What Sir J. B. Lawes Has Done fo Agriculture.

The agricultural experiments conducted by Sir John B. Lawes, Rothamsted, England, are extensively quoted by agricultural writers on both sides of the Atlantic, and the benefits which he has conferred upon British farmers, as well as those in other countries, are universally acknowledged. There are many experiment stations in Europe, but they are mostly all supported by the government, while Sir John's is conducted at his own expense. These investigations began in Germany, and have been followed up at Rothamsted. All that can be done at our stations is to copy these experiments more or less faithfully. As we have said very little about the work accomplished by Mr. Lawes, we present the following account of it as epitomized under his direction:—

Mr. Lawes commenced experiments soon after entering into possession of his hereditary property in 1834. The researches of De Saussure on vegetation were the chief subject of his study to this end. Of all the experiments so made, those in which the neutral phosphate of lime, in bones, bone-ash, and apatite, was rendered soluble by means of sulphuric acid, and the mixture applied for root-crops, gave the most striking results. The results obtained on a small scale in 1837, 1838, and 1839, were such as to lead to more extensive trials in the field in 1840 and 1841, and subsequently.

In 1843 more systematic field experiments were commenced; and a barn, which had previously been partially applied to laboratory purposes, became almost exclusively devoted to agricultural investigations.

The station has been entirely disconnected from any external organizations, and has been maintained entirely by Mr. Lawes. He has further set apart a sum of £100,000, and certain areas of land, for the continuance of the investigation after his death.

In 1854-5 a new laboratory was built, by public subscription of agriculturists, and presented to Mr. Lawes, in July, 1855.

From June, 1843, up to the present time, Dr. J. H. Gilbert has been associated with Mr. Lawes, and has had the direction of the laboratory. At first only one laboratory man was employed; but very soon a chemical assistant was necessary, and next a computer and record-keeper. During the last twenty-five years the staff has consisted of one or two, and sometimes three chemists, and two or three general assistants. There are now more than 30,000 bottles of samples of experimentally-grown vegetable produce, of animal products, of ashes, or of soils, stored in the laboratory.

A botanical assistant has also occasionally been employed, with from three to six boys. Two or three (for some time past four) computers and record-keepers have been occupied in calculating and tabulating. Chemical assistance is frequently engaged in London, or elsewhere; and, for some years past, Mr. R. Richter, of Berlin, has been almost constantly occupied with analytical work sent from Rothamsted. The field experiments, and occasionally feeding experiments, also employ a considerable number of agricultural laborers.

I.—Field Experiments on Vegetation.

The general plan of the field experiments has been:—

To grow some of the most important crops of rotation, each separately, year after year, for many years in succession on the same land, without manure, with farm-yard manure, and with a great variety of chemical manures; the same description of manure being, as a rule, applied year after year on the same plot. Experiments on an actual course of rotation, without manure, and with different manures, have also been made.

Comparative experiments with different manures have also been made on other descriptions of soil, in other localities.

Samples of all the experimental crops are taken, and brought to the laboratory. Weighed portions of each are partially dried, and preserved for future reference or analysis. Duplicate weighed portions of each are dried at 100° C., the dry matter determined, and then burnt to ash on platinum sheets in cast-iron muffles. The quantities of ash are determined and recorded, and the ashes themselves are preserved for reference, or analysis.

In a large proportion of the samples the nitrogen is determined; and in some this amount existing as albuminoids, amides, and nitric acid.

In selected cases, illustrating the influence of season, manures, exhaustion, &c., complete ash-analyses have been made, numbering in all more than 700.

Also in selected cases, illustrating the influence of season and manuring, quantities of the experimentally-grown wheat grain have been sent to the mill, and the proportion and composition of the different mill-products determined.

In the case of the experiments on the mixed herbage of permanent grass land, besides the samples taken for the determination of the chemical composition (dry matter, ash, nitrogen, woody fibre, fatty matter, and composition of ash), carefully averaged samples have frequently been taken for the determination of the botanical composition. In this way, on four occasions at intervals of five years—viz., in 1862, 1867, 1872, and 1877—a sample of the produce of each plot was taken, and submitted to careful botanical separation, and the percentage, by weight, of each species in the mixed herbage determined. Partial separations, in the case of samples from selected plots (frequently of both first and second crops), have also been made in other years.

Investigation of Soils.—Samples of the soils of most of the experimental plots have been taken from time to time, generally to the depth of 9, 18 and 27 inches, sometimes to twice and sometimes to four times, this depth. In this way about 1,500 samples have been taken, submitted to partial mechanical separation, and portions of the sifted soil have been carefully prepared and preserved for analysis. In a large proportion of the samples the loss on drying at different temperatures, and at ignition, has been determined. In most the nitrogen determinable by burning with soda-lime has been estimated. In many the carbon, and in some the nitrogen as nitric acid, and the chlorine have been determined. Some experiments have also been made on the comparative absorptive capacity (for water and ammonia) of different soils and subsoils. The systematic investigation of the amount, and condition, of the nitrogen, and of some of the more important mineral constituents, of the soil of the different plots, and from different depths, is now in progress or contemplated.

Rainfall and Drainage.—Almost from the commencement of the experiments the rainfall has been measured. From time to time the nitrogen, as ammonia and as nitric acid, has been determined in the rain waters. The chlorine, and the sulphuric acid, have also been determined in a considerable series of samples.

Three "drain gauges," also of one-thousandth of an acre each, for the determination of the quantity and composition of the water percolating respectively through 20 inches, 40 inches, and 60 inches depth of soil (with its subsoil in natural state of consolidation) have also been constructed. A more numerous series of smaller "drain gauges," arranged for the investigation of the influence of different crops, and of different manures, on the amount and composition of the drainage waters, has been constructed; but they have been found to be not sufficiently water-tight. Each of the differently manured plots of the permanent experimental wheat field having a separate pipe-drain, drainage waters have been and are frequently collected and analysed.

Water Transpired by Plants.—For several years in succession, experiments were made to determine the amount of water given off by plants during their growth. In this way various plants, including representatives of the graminiceous, the leguminous and other families, have been experimented upon. Similar experiments have also been made with various evergreen and deciduous trees.

Botanical Characteristics.—Having regard to the difference in the character and amount of the constituents assimilated by plants of different botanical relationships, under equal external conditions, or by the same description of plants, under varying conditions, observations have been made on the character and range of the roots of different plants, and on their relative development of stem, leaf, &c. In the case of various crops, but more especially with wheat and beans, samples have been taken at different stages of growth, and the composition determined, in more or less detail, sometimes of the entire plant, and sometimes of the separated parts. In a few cases the amounts of dry matter, ash, nitrogen, &c., in the above-ground growth of a given area, at different stages of development, have been determined. The amounts of stubble of different crops have also occasionally been estimated.

Assimilation of Free Nitrogen.—Experiments were made for several years in succession to determine whether plants assimilate free or uncombined nitrogen, and also various collateral points. Plants of the gramineous, the leguminous, and other families, were operated upon.

II.—Experiments on Animals, Etc.

Experiments with the animals of the farm were commenced early in 1847, and have been continued, at intervals, up to the present time.

The following points have been investigated:

1. The amount of food, and its several constituents, consumed in relation to a given live-weight of animal within a given time.
2. The amount of food, and of its several constituents, consumed to produce a given amount of increase in live-weight.
3. The proportion, and relative development, of the different organs or parts of different animals.
4. The proximate and ultimate composition of the animals in different conditions as to age and fatness, and the probable composition of their increase in live-weight during the fattening process.
5. The composition of the solid and liquid excreta (the manure) in relation to that of the food consumed.
6. The loss or expenditure of constituents by respiration and the cutaneous exhalations—that is, in the mere sustenance of the living meat-and-manure-making machine.

The general plan of experimenting was as follows:

To provide data as to the amount of food, or its several constituents, consumed in relation to a given live-weight of animal within a given time, and to produce a given amount of increase in live-weight, several hundred animals—oxen, sheep, and pigs—have been experimented upon. Selected lots of animals were supplied, for many weeks, or for months consecutively, and weighed quantities of food, selected and allotted according to the special point under inquiry. The composition of foods was determined by analysis. The weights of the animals were taken at the commencement, at intervals during the progress, and at the conclusion of the experiment.

The amount, and relative development, of the different organs and parts were determined in two calves, two heifers, fourteen bullocks, one lamb, 249 sheep, and fifty-nine pigs.

The percentages of water, mineral matter, fat, and nitrogenous substance, were determined in certain separated qarts, and in the entire bodies, of ten animals—namely, one calf, two oxen, one lamb, four sheep, and two pigs. Complete analysis of the ashes, respectively, of the entire carcases, of the mixed internal and other "offal" parts, and of the entire bodies, of each of these ten animals, have also been made.

From the data provided, as just described, as to the chemical composition of the different descriptions of animal, in different conditions as to age and fatness, the composition of the increase while fattening, and the relation of the constituents stored up in increase to those consumed in food, have been estimated.

To ascertain the composition of the manure in relation to that of the food consumed, oxen, sheep, and pigs have been experimented upon.

In the case of oxen, the food and litter (sometimes with an acid absorbent) were weighed, sampled, and analysed; the animals were fed in boxes, for periods of from five to nine weeks, and the total dung produced was well mixed, weighed,