The Rothamsted Long-Term Experiments: A Continuing Resource for Agriculture and Environmental Research for over 170 Years.

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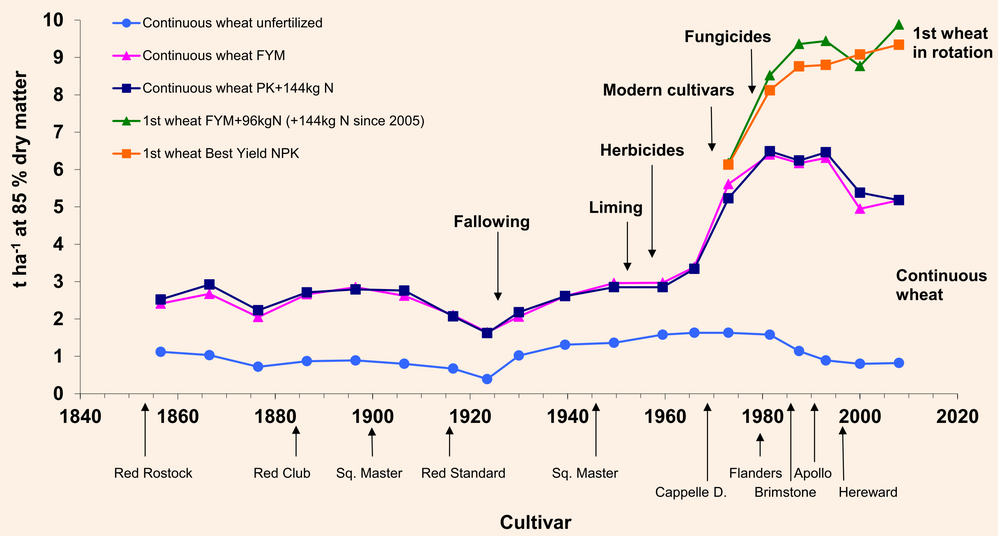
Agro-ecological research began at Rothamsted in 1843 when the first of the "Classical" field experiments was established by Lawes and Gilbert. Some of these experiments still continue and form part of the Rothamsted Long-Term Experiments National Capability. Amongst the best known of these experiments are the Broadbalk Winter Wheat Experiment (started 1843) and the Hoosfield Spring Barley Experiment (started 1852).

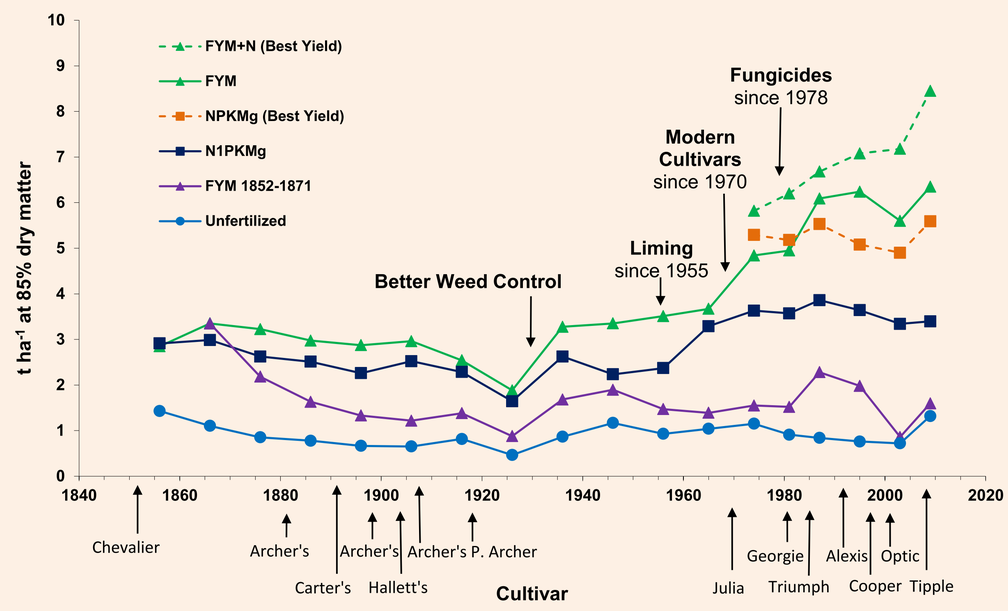
Initial research focussed on the value of fertilisers and farmyard manure (FYM) for crop production, but, over time, the experiments have been modified to include the use of lime, herbicides, fungicides, new crop varieties and higher N rates to ensure that they remain relevant to current agricultural issues whilst maintaining their long-term integrity. About 300 000 samples of dried plant and soil material, collected from the experiments since the 1840's, are stored in the Rothamsted Sample Archive. Data from the experiments, along with associated meteorological data, are stored in the electronic Rothamsted Archive (e-RA) and are accessible via the e-RA website (www.era.rothamsted.ac.uk). Selected yield data for Broadbalk and Hoosfield are shown below.

Broadbalk. Mean long-term winter wheat grain yields



The Rothamsted Sample Archive

Hoosfield. Mean long-term spring barley grain yields



On Broadbalk, yields of continuous winter wheat (autumn sown) given no fertiliser or FYM (but now with lime and pesticides) have continued at c.1 t ha^{-1}. Mean yields with PKMg+144 kg N ha^{-1} are similar to those from 35 t FYM ha^{-1}. After the change to shorter-strawed cultivars in 1968, mean grain yields on both treatments doubled to c.5 t ha^{-1}. Since 1979, summer fungicides have been used when necessary, and responses to fertiliser N increased, prompting an increase in the amounts of N tested. On average, only continuous wheat responded to the larger amounts of N. Yields of wheat grown after a 2yr break can be more than 2 t ha^{-1} larger than yields of continuous wheat, almost certainly because the effects of soil borne pests and disease, particularly take-all (*Gaeumannomyces graminis* var. *tritici*), are minimised. With the current cultivar (Crusoe) best yields are now about 13 t ha^{-1} for the first wheat after a 2yr break.

On the Hoosfield Spring Barley Experiment yields also responded to the change to short-strawed cultivars in 1970, larger amounts of N and the use of fungicides since 1978. Maximum yields are only obtained where soil organic carbon content has been increased through applications of FYM. Applying FYM for only 5 years increased yields almost as much as long-term applications (>160 years). But, as on Broadbalk, continued use of FYM led to large nitrate leaching losses.

These and other long-term experiments have been used to study numerous other topics (Macdonald *et al*, 2015) including:

- Soil carbon and nitrogen turnover
- Impacts of organic carbon content on soil physical properties
- Micronutrient concentrations in wheat grain and human nutrition
- Plant gene expression in relation to different manuring regimes
- Soil metagenomics and microbial diversity
- Crop pathogen diversity and atmospheric sulphur deposition
- Development of fungicide resistance in plant pathogens
- Weed population dynamics in arable cropping
- Plant species diversity in semi-natural grassland

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Macdonald *et al* (2015) Valuing long-term sites and experiments for agriculture and ecology. Aspects of Applied Biology, 128, 1-10.
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