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Woburn Experimental Farm

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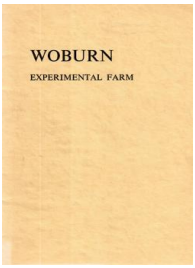

History

Rothamsted Research

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Woburn Experimental Farm

History

The agricultural background

Woburn Experimental Farm owes its existence to the Agricultural Holdings Act (England) 1875 which affected some of the relations between landlord and tenant. The need for this legislation arose gradually during the eighteenth and early nineteenth centuries as progressive tenant farmers sought to improve the productivity of their holdings. Such farmers soon found that increased productivity could only be achieved if money was spent on new and improved buildings, fences, draining, marling and chalking and on the purchase of extra feedingstuffs for their stock and manures for their crops. Tenant farmers were deterred from making such improvements because the existing laws of agricultural tenures gave no security for any capital invested. However, in various parts of the country, notably Lincolnshire, customs had arisen whereby landlords compensated tenants leaving their holdings for the value of any unexhausted improvements.

The value of this custom, often known as the 'custom of the country', was appreciated by Philip Pusey (1799–1855). The Pusey estates extended to about 5000 acres (2025 ha) in Berkshire and Philip Pusey was a founder member in 1838 of the English Agricultural Society which in 1840 became the Royal Agricultural Society of England (RASE). He was President of the Society in 1840–41 and again in 1853–54 and the first Chairman of the Society's Journal Committee and the effective editor of the Journal until 1855. Many of his articles and editorial comments show that Pusey was an advocate of 'Farmers Tenant Right'. He first introduced the term 'tenant right' in the House of Commons in the late 1840s after bills designed to give an agricultural tenant compensation for unexhausted improvements had been introduced without success in the House of Lords in the early 1840s. Pusey saw that, partly as a result of the Napoleonic Wars, there had for long been too little capital invested in agriculture. His remedy was to encourage tenant farmers to invest their own money and he saw the Lincolnshire Covenants as a way of financially compensating a tenant for any improvement, the benefit of which could not have been fully realised when he gave up the tenancy. The report of Pusey's Agricultural Customs Committee (1848) formed the basis of subsequent legislation on tenant right, first in the Landlord and Tenant Act of 1851, which gave only a few rights to the tenant, and then in the much more comprehensive Agricultural Holdings Act (England) 1875.

The 1875 Act was preceded by the Irish Land Act of 1870 which awarded compensation to an outgoing tenant for 'tillages, manures and other like farming works, the benefit of which is unexhausted at the time of the tenant quitting his holding'. If landlord and tenant could not agree on the compensation then arbitration was necessary and J. B. Lawes of Rothamsted was called as a scientific witness in one such case. This experience led him to comment that 'the Act is very explicit in all that related to the legal machinery

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by which claims may be tried or established; but it gives no information as to what constitutes unexhausted value, or how that value is to be estimated'. Pusey's Committee report shows that most local customs awarded compensation based on cost, but as early as 1862 Lawes thought this had little merit for purchased feedingstuffs given to animals.

Lawes and his co-worker Gilbert are now best remembered for their experiments on crops but they also did work on animal feeding at Rothamsted. They showed that only a small proportion of *plant nutrients* (N, P and K) in feedingstuffs were retained in the increased bodyweight of fattening stock or removed from the farm in dairy produce. The excess was in the dung and urine. Lawes and Gilbert estimated the amounts of N, P and K excreted by stock when they consumed a ton of each feedingstuff. The cost of buying these amounts of N, P and K at the current prices of purchased manures was calculated and called the original manure value of the feedingstuff. In 1875 Lawes published his first table of such values which, in some cases, bore little relation to the cost of the feedingstuff. Foods rich in carbohydrate or oil, highly esteemed for feeding to fattening stock, were costly but the dung produced contained little N, P and K. For example, in 1876 the purchase price per ton of linseed cake, decorticated cotton cake and barley meal was £12.50, £10.00 and £9.25 respectively; Lawes calculated their original manure values to be £4.62, £6.50 and £1.10.

Thus Lawes and Gilbert provided experimental evidence for paying compensation for purchased feedingstuffs and showed that this should be on the basis of manure value and not initial cost. In 1875 Lawes also pointed out that deductions should be made from the original manure value not only for losses, especially of N, that occurred in making manure but also for the number of crops grown after its application to the land. He tentatively suggested a 20% decrease for losses and writing off the manurial effect over three years.

The 1875 Act divided improvements which might be undertaken by a tenant into three classes.

Class 1 included drainage of land, erection or enlargement of buildings, laying down permanent pasture, making roads, bridges, fences.

Class 2 included chalking of land, clay burning, claying, liming and marling of land.

Class 3 was (1) application to land of purchased artificial or other purchased manures.
(2) consumption on the holding by cattle, sheep or pigs of cake or other feedingstuff not produced on the holding.

It was suggested that unexhausted values for improvements in class 3 would probably be written off over a period not exceeding two years and would not be payable if applied for a crop of corn, potatoes, hay or seeds or other exhausting crop. The small amounts of purchased artificial manures used at that time were probably applied to exhaustive crops and so were automatically excluded from claims for compensation. The restrictive clause did not appear in the 1883 Act, which repealed all existing Acts, but it is unlikely that this led immediately to a large number of claims. However, as fertiliser use increased, claims became more numerous and in the early years of this century the Central Association of Agricultural and Tenant-Right Valuers asked Voelcker and Hall if they could produce a table of compensation for artificial manures.

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Voelcker and Hall's table, which was headed 'From such data as are available the following Scale of Compensation may be taken as some guide', was first published in 1913; it included a range of artificial manures, fertilisers and lime.

Thus the 1875 Act gave a tenant the right to compensation but the amount had to be settled by agreement or arbitration. The manurial value of feedingstuffs became a much debated topic, not least within the RASE, because landlords and tenants wished to know if Lawes's tables could be relied on. Early in 1876 Dr J. C. A. Voelcker, Consulting Chemist to the RASE (p. 6), published a paper supporting Lawes's calculation of manurial values but suggested that the deduction for losses of N should be much nearer 50% rather than Lawes's 20% (Voelcker, 1876).

The RASE and the Duke of Bedford

At an RASE Council Meeting in November 1875, Mr C. Randell stressed the desirability of settling the matter of manurial values by direct experiments on different soils and under different conditions. The matter was referred to the Chemical Committee of the RASE; they acted with praiseworthy speed. In February 1876 they heard statements from scientific witnesses, Lawes and Voelcker amongst them, and from various 'practical' men, farmers and valuers. The Committee reported to Council in April that there was general support for Lawes's table but they stressed the need for supporting experimental evidence. It was suggested that this might be got by ordinary farmers making experiments in the course of their farm practice but the majority view was that these experiments would not be sufficiently accurate for the results to command confidence. At the same time there were few people with the necessary expertise to make field experiments.

The situation was resolved, as so often, by a compromise. The then Duke of Bedford (Hastings Russell, the 9th Duke), who was a Vice-President of the RASE, was aware of the value of experiments; records show that from as early as 1811 experiments with various manures had been made at Woburn. The Duke offered the RASE possession of a farm on the Woburn Estate and money to pay for experiments if the Society would be responsible for them and for the management of the farm. The offer was accepted, the Chemical Committee, renamed the Chemical and Woburn Committee, were made responsible and Lawes and Voelcker were asked to design suitable experiments.

Crawley Mill Farm, Husborne Crawley, with a granary and brick-kiln ground (now the large lake near the farm buildings) was selected. Letters in Estate archives suggest that the outgoing tenant requested what was considered to be excessive compensation for loss of tenancy and tenant right.

However no single field on the farm was large enough to make the proposed experiment on the manurial value of different feedingstuffs. The Duke therefore arranged to rent Stackyard Field from the tenant of Birchmore Farm. Although a mile from Crawley Mill Farm this was the only suitable field in the district. The original arrangement was for the Duke to pay £2 per acre each year for seven years but the tenant died during this period and the Estate apparently took the opportunity of adding Stackyard Field to Crawley Mill Farm.

Correspondence in the archives shows that nearly all the preliminary arrangements with the Duke's agent were made by Lawes. The Chemical

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Committee of the RASE became tenants at will of Crawley Mill Farm and Stackyard Field from Michaelmas 1876 at an agreed rent, paid to the Estate, which was about average for the class of land. The farm then consisted of 90 acres (36 ha) of which 67 acres were arable and 23 grass; Stackyard Field was just over 26 acres (10·5 ha). The acreage was increased again, at Michaelmas 1879, when Warren Field (about 14 acres) was made available for experiments on soluble and insoluble P fertilisers applied to arable crops. The account of this experiment shows that steam tackle was used for the preliminary cultivation of this heavy land. There were no buildings at the farm suitable for animal feeding experiments but during 1876 a building containing eight feeding boxes, each with cemented floor and rendered walls to prevent seepage, was built at the Duke's expense. In addition a weighbridge was installed. The first feeding experiments were made during the winter of 1876–77. The feeding boxes have only recently been demolished to make way for a potato store.

The accounts show that requests to the Duke for money were always met promptly. The 10th Duke continued to support the farm and so did the 11th Duke until 1912; the reasons for withdrawing are given later (p. 8). The cost to successive Dukes of Bedford was about £600 a year during the period 1876–1912.

The opportunity for making experiments on the light sandy loam soil at Woburn led Lawes and Voelcker to propose not only an experiment on the manurial value of different animal feedingstuffs but also experiments on the continuous growing of both winter wheat and spring barley. There was much discussion at that time whether Lawes and Gilbert's success in growing corn crops continuously on the heavier clay loam soils at Rothamsted could be repeated on light land. Today many farmers enjoy freedom of cropping and husbandry not allowed to the tenant farmer of the 1870s. Then the tenancy agreement often dictated the rotation to be followed and restricted what could be sold off the farm. There is a copy of a letter in the Woburn archives which refused a tenant permission to take a second successive cereal crop after a crop of sainfoin.

The first crops of wheat and barley were harvested in 1877 and in that year the feeding experiment was started on half of the 16 acres it was to occupy. Lawes and Voelcker reported the results in detail in the RASE Journal in 1878, the only report signed by both of them. Lawes seems to have resented interference by the Woburn Committee which had appointed a Mr Cathcart to superintend the experiments under the direction of Lawes. Cathcart was apparently censured for devoting too much effort to the experiments on Stackyard and not enough to making a commercial success of the rest of the farm, which was in a poor condition when taken over. Cathcart left to become Professor of Agriculture at Cirencester and Voelcker assumed responsibility for the experimental programme. Although both Lawes and Gilbert continued their interest in the results from Woburn, neither became personally involved again.

The Voelckers, father and son

Dr J. C. Augustus Voelcker (1822–84) was born in Germany, studied chemistry at Göttingen and worked for a short while with Liebig at Giessen and in Holland. In 1847 he was persuaded to go to the Agricultural Chemistry

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Association of Scotland's laboratory in Edinburgh, where he was both analyst and consulting chemist. He was appointed Professor of Chemistry at the Royal Agricultural College, Cirencester in 1849 and Consulting Chemist to the RASE in 1857. During 1857–62 he retained his Professorship at Cirencester and this gave him the opportunity to make field experiments there whilst the associated laboratory work was done in London. In this period he studied both the effects of storage on the composition of farmyard manure (FYM) and the capacity of soils to absorb ammonia, potassium and sodium. During the early 1860s he worked extensively on milk and dairy products. One of his major analytical studies was on the composition of drainage waters from soils given different manurial treatments on Broadbalk at Rothamsted. These analyses established that nitrate, sulphate, chloride, calcium and magnesium were lost in land drainage but that phosphorus and potassium were largely retained by the clay loam soil.

As Consulting Chemist to the RASE he analysed purchased feedingstuffs and manures for members. His reports, often exposing cases of adulteration or poor value for money, were published in the Society's Journal and so did much to raise the standard of materials offered for sale. He also had his own laboratories and did consultancy work. Voelcker and Gilbert were both extremely competent analysts and well acquainted professionally.

When Voelcker died in 1884 his son, John Augustus, succeeded him both as Consultant Chemist to the RASE and as Director of the Woburn Farm. J. A. Voelcker (1854–1937) graduated from University College, London and then studied for his Ph.D. at Giessen. He too quickly gained a reputation as an analyst and was at one time President of the Society of Public Analysts. He represented the interests of the RASE on many occasions. Not least of these was the various revisions (with A. D. Hall) of Lawes and Gilbert's tables (1897, 1898) of manurial values of feedingstuffs and the introduction, already mentioned, of the first table setting out residual values for artificial fertilisers and lime (Voelcker and Hall, 1902, 1913).

The Hills Bequest

Between 1877 and the late 1890s all samples taken from experiments at Woburn had to be analysed at the Society's London laboratory. Then in 1896 the RASE accepted a bequest of £10 000 from Mr E. H. Hills, a member of a firm of chemical manufacturers and makers of artificial manures, who also farmed in Sussex. He wanted the RASE to make experiments on the value of the 'rarer forms of ash' (trace elements) for agricultural crops. It was decided that this could be done best by pot culture techniques currently being developed in Germany. Buildings for a Pot-Culture Station, the first to be built in this country, were started at Woburn in April 1897 and completed early in 1898 (Voelcker, 1900). They consisted of a laboratory for analytical work, with office and store room, a large glasshouse and an area enclosed by small mesh wire netting supported on a metal frame, 'the cage'. The zinc or glazed earthenware pots in which the experimental crops were grown stood on trucks which could be moved between glasshouse and cage on rails. The laboratory building, now converted to offices, still stands; the glasshouse, much modified, is used as a workroom but the cage and railway have been dismantled.

A resident research chemist was appointed to make laboratory and glass-

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house experiments and take meterological observations with instruments first installed in 1898. The chemist was responsible to Voelcker and in 1898 H. H. Mann (1872–1961) was appointed. He was only there a short time when he accepted an appointment in India in 1900. However, when he retired from India in 1928 after a distinguished career in tea research and agricultural education, Mann returned to Woburn and worked there until 1956.

The Development Commission

Changes in financing Woburn came at a time of increasing costs and general uncertainty. Late in 1909 the Development Act, which set up the Development Commission, was passed. Substantially the Act was in two parts. One part provided for the 'economic development of the United Kingdom' and appeared mainly as a scheme to stimulate production from the land. There were two important features; firstly the Commission was permanent and the number of members and their tenure of office were fixed by law. The Commissioners were therefore not readily amenable to pressure from outside sources. Secondly, money was provided by Parliament in advance of any plans for its expenditure; for the first five years up to March 1915 the Commission was given £2·9 million pounds. A. D. Hall (Director of Rothamsted, 1902–12) was appointed an unpaid Commissioner at the outset, and a full-time Commissioner-with-Salary in 1912. Schemes for improving both research and education in agriculture were implemented under his guidance.

Once such funds were available the 11th Duke of Bedford decided to withdraw his financial support for the Woburn Farm. In December 1911 representatives of the RASE met the President of the Board of Agriculture (later to become the Ministry) and the Commissioners to try to secure a grant for Woburn. The application was successful and £500 was given for 1912–13; subsequently this grant was renewed each year. Apparently the Board of Agriculture would have liked to see the work at Woburn expanded. One suggestion was for the appointment of a plant physiologist to work on problems suggested by results from the pot experiments. However, neither the Board nor the Development Commission were able to increase their financial support and the RASE was unwilling to extend its commitment.

About this time there was much discussion within the RASE whether or not to continue the Woburn experiments. There was a long debate in Council in 1915 when the Chemical and Woburn Committee were successful in persuading Council to keep Woburn. It now seems almost unbelievable that an annual expenditure by the Society of about £150 was the cause of so much concern when gross annual income was about £10 000 and reserve funds exceeded £70 000.

Changes in the tenancy

A large financial loss on the Royal Show at Darlington in 1920 caused Woburn's future to be discussed again. An adroitly worded motion by the Finance Committee succeeded in getting the financial affairs of the Society, including those of Woburn, considered by a Special Committee. In addition, this Committee was given the power to terminate the tenancy of Crawley Mill Farm if this was thought to be financially desirable. The Committee gave the Duke of Bedford notice of intent to terminate the tenancy and then presented their report to Council at the end of 1920. Their recommendations

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effectively linked possibilities for increasing revenue from the Royal Show with saving money by giving up Woburn. The report was debated at great length and with much acrimony. The Council Chairman was given no opportunity to rationalise the situation by separating the two issues and the report was passed. When Council passed the report they automatically confirmed the notice to quit the tenancy at Michaelmas 1921.

Voelcker as tenant. Voelcker, however, had decided that he would continue the experiments and arranged to take the tenancy of the farm from October 1921. The RASE offered the crop and soil samples collected during 1876–1920 to Rothamsted, the offer was accepted and it was agreed with Voelcker that the samples would remain at Woburn; most are still there. The work done under the Hills Bequest was transferred to the Agriculture Department at Cambridge University, but the buildings and equipment were left at Woburn for Voelcker's use. The live and dead stock on the farm were not transferred. Their sale in September 1921 realised £635.

The RASE had one further role to play regarding Woburn. In February 1922 the Chemical Committee appointed a sub-committee 'to consider in what way—in view of the altered circumstances—the scientific side of the Society might be developed'. As a result of their report a Research Committee was established. Money from their Research Fund subsequently paid for work to be done at Rothamsted (from 1929) on analysing Woburn data using R. A. Fisher's statistical methods. In addition they suggested that all experimental work so far undertaken by the RASE, both at Woburn and on commercial farms, should be summarised and published. This suggestion was realised, at least in part, with the publication in 1936 of Russell and Voelcker's book, *Fifty Years of Field Experiments at the Woburn Experimental Station.*

In 1921 the Ministry of Agriculture decided to continue the annual grant of £500 towards the cost of the experiments which were mainly in Stackyard and Lansome fields. The grant was conditional on some supervision and this was to be exercised by Rothamsted's Governing Body, the Lawes Agricultural Trust (LAT); the grant was paid through Rothamsted. The experiments and farm were run by Voelcker for five years until increasing costs forced him to give up. The LAT then decided to take over and the Trustees took the tenancy of the farm in October 1926. Keeping Woburn cost Voelcker just under £2000. It is no exaggeration to say that those who, in recent years, have enhanced their scientific reputations by work done at Woburn owe much to him. If he had not taken the tenancy in 1921 the farm would have been lost to agricultural research.

Rothamsted assumes responsibility

From 1926 to 1936 the Rothamsted Farm Manager was responsible for all farming operations at Woburn. Voelcker, who was still Consulting Chemist to the RASE and working in London, was Honorary Local Director and from 1928 Mann supervised the field experiments and laboratory work. T. W. Barnes (1901–74) was appointed as chemist in 1928. Laboratory facilities were, however, far from satisfactory, and Barnes' work was restricted mainly to nitrogen analyses of crops and soils especially those from the Green Manuring, Market Garden and Ley Arable experiments. Later he undertook much daily supervision of the Irrigation experiment and investigated in detail

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the fate of N applied to grass plots with and without irrigation. When he retired in 1966 his vacancy was not filled.

Charity Farm. Both Mann and Barnes did much for the Husborne Crawley Charity Trustees; the Woburn staff are still involved for A. W. Neill, Farm Bailiff at Woburn, is Treasurer to the Trustees. The Trustees own Charity Farm, Husborne Crawley. Most of this farm, originally about 55 acres, is on heavy soil and was in permanent grass when in 1907 the tenancy was taken by the RASE. The Society first conducted an inquiry into tuberculosis in cattle, 1907–11, and built extra huts and pens so that stock could be kept in isolation. Later, 1912–18, a series of calf-rearing experiments were made there. In 1921 the RASE gave up the tenancy not only of Crawley Mill Farm but also of Charity Farm. Voelcker did not take the tenancy of Charity Farm.

The Farm today

Voelcker retired from his honorary directorship in 1936 and Mann assumed sole charge, not only for the experiments but also for the farm, being responsible to the Director at Rothamsted until 1946. In 1946 the Head of Farms at Rothamsted was again made responsible for all farming operations. Mann, however, continued to work on field and glasshouse experiments until he officially retired in 1956. From 1957 to 1968 C. A. Thorold assumed Mann's responsibilities but when he retired the vacancy was not filled.

Even in the 1930s laboratory facilities at Woburn were less than adequate and after the Second World War there was little desire to expand them. In the 1950s the increasing availability of road transport and later the opening of the M1 motorway eased travel between Rothamsted and Woburn and gradually all laboratory work was transferred to Harpenden. Currently the field experiments at Woburn, like those at Rothamsted, are the responsibility of the Field Plots Committee. By the mid-1960s the experimental programme at Woburn had increased so much that there were too few suitable sites. At Michaelmas 1962 the Woburn Estate were able to offer the tenancy of The Dairy Farm (17·5 ha) Husborne Crawley, and later two other fields were made available. These were Horsepool Lane Close, 3·3 ha, (1971) and Far Field 3·6 ha (1972).

Today the Woburn Experimental Farm is approximately 77 ha (190 acres). At Woburn the permanent staff consists of a bailiff, responsible to the Head of Farms for day to day management, two recorders who make experimental and meteorological observations and three farm workers. Some specialist help is provided by staff from Rothamsted and sponsors of experiments visit to make observations and take soil and mid-season crop samples, harvest time samples being taken by the Woburn staff.

In retrospect

In retrospect it is probably not unfair to say that the period from the First World War to the early 1950s was one of 'care and maintenance'. The rotation and green manuring experiments had not given the results confidently expected of them, the continuous growing of wheat and barley had run into serious problems and results from experiments in Lansome Field were very variable. These problems could not be adequately investigated because lack of money made expansion at Woburn impossible. Staff at Rothamsted did as much as possible but most were fully committed to other research projects.

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In 1931 a six-course rotation experiment was started on both farms. During the war there was considerable interest in increasing the productivity of light soils and the Market Garden experiment, 1942–67, measured the effects of large dressings of bulky organic manures. Probably however the experiment which, more than any other, served to reawaken interest at Woburn was the Ley Arable experiment started in 1938. This was the first experiment in this country to test one of the very few aspects of ley farming amenable to field experimentation, namely the extent to which leys can increase the yield of subsequent arable crops. As resources at Rothamsted increased both the Chemistry and Nematology Departments were able to investigate problems which became obvious during the 1950s. From these investigations the work of both Departments and others gradually expanded at Woburn.

During the discussion in the 1920s on the future of Woburn one member of the RASE contended that there was no point in continuing as the land was unfit for agriculture being altogether too light. The achievement of the last 20 years has been the large increase in yields of most crops at Woburn. It was in the Ley Arable experiment in 1971 that potatoes first yielded more than 75 t ha^{-1} (30 tons/acre) when biocides (chloropicrin and aldicarb) were used with large dressings of fertilisers.

The next two sections describe some of the work done at Woburn in the early years and that done since the 1950s.

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