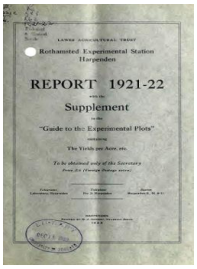
# Report 1921-22 With the Supplement to the Guide to the Experimental Plots Containing the Yields per Acre Etc.

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## The Feeding of the Planet

### Rothamsted Research

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labelled pH, and the lower they are the greater the degree of acidity. Thus the following Garforth soils have been tested :—

| | *pH value* |
|---|---|
| Very acid, wheat bad . . . . . | 4.37 |
| Less acid, wheat poor . . . . . | 4.44 |
| Still less acid, wheat better . . . . | 4.65 |
| Still less acid, wheat good . . . . | 4.82 |

Another set gave these results :—

| | |
|---|---|
| Acid, finger and toe prevalent on turnips . | 5.64 |
| Less acid, no finger and toe . . . . | 6.13 |

It is also shown that there is a closer relationship between the pH values and the Hutchinson-McLennan "Lime requirement" values than might have been expected, and the latter afford useful guidance in placing similar soils in order of acidity.

## THE FEEDING OF THE PLANT.

Farmers are now thoroughly familiar with the fact that the production of heavy crops necessitates a skilful and adequate use of fertilisers. In spite of the severe agricultural depression of the past two years, there has been a considerable consumption of fertilisers : in some cases greater than in pre-war times ; this is shown in the following table :—

AVAILABLE SUPPLIES OF FERTILISERS IN TONS : GREAT BRITAIN AND IRELAND.(1)

(1) Min. Ag. Statistics, 1921, Vol. LVI, p. 107 and private communication. No information is available as to actual consumption on farms or as to stocks carried over from one year to another.

| | 1912 | 1918 | 1919 | 1920 | 1921 | 1922 |
|---|---|---|---|---|---|---|
| Sulphate of Ammonia | 60,000 | 250,000 | 240,000 | 240,000 | 112,000 | 147,000 |
| Nitrate of Soda . | 100,000 | 9,000 | 40,000 | 100,000* | 55,000* | 33,000* |
| Superphosphate . | 700,000 | 650,000 | 580,000 | 660,000 | 450,000 | 515,000 |
| Basic Slag . . | 300,000 | 550,000 | 485,000 | 560,000 | 210,000 | 283,000† |
| Potash Salts (including Muriate and Sulphate of Potash) . . . | 80,000 | 5,000 | 50,000 | 125,000 | 53,000 | 201,000 |

* Net imports for all purposes. † Ignoring imports and exports.

Artificial manures influence not only the amount but also the character of the plant growth, and very often the quality of the produce. So long as farmers were confined mainly to farmyard manure they could and did discover for themselves its effects on the crop. But there are now more than thirty manures available for the farmer, and an ingenious chemist could make up over 6,000 different recipes for the potato crop alone, to say nothing of the mixtures required for other crops on the farm ; and to add to the complexity of the matter no manure acts in quite the same way on two different farms, while even on the same farm the effect may vary considerably from season to season. Hence the need for experimental work to discover the general rules by which to guide farmers as to the most suitable of the possible mixtures.

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The experimental work falls under two headings :—

1. The influence of fertilisers on the yield of crops under different conditions of soil and climate;
2. Their effect in altering the composition or quality of the crop.

The effect of fertilisers on crop yield is studied in three ways. The most direct and accurate is the method of water cultures and pot cultures used in the Botanical Department. Here the conditions are so rigidly controlled that the factors, except the one under investigation, are kept as nearly constant as possible. The results are plotted on curves which, if they pass certain statistical tests, can be used as a basis for physiological deductions. Experiments of this kind have shown that the plant responds to two kinds of added substances: the usual nitrogen, phosphorus and potassium compounds required in rather large amounts; and certain substances not yet fully known, which are required in very small amounts only. Agricultural chemists and farmers are familiar with the use of the former, but not of the latter.

Dr. Winifred Brenchley has already studied certain cases, notably manganese, and this year Miss Warington showed that broad beans and certain other leguminous plants die prematurely unless they receive a small quantity of boric acid in addition to the so-called "complete" plant food. The results suggest that some of the anomalies and unexpected failures in fertiliser experience may be traceable to the absence of some of these substances required in homeopathic doses only. But we must caution farmers that this work is still a long way from practical application and they must on no account be beguiled into buying "catalytic" or "radioactive" fertilisers in the hope of getting something outside the usual fertiliser constituents. We have tested several of these supposed "radioactive" fertilisers, but failed to obtain any benefit from them.

This method of experiment is invaluable where the factors can be controlled, but otherwise it breaks down. For this reason it does not give entirely reliable guidance for field practice where the weather conditions are entirely uncontrollable, and it completely fails to show how weather conditions influence the efficiency of the various fertilisers. A second method is therefore adopted. The Rothamsted data, extending as they do over a long series of years, can be subjected to modern methods of mathematical analysis. The variation in crop yield from season to season is traced to two types of causes: (*a*) annual, the variation in each season being independent of the years before and after, *e.g.*, weather; (*b*) continuous acting, of which there are two forms, steady, such as soil-deterioration, and variable, such as weed infestation. Mr. Fisher has devised methods for finding out how much of the variation is due to each of these causes, and has been able to trace out the average effect of rain above or below the average in amount in each month of the plant's life.

Methods are being developed to find out how much the crop yield is likely to be altered by deviations from the average weather and other conditions, and important results may emerge. There must always be a risk about crop yields whatever steps the farmer may take. At present the risks are entirely speculative.

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It is hoped as a result of this work that they may become calculable and therefore insurable, just as is the risk of death. We want to be able to say to farmers, "If your soil and weather conditions are of a certain kind, the chances are so many to one that a specified fertiliser mixture will give an increased crop of so many tons or bushels per acre." The difficulties of the work are very great, but they are being steadily overcome.

Meanwhile, however, the farmer urgently needs precise information about fertilisers, and it becomes necessary to adopt a third method which, though not as accurate as the single factor or the statistical methods already described, nevertheless gives some of the information desired. This consists in repeating a field experiment as exactly as possible at a number of centres carefully chosen to represent important soil and climatic conditions. For example, a Wold farmer sees our experiments, and asks if he could get the same results on his own farm. At present we cannot say, because we do not know the effect of differences in soil type and climatic conditions; but this can be ascertained by repeating one of our typical experiments on a typical Wold farm and then comparing the results with our own. This is being done on some 20 carefully selected farms in different parts of the country.

## FERTILISER INVESTIGATIONS.

In addition to field and pot tests these necessitate a considerable amount of chemical work, which is carried out in the Chemical Department under Mr. Page.

### THE NEW NITROGENOUS MANURES.—UREA.

Our experiments indicate that this substance has a value between that of nitrate of soda and sulphate of ammonia. In addition it has two attractive features—it is highly concentrated and it exerts no harmful influence on the soil (p. 93, p. 101).

### AMMONIUM CHLORIDE.

Experiments made in the past two seasons at Rothamsted and the outside centres show that the yields from ammonium chloride, when those from ammonium sulphate containing an equal amount of nitrogen are put at 100, are:—

| | 1921 | | 1922 | |
|---|---|---|---|---|
| | Rothamsted | Average of all outside centres | Rothamsted | Average of all outside centres |
| Cereals . . | 104 | 117<br>91 * | 103 | 99 |
| Potatoes . | 112 | 112<br>85 * | 110† | 98 |
| Mangolds . | 95 | 95 | | 98 |

* Two groups of results in each case. † With dung. The value without dung was 99.

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