REG. 9. 6. 28

SCIENCE IN AGRICULTURE

Sir John Russell's Lecture.

A Great Experimental Station.

Sir John Russell gave a lecture in Brookman Hall, Adelaide School of Mines before a large and representative audience on Friday evening on "The Rothamsted Experimental Station, England," of which he is director. The Chancellor of the Adelaide University (Sir George Murray) presided. His Excellency the Governor (Sir Alexander Hore-Ruthven, V.C.) was also present.

Discovery of Artificial Manures.

Sir John said that the Rothamsted experiments were started in 1843 by John Bennet Lawes, an English country squire, who lived in the beautiful old manor house of Rothamsted—one of the stately homes of England. The times were bad for farmers, and Lawes depended on farming; his hope was to get more out of the land. At that time the yield of wheat was about 20 bushels to the acre, but in some seasons it fell much lower. Lawes had a taste for making agricultural experiments, and great luck in that his experiments nearly always succeeded. He knew a little chemistry and something about the composition of farmyard manure—then the regular manure on all farms and still one of the best—and he had found by experiment that one of its constituents, nitrogen, could advantageously be given to crops in the form of sulphate of ammonia, a by-product in the manufacture of coal gas. He further experimented with bones, which had worked marvels on some of the English pastures but had failed at Rothamsted. He found that if they were treated with sulphuric acid they became instantly effective, being converted into the substance then called superphosphate of lime. At that time bones were dear; but rock phosphate, which had only just been discovered, was cheap, and Lawes found that if it were treated with sulphuric acid it produced the same superphosphate of lime as did the more expensive bones. So he patented the process, set up a factory near London, and made artificial manures for the first time in history. For many years he had the whole superphosphate industry in his hands, and he made a considerable fortune; but he continued the field experiments on his home farm and secured for Rothamsted a young chemist, Joseph Henry Gilbert. The two worked together for 60 years—all their lives, in fact. A barn was converted into a laboratory, and the field experiments were made year after year on the same land, and always with the same crops; so as to be quite certain that the result was not a trick of the season. The Broadbalk wheat field, which was perhaps the best known part of Rothamsted, was put into wheat in 1843 and had been kept in wheat every year since. It had never had a complete fallow all that time, though on three occasions half the field was fallowed one year and the other half fallowed the next season. The experiment had shown that wheat could be grown year after year without difficulty, except that weeds became troublesome and that the yield was maintained so long as fertilizer was given; and it fell off only slowly if fertilizer were withheld. The plot that had had no manure since 1839 still yielded about 10 bushels to the acre.

Far-reaching Experiments.

The experiments had made on all the ordinary farm crops, and they had shown that artificial manures—sulphate of ammonia, nitrate of soda, superphosphate, sulphate and muriate of potash—not only increased the growth of crops, but altered them in composition and habit of growth. Thus superphosphate increased root development and maturation, and hastened ripening—a great advantage in helping the plant to avoid certain pests and diseases. Further, some of the changes in growth enabled the plant to stand up better against the effects of bad seasons, especially lack of sunshine and temporary drought. The science of manuring was now so far advanced at Rothamsted that if the general nature of the season could be predicted, it would be possible to draw up fertilizer mixtures for the different crops that would make the best use of the sunshine and the rain. Many experiments were now being made on this subject, and it had been found necessary to set up a statistical department so as to control the accuracy of the work, and to trace the relationship between soil and weather conditions and the efficiency of the different fertilizers. New methods of field experiments had been devised, and it was now possible to estimate quite small differences in value between different fertilizers and to say under what conditions any one of them was likely to be better than any other. The advantage of the work was that they could now advise farmers how to choose, with considerable certainty, between the eight different nitrogenous fertilizers now on the market; and also the five phosphatic fertilizers, and the four potassic fertilizers, according to the soil and weather conditions in which they were farming.

Artificial Manure from Straw.

Artificial fertilizers, however, had not quite the same action as farmyard manure. Indeed, so far science had failed to provide any concentrated fertilizer that would act as well, particularly in a dry season. Farmyard manure was becoming costly on English and European farms. At Rothamsted, however, a method had been devised for making it from waste straw or other vegetable matter, without the use of animals at all. It was found that farmyard manure owed its value not the animals, but to the great crowd of minute living organisms always present in it, and so the manure was made by encouraging those organisms to act. The process was not perfect, but it had already given valuable results in Great Britain, the United States, Canada, South Africa, and elsewhere, and it was continually being improved. Straw which formally had to be wasted could not be changed to good manure.

Wonderful Micro-organisms in Soil.

Some of the most interesting of the recent work—and it might in future turn out to be some of the most useful—had been in connection with the micro-organisms in the soil. Its interest arose out of the fact that farmyard manure and green manure were not themselves plant foods: indeed, in themselves they were harmful to plants. But, once in the soil, they went through a remarkable series of changes, to end up by being of great value to soil fertility. For 40 years scientific workers had tried to discover how those changes came about, but always unsuccessfully. Then it was shown that they were effected by myriads of minute living organisms, so numerous that a salt-spoonful of soil might contain millions of them, yet so small that they could be seen only imperfectly. Gradually they were being picked out from the soil and their habits studied; and methods had also been devised for estimating their numbers. Every month, however, new ones were discovered, and no one would venture to say what that great soil population was really like. Some of them changed the useless residues of dead plants into humus and valuable food for the next generation of plants. Others fixed the nitrogen from the air and built it up into complex preteins by a process that no chemist could imitate or even understand. Others fed the valuable clovers and other leguminous plants. Some were like plants in that they simply took up plant food without themselves making any; yet those also were useful, because they protected the food from being washed out by the rain. Others fed upon smaller organisms. All those were being studied.

The Part of the Scientists.

As yet, the knowledge gained had not found much practical application but beginnings had been made in:—(1) Making artificial farmyard manure; (2) innoculation for the growth of leguminous crops; (3) the treatment of sick soils; and (4) making manure from sewage. All experience showed that the really important thing was to be quite sure about the facts; to be certain that the supposed knowledge was really true. That was the business of the universities and the experimental stations. Once the facts were definitely established, the ingeniou agriculturist began to use them first i one direction, and then in another, unti finally some really great advance wa achieved. Artificial fertilization bega at Rothamsted as laboratory experiment of no practical value; but they were now the basis of a great industry and of a high standard of farm production. So the laboratory experiments of to-day made in the universities and experimental farms might, in their turn, develop into methods of great practical value to-morrow and so add further to the achievement of science in agriculture.

ADV. 9. 6. 28

EXPERIMENTS WITH FERTILISERS.

What Rothamsted Has Done.

Lecture By Sir John Russell.

The Value of Farmyard Manure.

There was a large attendance at the Brookman hall, School of Mines, on Friday evening, when Sir John Russell lectured on the agricultural experiment station at Rothamsted, England, explaining how it began, and what it had done. His Excellency the Governor and Lady Hore-Ruthven were interested listeners. They were welcomed by the Chancellor of the University (Sir George Murray), who explained that the lecture was really in association with the University, which appreciated the action of the School of Mines in placing the larger Brookman hall at Sir John Russell's disposal.

Sir John Russell, who illustrated his lecture with many lantern slides, explained that the Rothamsted experiments were started in 1843 by John Bennet Lawes, an English country squire, who lived in the beautiful old manor house of Rothamsted, one of the stately homes of England. The times were bad for farmers and Lawes depended on farming. His hope was to get more out of the land. At that time the yield of wheat was about 20 bushels an acre, but in some seasons it fell much lower.

Discoverer of Artificial Manure.

Lawes had a taste for making agricultural experiments, and great luck in that his experiments nearly always succeeded. He knew a little chemistry and something about the composition of farmyard manure—then the regular manure on all farms and still one of the best. He had found by experiment that one of its constituents, nitrogen, could advantageously be given to crops in the form of sulphate of ammonia, a by-product in the manufacture of coal gas. He further experimented with bones, which had worked marvels on some of the English pastures, but had failed at Rothamsted. He found that if they were treated with sulphuric acid they became instantly effective, being converted into the substance then called superphosphate of lime. At that time bones were dear, but rock phosphate which had only just been discovered was cheap, and Lawes found that if it was treated with sulphuric acid it produced the same superphosphate of lime as did the more expensive bones. So he patented the process, set up a factory near London, and made artificial manures for the first time in history. For many years he had the whole superphosphate industry in his hands, and he made a considerable fortune. But he continued the field experiments on his home farm and brought to Rothamsted a young chemist, Joseph Henry Gilbert. The two men worked together for 60 years, all their lives in fact. A barn was converted into a laboratory. The field experiments were made year after year on the same land and always with the same crops, so as to be quite certain that the result was not a trick of the season. The Broadbalk wheat field was perhaps the best known of Rothamsted. It was put into wheat in 1843, and had been kept in wheat every year since. It had never had a complete fallow all the time, though on three occasions half the field was fallowed one year and the other half fallowed the next. The experiment had shown that wheat could be grown year after year without difficulty except that weeds became troublesome. The yield was maintained so long as fertiliser was given; and it fell off only slowly if fertiliser was withheld. A plot that had had no manure since 1839 still yielded about 10 bushels per acre.

Habits of Growth Altered.

The experiments were made on all the ordinary farm crops, and they had shown that artificial manures—sulphate of ammonia, nitrate of soda, superphosphate, sulphate and muriate of potash—not only increased the growth of crops, but altered them in composition and habit of growth. Thus superphosphate increased root development and naturation. It hastened ripening, which was a great advantage in helping the plant to avoid certain pests and diseases. Further, some of the changes in growth enabled the plant to stand up better against the effects of bad seasons, especially lack of sunshine and temporary drought. The science of manuring was now so far advanced at Rothamsted that, if the general nature of the season could be predicted, it would be possible to draw up fertiliser mixtures for the different crops that would make the best use of the sunshine and the rain. Many experiments were now being made on this subject, and it had been found necessary to set up a statistical department to control the accuracy of the work, and to trace the relationship between soil and weather conditions and the efficiency of the different fertilisers. New methods of field experiments had been devised, and it was now possible to estimate quite small differences in value between different fertilisers and to say under what conditions any one was likely to be better than any other. The advantage of the work was that they could now advise farmers how to choose with considerable certainty between the eight different nitrogenous fertilisers on the market; also the five phosphatic fertilisers, and the four potassic fertilisers, according to the soil and weather conditions in which they were farming.

Farmyard Manure From Waste Straw.

Artificial fertilisers, however, had not quite the same action as farmyard manure; indeed, so far science had failed to provide any concentrater fertiliser that would act as well; particularly in a dry season. Farmyard manure was becoming costly on English and European farms. At Rothamsted, however, a method had been devised for making it from waste straw or other vegetable matter, without the use of animals at all. It was found that farmyard manure owed its value not to the animals, but to the great crowd of minute living organisms always present in it; and so the manure was made by encouraging these minute organisms to act. The process was not perfect, but it had already given valuable results in Great Britain, the United States, Canada, South Africa, and elsewhere, and it was continually being improved. Straw, which formerly had to be wasted, could now be changed to good manure. Some of the most interesting of the recent work, and it might turn out to be some of the most useful, had been in connection with the micro-organisms in the soil. Its interest arose out of the fact that farmyard manure and green manure were not themselves plant foods. In themselves they were actually harmful to plants; but once in the soil they went through a remarkable series of changes, to end up by being of great value to soil fertility.

What Minute Organisms Do.

For 40 years scientific workers tried to discover how these changes came about, but always unsuccessfully. Then it was shown that they were effected by myriads of minute living organisms, so numerous that a salt-spoonful of soil might contain many millions of them, yet so small that they could be seen only imperfectly. Gradually they were being picked out from the soil, and their habits studied. Methods had also been devised for estimating their numbers. Every month, however, new ones were discovered, and no one would venture to say what this great soil population was really like. Some of them changed the useless residues of dead plants into humus and valuable food for the next generation of plants. Others fixed nitrogen from the air, and built it up into complex proteins by a process that no chemist could imitate or even understand. Others fed the valuable clovers and other leguminous plants. Some were like plants in that they simply took up plant food without themselves making any: yet these also were useful, because they protected the food from being washed out by the rain. Others fed upon smaller organisms. All these were being studied.

Applying the Knowledge Gained.

As yet the knowledge gained had not found much practical application, but beginnings had been made in making artificial farm-yard manure, inoculation for the growth of leguminous crops, the treatment of sick soils, and making manure from sewage. All experience showed that the really important thing was to be quite sure about the facts; to be certain that the supposed knowledge was really true. This was the business of the universities and the experiment stations. Once the facts were definitely established the ingenious agriculturist began to use them, first in one direction, then in another, till finally a really great advance in practice was achieved. Artificial fertilisation began at Rothamsted as laboratory experiments of no practical value. They were now the basis of a great industry, and of a high standard of farm production. So the laboratory experiments of to-day made in the universities and experiment farms might in their turn develop into methods of great practical value to-morrow, and add further to the achievements of science in agriculture.