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Rothamsted and the correspondence of Sir John Lawes and Sir Henry Gilbert

MARGARET HARCOURT WILLIAMS

Rothamsted Experimental Station is situated south of Harpenden in Hertfordshire, on the road to St Albans. From the road or railway it appears as a long two-storey building separated from the main road by a small area of woodland with glasshouses and other modern buildings beside and behind it. There is nothing to indicate that this is one of the oldest agricultural research stations in the world, a place where experiments have been carried out and recorded without a break since 1843. Rothamsted is therefore celebrating its 150th anniversary in 1993. 1843 is considered the foundation date because it was then that John Bennet Lawes, the owner of Rothamsted Manor and estate, who was already doing some agricultural experiments on his land, was joined by the scientist Henry Gilbert. They formed a partnership which lasted almost sixty years, until Lawes's death in 1900, and which is recognised as one of the longest and most productive in the history of science.

Lawes was born in 1814 into a family which had been at Rothamsted since the early seventeenth century. Although the estate had twice passed through the female line, Lawes was a direct descendant of the Wittewronges, the family which bought the estate in 1623. The Wittewronges were from the Low Countries and they had come to England in 1564 to escape religious persecution. Jacob Wittewronge was six when he arrived in London with his parents and brother; by 1600 he was a successful brewer and in 1623 his widow Anne bought Rothamsted for their young son John. It had previously been mortgaged to Jacob Wittewronge by one of the Bardolphs, the family which had obtained the estate in the 1500s by marriage into the Cressy family, whose title to the estate came in turn from another local family, the Nowells, in the middle of the fourteenth century.

John Bennet Lawes inherited his estate in 1822, at which point it seemed his life was to be that of a country gentleman. He had an uneventful career at Eton and left Oxford without a degree, but from boyhood he had shown an interest in chemistry. As a young man he had one of the bedrooms in the manor converted into a chemical laboratory - an event which he later recalled 'seriously disturbed the peace of mind of my mother'. His interest in agricultural chemistry started when he noticed that when bones were spread on his fields as fertilizer, which was a widespread practice at the time, they had a much less beneficial effect on some soils in the locality than on others. When he realised this, Lawes began treating ground-up bones with sulphuric acid and produced a fertilizer called superphosphate of lime. He began to use this on a large scale in 1840 and 1841 and the results were so successful he patented his process in 1842. Lawes is recognised as the founder of the huge artificial fertilizer industry, and for the next thirty years he had a thriving artificial fertilizer business with factories at Deptford and Barking. His concern for his business was such that Lawes spent his honeymoon looking for a site for his manure factory and comments in a notebook that 'instead of the proposed tour abroad I started one day in a boat on the Thames to find some waterside premises. The loss of the proposed foreign tour was a great disappointment to my wife'. Caroline Lawes's opinions of this are unrecorded, but Lawes seems to have been rather a

trial to his womenfolk. Lawes's artificial manure business did so well that others followed suit and in the 1850s Lawes successfully took action against infringements of his modified patent. In 1872 he sold his business for £300,000; from then on he concentrated entirely on his experiments at Rothamsted. However, the business, the 'Lawes Patent Manure Company', continued trading until about 1970.

While he had been developing the business, Lawes had also been carrying out experiments on the growth and nutrition of plants and animals. His partner, Gilbert, supported Lawes's wide-ranging ideas by his own precise and careful work. Joseph Henry Gilbert had a very different background from that of Lawes. He was born in Hull, where his father had been a Congregational minister. His mother, Ann Gilbert (born Ann Taylor) was an author of pious verse and poems for children. In her lifetime she was probably best known for a book called *Hymns for Infant Minds* but she should be remembered today as the author of the well-known children's rhyme 'Twinkle, Twinkle, Little Star'. Gilbert sounds a formidable character. He was blind in one eye and had poor sight in the other as a result of a childhood accident, and his portrait at Rothamsted shows a severe and heavily bearded Victorian gentleman. Lawes's portrait, by contrast, is that of a benevolent squire and there are several stories recorded of his kindness to tenants and generous concern for the people of Harpenden. Gilbert did not have a high public profile although he lectured widely both in England and abroad, and on his death it was said that he had achieved the strange feat of being both a household name and unrecognisable by the man in the street. Gilbert was well-qualified for his work at Rothamsted. He had studied with well-known scientists at Glasgow and London Universities and he had a doctorate from the University of Giessen in Germany. At Giessen he had studied with the eminent scientist Professor Liebig.

When Lawes and Gilbert began working together they intended to learn by experiment about soil management and the growth of crops. They started with wheat and turnips, the chief crops of the time, and soon added barley, beans, clover and meadow hay. Today, when there is widespread concern about the over-use of artificial fertilizer, it is difficult to appreciate the feelings of mid-nineteenth-century farmers when they were told that a factory-made manure, supplied in a bag and applied in hundredweights rather than tons per acre, was more effective than the farmyard manure they had traditionally used. They were convinced by the results, however, and the Rothamsted experiments were there for all to see. At first the research was carried out in a barn fitted up as a laboratory, but the farming community was so impressed by the work being done that in 1854 they collected over £1,000 to build a new and better laboratory. Unfortunately this new building was not a success, although much valuable scientific work was done there. It was designed by Gilbert's architect brother, Charles, and records of its construction survive in Rothamsted archives where it is amusing to read today of walls falling down, chimneys blowing away, vital figures omitted from specifications, estimates wildly exceeded and similar disasters. Surprisingly, most of the building work was done in mid-winter and late in 1854 Gilbert complained to his brother that everything done the previous week had fallen down. He questioned the competence of the builder, a man called Martin. Charles Gilbert's reply was not reassuring for he wrote 'Martin is quite accustomed to having his work fall down and I do not think it needful to come over'. Lawes insisted the building must be paid for by the subscribers, although he seems to have paid for the fittings, and he frequently reminded Gilbert that he must work within the available funds. In 1856 the building was already in need of repair, and Lawes showed his irritation when he wrote 'Marlowe says he could have done the work for 25 per cent less than that which has been charged. It is very disgraceful that I should be imposed on in this manner'. Eventually the laboratory was made to stay up but it needed constant maintenance and it was finally demolished and replaced about 1914.

When they were both in Harpenden, Lawes and Gilbert met every day. If one or other was away they kept in touch by letter, and Rothamsted archives include a long series of their correspondence from 1846 to 1900. There are about 1,200 letters, the majority of which are from Lawes to Gilbert; Lawes's letters are usually brief, while Gilbert's, although fewer, are much longer and more detailed. Many of Lawes's letters are from Scotland where he spent part of most summers at Dalmally in the Highlands, and they include instructions for work at Rothamsted, while Gilbert's replies describe work in progress. Because of the time of year there are many references to the harvest and to proposed autumn sowing and fertilizing of crops, but other experimental work such as on nitrogen in plants or animal feeding is also covered. Lawes also mentions publication of their papers and local Harpenden matters. Among Gilbert's letters those he wrote while attending scientific meetings abroad are particularly interesting.



Sir John Bennet Lawes 1814-1900

The best known of the Rothamsted experiments is that of continuous wheat growing on Broadbalk field. This was begun in 1843 with the aim of testing the manure requirements of wheat by growing it continuously with various combinations of fertilizers repeated year after year on the same plots. The results were from the first recorded in books bound in white vellum and known as White Books which are also in the Rothamsted archives. Broadbalk has been called the most famous field in the world, and the results of wheat growing experiments there have been carefully studied, but one small item of general interest was the problem of weed control. As with any cultivated ground, keeping the field clear of weeds was difficult. Lawes suggested leaving parts of each plot fallow sometimes or possibly getting local boys to do the weeding. Gilbert opposed both these suggestions, especially the latter, for in his opinion boys caused trouble and were lazy and would damage the crops.

Girls were acceptable however, so Lawes suggested using 'a gang of girls' with a prize for the parents of the best weed gatherer. Nevertheless weeds continued to be a problem. So, Gilbert thought, did boys, and in one letter he asked to have barbed wire and broken glass put on the walls near the laboratory to stop them playing there but Lawes refused to authorise this.

From the first, Lawes and Gilbert published the results of their experiments. This was not always straightforward and many letters show Lawes's irritation with slowness both at Rothamsted and at the publishers. In 1851 he rebuked Gilbert over delays to a paper on animal feeding which 'hangs about year after year until I am quite tired of thinking about it'. In 1878 he described the editor of *The Times* as 'conceited and ignorant' while Philip Pusey, editor of the *Journal of the Royal Agricultural Society of England*, was often criticised, particularly for what seemed to Lawes to be high-handed editing: 'everyone who has had anything to do with the Journal complains of Mr Pusey'.

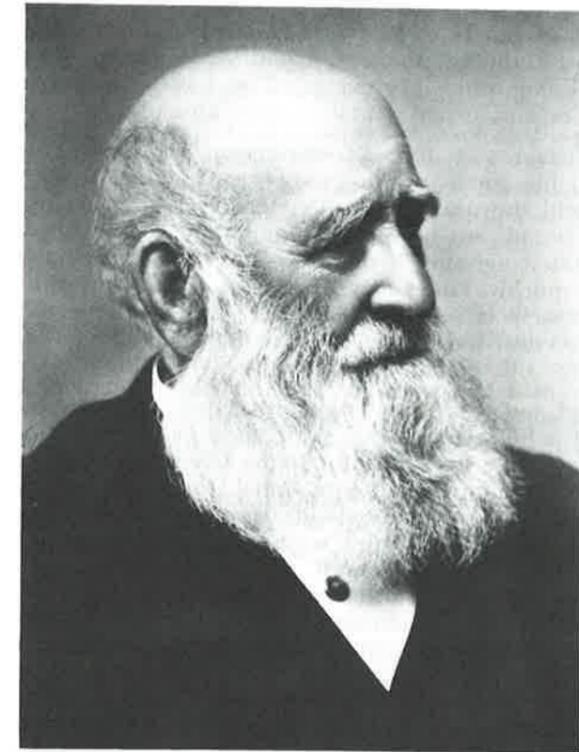
Lawes and Gilbert welcomed visitors who came to see the work in progress at Rothamsted. Lawes was especially anxious his work should be made public and wrote in 1851 'I consider my investigations so much in the light of public property and am so anxious that they should be of service to the scientific world that I do not care how much my figures are circulated'. Gilbert's letters record visitors from the United States, France, India, Poland and Russia and also from less distant parts. In the 1890s, when he was in his 80s, he wrote to say that he had had to give up work one afternoon to show an unexpected visitor round, for 'as he had come all the way from Ipswich I felt obliged to go round with him'.

Groups of visitors were well looked after and on at least one occasion Lawes sent Gilbert grouse from Scotland and the keys of the manor wine cellar for him to use for their benefit. The Hertfordshire Natural History Society and Field Club were invited to stay to tea after their visit, provided the party numbered no more than twenty, the most Mrs Gilbert felt able to entertain. Lawes records the menu for visiting farmers as 'cold beef and lamb, salads, hot potatoes, cold fruit tarts and for drink beer and claret cup'. If this was provided regularly it must have added considerably to the cost of running the Station and made great demands on Mrs Lawes's and Mrs Gilbert's domestic staff.

Lawes and Gilbert were not alone in carrying out scientific agricultural experiments and they soon became involved in a controversy on the sources of nitrogen for plant nutrition with Gilbert's former teacher Liebig and other European scientists. Although to the layman this might sound an unpromising subject for an argument that lasted over 30 years, it is a matter of crucial importance in man's ability to provide for himself. In 1843 Liebig wrote that plants obtained most of their nitrogen from the atmosphere, while Lawes and Gilbert realised from their experiments that plants took up nitrogen from the soil as nitrates or ammonia. In 1851, after some years of bitter controversy, Lawes published a paper criticising Liebig's theories and expressed the hope that 'Liebig's defenders will be content to leave our disputes to sink into oblivion'. Far from it, for Liebig retaliated, and in a letter to one of his supporters, described Lawes and Gilbert as 'a vile vermin and I must get rid of them by all means; they destroy all my efforts to make the British farmer understand the right way of progress'.

In fact the gradually increasing body of scientific data supported the Rothamsted experiments, which seemed to exclude the possibility of atmospheric nitrogen being used by living plants. However there had always been one group of plants, the legumes, which did not respond to nitrogen fertilizers and in 1886 at a conference in Berlin the German scientist Hellriegel put forward the idea that nitrogen was fixed in the soil by the action of bacteria in structures in the roots of leguminous

plants, today known as nodules. Gilbert was at this meeting and reported it in detail to Lawes, describing Hellriegel's paper as 'sensational'. Experiments were begun immediately at Rothamsted which confirmed Hellriegel's theories and showed that because Lawes and Gilbert had carried out their earlier work under very aseptic conditions, the bacteria responsible for nitrogen fixation had been killed. In 1892 Gilbert wrote to tell Lawes that half a ton of nodules had arrived in the laboratory from Madras. 'What is to be done with them', he asked anxiously, but Lawes's reply has not survived.



Sir J. Henry Gilbert 1817-1901

The other long-standing controversy which Lawes and Gilbert had with their scientific colleagues was over the sources of fat in animals. When they began their experiments, even less was known in England about animal nutrition than about plant nutrition although in Europe serious attempts had already been made to apply scientific principles to animal feeding. Lawes and Gilbert followed suit by beginning work on the relationship between animal feeding and weight increase. They started with sheep and followed them with pigs and cattle and also experimented with patent animal foods. They succeeded in producing results which gave farmers a sound general idea of the principles of animal feeding and eventually established that some part of an animal's fat came from the carbohydrates in its food, and not just from the fats alone. In this they differed from German scientists, and in 1875 Lawes wrote 'regarding the pig I am by no means disposed to carry out a fresh set of experiments merely to prove the Germans are wrong. Unless my own experiments are open to doubt I think it is far more dignified for us to take our stand upon our own work and challenge anyone to disprove it'. Five years later he was still unwilling to continue experiments for he said 'the Germans would claim all the

merit of the discovery of converting starch into fat even if we established it'. He made final comments on this in 1881 when he wrote 'after 20 or 30 years of work the Germans are beginning to find out that a pig would have told them what they wanted to know in six weeks' and 'a question of this sort ought not to require a lifetime of controversy'.

When Gilbert visited Liebig in 1860, he described him as a dignified and distant man who spoke strongly of the uselessness of the field experiments in progress in England. However it seems that despite disagreements all parties respected each other, for a few years later Gilbert contributed to Liebig's memorial fund and subsequently Liebig's son visited Rothamsted. Lawes did not lecture or travel abroad but Gilbert was part of the international scientific community and a welcome speaker at conferences. He reported in great detail to Lawes on these meetings and on visits to universities and experimental stations abroad.

As well as experiments on animal feeding, work was carried out on human food consumption and tables survive of amounts of bread and beer consumed by Harpenden families. Lawes held the unusual opinion that everyone, but especially labourers, should eat white bread, not brown. He thought that as brown bread took longer to digest than white, digesting it therefore used up additional energy and made people tire more quickly. Lawes may here seem out of step with modern thinking but he could also seem in advance of his time. In 1899 he wrote that people were 'already predicting a dearth of oxygen owing to the destruction of woods', a forerunner of today's concern with global warming.

On a local level, letters and other records survive which show Lawes's concern for Harpenden, for he was the local squire and Gilbert was his representative in his absence. One question was education. In the 1850s, at the height of the nationwide controversy between those who wanted national (that is, Church of England) schools and those who wanted an education outside the established church, Lawes listed the possibilities for Harpenden. These were an independent school run on the most liberal basis possible; a national school, provided the dissenters in the parish did not oppose this too strongly; and, Lawes's own preference, 'each party to have its own school'. In 1863 the schoolmistress left suddenly, but this was considered a minor problem, soon to be brought under control, for Gilbert wrote 'Mrs Gilbert has gone up to Mrs Lawes to talk over the matter'. A few years later a teacher again left unexpectedly in early summer, but this time schooling was abandoned until the autumn, for it was haymaking time and a new teacher would have found no one to teach.

Adult education in Harpenden was not neglected, and in the late 1880s lectures were planned 'to improve the labourers and their families'. The newly completed laboratory was used for these meetings, and chairs were supplied, but Lawes was reluctant to buy polished ones, maintaining 'there is no use paying for polish when it can be done free or gratis by those who sit on them'. Several of the Rothamsted staff gave talks and the laboratory was also used for concerts and conjuring shows. Later Lawes supported the idea of a public reading room in Harpenden.

Lawes believed all should be free to worship God in their own way. However he was patron of the living of Harpenden and sometimes mentioned church matters in his letters. One rector, Spencer, he suspected of being biased in his distribution of money given to charity, and he feared that Spencer's successor, Vaughan, had 'opinions on religious matters that are not over liberal'. Canon Vaughan actually became a popular rector of Harpenden for over 30 years.

Staff matters are also mentioned by Lawes and Gilbert in their letters. Although their partnership was in the end a long one, it took some time to become established. In 1848, when they had been working together for about five years. Lawes reminded Gilbert he should look for permanent employment and at one time it seems Gilbert

was going to work in a laboratory in Brighton. Later, he held a part-time post as Professor of Rural Economy at Oxford and lecturer at the Royal Agricultural College at Cirencester while continuing to work at Rothamsted.

Finding farm and laboratory staff was always a problem. What was wanted was 'a young man brought up as a labourer but of superior character and capabilities'. At least one employee, a clerk called Williams, left because of a poor salary and Lawes admitted his wages 'would not tempt an ambitious man'. Another employee, Hemsley, a botanist, was dismissed because 'his conduct from the commencement of his work with me has been influenced entirely by selfish considerations'. Gilbert unsuccessfully opposed this but Hemsley does seem to have been rather a black sheep, for he later wrote a scientific paper using material which Lawes claimed 'he had no right to have in his possession'.

Despite these references to staff there is not really much that is personal in Lawes and Gilbert's correspondence. Unusually for Victorians they did not say much about their health, although from time to time Lawes urged his partner to rest more. Once, in a rather paternal way, he urged him to go to bed at nine o'clock each night and read for a while, but Gilbert was a very hard worker and certainly ignored this well-meant advice.

Lawes was determined that work in agricultural science should go on at Rothamsted after his death and in 1889 he established the Lawes Agricultural Trust. He endowed it with £100,000 and appointed Sir John Evans of Kings Langley as chairman. Gilbert found being responsible to trustees difficult and complained 'there is no objection whatever to the Committee knowing everything that is going on but if a precedent were established of getting their assent beforehand to everything that is beyond the most ordinary routine it would involve a great deal of extra work'. However he got used to it and in 1893, when he was in his late 70s, he went to America to give the second of the Trust's lectures there. The Trust still exists but the management of Rothamsted has changed considerably in the last few years.

Lawes died in 1900 and Gilbert in 1901 and many of their archives remained virtually untouched until the 1980s. From 1985 onwards first the Leverhulme Trust and then the Lawes Trust have financed cataloguing work on these records and there are now catalogues of the records in the Station library and of Lawes and Gilbert's correspondence. The catalogues can be purchased and the records are open to bona fide researchers. Anyone wishing to use the records should apply in writing to the Rothamsted librarian.

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Both the above are available from the Library, Rothamsted Experimental Station, Harpenden, Hertfordshire, AL5 2JQ, price £15.

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