the Lincolnshire pig which has taken place during the last half-century may have had its influence on the system of pig keeping in the county. In the olden time the fatted pig would be a year and a half to two years old and not infrequently it would also be a young sow which had reared one litter of pigs, as the far too common practice was to utilize the extended growing period of the female pig by breeding a litter from the young sow and then fattening her. The quality of the resultant pork would suffer somewhat, but this was not considered to be of any great importance owing to the absence of fastidiousness of taste in the general consumer. The farmer, however, handicapped himself very considerably in the improvement of his pig-breeding stock, as by fattening off the young sow after she had reared one litter of pigs, it was impossible to make a selection of the sows which were the best producers of large litters of those pigs which would grow and mature most quickly. A permanent and considerable improvement in any breed of live stock can only be assured by the continuous selection of those sires and dams whose produce most nearly approaches the standard of excellence of the breed. We believe also that the system of mating a young boar with gilts, then castrating and fattening the boar as soon as the gilts are in pig, has ceased to be followed to so great an extent as in former times. It is to be hoped that still further improvement may soon be carried out

by the complete discontinuance of these old practices, which are now followed only in the breeding of ordinary pigs on the farms.

The following is the official scale of points:—

Colour.—White.	
Face and Neck.—Medium length and wide between the eyes and ears	5
Ears.—Medium length and not too much over face	10
Jowl.—Heavy	3
Chest.—Wide and deep	3
Shoulders.—Wide	15
Back.—Long and level	10
Sides.—Deep, and ribs well sprung	10
Loin.—Broad	5
Quarters.—Long, wide and not drooping	5
Hams.—Large and well filled to hocks	15
Tail.—Thick and set high	3
Legs.—Short and straight	5
Belly and Flank.—Thick and well filled	3
Coat.—Fair quantity of curly or wavy hair	8
	100

Objections.—Narrow forehead, thin ears.

Disqualifications.—Pricked ears, dished or long nose, coarse, straight or bristly coat, any other colour of hair than white.

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HOP "CANKER" OR "GROWING-OFF."

E. S. SALMON and H. WORMALD,
Mycological Department, S.E. Agricultural College, Wye, Kent.

HOP "canker" has been known for the past thirty or forty years, if not longer. It is known generally in Kent, Sussex, Surrey, Hampshire, Herefordshire and Worcestershire as "canker,"* but in many districts of the Weald of Kent and of Sussex, farmers as well as foremen in the hop garden give the disease the descriptive name of "growing-off."

A short account of the disease was published in 1902 by Professor John Percival,† who wrote: "I have noticed examples as early as the end of June, but it is most frequently noticed later in the season, and in many cases the bine may remain connected as it were by a mere thread almost up to the time of hop-picking and then suddenly droop and die with its load of hops in an hour

* The present disease must not be confused with that occasionally caused by the grub, or caterpillar, of the Ghost Moth (*Hepialus humuli*), which lives underground and bores its way into the rootstock of the hop.

† Jour. S. E. Agric. College, XI, 87-89 (1902).

or two. On scraping away the soil, the lower end of the bine will be found completely severed from the parent plant."

The cause of the disease was attributed by Professor Percival to the fungus *Fusoma parasiticum*. During the past ten years the writers have had, from time to time, opportunities for studying the disease, and have been able to confirm the general conclusions arrived at by Professor Percival.

Description of the Disease.—Above ground the presence of the disease is indicated by a wilting of one or more bines at each affected "hill"; such bines are usually found to be almost severed at the base and easily come away from the rootstock with a slight pull, a condition which, as noted above, is sometimes described by growers as "growing-off" of the bines. This wilting of the bines is accompanied by a canker of the underground rootstock, the infected portions being brown and dead.

The basal parts of diseased bines which have been dead for some time often bear white pustules of a fungus, the conidia produced on these pustules being of the *Fusarium* type. Bines just beginning to wilt may not show these pustules, but usually the bark and even the wood is brown, and *mycelium* of a fungus is to be found in the brown tissues. In experiments where particles of such brown tissues were placed on sterilized culture-media, the fungus grew out and eventually gave rise to the *Fusarium* fructifications.

If the bines become infected but are not killed until late in the season, their bases become abnormally thickened, presumably owing to the accumulation of foodstuffs travelling downwards from the leaves and unable to reach the rootstock because of the partial severance of the tissues at the junction of bine and rootstock. These swollen bases become invaded by the fungus, which produces its fructifications at the surface. If the fungus is not fruiting at the time the hill is "cut" or "dressed," *Fusarium* fructifications almost invariably appear within a few days if the basal part of the bine—known as a "strap cut" when used for propagation—is kept in moist air.

A serious outbreak of the disease in a "Bramling" hop-garden came under the writers' notice in 1914, and the following notes on observations made there will serve to illustrate a typical case of hop-canker. Many hundreds of bines had been killed during the first three weeks of June of that year. By the end of the month the damage had almost ceased but the check was probably only a temporary one, as in previous infestations in the same hop-garden a certain further number of bines died

later in the season when bearing hops. Some of the diseased bines were quite detached from the rootstocks, and others showed various stages in the process of becoming separated. Many of the dead bines were found to be bearing *Fusarium* pustules when examined in the hop-garden; in some cases the pustules had developed while covered with two or three inches of soil. In very rare instances the separated bines were found to have produced tufted growths of adventitious roots, mostly from the nodes, in the region between the plane of separation and the surface of the soil.

It is noteworthy that this Bramling garden was on land which had not previously borne hops and the plants were only about four years old; the soil was loamy and certainly not to be described as a wet soil. In a few hills all the bines had been killed and only such hills were, in practice, grubbed up and destroyed. As a rule 1 to 3 out of the six bines trained up from a hill had been killed; such hills were not grubbed up.

A number of hills which had lost 1 or 2 bines during the summer were marked and examined in the following March, when it was found that in each case some or all of the remaining "straps" (bases of the bines) were diseased, a slight pull usually being sufficient to sever the connection with the rootstock; in one hill only were all the "straps" securely connected with the rootstock and, on cutting, it was found that two were sound throughout while the third showed a trace of decay on one side.

Where the straps were not wholly destroyed the decay in every case was at the lower end, the upper end being still alive and bearing young shoots. This indicates that the disease spreads from the crown of the rootstock into the straps. One such strap which was carefully examined showed a sharply marked margin at the upper limit of the diseased tissue which extended to about the middle of an internode, the lower node bearing dead buds, the upper living ones. The same sharp demarcation of the brown dead portion was also seen on cutting the "strap" longitudinally, and on making a microscopic examination fungus mycelium was found in the brown tissues up to one or two layers of cells from the sound tissues; mycelium was not found actually in the cells not discoloured. The mycelium present was proved to be that of the *Fusarium*.

It was the practice in this garden, at the time the hills were cut, to remove the straps almost immediately and burn them; at the time of the visit (March) this was being done, the

FIG. 1.—Hop-canker, showing "growing off" of bines (stems) from the rootstock: the one on the left is completely severed. Of the three bines attached to the rootstock, the one on the left is partly severed. The detached bine, from the same rootstock, shows how the fungus (pustules of which are evident at X) has eaten away the base of the stem, leaving only a tapering slender point of attachment. (*Nat. size.*)

FIG. 2.—Portion of crown of hill, showing the thickened bases of two bines. The fungus is seen at the lower end of the bine on the right. (*Nat. size.*

fire being at the side of the garden. However, a few straps from diseased hills had been left lying on the ground for about two days and on some of these there were pustules which proved to be the fructifications of the *Fusarium*, although none of the hills, as they were uncovered and examined that day, showed any pustules. It is evident therefore that if diseased portions of the plants are not destroyed immediately, but are left lying about in the hop-garden, they serve for the continued development and dissemination of the fungus. It seems probable that the fungus can remain alive even when the " strap cut " in which it is living becomes desiccated. Infected " strap cuts " from the hop-garden referred to above were brought into the laboratory in June and allowed to become air-dried at room temperature. In the following February they were moistened and placed on damp filter paper in a covered dish. Within four days mycelium had grown out and already conidia, in general resembling those seen on the freshly-killed straps but not produced in definite pustules, had developed. The rapid development of mycelium and fructifications suggests that the growth had arisen from internal mycelium rather than from chance conidia on the surface, but the experiment must be repeated under more controlled conditions for confirmation of this point.

In another case, the farmer has described the damage inflicted as follows :—" In some years, in my Rodmersham Golding hop-garden, I lose a small percentage of bines, which die off both in burr and in full hop. One season we had a most disastrous time —they were a wonderful looking crop, till they started dying both in burr and hop and continued to do so up to and through picking. I should say we lost about 30 per cent. of the crop."

In some cases " canker " may appear soon after the planting of the hops. A Worcestershire grower wrote in 1914 :—" I am sending you the enclosed hop roots. They were planted last year as yearling roots. You will notice that the body of the plant is going rotten. There are thousands of plants like them in the hopyard." The specimens sent bore the same fungus as found in other cases of hop-canker.

As will be inferred from the above accounts, hop " canker " is a sufficiently serious disease to cause appreciable damage. As a rule only a certain number of the " bines " on any one hill die off, and the whole plant—the " hill "—is not generally killed. Cases have occurred, however, where from 5 to 10 per cent. of the hills in a garden have been completely killed. Where the hops planted belong to a variety which is particularly suscep-

tible to "canker," a certain number of dead hills are almost invariably to be found.

Varieties Susceptible to "Canker."—Some varieties of hops appear to be more susceptible than others. In the Weald of Kent and Sussex, Bramlings and Tolhurst are severely attacked; Fuggles do not escape the disease, but the injury inflicted is not usually so great as in the above-noted varieties. In East Kent the variety Rodmersham (or Mercer's) Golding has proved particularly susceptible; Bramling to a less degree, while Cobbs and Old Golding are little affected.

In Worcestershire the Mathon White is very liable to the disease, and in Hampshire the Farnham Whitebine.

Influence of Soil Moisture.—While by no means confined to hop-gardens on heavy, wet soils, the disease does appear to be favoured by moist conditions. The general experience of hop-growers is that "canker" is worse in a wet season or following a wet winter. If there is a wet clayey patch in a garden, the "hills" are likely to be more severely attacked there than in the other part of the garden, and that side of a garden which gets least sun will frequently show the greater number of diseased hills. A grower in East Kent writes:—"My garden of Rodmersham Goldings which was so severely attacked by "canker" lay rather low and damp, and somewhat shaded from the early morning sun; the soil is a deep loam overlying brick earth. I grubbed this garden and it has not been replanted, but I planted up some Rodmersham Goldings in another garden which has a lighter and sharper soil, with a gravel and chalk subsoil. The plants do not crop so heavily but on the other hand we have much fewer losses by dead hills or dying off after the bines have reached the top wire."

The Fungus Causing the Disease.—The constant association of the *Fusarium* fungus with the disease, and the fact that this fungus can be directly isolated as a pure culture from tissues of the hop-plant bordering on the healthy parts supply strong presumptive evidence that the fungus is the cause of the disease.

Inoculation experiments carried out by the writers on hop sets, although not conclusive (owing to the fact that some of the control sets contracted the disease) give further evidence in the same direction.

Eight hop sets were inoculated with the fungus (by placing on the cut surface mycelium from a pure culture) and planted up in pots; all gave rise to diseased plants, six of them becoming

cankered and producing *Fusarium* pustules; the other two produced wilted bines but when examined no *Fusarium* pustules were present. Of the four "control sets," planted up at the same time but not inoculated, two also became infested with the *Fusarium;* the other two produced healthy shoots.

Preventive Measures.—*Direct.*—(1) In several cases hard "cutting," or "dressing," of all the hills in the affected part of the garden has been advised, and success has followed this treatment. All the browned part of the hill (rootstock) contiguous to the swollen or "cankered" bines should be pared away with a sharp knife. The experience of many observant hop growers has led them to believe that a thorough "cutting" or "dressing" of the hills is the best treatment for "canker."

(2) All dead hills in the garden should be grubbed up *and destroyed.*

(3) In the affected part of the hop-garden all the cuttings from the hills should be collected and destroyed when they are cut, as the fungus causing "canker" will develop on the swollen cut-off "straps," and may infect the cut surface of the plant in the hill.*

Indirect.—Drainage, or cultivation to remove the moisture of wet land, or letting in the sun, appears to have a favourable effect on keeping "canker" in check.

* * * * * *

COUNCIL OF AGRICULTURE FOR WALES.

THE half-yearly statutory meeting of the Council of Agriculture for Wales was held at the University College of Wales, Aberystwyth, on the 19th May, 1922, under the Chairmanship of Mr. W. S. Miller, who was re-elected to the Chair for the year 1922.

There was a representative gathering of members and the Minister of Agriculture and Fisheries (Lt.-Col. the Right Hon. Sir Arthur Griffith-Boscawen, M.P.), Mr. C. Bryner Jones, C.B.E., Welsh Secretary, and other Officers of the Ministry were present.

Address by the Minister.—The Minister gave a general review of the situation in regard to agriculture during the preceding six

* A farmer writes to us: "This year for the first time we are collecting and burning everything cut from the hill at 'dressing' time in the garden of Tolhursts that has 'canker' badly."

months, and, in the course of his remarks, referred to the anxious times through which the agricultural industry had been passing after the comparative prosperity of the war period. The situation was rendered more difficult as a result of the outbreak of foot-and-mouth disease, which was the severest visitation of the disease that this country had experienced since 1883. On the other hand, the reduction in the wages of agricultural labourers, which was inevitable having regard to the fall in the prices of agricultural produce, had afforded some compensation to the farmer. He expressed gratification over the fact that the necessary adjustment in wages had been made in a spirit of conciliation and goodwill, which was essential in order to ensure peace on the farm, without which it would not be possible to secure prosperity. The Ministry had, on its part, taken prompt measures to meet the Corn Claims, which, with the exception of those in regard to which queries had been raised, were all paid in the early part of January.

Dealing with the report of the Committee on National Expenditure, the Minister stated that he had been able to prevail upon the Government, in spite of the recommendations made by the Committee, to preserve the Live Stock Scheme, with the exception of the sections relating to Heavy and Light Horse Breeding. It had been found possible also to retain, in addition to the Grant of £850,000 provided under the Corn Production Acts (Repeal) Act for the promotion of agricultural development in England and Wales, the full provision already made for aiding agricultural education and research. He explained in detail the position as regards the proposed allocation of the fund of £850,000 to different services and emphasised the fact that no money would be allocated from the fund for the completion of schemes for the establishment of Farm Institutes pending a decision as to the amount required for research into animal diseases.

Proceeding, the Minister called attention to the benefits derived by the agricultural industry from the land drainage schemes adopted for the alleviation of unemployment and to the steps taken by the Ministry to secure a settlement of the difficulty as regards milk prices. Amongst other things he referred to the relief given to the farmer in the Budget that had been recently introduced, which provided for assessments under Schedule B for income tax purposes to be made in future on the basis of the annual value. In conclusion, while admitting that the rating question remained to be dealt with and that under the present

system the farming industry was undoubtedly over-rated, he expressed the hope that it would be possible in the near future to place the matter on a proper basis.

The Chairman proposed and Col. Curre seconded a vote of thanks to the Minister.

Importation of Store Cattle.—The question of the importation into this country of live store cattle from Canada was again considered and the following resolution, which is in the same terms as the resolution passed at the previous meeting of the Council, was, on the proposition of Mr. C. D. Thompson (Glamorgan), seconded by Mr. G. B. Bowen (Pembroke), carried *nem. con.*:—

> "That the Council of Agriculture for Wales strongly protests against any proposal to remove the present embargo on the importation of Canadian cattle, and calls upon the Ministry of Agriculture to take steps to ensure that the interests of the agriculturists of this country are safeguarded in this matter."

Report of Live Stock Committee.—In submitting the report of the Live Stock Committee, Mr. G. B. Bowen, Chairman of the Committee, called attention to the increased number of sires placed out under the Live Stock Scheme in Wales and Monmouthshire. Although the heavy horse grants had been discontinued, it was particularly gratifying to find that five milk recording societies were at present carrying out operations in the Principality. The Committee had at its meeting held on the 28th April adopted proposals for the allocation of the grants available for Wales for 1922-23, viz., 110 boar grants, 245 bull grants and 16 ram grants. He moved the adoption of the report and the motion was seconded by Mr. S. T. Griffin (Monmouth).

On being put to the meeting the report was adopted.

Report of Committee on Agricultural Policy.—The Council then proceeded to consider the report of a Sub-Committee appointed at the previous meeting to draft suggestions for the formulation of an agricultural policy for Wales. Mr. Bryner Jones explained that the Committee had met on two occasions to consider this matter, and after fully discussing various aspects of the question had asked him to draft a report embodying generally the views expressed at the meetings of the Committee. As indicated in the memorandum circulated with the report, the Committee, when they met subsequently, were unable to agree without reservations to all the recommendations included in the report, but it was their unanimous desire that the report as drafted should be submitted to the Council for discussion.

After considerable general discussion it was agreed that detailed consideration of the report be deferred to a special meeting of the Council to be called for the purpose at the end of three months.

Credit for Farmers.—Consideration was given to the report of the Sub-Committee appointed by the Agricultural Advisory Committee for England and Wales to consider the question of providing further credit facilities for farmers. On the motion of Mr. Griffin (Monmouth), seconded by Mr. C. D. Thompson, and supported by Mr. William Edwards (Anglesey), it was decided to support the recommendations embodied in the report.

Agricultural Statistics.—Mr. Bryner Jones called attention to the memorandum which had been circulated to the members in regard to the proposed Bill for dealing with the collection of Agricultural Returns and stated that the Ministry would be glad to receive an expression of opinion on the part of the Council as to whether it was desirable that a Bill should be promoted with a view of making it compulsory upon holders of agricultural land to furnish the information required in the annual Returns.

Mr. C. D. Thompson proposed and Mr. Thomas Williams (Montgomery) seconded the following resolution, which was carried unanimously:—

> "That provided the information furnished by individual farmers is not disclosed or used for any other purpose than the compilation of agricultural statistics this Council approves of the proposal of the Ministry of Agriculture to promote a Bill making it obligatory upon farmers to supply the particulars required in the annual Agricultural Returns."

The half-yearly report (No. 3) of the Proceedings of the Agricultural Advisory Committee for England and Wales, dated the 10th May, 1922, was received by the Council.

* * * * * *

VARIETIES OF SWEDES RESISTANT TO FINGER-AND-TOE.

T. WHITEHEAD, A.R.C.Sc.,
Agricultural Department, University College, Bangor.

ALTHOUGH it has become widely known that clubroot or finger-and-toe (*Plasmodiophora brassicae*) can be eliminated, or at least greatly reduced in severity, by the application of lime, there is no indication that the disease is actually being controlled on any large scale. Individual farmers, of course,

have succeeded in stamping out clubroot, but in general the position in the country with regard to this disease has not changed very appreciably during the last twenty years.

Whilst it is true that liming is not usually resorted to on the scale which is found necessary to check clubroot, this is not altogether to be attributed to slackness or lack of knowledge on the part of farmers, but in many cases to the real difficulties experienced in carrying out remedial measures.

It is perhaps significant that clubroot is serious in stock-raising districts in the North of England, and in North Wales—essentially pastoral areas. These districts have, generally speaking, a soil rich in humus and a relatively high rainfall—factors which will tend to reduce soil aeration and presumably to increase soil acidity. Moreover, under these conditions lime will often be applied to grass in preference to arable land. Incidentally it may be observed that liming is a costly and laborious operation. The cost of applying two tons of lime at present prices will be at least £5 per acre, and in some cases—as in North Wales—where a farm may be as much as ten miles from a railway, the cost and labour involved become prohibitive.

These facts, taken in conjunction with the opportunities which occur for infecting land through farmyard manure and the common farm practice of feeding off roots to sheep on grass which will eventually be broken up, often result in the soil being kept permanently contaminated with clubroot spores.

So long as these conditions exist it is not reasonable to expect any radical change in the extent to which lime is employed and the uses to which it is put. It becomes necessary therefore, to determine whether any other method of controlling the disease is available.

The most obvious alternative is the production of resistant strains of swedes which can be relied upon to give a good crop even on land badly contaminated with clubroot. This possibility has received the attention of some seedsmen in this country, and in Denmark several highly resistant kinds of swedes have been produced by selection from two old Danish varieties, Klank and Bangholm Pajberg.

Preliminary Trials in 1920.—With a view to testing the resistance of varieties of swedes to clubroot under the conditions usually prevalent in North Wales, preliminary trials were laid down on three farms in 1920. In these trials eleven British varieties were tested alongside two Swedish and two Danish kinds. Although the season was an abnormally wet one (dis-

TABLE I.

Results with English and Danish Varieties at Dinas on Limed and Unlimed Plots.

	LIMED PLOTS								UNLIMED PLOTS							
	No. of Sound Roots	No. of Bad Roots	No. of Destroyed Roots	Intensity of Attack Max'm. = 20	Total Weight of Crop per acre		Est'd. Weight of Sound Roots when lifted, per acre		No. of Sound Roots	No. of Bad Roots	No of Destroyed Roots	Intensity of Attack Max'm. = 20	Total Weight of Crops per acre		Est'd. Weight of Sound Roots when lifted, per acre	
					tons.	cwt.	tons.	cwt.					tons.	cwt.	tons.	cwt.
Lord Derby	70	162	4	6·9	13	0	3	18	32	199	4	8·8	14	14	2	0
Danish Variety 4 ...	189	87	0	3·2	12	18	8	16	136	133	1	4·9	14	8	7	8
Magnum Bonum ...	95	170		6·3	14	2	5	2	48	204	4	8·2	14	14	2	16
Pioneer	90	159	1	6·4	13	4	4	16	34	210	5	8·8	13	14	1	18
Danish Variety 25 ...	173	72	0	2·9	12	8	8	14	166	97	1	3·7	14	12	9	4
Dreadnought ...	95	142	2	6·1	13	6	5	6	51	178	5	7·9	13	14	3	0

NOTE.—The above table gives the average results of three series in each of the two plots, the figures in each series being quite consistent.

tricts with a normal annual rainfall of 30 in. recording 8.9 in. in the month of July alone) the results were sufficiently promising to make a second trial advisable. It is the object of this article to discuss fully the results obtained in 1921.

1921 Trials.—In order to keep these trials within reasonable limits only four British varieties were tested, together with the two Danish strains which had proved most resistant to clubroot at Studsgaard and Herning in Denmark.

The seed of the former varieties was obtained from seedsmen in the ordinary way, whilst that of the Danish varieties was obtained from the experimental station at Herning through the courtesy of Mr. C. I. Christensen.

The trials were carried out on three farms in Carnarvonshire, viz. :—Dinas, Tregarth; Dolgynfydd, Carnarvon; and Pennarth, Clynnog. At each centre three series of plots were laid down, and in addition, each series was divided to allow of comparison of different treatments.

In this way eighteen series of plots were kept under observation, and a thorough check upon the results was obtained.

The swedes were sown on 13th May at Dinas, 30th May at Dolgynfydd, and 2nd June at Pennarth. A good and uniform plant was obtained at each centre, and considering the dry season the progress of the crops, except so far as they were affected by clubroot, was fairly good. The swedes were lifted at all the centres at the end of November.

Method of Examination and Stating Results.—The crop was examined in the field immediately after lifting, and before the roots were cleaned. Roots which showed no signs of disease, and those so slightly attacked that the diseased part would be removed in cleaning, were classed as *sound*. Roots so seriously affected that no cleaning could remove the whole of the diseased tissue, were classed as *bad*. The term *destroyed* was applied only to such useless roots as appeared to be destroyed by clubroot. The intensity of attack is shown in tables I and II by a figure calculated from the proportions of roots of these three classes in the crops. The figure "0" would signify that the crop contained none but sound roots, and is increased with the number of bad and destroyed roots up to 20, which would indicate a totally destroyed crop. This is a slight modification of the method used by Christensen.*

* Christensen, C. I., in Tidskrift for Planteavl : vol. xxvi, pt. I 1917 (abstract in Rept. of Int. Inst. of Agric. Rome, March 1918, p. 317).

The Tables show that at Dinas, the field was thoroughly and uniformly affected with the disease. At Pennarth and at Dolgynfydd the intensity of attack was not nearly so great, but they confirm the Dinas results very well. In every case the Danish varieties proved superior.

Table I gives in detail the results at Dinas, and clearly shows the great resistance of the Danish varieties as compared with the others. For instance, on the unlimed land the average intensity of attack of all the British varieties was 8.4, whereas the two Danish varieties suffered to the extent of only 4.9 and 3.7 respectively.

On the limed plots the difference was even more striking. Taking the last column but one there is little difference between the total weights per acre, but the last column shows that the Danish varieties gave a much better weight of *sound* roots than any of the other kinds tested.

TABLE II.—*Summary of Results three Centres.*

Average Intensity of Attack. Maximum = 20.

	Dinas.		Dolgynfydd.		Pennarth.	
	Limed.	Unlimed	Slag.	Compound Manure.	Sulphate of Ammonia.	Super-phosphate.
	Average of 3 series.	Average of 3 series.	Average of 3 series.	Average of 3 series.	Average of 2 series.	Average of 2 series.
Lord Derby ...	6·	8·8	1·20	3·25	2·15	0·90
Danish Variety 5 ...	3·	4·9	0·4	0·93	0·84	0·50
Magnum Bonum ...	6·	8·2	1·3	3·70	0·95	0·84
Pioneer	6·	8·8	1·12	2·90	1·35	1·25
Danish Variety 25	2·	3·7	0·36	0·88	0·27	0·23
Dreadnought ...	6·	7·9	1·1	2·70	1·37	0·76

Effect of Treatment on Clubroot.—It will be seen from the Tables that in addition to the plots of the different varieties, cross plots were arranged and treated in different ways. Owing to some variation in the ground, and the difference in exposure to infection at Dolgynfydd and Pennarth, it is impossible to draw definite conclusions from the results at these two centres, but the different intensities of attack shown in the Dinas results may be taken as a fair indication of the effect of lime in preventing clubroot. The results are all the more striking on account of the fact that the lime was only applied shortly before sowing the seeds. If it had been applied in the previous year the chances are that its effect would have been even more marked.

Keeping Qualities.—In order to test the varieties still further at Dinas, all the roots of each variety from series 1 and 2 of the unlimed plots which were considered by the farmer to be sound enough for use, were clamped separately and left till 14th January, when they were again examined. Many of the swedes had rotted so completely as to be unfit for feeding to stock. These were discarded and the remainder were counted and weighed. The percentage losses in weight for the different varieties were found to be as follows:—Lord Derby 11.5; Magnum Bonum 15.6; Pioneer 20.4; Dreadnought 13.8; Danish Variety No. 4, 3.3; Danish Variety No. 25, 2.7. The two Danish varieties thus showed much better keeping powers than the rest.

Feeding Value.—Finally, it was desirable to determine the feeding value of the different varieties. This was done by obtaining the percentage of dry matter, the analyses being carried out by Mr. W. McLean, Lecturer in Agricultural Chemistry.

The results are as follows:—Lord Derby 8.3; Magnum Bonum 9.5; Pioneer 8.6; Dreadnought 8.7; Danish Variety No. 4. 10.0; Danish Variety No. 25, 10.0. The Danish varieties contained a higher percentage of dry matter than the other varieties tested. Since the feeding value of roots usually varies according to the proportion of dry matter, it is not unfair to assume that the two Danish varieties possessed a higher feeding value than the British varieties. It should be noted that previous experiments carried out by the University College, Bangor, have shown that roots grown in North Wales generally have a lower proportion of dry matter than the same varieties grown in some English districts.

General Conclusions.—It seems clear from the results obtained that two varieties have been found which resist clubroot to a marked degree, and in addition, keep better and have a higher feeding value than the remainder of the varieties included in the trial. This is the only conclusion one can arrive at even though reliable results are only available for one year, and that a relatively dry one in which the disease was less serious than usual.

An examination of Christensen's results shows that the Danish varieties exhibit an even higher degree of resistance in Denmark than they do in North Wales. In the present investigation Danish Variety 25 is consistently more resistant than Danish Variety 4. This is true of both the 1920 and 1921 trials, and is just the reverse of the results obtained by Christensen.

In assigning a value to the breeding of resistant strains it

should not be forgotten that at most it is a palliative, though it would seem that the growing of such strains will tend to starve out the fungus in the absence of susceptible weeds. The most certain way of eliminating the disease is to destroy the clubroot spores in the soil by the application of lime, and by prolonging the rotation. We do not, however, as yet know the minimum dressing of lime required for this purpose and, indeed, it is still uncertain what the effect upon the soil itself will be following the application of a given quantity of lime to any particular soil. For this reason as well as for other reasons previously discussed it is advisable to explore more fully the possibility of raising varieties of cruciferous crops resistant to clubroot.

Since these experiments were carried out Danish Variety 4 has been placed on the market and is obtainable from the firm Danske Landhoforeningers Froforsyning of Roskilde, Denmark, under the name "Studsgaard Bangholm." Possibly further selection from the point of view of resistance to clubroot may result in the production of a resistant strain of some well-known British variety.

Acknowledgment must be made of the great assistance rendered by Mr. Edwin Jones, B.Sc., a post-graduate student, in carrying out the trials here reported upon.

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A TRIAL OF TIMBER JACKS AND A MONKEY WINCH.

A Report* was recently published by the Ministry on hedge and stump clearing devices, containing the results of tests conducted at Long Sutton in Hampshire. An abstract of this report appeared in the Ministry's *Journal*, April, 1922, page 6. One of the devices tested was a mechanical jack, manufactured by Messrs. Trewhella Bros., of Birmingham, the results with which were far from satisfactory. Messrs. Trewhella therefore requested the Ministry to subject the device to a further trial, and with the concurrence of the Hampshire Agricultural Education Authorities advantage was taken of a test of sub-soiling and tillage machinery recently held at Sparsholt Agricultural Institute near Winchester, to obtain further data. Conditions were obtained as far as possible similar to those in the former trial at Long Sutton, and a monkey winch for timber removing manufactured by the same firm was also included in the test. Much better results were obtained in the later trial with the jack, and the device can be regarded as an economic unit worthy of consideration by any farmer desiring to clear timber over a protracted period.

The Test Ground.—The plot upon which the jacks and winch worked was level and consisted of light loam, with chalk at a depth of from 1 ft. to 1 ft. 6 in. In consequence all the timber was shallow rooted. The test lasted over a period of two days. During the first day, the monkey winch only was tested, and on the second day the jacks were tested. The timber consisted of elder, hazel and maple stools and blackthorn and maple trees.

Data were obtained under the following heads :—

1. Weight and volume of timber, size of crater, and quantity of earth displaced.
2. Number of hands required to operate the device.
3. Time taken to prepare for work.
4. Capital cost, depreciation, and maintenance.
5. Comparative degree of skill needed to work the device.
6. Mechanical design and construction, and general efficiency of the device.

* Miscellaneous Publications No. 35. Price 2/6, post free, from the Ministry, 10, Whitehall Place, London, S.W.1.

7. Mechanical construction having regard to simplicity and access to wearing parts.
8. Method of extraction having regard to simplicity and safety.
9. Ease of handling, including manœuvring to the scene of operation.
10. Usefulness of the appliance for other work.

Description and Test.

Sale Price: March, 1922.

		£	s.	d.
A.	Ten-ton jack	13	10	0
	Five-ton jack	8	15	0
B.	Monkey winch (with stumping tackle)	57	0	0
	Monkey winch (without stumping tackle)	47	10	0

The Timber Jack.—The jack is of the well-known rack and bar type, the distinguishing feature being that the casing is made to move up and down the pillar instead of remaining stationary. This casing carries two lifting claws fitted at different heights, and on opposite sides, the top claw being at a convenient height to go under a load which the bottom claw has raised to its limit. To transfer the weight from the bottom to the top claw simply involves turning the pillar round.

The pillar of the jack consists of hard railway steel of great strength. Each jack is fitted with two spears of different lengths supported by guides, and by these the working range of the jack is considerably increased.

A simple device on the side of the casing releases the pawl action and thus permits the jack to be raised or lowered right up or down without working the handle.

To uproot a stump, a trench is dug on one side and the jack placed under a strong root. To prevent the base of the jack from sinking too far into the ground a steel base or a stout plank is placed underneath. Upon the lever being worked the jack rises and tears the stump bodily out of the ground.

Method of Trial.—Two men only worked on these machines and were equipped with grub axes, a spade and a crowbar. The jacks first worked approximately 1½ hours upon elder, hazel and maple and shallow-rooted stools. Considerable hand grubbing was done. It was observed that upon a stool being raised to a certain limit, the roots holding the stool to the ground were

cut and the extraction of the stool therefore presented no great difficulty. Following this, record was taken of the work of these jacks in extracting a blackthorn and a maple tree. These trees had an average diameter of about 10 in. and were shallow rooted. It was observed in this instance also that all roots were cut by means of the grub axe. Heavy rain fell while these trees were being extracted and hampered the work considerably.

Results.—	*Stools.*	*Trees.*
Average diameter of stumps	18·5 in.	9·9 in.
Average time occupied in removing ...	9·61 mins.	30·5 mins.
Average cost per stump	4d.	12·75d.
Average cost per sq. ft. of cross section...	1·75d.	23·93d.
Average cost per cubic ft. of timber lifted	1·04d.	10·52d.

The Monkey Winch.—The mechanism of this machine does not depart greatly from the ordinary winch fitted with a ratchet gear, except that the steel rope is specially adapted for holding and pulling timber. The winch gear is fitted in a very compact steel frame, which can be moved from place to place on its own two wheels where the ground is not too rough. In other cases, two men can easily carry the machine from one spot to another.

The winch is fitted between trees or stumps by means of the steel ropes which are equipped with specially made couplings which wedge themselves on the rope, thus avoiding any possibility of slipping at high tension. By means of the single ratchet gear the load is applied by working a handle backwards and forwards which has the effect of winding in the rope and ultimately the strain becomes so great that the stump is torn from the ground.

Method of Trial.—Three men were allocated to the winch and were provided with grub axes, a spade and a crowbar. The stools in this plot consisted of elder and hazel and had very shallow roots. Little time was required for fixing the cable round the stool to be extracted, and the winch proved easily capable of extracting all stumps encountered. Owing to the radius within which this winch may work, it was found unnecessary to change the position of the machine.

Abstract of Results.—The results are as follows, details of which are given in the table on p. 372 :—

	Stools.
Average diameter of stump	23·3 in.
Average time occupied	5·8 mins.
Average cost per stump	3·6d.
Average cost per sq. ft. cross section...	1·1d.
Average cost per cubic ft. of timber lifted	·6d.

Observations on the Use of Each Device.—Both types of device were simple to operate and no difficulty was experienced in the test at Sparsholt. It may, however, be observed that before men can become skilled operators a certain amount of continuous practice is necessary. The mechanical construction of the machines is robust and simple and there appeared little likelihood of any defect occurring in the working parts. Both types of machines have been built to withstand excessive overloading. At no time was a very big load imposed on any of the devices, as the timber was all shallow rooted, whereas the timber in the test at Long Sutton was deep rooted. For this reason and the fact that the average diameter of the timber was smaller it is impossible to compare the results of the two tests. For similar conditions to those obtaining at Sparsholt the jacks can be regarded as very useful for land cleaning over a protracted period. The same remark applies to the monkey winch, though the usefulness of this device is greater than that of the jacks, because of its high load extraction capacity and the facility with which it can work in dense undergrowth.

	Jacks.		*Winch.*
	Stools or Coppice.	*Trees.*	*Stools or Coppice.*
Total number of stumps extracted ...	9	2	27
Diameter of stumps in inches—			
Smallest	12	9·5	12
Largest	27	10·3	43
Average	18·5	9·9	23·3
Number of working hours	1 hr. 26 m.	1 hr. 1 m.	2 hr. 37 m.
Average time per stump in min.—			
Grubbing	4·4	22·3	2·2
Extraction	5·2	8·3	3·6
Total	9·6	30·5	5·8
Average cost per stump	4·0d.	12·8d.	3·6d.
Cost per sq. ft. of cross section ..	1·7d.	23·9d.	1·1d.
Cost per cubic ft. of timber lifted ...	1·0d.	10·5d.	·6d.
Average volume of crater in cu. ft.	4·3	2·1	8·5

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NOTES ON FEEDING STUFFS FOR JULY.

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

The Feeding Value of Milk By-products.—In the manufacture of butter, cheese and cream, a considerable amount of buttermilk, whey and separated milk is produced. These milk by-products are valuable feeding materials if rightly used with suitable meal mixtures. It is common practice on most farms where cheese, butter or cream is manufactured, to feed pigs with the milk residues, although there are still some places where the residues are thrown away as useless materials. A correspondent has recently asked for information on the feeding value of these by-products, and the following notes are appended in the hope that they may be of value to stock feeders accustomed to deal with such by-products.

Skim Milk.—On farms in favoured situations it is a common summer practice to sell cream and feed the skim milk. Skim milk is a highly nitrogenous feed, having a nutritive ratio of 1—1.5, and is of great value for building flesh and the bony framework of young animals. Experiments have shown that skim milk is more valuable than whole milk *per lb. of dry matter*. Skim milk is therefore of value for feeding to young growing livestock. For calves, it is possible to replace whole milk entirely at an age of from five to six weeks. For pigs, it is an excellent food at all ages. Danish experiments have shown that skim milk, potatoes, and mixed meals produce bacon of a high quality. Skim milk is best fed in conjunction with starchy foods, such as potatoes and maize meal. Compared with grain, 5 lb. of skim milk will replace 1 lb. of grain in feeding, and may be regarded as having equivalent feeding value. Skim milk and maize meal together form a good pig feed, although the inclusion of a little middlings or barley meal is beneficial, particularly where the production of first quality bacon is aimed at. In feeding meals with skim milk, the best proportion is at the rate of 1 lb. of meal to 3 lb. of skim milk. One last point, skim milk produces costiveness, and the meals fed with it should possess the opposite tendency.

Whey.—Whey consists chiefly of milk albumen, milk sugar, and mineral substances. Unlike skim milk, it has a somewhat

DESCRIPTION.	Price per Qr. s.	lb.	Price per Ton. £ s.	Manurial Value per Ton. £ s.	Cost of Food Value per Ton. £ s.	Starch Equiv. per 100 lb.	Price per Unit, Starch Equiv. s.	Price per lb. Starch Equiv. d.
Wheat, British	58/–	504	12 18	1 0	11 18	71·6	3/4	1·78
Barley, English Feeding	39/–	400	10 18	0 18	10 0	71	2/10	1·52
,, Canadian No.2 Feed	34/–	400	9 10	0 18	8 12	71	2/5	1·29
Oats, English White	38/–	336	12 13	0 19	11 14	59·5	3/11	2·10
,, ,, Black & Grey	36/–	336	12 0	0 19	11 1	59·5	3/9	2·01
,, Canadian No.2 Feed	29/9	320	10 8	0 19	9 9	59·5	3/2	1·70
,, Argentine	27/6	320	9 12	0 19	8 13	59·5	2/11	1·56
Maize, ,,	38/6	480	9 0	0 17	8 3	81	2/–	1·07
,, South African	37/–	480	8 13	0 17	7 16	81	1/11	1·03
,, American	35/–	480	8 3	0 17	7 6	81	1/10	0·98
Beans, English Winter	61/3*	532	12 18	1 15	11 3	67	3/4	1·78
,, Rangoon	—	—	8 0	1 15	6 5	67	1/10	0·98
Buckwheat, Manchurian	51/–	392	14 11	1 6	13 5	53·4	5/–	2·68
Millers' offals—								
Bran	—	—	6 10	1 16	4 14	45	2/1	1·12
Broad Bran	—	—	8 10	1 16	6 14	45	3/–	1·61
Fine middlings (Imported)	—	—	9 15	1 7	8 8	72	2/4	1·25
Coarse middlings	—	—	9 5	1 7	7 18	64	2/6	1·34
Pollards (Imported)	—	—	7 17	1 15	6 2	60	2/–	1·07
Rice Bran	—	—	7 10	—	—	—	—	—
Barley Meal	—	—	11 10	0 18	10 12	71	3/–	1·61
Maize ,, S. African	—	—	8 15*	0 17	7 18	81	1/11	1·03
,, Germ Meal	—	—	8 17	1 5	7 12	85·3	1/9	0·94
,, Gluten-feed	—	—	8 17	1 11	7 6	75·6	1/11	1·03
Locust Bean Meal	—	—	9 0	0 9	8 11	71·4	2/5	1·29
Bean Meal	—	—	13 10	1 15	11 15	67	3/6	1·87
Fish ,,	—	—	15 5	5 10	9 15	53	3/8	1·96
Linseed	—	—	22 0	1 16	20 4	119	3/5	1·83
,, Cake, English (9% oil)	—	—	13 5	2 6	10 19	74	2/11	1·56
Cotton seed ,, English (5% oil)	—	—	8 10	2 6	6 4	42	2/11	1·56
,, ,, Egyptian (5% oil)	—	—	8 5	2 6	5 19	42	2/10	1·52
Soya Bean Cake (6% oil)	—	—	11 10	3 3	8 7	69	2/5	1·29
Coconut Cake (6% oil)	—	—	9 15	1 19	7 16	73	2/2	1·16
Groundnut ,, (6% oil)	—	—	9 7	3 5	6 2	47	2/7	1·38
Palm kernel Cake (6% oil)	—	—	7 5*	1 9	5 16	75	1/7	0·84
,, ,, Meal (2% oil)	—	—	6 5	1 9	4 16	71·3	1/4	0·71
Feeding Treacle	—	—	4 15	1 1	3 14	51	1/5	0·76
Brewers' grains, dried, ale	—	—	7 12	1 11	6 1	49	2/6	1·34
,, ,, ,, porter	—	—	6 15	1 11	5 4	49	2/1	1·12
,, ,, wet, ale	—	—	1 0	0 8	0 12	15	–/10	0·45
,, ,, wet, porter	—	—	0 16	0 8	0 8	15	–/6	0·27
Malt culms	—	—	8 0*	2 3	5 17	43	2/9	1·47

* Prices at Liverpool.

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

wide nutritive ratio, and therefore requires feeding with foods rich in protein, as, for instance, linseed meal and wheat middlings. Where the meals available on the farm are of a starchy character, the introduction of a little earth-nut cake, pea meal or bean meal will be of value. For feeding to pigs, whey has about half the feeding value of skim milk, *i.e.*, 10 lb. of whey equals about 5 lb. of skim milk. Whey is laxative in character and should be fed with foods producing the opposite effect.

Buttermilk.—Buttermilk has substantially the same value for pigs as skim milk, and the remarks as to the value of skim milk apply generally to buttermilk, except perhaps with regard to calves. Buttermilk has been used successfully with calves, but cannot be generally recommended except in cases where scrupulous cleanliness prevails. Unless such conditions exist, fermentation sets up in the buttermilk, and a comparatively harmless and useful feeding stuff then becomes dangerous.

* * * * * *

Goat-keeping in British Columbia.

THE Department of Agriculture for British Columbia has recently issued a third edition of its Bulletin No. 64, entitled "Goat-raising in British Columbia." The place of the milch goat in the Province is now well established, and what was at one time considered a passing fad is looked upon as a profitable and useful branch of the live stock industry.

The chief place of the milch goat in the Province is as a provider of wholesome milk for the household at a moderate cost, but it is considered that there is money to be made from the regular supply of goats' milk to large cities owing to the well-known pre-eminence of this milk as the best form of nutriment for infants and invalids, as a result of which it commands a ready sale at double the price of cows' milk.

Under the rules of registration of the Canadian Goat Society, it is interesting to note that in the case of British milch goats, Toggenburgs, and Nubians, animals are admitted for registration if they have already been registered in the British Goat Society's Herd Book.

The Bulletin gives valuable information on the housing, feeding and general management of goats. It also describes methods of making goats' milk into butter and cheese and deals with the utilisation of goat flesh for the table. It is stated that goat's milk has been known for centuries as an ideal food for infants and invalids, because of its easy digestibility, and many hospitals and sanatoria keep herds to supply milk for their patients. Though

rich in butter-fat, generally averaging about 5 per cent., the milk does not form heavy curds in the stomach; the curd from goats' milk is light and flaky and digests in about one-third the time of that of cows' milk.

A special section of the Bulletin is devoted to the breeding of Angora goats, some fine illustrations of these animals being given. The cheaper grades of this breed are kept largely in the United States, primarily for keeping down brushwood growth. The goats are turned out on to the brush and kill off all but the larger saplings by persistent browsing on the foliage and bark, and thus convert the useless brush into mohair and goat flesh. Angora goats which are nearly pure bred are stated to produce a fleece of about 3 lb. to 5 lb., and the price of mohair has been steadily rising of late years. Angora hides of the best quality are made into morocco leather for books, while the poorer quality make workmen's gloves. Angora pelts are in demand for robes, for baby-carriages and children's cloaks, and for house-rugs. They are worth from 2 to 3 dollars each.

(The Ministry of Agriculture and Fisheries has published the following leaflets on goat-keeping, copies of which may be obtained from the Ministry's offices, 10, Whitehall Place, London, S.W.1, price 1d. each:—No. 306, The Goat as a Source of Milk; No. 383, Hints on Goat-keeping.)

* * * * * *

Road Regulations for Agricultural Tractors.

Farmers who own agricultural tractors would be well advised to make themselves acquainted with the recommendations contained in the Second Interim Report of the Departmental Committee on the Taxation and Regulation of Road Vehicles with regard to the use of tractors on highways. The Committee point out that the introduction of tractors is comparatively recent and consequently the regulations governing the use of mechanically-propelled vehicles are not always applicable. In many cases the use of these tractors on roads is believed to be illegal, and the Committee consider that the time has arrived when special regulations should be made to regularise and legalise this type of vehicle. At the same time, it is necessary to provide for the safety of the public, and to ensure that the risk of damage to the roads is reduced to a minimum.

The principal recommendations of the Committee are as follows:—

(i) An agricultural tractor is defined as "a mechanically-propelled vehicle constructed and used for agricultural purposes not exceeding 3½ tons in weight unladen, and drawing, but not itself carrying, any load except such as is necessary for its propulsion and use."

(ii) The sum of the axle weights of an agricultural tractor and any trailer drawn by it should not exceed 8 tons.

(iii) The speed of agricultural tractors on a public highway should be limited to four miles per hour, unless the tractor complies strictly with the Regulations governing any other class of vehicle, in which case it might proceed at the speed appropriate to that class, subject to a maximum of 16 miles per hour.

(iv) Agricultural tractors should not be required to be constructed with springs between any axle and the frame.

(v) The steering wheels of an agricultural tractor should, when used on roads, be fitted with a band which should be smooth, and, where the tyre touches the surface of the road, flat and not less than 2½ inches in width.

(vi) The driving wheels of an agricultural tractor should be not less than 36 inches in diameter, and wheels, other than driving wheels, not less than 24 inches in diameter; it is recommended that this provision should not apply in the case of tractors weighing 15 cwt. or less unladen, or in the case of the trailing wheels of self-contained motor ploughs. This provision it is proposed should not come into operation until 1st April, 1923.

(vii) All agricultural tractors should be fitted with two brakes, with the exception of:—

(*a*) Tractors under 20 cwt. in weight, used exclusively for hauling agricultural implements and agricultural machinery;

(*b*) Tractors of the "caterpillar" type up to 30 cwt. in weight, used exclusively for hauling agricultural implements and agricultural machinery.

(*c*) (*Up to 1st April*, 1923) tractors between 20 cwt. and 30 cwt. in weight used exclusively for hauling agricultural implements and agricultural machinery.

In these cases one brake only, it is considered, need be fitted.

(viii) One identification plate only should be required on agricultural tractors used exclusively for hauling agricultural implements and agricultural machinery, such plate to be affixed in front of the tractor.

(ix) Driving wheels of agricultural tractors used exclusively for hauling agricultural implements and agricultural machinery should, as regards their tread, be either smooth and flat, or flat but fitted with diagonal crossbars of not less than 3 inches in width nor more than ¾ inch in thickness, extending the full width of the tyre, provided that the space intervening between each pair of crossbars should not exceed 3 inches. The crossbars should be so disposed throughout the tyre that the aggregate extent of the crossbars or crossbar in the course of a straight line drawn horizontally across the circumference of the wheel would nowhere be less than half the width of the tyre. The width of the driving wheels should be such as to allow no greater load per inch width of wheel than 3 cwt.

(x) Agricultural tractors of the "caterpillar" type should be legalised for the same purposes as wheeled tractors, provided that those parts of the track which are in contact with the ground are either flat or rounded and have a minimum width or diameter of ½ inch. The total area of the

track actually in contact with the ground should be not less than 36 square inches in respect of each ton of the unladen weight of the tractor.

(xi) An agricultural tractor should be permitted to draw only one trailer but no trailer should be drawn when the tractor is drawing agricultural machinery or agricultural implements running on their own wheels.

(xii) It is not proposed that Paragraphs (v), (vi), (vii), (ix), (x), (xi) above should apply in the case of agricultural tractors not exceeding 10 cwt. in weight unladen.

It is understood that an Order based upon these recommendations will be issued shortly by the Minister of Transport. The practical effect will be that owners of tractors will by the dates laid down in the Order (not necessarily those recommended by the Committee) have to ensure that their tractors *when travelling on the road* are properly equipped. The provisions entailing most trouble to farmers to be included in the Order if the recommendations of the Committee are adopted, are those relating to steering wheels and brakes. Where the steering wheels have a non-detachable sharp projecting flange, it will presumably be necessary to fit bands which will make the surface flush; in point of fact an owner who at present permits any such tractor to be driven on the highway runs a very serious risk, and the recommendation is in accordance with the precautions at present taken by reasonable users of the road. It will not be disputed that the brakes required by the Committee are for the safety both of the driver and other users of the highway.

It is to be anticipated that tractors in future placed upon the market will comply strictly with any Order that may be issued, and any inconvenience which it may cause will be limited to the transition period when owners are under the necessity of adapting their machines to the new requirements.

* * * * * *

Covers for Corn Stooks and Hay Cocks.

IN view of the difficulty of successfully harvesting corn and hay (particularly clover, lucerne, tares, etc.) in wet weather, the Ministry in 1920 had small tests carried out with a device for covering corn stooks, and in 1921 both corn stooks and hay cocks.

1920 Trials.—*Description of Covers.*—The covers tested in 1920 were of semi-glazed heavy paper, which was claimed to be water proof, and they were six feet in length, and in the shape of a cottage roof. They were intended to cover and protect from rain and birds stooks of from 10 to 12 sheaves each. The

fasteners consisted of cord (two pieces on each cover) which were fastened through eyelets on one side of the cover, and when adjusted were threaded through the stook by means of a long steel needle and fastened to eyelets on the opposite side of the cover.

The trials were carried out in 1920 at Cambridge University, Armstrong College (Newcastle-on-Tyne), Leeds University, Aberystwyth Plant Breeding Station, Newton Rigg Farm School (Westmorland), and in the counties of Derby, Cornwall, and Cardigan.

Durability of Covers.—The covers stood rain well at Cambridge, Leeds, Cardigan and Cornwall. Conditions seem to have been more adverse at Armstrong College, Aberystwyth, Newton Rigg, and Derby. More damage was apparently caused by high wind than by rain. At Armstrong College four weeks of bad weather rotted and tore the covers, at Aberystwyth 70-80 per cent. were broken after a week of unsettled weather, in Derby some were ripped by the wind, while at Newton Rigg the trial covers withstood heavy rain but some were torn by high winds.

The result of the trials seemed to show that if the covers were used in districts where the heaviest weather is experienced they must be made of more durable material.

Efficacy and Special Uses.—At Cambridge the rain passed off the covers and the corn beneath dried continuously though rather more slowly than that which was not covered. At Leeds rain followed the cutting of the barley so that the corn was wet when stooked. Unfavourable drying conditions followed, and when stacked the moisture content of the covered corn was found to be higher than that of the uncovered. At Aberystwyth the covers that withstood the wet spell kept the stooks in very good condition, provided they had been covered when the sheaves were dry. Stooks that were covered when damp were in a poor condition when the covers were removed.

In Derby the covers kept the oats dry, and, when taken off, the oats were very clean and bright. In Cornwall the oats under the covers were in splendid condition and the covers were stated to provide protection against wood pigeons and to be useful, therefore, in positions adjoining woods.

It appeared that in Cardigan, Derby and Cumberland the covers would have to meet the competition of local methods of covering stooks. In Derby and Cumberland it is usual to place hooding sheaves on the top of the stook to act as cover.

Labour and Cost.—At 1s. apiece the cost of covers alone is about £3—£4 per acre, and the cost of labour in fixing and unfixing has to be added to this. As regards extra labour required, at Aberystwyth it was found to take two men about two minutes to cover one stook, or about two to three hours to cover one acre. On account of the expense of covers and labour the practice was not considered economical at Cambridge and at Armstrong College, and the extra labour was stated to be an important item at Newton Rigg and in Cornwall.

1921 Trials.—As a result of the 1920 trials the manufacturers of the covers used for the 1921 season stronger paper and dispensed with the arrangement for threading them together with needles, using instead better twine, attached to the eyelet holes, for tying to the sheaf bands. 5,000 covers for corn stooks and 5,000 for hay cocks were supplied free of charge and distributed to 48 different centres in England and Wales by arrangement with the Ministry. Owing, however, to the exceptionally dry weather experienced, 23 of the centres were unable to use the covers.

Durability.—It was again found at a number of centres that the covers did not stand strong wind, especially after rain. At other centres, however, they were stated to be quite fit to use again.

Effectiveness.—Protection from damage by birds was reported from the Oxford School of Rural Economy, Cumberland and Westmorland Farm School, Worcestershire, Cornwall and Cheshire. Prevention of sprouting in stooks was reported from Cumberland, Staffordshire, and Cornwall, while in Staffordshire, Worcester, Cornwall, Bangor, and Denbigh grain and straw from covered stooks appeared to be freer from stain, and brighter and sweeter in smell than that from uncovered stooks.

From Worcester and Cornwall it was reported that the covers would be suitable for special seed crops. At Armstrong College the covers saved oats which were out in bad weather for five weeks. The report from Montgomery stated that the covers would be very valuable in a wet season. Rothamsted Experimental Station stated that stooks sink after making and leave the covers loose and liable to damage by wind, while covered barley did not bleach so well as uncovered. In E. Suffolk the covers were found to prevent hay from drying.

Summary.—The exceptionally dry weather which was experienced in 1921 did not allow of a fair test as to the strength of the covers when subjected to heavy rain, but it appears that,

although they stand the rain well, they will need to be made of a stronger material (especially at the corners where the strings are attached) to be of use in wet and windy weather. They should also be made a little larger so as to come below the bands of the sheaves.

As a protection against birds the covers are very useful, while grain and straw from covered stooks appear to be freer from stain, brighter, and sweeter in smell than those from uncovered stooks. The covers also prevent sprouting in stook.

They would obviously be useful in the case of special crops, such as pedigree corn, where protection from birds and prevention of darkening by bad weather is more than usually necessary.

At 1s. each, the initial cost of the covers, which should last with ordinary use two seasons, is about £3—£4 per acre, while the extra cost of fixing averaged about 2s. per acre.

* * * * * *

Live Stock Importation Regulations.

A SUMMARY of the general regulations governing the importation of Live Stock into the British Dominions, Colonies and Protectorates, and into foreign countries, has been prepared by the Ministry for Departmental use. It is, however, thought that copies of this summary may be of service to exporters, and typed copies are obtainable at the Ministry's Offices, 10, Whitehall Place, London, S.W.1, price 10s. each. A copy of the summary relating to any particular country for which the regulations are available will be supplied free.

The information given in the summary is an indication of the general regulations (apart from temporary prohibitions) of the various countries on the importation of stock from Great Britain and Ireland, as far as they are at present available. Purchasers will be informed of any amendments made in 1922 to this summary in the case of the more important countries. From 1923 onwards a charge, to be notified later, will be made for supplying such amendments.

* * * * * *

NOTICES OF BOOKS.

British Goat Society's Year Book, 1922.—(Compiled and issued by the Hon Secretary, Thomas W. Palmer, 5, Fenchurch Street, London, E.C.3. Price 1s. 6d.) The second issue of the British Goat Society's Year Book contains much information which should prove useful and interesting both to goat keepers and to many who may consider the keeping of goats.

The Society has been in existence for many years and has done much to assist the development of goat keeping and to further the interests of goat keepers in Great Britain and Ireland. The objects of the Society are stated to be :—

(*a*) To circulate knowledge and general information upon goats with a view to counteracting the prejudices and ignorance which prevail in a great degree concerning these animals.

(*b*) To extend and encourage the keeping of goats, particularly by cottagers, so as to increase the supply and consumption of milk in rural districts where this article is frequently unobtainable.

(*c*) To improve the various breeds of goats and specially to develop those qualities which are generally recognised and valued in milch stock.

The Society, which now consists of several thousand members, has for many years carried on an active campaign in favour of the goat, and it is due to the Society that any reliable pedigrees and records of the milking qualities of goats in this country are available. Such importations of foreign blood as have been made from time to time in the past with the object of improving the quality of British goats have been due mainly, if not entirely, to the British Goat Society, and it is to its efforts and the work of its affiliated societies that goat shows and classes for goats at agricultural shows have been organised on more extensive lines. The milking trials held under the regulations of the British Goat Society and the distinguishing descriptions awarded to good milkers and their progeny under the Society's regulations have done much to improve the milking qualities of British goats.

Mr. Reginald Pease, Chairman of the Committee, states that "during the past year a few animals were exported to some of our colonies and elsewhere and there is no reason why a lucrative and much larger trade should not be done in this direction."

An article is contributed by Mr. Arthur W. Abbey, entitled "The Goat and Agriculture," in which he gives his experiences of the value of the goat as an agent in the improvement of pasture land.

In an article on Goat's Milk, Doctor B. D. Z. Wright states that many infants suffering from what is commonly called "marasmus" have been saved by goat's milk, and that many more might be saved if they had the chance of being reared on goat's milk instead of tinned condensed and dried substitutes for mothers' milk. He also refers to the freedom of goat's milk from tubercle bacilli as an enormous asset.

An article on goat keeping in Holland by Mr. P. A. Francis gives a brief description of the remarkable development of goat keeping in Holland during recent years. The fact that according to official figures there were in the

year 1900 some 224,231 goats in the Netherlands is significant when it is borne in mind that dairy cattle are also kept in large numbers in that country.

Holland possesses perhaps the only Goat Breeding Experiment Station in the world. This Station was established through the generosity of a private individual, but the Station is stated to be now maintained by subscriptions from the provincial Unions, by grants from Local Authorities and from the Government.

Productive Swine Husbandry.—(George E. Day, London and New York ; J. B. Lippincott Company ; price 10s. 6d. net.) This volume is a third and revised edition and forms one of the series of Farm Manuals published by the J. B. Lippincott Company. As "review questions" are given at the end of each chapter, it may be surmised that the author had specially in view the needs and instruction of farm students. Productive Swine Husbandry, with its chapter on suggestions to beginners, is eminently suitable to farm students as well as to those who are already engaged in the breeding of pigs and the production of pork. The illustrations (ninety-five) are well reproduced and should be of great assistance to the reader.

One of the early chapters is devoted to a description of the two types of swine, the lard type and the bacon type—divisions which appear to have been considered to a greater extent in the United States than in this country, and in the near future will receive still greater consideration if the pork packers persist in their endeavour to pay far greater attention to the requirements of the British market for pork and bacon, and the produce of pigs of the bacon type which have not been fattened mainly on maize.

A considerable amount of space has been devoted to descriptions and histories of the various breeds of swine which have originated in the United States and in this country. The former appear to be clear and complete, although the scales of points show quite a number of variations from similar ones adopted in England. In the Poland China score card, twelve points are allotted to chest, fourteen to back and loin, ten to sides and ribs, ten to ham and rump, and ten to feet and legs. Action and style, condition, disposition and symmetry of points, together claim ten points. The American breeds described include the following :—Poland China, Chester white, Duroc Jersey, Thin Rind, or Hampshire, Victoria, Cheshire, Essex, Suffolk and Mule Foot. The descriptions of the British breeds are not so complete and refer to large Yorkshires or Large Whites, Tamworths, Small Yorkshires, or Small Whites, and of two so-called minor breeds, Large Blacks and Middle Whites. Probably the cause for this last is that in Canada particularly the two latter breeds are little known. Further, the fact that in this country these two breeds have enormously increased in popularity of late years does not appear to have been realised on the American Continent. The Cumberland, Gloucester Spots, Lincolnshire Curly Coat, Essex or Wessex Saddleback are not described.

The chapters on selection of bear and sow, on breeding, feeding and fattening are very complete, and a considerable number of experiments are described, many of which are acknowledged to be from Henry's admirable work on "Feeds and Feeding." The various systems of pig-keeping are fully given, with illustrations of piggeries varying from large and permanent buildings to the small movable pen, which is freely utilised in small enclosures

where open-air pig keeping has been carried on extensively for at least two or three decades. The chapter on suggestions to beginners is short, but is full of good advice. To complete a most useful and instructive volume a chapter is added on the diseases of swine.

* * * * * *

Foot-and-Mouth Disease.—Since the 21st May, the date of the note contained in the *Journal* for June, 1922. page 286, only 22 outbreaks of Foot-and-Mouth Disease have been confirmed in Great Britain, bringing the total up to the 22nd June, 1922, to 1,121, of which 1,016 were in England, 3 in Wales, and 102 in Scotland. Of these 22 outbreaks, 5 occurred in Derbyshire, 8 in Lancashire, 1 in Nottinghamshire, 2 in Staffordshire, 3 in Warwickshire, 1 in Worcestershire, 1 in Cheshire and 1 in Northumberland. As most of the districts had been freed from the Foot-and-Mouth Disease restrictions in force earlier in the year, all except the outbreak in Staffordshire occurred in free districts, and necessitated the re-imposition of Orders controlling the movement of animals over considerable areas around Chesterfield and Bakewell (Derbyshire), Birmingham, and Rochdale (Lancs.), Holmeschapel Crewe, in Cheshire, and Ponteland, near Newcastle, Northumberland. The Scheduled District round Rochdale had to be extended westwards on account of outbreaks at Westhoughton on 20th June, and near Liverpool on 22nd June. The outbreak in Nottinghamshire involved a small extension of the Scheduled Area in that county. All the 22 outbreaks above mentioned were dealt with by slaughter of the affected animals and of the animals in direct contact with them, involving the slaughter of a total of 346 cattle, 100 sheep and 301 pigs.

During the period under review, the restrictions were withdrawn entirely from the remaining Scheduled Areas in Midlothian, Forfarshire, Renfrewshire, Dumbartonshire, Durham, Leicestershire, and the 3 Ridings of Yorkshire (except a small portion of the West Riding, forming part of the new Rochdale Scheduled District). In addition the area in Berwickshire has been considerably reduced.

The origin of the disease at the new centres in Derbyshire, Warwickshire, Lancashire, Cheshire and Northumberland is unknown, and it is possible that infection from previous outbreaks may still be lurking in railway trucks used for stock. Having this in mind the Ministry has issued a circular letter to all railway companies asking them to give instructions for a special and thorough cleansing of all railway trucks used for the conveyance of animals in order that this source of infection may be destroyed, and Local Authorities have been asked to keep special observation over the manner in which the cleansing and disinfection of railway vehicles and railway pens used for stock is carried out. It is also necessary that farmers should remain constantly on the watch for any symptoms amongst their stock suggesting the presence of Foot-and-Mouth Disease, and should report such cases immediately to the police.

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