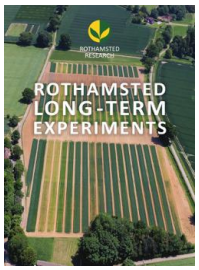
Guide to the Classical and Other Long-term Experiments, Datasets and Sample Archive



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OTHER LONG-TERM EXPERIMENTS

In addition to the Classical experiments started by Lawes and Gilbert, there are several other long-term experiments at Rothamsted and at Woburn on contrasting soil types. Some of these are described below.

At Rothamsted

Highfield and Fosters Ley-arable Experiments

The Ley-arable experiments at Rothamsted, on Highfield and Fosters fields, started in 1949 (Johnston, 1973). Their purpose was to look at the effects of different cropping systems on yield and soil organic matter. The two sites have the same soil type but very different cropping histories. Highfield had been in permanent grass since 1838; on this site some plots stayed in permanent grass, others went into continuous arable cropping and some alternated between leys and arable. Fosters had been in arable cropping for several centuries; on this site some plots stayed in continuous arable, some went into permanent grass and others alternated between leys and arable. Although we no longer measure yields we continue to monitor SOM. Figure 10 shows that, it has taken about 60 years for soils to approach a stable equilibrium following changes in the cropping systems. Thus, in soils ploughed out of permanent grass or put into permanent grass after arable cropping the SOM is now relatively constant.

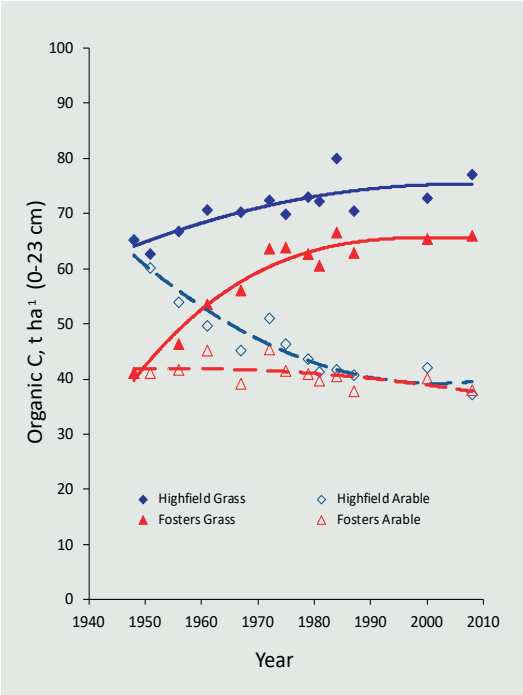

Fig. 10 Highfield and Fosters Ley-arable; changes in the amount of soil carbon in the top-soil (0-23 cm), 1949-2008. Data has been adjusted for changes in bulk density.

The Long-term Miscanthus Experiment

Other work at Rothamsted has focussed on non-food crops, including Miscanthus, a perennial grass originating mainly from east Asia. *Miscanthus* x *giganteus* is a naturally occurring hybrid between *M. sinensis* and *M. sacchariflorus* thought to have originated in Japan. It was first recorded in European botanical gardens in the 1930s but it wasn't until 50 years later that researchers interested in renewable energy began to take an interest in its suitability as an energy crop.

Miscanthus utilises the C4 pathway for photosynthesis but unusually amongst C4 grasses shows good low temperature adaptation. For cooler northern areas of Europe this introduced the possibility of capitalising on the advantages of the C4 pathway, namely; lower nitrogen requirement, greater water use efficiency and greater ability to utilise high light intensities, when compared to C3 grasses. As a perennial, *M.* x *giganteus* offered savings on cultivation costs plus the potential for increasing soil carbon content, giving the crop a favourable Life Cycle Analysis compared to annual crops. When research work began, it became evident that the perennial cycle also involved nutrient

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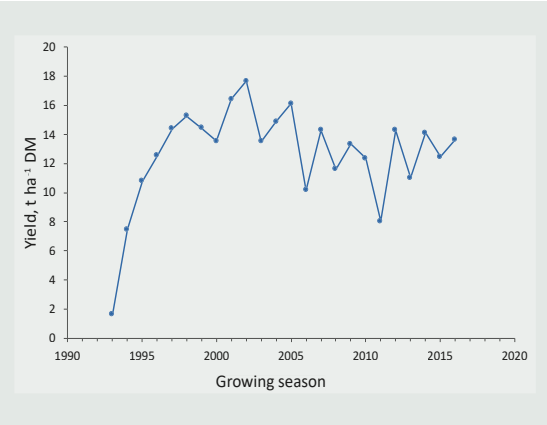

Fig. 11 Rothamsted; yield of *Miscanthus x giganteous*, 1993-2016.

remobilisation between the rhizome and shoots and *vice versa*. The nett effect being efficient utilisation of nutrients, especially N, and, if harvested when fully senesced (early spring of the year following growth) a biomass fuel low in contaminants such as N, K, S and Cl.

Rothamsted Research first planted *M*. x *giganteus* in spring 1993. The belief at that time was that a crop may remain productive for 20 years. As Figure 11 shows, following an establishment phase of 3 years the Rothamsted crop has remained productive for a total of 24 years. Seasonal variation is clear, but there is no sign of a yield decline. Very few of the experimental crops planted around Europe between 1988 (the earliest known planting as a crop) and 1993 remain in place. The Rothamsted crop is certainly one of the oldest stands in the world, if not the oldest. This experiment is maintained to determine how long a single planting may remain productive and to monitor for pests and diseases that may threaten that productivity.

The Large-scale Rotation Experiments (LSREs): new long-term experiments

The Rothamsted long-term experiments have proved to be a unique resource for understanding the behaviour of agricultural systems over decadal time scales. However, the potential to use the existing experiments to answer new questions is sometimes limited by the need to maintain the original treatment structure, the lack of replication and plot size. To address these constraints, a new long-term experiment, supported by the Lawes Agricultural Trust, has been set up on the Rothamsted farm at Broom's Barn (Suffolk). The new experiment compares contrasting farming systems with multiple interacting factors. Treatments were chosen that would impact on a wide range of agronomic and environmental response variables as well as addressing issues relevant to modern farming systems. The experiment was established at Broom's Barn in autumn 2017 and a similar experiment started at Harpenden in autumn 2018.

The main treatment is crop rotation with large 24 x 24m plots in one of three rotations: a three-year rotation aiming at short-term economic return, a five-year rotation with a greater diversity of crops (including cover crops) and a seven-year rotation designed for increased environmental sustainability (also including cover crops and a two-year ley). A second treatment of contrasting soil cultivation is also included: either annual ploughing or zero tillage (using a direct drill). The main plots are also split with half receiving organic amendments. Each phase of each rotation is present in every year in all treatment combinations. The design also includes the flexibility to test contrasting crop protection strategies. These new LSREs will serve as valuable experimental platforms in the coming years for integrating the breadth of science covered by Rothamsted Research and informing the design of future farming systems with the aim of increasing yields while reducing the impact on the environment.

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