Lawes Agricultural Trust Committee - Brief Summary of Proceedings During Its First Five Years of Office

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THE

LAWES AGRICULTURAL TRUST COMMITTEE.

BRIEF SUMMARY OF PROCEEDINGS DURING ITS FIRST FIVE YEARS OF OFFICE.

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THE LAWES AGRICULTURAL TRUST COMMITTEE.

Brief Summary of Proceedings during its first Five Years of Office.

1. The *Lawes Agricultural Trust* was constituted by a deed made February 14, 1889, between Sir John Bennet Lawes, Bart., of Rothamsted, of the one part, and three Trustees—Sir John Lubbock, Bart., William Wells, Esq.,[1] and John Evans, Esq.—of the other part.

As is known to all the world, Sir John Lawes has long conducted scientific experiments in connexion with agriculture at Rothamsted, and has maintained a laboratory there for the examination of the materials collected in the field and other experiments. His object in founding the Trust has been to secure the continuation and further development of the experiments, and thus to advance the science of agriculture.

By a special deed Sir John Lawes has leased the laboratory and certain lands at Rothamsted to the Trustees for 99 years at peppercorn rent, and has also secured to the Trustees a sum of 100,000*l.* as an Endowment Fund.

The use to be made of the premises leased to the Trustees is fully set forth in the Deed of Foundation : they are to be devoted to and used under the direction of a Committee "for the purpose of scientific investigation and experiments in connexion with agriculture, embracing all or any subjects connected with or bearing upon agriculture, animal and vegetable physiology, meteorology, botany and chemistry, and the objects of such investigation and experiments may be from time to time extended or varied as the Committee shall determine, but so, nevertheless, that such objects shall be confined exclusively to original investigation and research with the view of advancing the science of agriculture."

2. *Committee.*—By the Foundation Deeds it was provided that, within six calendar months from its date, a Committee should be formed to consist of nine persons and no more, selected and appointed as follows, viz. :—

[1] On the death of Mr. Wells in May, 1889, the President and Council of the Royal Society, acting in pursuance of the provisions of the Deed of Foundation, appointed Lord Walsingham a Trustee in his place.

Four members by the President and Council of the Royal Society.
Two members by the President and Council of the Royal Agricultural Society of England.
One member by the President and Council of the Linnean Society.
One member by the President and Council of the Chemical Society.
Sir John Lawes during his life, and after his decease "the owner in possession for the time being of the mansion of Rothamsted, at which he now resides, if such owner shall be of full age, and shall be from time to time able and willing to act," with provisions for the contingency of there being joint-owners.

The Foundation Deed provided that members of the Committee shall be appointed for a period of five years, and that a member whose term of service has expired is eligible to be again appointed.

The President and Council of the Royal Society selected and appointed as the members ot the Committee to be nominated by them:
Mr. John Evans, Mr. W. T. Thiselton Dyer, Professor Michael Foster, and Dr. Hugo Müller.
The President and Council of the Royal Agricultural Society of England appointed:
Sir J. H. Thorold, Bart., and Mr. Whitehead.
The President and Council of the Linnean Society appointed:
Mr. W. Carruthers.
The President and Council of the Chemical Society appointed:
Dr. H. E. Armstrong.

The first meeting of the Committee was held on June 6, 1889. Sir John Lawes having declined the chairmanship, Mr. John Evans was appointed chairman, and Sir John Thorold deputy-chairman.
Dr. Hugo Müller was appointed honorary treasurer.
Mr. Herbert Rix was appointed secretary for the current year; his appointment has been renewed each successive year.
A meeting of the Committee has always been held once a year in June at Rothamsted; the other meetings have taken place at the Royal Society's rooms, Burlington House, London, at suitable intervals, four to six meetings being held each year.
3. *Financial.*—The banking account of the Committee has been kept by Messrs. Robarts, Lubbock & Co. The income of the Committee has hitherto been nearly 3,000*l.* a year, which has fully sufficed to meet all demands for salaries, labour, and other expenses of carrying on the experiments. Now that the 100,000*l.* secured by Sir John Lawes has been received and is being invested by the Trustees, owing to the high price of stocks the income will be somewhat reduced.
While the transfer of the premises to the Committee was proceeding, various improvements in the buildings, especially in connexion with the storage of samples, were effected. The Committee have been much indebted to Sir John Lawes for his generosity in defraying the cost of the alterations and in other matters connected with the foundation of the Trust.
4. *Conduct of the field work.*—The sole management, superintendence and direction of the Trust, including the investigations, being vested in the Committee by the Deed of Foundation, the first ques-

tion taken into consideration had reference to the best method of conducting the field work. Two courses were open—the one being to establish the station on an independent footing as a small field station provided with a limited staff, horses, &c., as a labour nucleus, to be supplemented as required by hiring; the other to allow the work to be executed by the tenant of Rothamsted farm under strict terms of agreement.

A full report on this matter was furnished in June 1889 by Colonel Durnford, who had long assisted in the management of the experimental fields. After discussing this report, the Committee requested Sir John Lawes to continue the assistance he had rendered from his farm towards carrying out the experiments.

Early in 1890 Sir John Lawes suggested the erection of a small farm steading at an estimated cost—including buildings, horses, machines, &c. —of 2,000*l*. A sub-committee was appointed to consider such a scheme in relation to any possible future enlargement and in relation to the position of the laboratory.

This committee submitted a report recommending that, if such action were taken, a small steading should be placed at the N.E. corner of Broadbalk Field and that it should consist of a bailiff's cottage, barn, stable, implement shed, &c., including a covered yard for stock, should such at any time be found desirable. It was estimated that it would be necessary to expend 2,000*l*. on buildings and 600*l*. to 700*l*. on horses, implements, &c.

Further action in this matter was for the time being suspended in consequence of an offer made by Sir John Lawes, which was most thankfully accepted by the Committee, and put into legal form. An agreement entered into with Sir John Lawes provides that he shall take charge of the experimental fields, he finding all necessary machinery, labour, &c, as well as seeds and manures, in return for a certain fixed sum placed at his disposal for the purpose, the laboratory furnishing the usual staff to superintend the experiments. The produce of the various crops, after the necessary samples are withdrawn, is received by Sir John Lawes for his own use. This agreement is to continue in force from year to year until terminated by either party giving notice to terminate it, such notice to be given before December 31. In the event of the agreement being in force at the time of Sir John Lawes's decease, it is to be binding upon his successor for one whole year from February 15 following the death of Sir John Lawes.

5. *Inquiries in Progress.*—In order to obtain the necessary information as to the value of the various inquiries in progress, Dr. Gilbert was requested to furnish a general report on the subject of the experiments, arranging these in three categories—those of first-rate and pressing importance; those of secondary importance; and those which, though still carried on, were not in need of immediate consideration. He was also asked to point out in what respect the discussion of the observations was in arrear.

Dr. Gilbert prepared a most interesting account of the history and present position of the Rothamsted Investigations, which was printed and privately circulated.

The inquiries in progress comprise the permanent grass experiments in the park occupying an area of about 7 acres; the arable field experiments on Broadbalk (total area 13 acres), Barn-field (9), Hoos-field (13½), and Agdell (3½), the actual area of the experimental fields being about 46 acres.

The subjects to which the experiments relate are :—

1. The continuous growth of wheat in *Broadbalk Field.*
2. The continuous growth of barley ; the growth of leguminous crops, of wheat alternated with fallow, and of potatoes in *Hoos-field.*
3. Root-crops in *Barn-field.*
4. Rotation of crops in *Agdell Field.*
5. Permanent grass in *The Park.*

When Dr. Gilbert wrote (July 1889), the forty-sixth wheat crop, and the thirty-eighth crop of barley, in succession on the same land were growing. The experiments with root crops were commenced in 1843, and those on rotation in 1848; the majority of the grass experiments were commenced in 1856.

To quote Dr. Gilbert, "So far as crops are concerned, the characteristic elements of our agriculture are investigated, both as to their intrinsic or individual characters, as shown by their growth year after year on the same land under different conditions as to manuring, and as to their relative or complementary characteristics, as grown in rotation."

After consultation with Sir John Lawes, Dr. Gilbert came to the conclusion "that the various experiments could not be classed as of varying degrees of importance; that, in fact, perhaps with the exception of those with potatoes, they must be considered as of substantially equal importance—that is, if, as hitherto, questions of fundamental, permanent, and general as distinguished from those which are of passing or local interest were to be kept in view. Similarly, the laboratory investigations connected with the field results were not susceptible of any great or material change or reduction, especially as the plan on which they were arranged, and the objects in view involved the keeping up of the chemical history, both of the experimental crops and of the soils on which they are grown."

Sir John Lawes also expressed the opinion that it was very difficult to select what was of most importance in their experiments. But, looking forward to the great questions which are being raised in regard to exhaustion of soil and restoration of fertility, he certainly thought, he said, that their soil samples and their history took the first place in importance.

After fully considering Dr. Gilbert's report, the Committee came to the conclusion not to make any alterations in the experiments, it being obviously of the first importance that the continuity of the record should be as far as possible preserved.

Dr. Gilbert pointed out in his report that the most important of the reports to be brought out was that on the "Mixed Herbage of Grass Land" dealing with the chemical results ; next in importance was that on the experiments on rotation, including both field results and laboratory investigations.

Much work has been done in the interval which is essential for the consideration of the mixed herbage results, and the report on this subject is now in preparation.

During the years 1888-91 numerous quantitative experiments on the fixation of free nitrogen from the atmosphere by leguminous plants have been carried out at Rothamsted, and abundant evidence has been obtained of the fixation of nitrogen occurring coincidently with nodular development on the roots.

A considerable number of analyses of the ashes of barley, wheat, mangel, and grass crops have been made during the period by Mr. Richter of Berlin, who has long aided the Rothamsted inquiries in this direction.

It was decided in 1893 to issue the "Memoranda" of the experiments—with which all who know Rothamsted are familiar—in a

more convenient form, viz., as a large octavo instead of a quarto pamphlet, and this change is admittedly a satisfactory one.

6. *New inquiries.*—The vast experience gained at Rothamsted necessarily serves to suggest many new lines of inquiry, but both on financial grounds and in view of the primary importance of as far as possible completing the record of the work hitherto accomplished, it has been thought undesirable at present to widen the field of investigation.

But from the outset the Committee, adopting a suggestion made by Mr. Horace Brown, F.R.S., have provided that sufficient of the grain crops should be preserved and submitted to an examination by an expert for an opinion of the market value, in the case of each kind of grain, of the produce from the different plots. A series of valuable reports have been furnished by Mr. R. Hewlins, commencing in 1889 ; these reports have been very fully discussed by Dr. Gilbert, and in some cases additional analyses of the grain samples have been made in order to obtain further information as to the influence of manuring on quality. The conclusion arrived at after no fewer than three seasons' growth had been thus examined was succinctly stated by Dr. Gilbert in the following words :—

> The whole of the evidence relating to both the wheat and the barley samples points to the conclusion that whilst the influence of manures on the quantity of produce is very direct and very marked, it is very indirect on the character and quality of the grain, for although quantity as well as quality is very materially affected by season, the influence of manures on the quality of the grain is to a much greater extent dependent on the characters of the season, especially at the period of seed forming and ripening, the season itself being the main controlling element.

Subsequent reports by Mr. Hewlins fully support this view. Now that the produce of several successive seasons has been thus valued, it is proposed to publish the reports.

In connexion with the question as to the influence of manures on the quality of barley used for malting, the following memorandum laid before the Committee by Sir John Lawes is of interest, and its publication may serve to lead to the desired experiments being made.

> In 1875 I read a paper at the London Farmers' Club "On the more frequent growth of barley on heavy land." The object was to show that barley could be grown in larger quantities, and at less cost, by taking the crop after wheat, and manuring it with nitrate of soda and superphosphate, than by growing it after roots fed upon the land. Those remarks, and the large produce obtained for so many years by the same manure in our permanent barley experiments, have doubtless led to much more barley being grown by artificial manures. Mr. Horace T. Brown, F.R.S., who is connected with a large brewing establishment at Burton-on-Trent, has, at different times, been in correspondence with us upon the subject of barley. In 1889 he wrote to Dr. Armstrong, as a member of the Trust Committee, suggesting, amongst other things, that our barley samples should be submitted to an expert to pronounce upon their relative commercial value. Quite recently Mr. Brown has pointed out to me that for some years past brewers have experienced increasing difficulty in the clarification of their beer, and

they are disposed to attribute it to the increasing use of nitrate of soda in the growth of barley. Undoubtedly, small crops of barley grown without nitrate, and with mineral manures only, will generally give a better malting sample; but the increased price given by the brewer would not compensate the grower for having perhaps only one-half the crop. Mr. Brown mentioned that there had been much talk of the desirability of making experiments to ascertain the relative malting qualities of barley grown by different artificial manures and in the ordinary way, but that nothing has yet been done. He seemed to assume that 50 quarters of each lot to be compared would be required I pointed out that, in order to supply such amounts of barley to be malted, a very large area of land must be devoted to the experiment. Thus, if a mineral manure without nitrogen yielded, say only 25 bushels per acre, 16 acres would be required to produce 50 quarters or if nitrate of soda or other nitrogenous manure were used in addition, and the produce were 40 bushels per acre, an area of 10 acres would then be required to yield 50 quarters. The experiments should be made on light land, and they should be continued for four or five years. As the object would simply be to produce the necessary quantities of barley grown by different manures, no great accuracy would be required in carrying out the experiment.

Nowhere has the effect of maintaining fields under one set of conditions during prolonged periods of time been followed as at Rothamsted, and the observations made there undoubtedly serve to raise many new issues which will demand most careful investigation in the future. One instance in particular brought under the notice of the Committee by Sir John Lawes is the following :—

Geescroft field, adjoining the Rothamsted Park, was for a great many years (32) under experiments with leguminous crops, about one-half being devoted to continuous bean crops; the results were by no means satisfactory, as it was found impossible to grow full crops of beans with any description of manuring. In 1878, it was decided to abandon the experiments. The land was left fallow until September 1882, when it was sown with grass seeds, which, however, failed in the winter. It was then decided to sample the soil in various places and submit it to analysis, and afterwards to grow barley and red clover; that is, another leguminous crop, which had not been grown on the land for many years. The crop of clover was exceedingly fine, even where the beans had been grown almost every year for thirty-two years without manure, and had hardly returned the seed sown. After the growth of the beans the soil contained but small quantities of nitric acid, and was poor in organic nitrogen. After growing clover for two years, Sir John had that part of the field which had been under beans fenced off, and left to grow what it pleased, the object being to ascertain whether in the course of time the spontaneously appearing vegetation would restore fertility to the soil exhausted by the continued cropping with beans. At the present time the herbage consists mainly of tall tufted grasses, such as Dactylis, &c., leguminous plants being rare, and miscellaneous species not prominent. On a portion at the top of the experimental wheat field, however, which was treated in a somewhat similar manner, the herbage is much more mixed; miscellaneous species being much more prominent, and leguminous plants (especially Lathyrus pratensis and Medicago lupulina) very much more abundant, than in Geescroft field. It would seem therefore, that under cereal growth food suitable for leguminous and other non-gramineous herbage accumulates; and also that food suitable for a different leguminous plant accumulates during the growth of another plant of the same

natural order. The question of the explanation of the above facts offers a very interesting subject for investigation; and it is only upon soils such as those at Rothamsted, the history and treatment of which are known, that such investigations can be successfully carried out. The accumulation of fertility in Geescroft field by natural growth must require a considerable time before it can be measured by analysis, and new samples cannot be taken for some years to come. The field is fenced, and no animals have been allowed to go upon it, otherwise the accurate sampling and analysis of the soil would be impossible. The field is not placed under the Trust, but Sir John has suggested that in case of his decease before the investigation is complete, a request should be made to his successors to allow the Committee to have the use of the field until they no longer require it, and also that a similar request be made for the use of the historical small plot of garden ground on which red clover has been grown during so many successive years.

The inquiries at Rothamsted may be said to include two great problems: the one relating to the effect of variations in soil conditions, under fluctuating atmospheric conditions, on the crops; the other being the reciprocal problem as to the effect of crops on the soil. The experiments have been so long in progress that fairly complete information is now available for the discussion of the former, having regard to the particular plants and the conditions of soil and atmosphere dealt with at Rothamsted; but the latter problem, it is to be supposed, will be ripe for discussion only after the lapse of a much greater interval of time, and it is on this account especially that it is so important to continue the experiments—especially those on permanently unmanured soil.

A great deal has been done at Rothamsted in relation to the amount, condition, and distribution of the nitrogen in the soil and subsoil. But the methods which have until recently been available for the examination of soils in the laboratory, in regard to the availability of certain of the mineral constituents, have afforded but little information of value as evidence of comparative fertility. The Committee have therefore gladly placed at the disposal of Dr. Bernard Dyer samples of soils for examination by the method which he has described in a paper communicated to the Chemical Society (Trans., 1894, p. 115). To judge from the preliminary results obtained with soils from Rothamsted of which the manure and crop history during nearly fifty years was known, the method gives promise of affording valuable information as to the condition of availability of certain of the more important mineral manurial constituents.

The investigations carried out within recent years, in Germany, France, and at Rothamsted, which have led to such remarkable discoveries regarding the fixation of nitrogen from the atmosphere partly in the soil, but mainly, it would seem, within the plant, under the influence of organisms, serve, however, to show that the problem of the "fertility" of soil may be largely a biological phenomenon, and the results obtained in Geescroft field are interesting from this point of view. It will, in fact, be necessary in future, in studying this question, to considerably extend the range of agricultural inquiries.

7. *American lectureship.*—By the Foundation Deed it was provided that the Committee shall, in the year 1890 and in every alternate year thereafter, select some competent person to be sent as a lecturer to the United States of America, and the person so selected shall deliver at such place or places in the United States as the Committee shall determine a course of lectures upon the investigations and experiments from time to time made and carried on at Rothamsted.

In 1890 Mr. Warington, F.R.S., was appointed the first lecturer under the Trust. He delivered six lectures in August 1891 at Columbia University, Washington, D.C., before the Association of American Agricultural Colleges and Experiment Stations at a meeting attended by delegates from 39 States and from the Province of Ontario. The lectures were subsequently published by the U.S. Department of Agriculture as Experiment Station Bulletin No. 8 (Washington, Govt. Printing Office, 1892), and no fewer than 5,000 copies were distributed.

The titles of the lectures are as follows:—

Lecture I. The Rothamsted Experimental Station.
,, II. The circumstances which determine the rise and fall of nitrogenous matter in the soil.
,, III. Nitrification.
,, IV. Nitrification and Denitrification.
,, V. Nitrification of soils and manures.
,, VI. Drainage and well waters.

Regarding these lectures the Association unanimously adopted the following resolution:

"Resolved: That this Association renew its expression of sincere thanks to Sir John Bennet Lawes for his munificent provision for a course of lectures on the work done at Rothamsted, to be delivered biennially in the United States; and that it also wishes to express its sincere thanks to Mr. R. Warington for consenting to deliver the first series of lectures, and its appreciation of the high scientific and practical value of the course delivered at this meeting."

Mr. Warington, in his report to the Committee on his return, pointed out that no more appropriate audience could be found, but that it would be desirable, if possible, to repeat the lectures at some of the colleges in the United States.

In 1892 Dr. Gilbert was appointed to give the second course. His lectures were to have been delivered at Chicago before the convention of the Association of Colleges and Stations held in connexion with the Agricultural Congresses of the World's Columbian Exposition, and the introductory lecture was so delivered on October 17, 1893. But it was impossible to complete the plan, and the lectures (six) were therefore delivered

before the faculty and students of the Massachusetts Agricultural College at Amherst by Sir Henry Gilbert in November 1893.

Again, the lectures have been published by the U.S. Department of Agriculture, 7,000 having been issued, under the title *Agricultural Investigations at Rothamsted, England, during a period of Fifty Years.* They form a practically complete survey of the work done at Rothamsted by Lawes and Gilbert, and afford the only comprehensive summary of their work hitherto published.[1] A considerable portion of the matter has also been published in the Journal of the Royal Agricultural Society of England, and the Highland and Agricultural Society of Scotland have since published the entire series in a slightly modified form.

In view of the difficulty of securing both the services of a competent lecturer and a suitable audience at such frequent intervals as two years, and taking advantage of the presence of the founder of the Trust on the Committee, it was resolved in 1894 to modify the clause of the Foundation Deed so as to allow of the lectures in the United States being delivered at intervals not exceeding four years. The necessary supplemental deed has been since executed.

Lastly, it may be mentioned that a large number of diagrams illustrating the Rothamsted work in all its branches were prepared in 1893 under Dr. Gilbert's directions and forwarded to the World's Columbian Exposition at Chicago, where they were shown, covering a wall space of 4,786 square feet. Photographs of these diagrams for the preparation of lantern slides are being taken so that they may be made available for the use of lecturers.

8. *Rothamsted Jubilee.*—By a resolution of the Committee in December 1892 it was decided that it was "desirable to celebrate in some public manner the Jubilee of the initiation of the Rothamsted experiments, and that the Committee take into consideration at

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[1] The opinion of the lectures and of the Rothamsted work expressed in the U.S.A. *Experiment Station Record* has already been published in the Journal of the Royal Agricultural Society of England (this volume, Part I., p. 140). The following letter with reference to the lectures has been received by Sir John Lawes:—

U.S. Department of Agriculture,
Office of the Secretary,
Washington, D.C.,
August 10, 1895.

Sir John B. Lawes, Bart.,
Rothamsted, St. Albans, England.

Dear Sir,—Having been informed by the Director of the Office of Experiment Stations that the Trustees of the Lawes Agricultural Trust have expressed a desire to have a thousand copies of Dr. Gilbert's "Lectures on Rothamsted Investigations," recently published by this Department, furnished to them by the Government Printing Office, I have directed that such copies as they desire be forwarded to your address directly from this Department, hoping in this way to show our appreciation of the benefits which will accrue to our people from the provisions of the Lawes Agricultural Trust, under which information regarding the work of the Rothamsted Experimental Station is brought to the attention of our people. I wish also to indicate in this way the high value which I place upon the lectures by Dr. Gilbert and upon the services rendered by yourself and your associates in the cause of agricultural science.

Respectfully,
J. Sterling Morton, Secretary.

an early date the best mode of doing so." The subsequent history of the movement has been given elsewhere. It is only necessary to say that the celebration took place at Rothamsted on July 29, 1893, the Minister of Agriculture, the Right Hon. Herbert Gardner, M.P., occupying the chair.

Subsequently, on August 11, 1893, Dr. Gilbert received the honour of knighthood.

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