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### War-time Fertiliser Policy (Joint Report by the Departments of Statistics and Chemistry)

**Anon**

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## WAR-TIME FERTILISER POLICY

*(Joint Report by the Departments of Statistics and Chemistry)*

Before the war the amounts of fertiliser used in the United Kingdom were determined by the price structure and the aggregate demands of individual farmers. Early in the war it became apparent that the amounts of phosphate and potash to be imported would raise acute questions. It would be necessary to use every cubic foot of shipping space to best advantage and this would require a scientific assessment of the total amount of shipping space saved in food imports with different levels of fertiliser imports. For this it was necessary to know as accurately as possible the changes in food production that would result from changing amounts of the different classes of fertiliser or raw material.

### RESPONSES TO FERTILISERS

It is a somewhat remarkable fact that no comprehensive summary had previously been made of the results of fertiliser trials conducted in this country. After Dunkirk, it was decided that such a summary should be made as a matter of urgency. The work was carried out with the assistance of various members of other Departments, and a summary of the results of all fertiliser trials in this country since 1900, of which results could be obtained, was communicated in the autumn of 1940 to the Ministries of Agriculture and Supply as a factual basis for a war-time fertiliser policy. As a result of the contacts thus established the administrative and policy-making bodies concerned with fertiliser supplies have worked throughout the war in close association with Rothamsted and a committee of the Conference of Advisory Chemists in considering the scientific and technical problems involved in importing, distributing and using fertilisers.

The summary of experimental results, supported by closely similar ones from other countries in North-West Europe, was published (1) early in 1941 under the title "Fertiliser Policy in War-time," preprints being widely distributed. Subsequently a series of papers was published (2, 3, 4, 5, 6) in agricultural journals to show how the principles of scientific rationing could be applied to practical problems of manuring both during and after the war.

A necessary part of the investigation was to determine the form of the response curves for nitrogen, phosphate and potash in fertilisers or, in other words, to ascertain how on the average the yields varied as the amounts of fertiliser varied. This was required both to estimate the aggregate returns for changing imports and also to standardise results from experiments which had inevitably been carried out at many different rates of dressing. One by-product of the investigation was the demonstration that the response-curve coefficients adopted long ago by E. A. Mitscherlich, though substantially correct for phosphate and potash, were wildly in error for nitrogen. The uncritical application of Mitscherlich's coefficients to field conditions had given rise to such books as "Nations Can Live at Home," in which O. W. Willcox expounded a so-called science of agrobiolgy and maintained that crop yields could be enormously increased by fantastically heavy dressings of inorganic nitrogen fertilisers.



Another by-product of fundamental scientific and immediate practical interest was the establishment of the fact that, though farmyard manure reduces the responses to given amounts of phosphate or potash fertilisers, the crop responses to inorganic nitrogen are almost the same in the presence as in the absence of farmyard manure. Previously it was commonly assumed that the nitrogen in farmyard manure necessarily reduced the response to inorganic nitrogen. Numbers of field experiments had been conducted to find the nitrogen-fertiliser equivalent of farmyard manure. The true situation appears to be that the improved soil conditions resulting from the use of farmyard manure enable the plant to respond to considerably more nitrogen than is supplied in the farmyard manure. There is, therefore, no need to cut down nitrogen fertiliser dressings where farmyard manure has been given. This result affords a good illustration of the general recommendation that farmyard manure and inorganic fertilisers should be regarded as complementary and not as alternative materials.

#### SURVEY OF FERTILISER PRACTICE

The actual increases in food production resulting from a given amount of fertiliser depend on the way in which it is used by farmers. In order to obtain better information on this subject the two Departments pressed for a national survey to discover how farmers actually used their fertilisers, to what crops they were applied, what were the amounts of dressings, and how these varied from farm to farm and district to district.

A preliminary survey of a small district of Hertfordshire was undertaken by Mr. H. W. Gardner of the Hertfordshire Farm Institute primarily to test whether the collection of such information was practicable. A systematic Survey of Fertiliser Practice was eventually commenced in April, 1942 in three Advisory Provinces, Bristol, Cambridge and Leeds. The results were utilised as they became available as an aid in framing policy, and a preliminary account of the results of the first three provinces has been published (5). The survey is conducted by field workers under the direction of the Advisory Chemists. These workers visit a random selection of farms, and on each farm select at random one field of old arable land and one of new arable land for each crop grown, and also one or more permanent grass fields. The amounts and compositions of the fertilisers applied to these fields and the crops grown over the preceding three years are ascertained from information given by the farmer, and soil samples are taken for analysis from one old arable, one new arable and one grass field.

The survey has provided quantitative evidence to substantiate a number of general impressions, but it has also revealed certain unsuspected defects. Thus it was to be expected that farmers in the pre-war grassland districts would use less fertiliser on their new arable crops than farmers in the old arable areas. It was not, however, realised how generally farmers would fail to recognise the deficiencies of lime and phosphate in their newly ploughed grassland. These two facts taken together had the result that cereals on the new arable land received on the average less phosphate than those on the old arable land. A substantial improvement in the use of limited rations of phosphate could have been effected had farmers



as a whole not overlooked the important difference in nutrient status between old arable and old grassland. Part of the blame for this mistake must be attributed to over-generalised statements about the nature of stored-up fertility. Old grassland tends to accumulate nitrogen in organic matter (humus) but it generally becomes deficient in available phosphate and lime, especially in the wetter districts. When old grassland is ploughed up it may supply adequate or sometimes even excessive amounts of readily available nitrogen, but quite inadequate amounts of lime and phosphate for arable crops. Soil fertility is a complex of many factors, and a potentially fertile soil may still lack one or more of the essential plant nutrients.

## PUBLICATIONS

1. CROWTHER, E. M. and YATES, F. 1941. *Fertiliser policy in wartime: The fertiliser requirements of arable crops*. *Emp. J. Exp. Agric.* **9**, 77-97.

In order to formulate a flexible fertiliser policy which will ensure maximum agricultural production and make the best use of available fertiliser supplies, all published results of one-year fertiliser experiments conducted since 1900 in Great Britain on the main arable crops, and also of similar series of experiments in other northern European countries, have been summarised.

The main conclusions are as follows:

(a) The responses to phosphate and potash are substantially reduced when dung is applied, but crops are equally responsive to inorganic nitrogen on dunged and undunged land. Consequently smaller dressings of phosphate and potash are required on dunged land, but no reduction should be made in the nitrogenous dressings.

(b) The pre-war level of nitrogenous manuring, both in absolute amount and relative to that of the other fertilisers, was too low, particularly where dung was also given. Considerable increases in agricultural production would result from the greater use of nitrogen, especially on cereals.

(c) Additional phosphate is needed for root crops, especially in the wetter districts and on phosphate-deficient soils, including much of the newly ploughed grassland. Cereals also need phosphate on these deficient soils, but not on old arable land in good condition.

(d) The general policy of making fertilisers in short supply available only for the most responsive crops (already adopted in the case of potash) is the correct one. Potatoes should receive potash, even in the presence of dung, unless supplies are very short.

(e) The responses to phosphate and potash (in contrast to nitrogen) vary markedly with soils and districts. Consequently, in order to ensure the most efficient utilisation of soil reserves and fertiliser supplies, local knowledge or soil analysis should be used as far as possible.

2. CROWTHER, E. M. 1941. *Making the most of fertilisers*. *Farmer and Stockbreeder*, **55**, 386.
3. CROWTHER, E. M. 1942. *Nitrogen: a cycle of benefit*. *Farmer and Stockbreeder*, **56**, 349.

A general article on the value of sulphate of ammonia in the food production campaign.

4. CROWTHER, E. M. 1942. *Fertiliser policy on the farm*. *J. Min. Agric.* **49**, 68-79.

The fertiliser permit scheme for England and Wales for the 1942-43 season is described, and recommendations given for utilising to best advantage the amounts of phosphate and potash available.

5. CROWTHER, E. M. 1942. *Manuring under a fertiliser rationing scheme*. *J.R.A.S.E.*, **103**, 150-160.

The war-time use of fertilisers is discussed in relation to the supplies available, the rate of action and residual values of fertilisers, and the conservation of plant foods on the farm.



6. CROWTHER, E. M. 1945. *Fertilisers during the war and after*. Bath and West and Southern Counties Society. Pamphlet No. 13, pp. 51.

A review of the wartime developments and future prospects in the use of fertilisers in Great Britain. The results of large numbers of field experiments are summarised as average responses to increasing amounts of nitrogen, phosphoric acid and potash under various conditions, and then used to show how the most profitable dressings can be worked out. Practical recommendations are compared with those obtainable under the wartime rationing schemes, and with the actual average practice of farmers as revealed in random sampling surveys. Attention is directed to a number of points in which useful improvements and economies could be made in the better use of farmyard manure, ground limestone and fertilisers. The relative merits of some of the alternative fertilisers are considered, and some promising new developments are outlined. Detailed tables are given to show the composition and relative costs of the principal straight fertilisers and compound fertilisers, the advantage of using a restricted number of standard compounds, and some current discrepancies between the relative costs of concentrated and ordinary compound fertilisers.

7. YATES, F., BOYD, D. A., and MATHISON, I. 1944. *The manuring of farm crops : Some results of a survey of fertiliser practice in England*. *Emp. J. Exp. Agric.*, **12**, 164-176.

The report presented some of the main findings of the survey which had immediate relevance from the point of view of improving the use of fertilisers.

Generally speaking, districts which have always depended mainly on arable cropping use adequate amounts of fertilisers, and make satisfactory differentiation between the needs of different crops. Even in these districts, however, the special needs of newly ploughed-out grassland have not been fully recognised, and crops tend to be manured without regard to the land on which they are grown. The report covers counties in the Advisory Provinces of Cambridge, Bristol and Leeds, and in the main the report relates to the manuring of the 1942 crops.

Farmers in the dairy and cattle-raising districts of the west of England and Yorkshire, who before the war had had little experience of arable farming, are much less "fertiliser conscious" than farmers in the eastern arable counties, and make insufficient use of fertilisers, even on old arable land. For example, the manuring of root crops is frequently ill balanced and inadequate in the western counties; although very large supplies of farmyard manure are available, almost one-third of the root acreage received none, and many fields received no phosphate or no nitrogen. Even within the chief arable districts there were many farms, mainly in grass before the war (e.g., in West Bedford and South Essex), which make less effective use of fertilisers than their neighbours with greater experience of arable farming.

As a consequence, the use of lime and phosphate on new arable land has been quite inadequate over most of the surveyed area. The survey has confirmed (what has already been frequently emphasised) that new arable land is generally both much more acid and much more deficient in phosphate than old arable, but it is apparent that except in one or two districts this land has received less lime and less phosphate in recent years than has the old arable land.

The failure to recognise the function of farmyard manure as a source of phosphate, and more particularly, potash, is also striking. The survey shows that farmers require encouragement to use mixtures with a lower proportion of phosphate and potash where farmyard manure is also given.

The failure to distinguish clearly between the different action of the various plant nutrients has also led to an inadequate use of nitrogen on cereals grown after roots, presumably owing to the belief that the heavy manuring of the roots will have led to sufficient stored-up fertility. Certainly in those cases where only inorganic nitrogen has been used to manure the root crop, there is every reason to give a reasonably nitrogenous dressing to the following corn. There are also wide differences from farm to farm in the use of nitrogen on cereals, and it is clear that some farmers, at least, could profitably make greater use of this fertiliser. Only half the acreage of cereals in the surveyed provinces actually received nitrogen, and it is unlikely that a higher proportion receives nitrogen in the country as a whole.