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Rothamsted - the Classical Experiments

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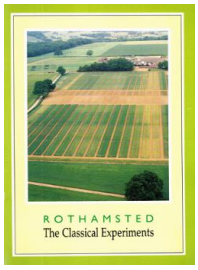

Introduction

Rothamsted Research

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INTRODUCTION

Between 1843 and 1856 Lawes and Gilbert started nine long-term experiments, of which they abandoned only one, in 1878. Some of the plot treatments were changed during the first few years and later further changes were made to a few plots to answer specific questions raised by the results. When Lawes died in 1900 the eight remaining experiments were continuing more or less as originally planned; these are called the 'Rothamsted Classical Experiments'.

Their main object was to measure the effects on crop yields of inorganic compounds containing nitrogen, phosphorus, potassium, sodium and magnesium, elements known to occur in considerable amounts in crops and farmyard manure, but whose separate actions as plant foods had not been studied systematically. The materials used were superphosphate (at first made by mixing bones and sulphuric acid for each experiment) and the sulphates of potash, soda and magnesia (often referred to then, and in this Guide, as minerals) and ammonium salts and nitrate of soda (as alternative sources of nitrogen). The effects of these inorganic fertilizers were compared with those of farmyard manure and rape cake in most of the experiments. The inorganic fertilizers were tested alone and in various combinations. Nitrogen was often applied at two or more rates.

Growing the same crop each year on the same land was a feature of many of the experiments. This practice, considered bad farming in the nineteenth century, is now common in cereal growing and has given added interest to the experiments.

Lawes and Gilbert recorded the weights of all produce harvested from each plot, and samples were kept for chemical analysis. These results, together with details of the quantity and composition of each fertilizer applied, enabled a balance sheet for the major nutrients to be compiled for each plot. Analysis of soil samples showed how nitrogen, phosphate and potash accumulated or diminished in soil depending on fertilizer applications, offtakes in crops and losses from leaching in drainage water.

The results were of immediate importance to farmers, showing which nutrients had the largest effects on different crops. However, their value to farmers diminished as the contrasted processes of depletion and enrichment of nutrients went on, progressively reinforcing the effect of each annual application of the manures. In addition the annual application of FYM caused the soil humus content of fertilizer- and FYM-treated soils to become progressively different. Until about 1939 the best yields obtained on each experiment were roughly equal to the average yields of the same crops grown on English farms. After 1939 with better-yielding varieties and increased use of fertilizers English farm yields exceeded those of the Classicals, until the recent modifications.

The Classical experiments have been modified occasionally since Lawes's death. Sir Daniel Hall, in 1903-06, added a few plots to Broadbalk, Park Grass and Barnfield, mainly to test the combination NKNaMg (that is, all major nutrients except P) which had been omitted from these experiments. Hall also started the first scheme of regular liming on Park Grass, the only Classical experiment not on a neutral or slightly calcareous soil. (The others were on old arable fields and had received the traditional heavy dressings of locally

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dug chalk, a practice not followed on grassland.) A differential liming scheme started on Park Grass in 1965.

From 1957 several of the Classical experiments were modified to evaluate the residual effects of the annually repeated dressings of different combinations of nutrients. This was done for a range of crops (often several crops grown side by side on each of the original plots, as on the Exhaustion Land, Barnfield and Agdell) by subdividing the old plots to test new fertilizer treatments. These modifications, together with detailed analysis of the soil by several methods, gave much information on the value of the accumulated residues of materials applied in the past.

On Broadbalk and Hoosfield Barley crop rotations were introduced in 1968 although substantial areas of each experiment remained in the traditional crops. The rotations were:

Broadbalk: Potatoes, spring beans, winter wheat.
Hoosfield Barley: Potatoes, spring beans, spring barley.

Beans became seriously infested with stem eelworm (*Ditylenchus dipsaci*) and they were not sown after 1978. On Broadbalk the rotation is now:

Fallow, potatoes, winter wheat, winter wheat, winter wheat.

and on Hoosfield Barley the whole area has returned to continuous spring barley. The crop rotations have shown the extent to which the yields of wheat and barley can be increased when soil-borne diseases and pests are lessened by growing non-susceptible crops for two years.

Barnfield, formerly a Classical experiment with mangolds and sugar beet, has been progressively modified since 1960 and is at present in ley.

Another major change introduced in 1968 except on Park Grass was the replacement of sulphate of ammonia and nitrate of soda by ammonium nitrate initially as 'Nitro-Chalk' now as 'Nitram'. Castor meal has been discontinued, but its residual value is assessed. Most of the applications of sodium (as sulphate or chloride) have been discontinued. On Broadbalk, Hoosfield Barley and Barnfield magnesium is now applied as kieserite (replacing Epsom salts), every third year except for certain plots.

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