and thereby aroused such a spirit of investigation as had never before been known in England Among other labourers in this field, Mr. John Bennett Lawes and Dr. Gilbert, commenced, in 1843, the systematic investigation of the action of chemical combinations when applied as manures to the most important crops of the farm; more especially devoting their attention to the proof or disproof of the startling announcement of what is commonly known as Liebig's *mineral theory*; which is embodied in the following sentence, to be found at page 211 of the third edition of his work on Agricultural Chemistry: "The crops on a field diminish or increase in exact proportion to the diminution or increase of the *mineral* substances conveyed to it in manure?

In a subsequent edition of his work, Liebig still more strongly asserted the truth of his theory; for he says, speaking of the farms of England, "sooner or later, they must see that in this so-called "mineral theory," in its development and ultimate perfection, lies the future of agriculture."

This then was the assertion which Lawes and Gilbert set themselves to disprove: That all that the cultivated plants on a farm required for their support was the mineral matters contained in their ashes!

The first idea that struck them was, that in order to discover what a certain piece of land required to be added to it to enable it to produce a crop, it would be as well to make a chemical analysis of the soil. But, upon consideration, they were deterred from this by the reflection that the addition of a quantity of ammoniacal salt containing 100 lbs. of ammonia —an unusually large dressing = 400 lbs. of sulphate of ammonia—to the acre, would only increase the percentage of ammonia in the soil by 0.0007 or $\frac{7}{10,000}$—the acre of land six inches deep being taken to weigh about 1,344,000 lbs. It is quite clear that no method of analysis would enable the chemist to appreciate the difference between the soil before and after the application. There, we see that they acknowledged at first starting the inutility of seeking to discover the productive power of a soil from its percentage composition, a position that I have maintained many a time in this periodical.

The next question that the two partners in these trials asked themselves was: In what condition should the land be to make it fit for replying fully to the inquiries to be propounded to it? Now, the answer involved the following considerations:

Some system or other of rotation is invariably pursued in British agriculture; what is called a *course* of rotation is the period of years which includes the circle of all the different crops grown in that rotation; as a general rule, in the course of rotation no two crops of the same kind are grown consecutively on the same soil. (1) Wheat, for instance is never sown immediately after wheat, but only after some other crop has intervened, and at such a period of the rotation as, by experience, it is known that the soil will, by direct manure or by other means, have recovered its power to produce a profitable yield of that crop.

So, looking at these considerations, it was decided to begin the experiments on land that had just been put through a course of rotation, and which was, in consequence, in what may be called a *practically* exhausted state. And this exhaustion of the soil before trying experiments in manure on it, I esteem of the very highest importance; for I am sure that the utter failure of many of the numerous experiments tried at some of our agricultural colleges, notably at Guelph, may be attributed to the neglect of this precaution.

Thus, it was determined after a full investigation to proceed by way of *synthesis* instead of by the *analytic* method, and in carrying out the inquiry it was decided to take Wheat as the type of cereal plants and Turnips as the type of root-plants. Beans were also experimented on, but as these are rarely grown in this province, I shall not describe this part of the work.

And in order to carry out the experiments in so full a manner as to be convincing to the most sceptical, it was determined to devote 14 acres to the continuous growth of wheat, and 8 acres to the continuous growth of turnips. My readers will please to remember that the experiments began in 1843, and have been continued, though on a much more extensive scale, ever since.

Let us, first, pay attention to the series of experiments on the manures supposed to be adapted to the growth of wheat; for it is here that, as I believe, we shall see more clearly than elsewhere the utter futility of Liebig's mineral theory.

No one doubts that, in the case of vegetation in a native soil, the atmosphere is found to be a sufficient source of the nitrogen and the carbon; but agriculture is essentially an artificial process; and we shall see that, especially as regards the production of wheat, it is only by the accumulation within the soil itself of nitrogen, naturally derived from the atmosphere, rather than of the peculiarly soil-constituents, that our crops can be *increased*.

We have seen that all the experimental fields were selected when they were in a state of agricultural exhaustion—they had grown, that is, the regular number of crops which constitute a rotation since the application of manure. In fact, the wheat-field was regularly scourged, for, since the manured turnip-crop, it had grown barley, pease, wheat, and oats, without any further manuring.

In the first season, the 14 acres intended for wheat were divided into about 20 plots, and it was by the *mineral theory* that Mr. Lawes was mainly guided in the selection of manures, ammonia being, at that time, considered of less importance. Rape-cake, containing, besides some minerals and nitrogen, a certain quantity of *carbonaceous* substance, in which both corn and straw so much abound, was added to one or two of the plots.

I shall not apologise for asking my readers to attend most seriously to the repulsive mass of columns of figures that will pass under their eyes in the tables that follow. I believe with all my heart and understanding that the whole future of the agriculture of all lands, after the first virgin fecundity of the hitherto unbroached riches of their new lands has been deflowered, depends upon a thorough knowledge and appreciation of the perfect truth of the deductions made by our devoted servants and friends from the experiments now under investigation. The labours and studies of all preceding agricultural students fade into nothingness by the side of these noble benefactors to the human race.

Most of my readers will have no difficulty in drawing their own deduction from the above table; but as some readers are too lazy to draw even the simplest lesson from the clearest statement, I may as well say what I see in it:

First, I observe that the natural yield of the more than agriculturally exhausted land at Rothamsted was, in a season which was a bad one for wheat, 16 bushels to the acre—$2\frac{3}{4}$ bushels more than the average yield of the United States; next, that the addition of 14 tons of cake- and grain-fed dung to the acre, only raised the crop by six bushels of grain and 356 lbs. of straw; that the ashes of 14 tons of dung added nothing to the number of bushels, and that the weight of the bushel was by no means improved by the dressing, but, on

(1) In parts of Hampshire, Sussex, and other southern counties in England, I have known the rotation to consist of two root-crops, both fed off by sheep, and then two grain-crops, the latter of which is invariably barley sown down with grass-seeds. The reason for this is that if the barley were to succeed a fed-off crop of roots on these soils, it would lodge, destroy the young grass, and not be fit for the maltster. A. R. J. F.