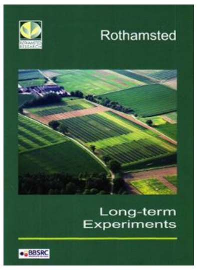
ROTHAMSTED RESEARCH

The Long Term Experiments

Full Table of Content



At Woburn

Rothamsted Research

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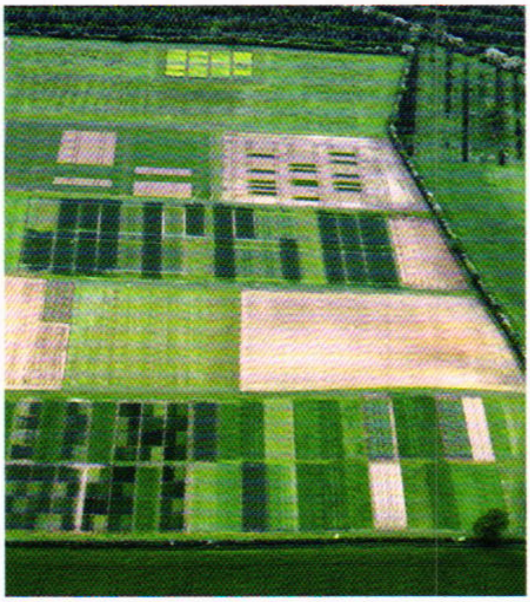
AT WOBURN

Experiments at Woburn began in 1876 under the auspices of the Royal Agricultural Society of England. The principal aim was to test the residual manurial value to crops of two contrasted feedstuffs fed to animals in covered yards or on the land. Rothamsted took over the management of the farm in the 1920s. In contrast to the silty clay loam at Rothamsted, which, typically, contains 20-40% clay, much of the soil at Woburn is a sandy loam containing about 8-14% clay. It is much more difficult to maintain or increase SOM on this soil, and several of the long-term experiments at Woburn were established to study the effects of management on SOM and yield.



Ley-arable (foreground) and Organic Manuring (middle) experiments at Woburn

The Intensive Cereals experiment (winter wheat and spring barley grown continuously to mirror those at Rothamsted) started in 1876. Unlike most of the arable soils at Rothamsted, those at Woburn contained little or no free calcium carbonate and the soil pH was probably *c*.6. Consequently, within 20 years the experiment ran into problems with soil acidification where ammonium sulphate was applied, and yields declined markedly. Although the first experiments on liming in the UK were started on these plots in 1897 yields did not recover to their former level. In retrospect, it is possible that yields were also affected by cereal cyst nematodes, which can be a problem with continuous cereals on lighter textured soils. For many years, the yields remained poor, and the site was divided for a number of other experiments. One tested the effects of growing grass-clover leys for one to six years on the yield of subsequent arable crops. Yields of up to 9.0 t ha^{-1} of wheat grain and 75 t ha^{-1} of potato tubers were achieved following the longer leys.

The Ley-arable experiment started in 1938 to compare the effects of rotations with or without grass or grass-clover leys on SOM and the yield of two arable test crops. Soils at Woburn that have been in continuous arable cropping since 1876 contain about 0.8 % C, and %C is still declining slowly; soils that have alternated between 3-year leys and 2-years arable since 1938 contain about 1.2 % C. Effects on the yield of the first test crop, winter wheat, are shown in Figure 9. Typically, where no fertiliser N is applied, yields are greater following the grass leys than in the continuous arable sequence because more N is available from the mineralisation of SOM. Following grass-clover leys, yield is increased further because of the extra N being made available from the breakdown of the leguminous residues. Following the leys, a larger yield is often achieved, with less fertiliser N, compared with continuous arable cropping.

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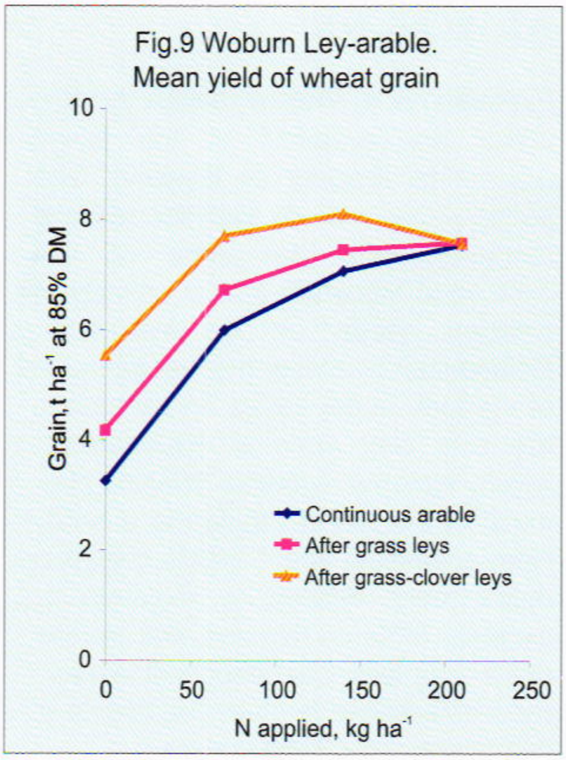
The Market Garden experiment started in 1942, originally to look at the effects on SOM and crop yield of various organic inputs; namely FYM, compost and sewage sludge. The experiment was grass from 1974 to 1982. When concerns were expressed in the late 1970s about the heavy metal content of sewage sludges being applied to agricultural land, the experiment was "re-activated" to examine the fate of metals that had been applied in the sewage sludge between 1942 and 1961. The value of archiving samples was well demonstrated because soils and samples of sewage sludge from the earlier phase of the experiment had been saved. It was, therefore, possible to compile, for various metals, a budget of the amount applied and the amount remaining in the soil. Total zinc (Zn) and cadmium (Cd) concentrations in the topsoil were much higher in sludge-amended plots than with other treatments. Calculations suggest that about 80% of the metal load applied between 1942 and 1961 remained in the soil, predominantly in the top 27cm. From 1983, crops potentially sensitive to heavy metals were grown and analysed, as was the soil. Uptakes of Zn and Cd by these crops were minimal, although concentrations of *e.g*. Cd in barley grain could exceed current guidelines when grown on soils with high Cd contents. The heavy metals applied in the sludge also affected the soil microbial biomass; more than 20 years after the last application, the total amount of biomass in sludge-amended soils, was half that in low-metal soils. It was also found that a strain of *Rhizobium* (*R. leguminosarum* biovar *trifolii*) involved in symbiotic N_2 fixation in clover (*Trifolium repens*) was ineffective at N_2 fixation in sludge-amended soils but remained effective in FYM and control soils. Clover grown on the metal-contaminated plots yielded 60% less dry matter than clover grown on uncontaminated plots. Although the permitted levels of metals in sludges are now much lower than those used in the Market Garden experiment, findings from the experiment are still relevant and were used to help formulate EU legislation regarding loadings for heavy metals in soil. The experiment is now being used to evaluate the effectiveness of hyperaccumulator plants, *i.e*. plants that can naturally accumulate large amounts of metals from soils and which, potentially, could be used to "clean up" soils contaminated with heavy metals.



Other long-term trials at Woburn include the Organic Manuring experiment, which started in 1964, and further experiments on heavy metals, incorporating straw and continuous maize (the latter two experiments duplicating those on the heavier soil at Rothamsted).

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