

of dry matter, than plants of other orders, but the further and astounding fact that they left the soil richer in nitrogen by their growth. Where did this additional nitrogen come from? What was its source? If from the uncombined, free nitrogen of the air, in what way did the legumes appropriate it? For by this time it had been fairly well established that crops in general could only obtain the nitrogen necessary for their growth from the organized nitrogen in the soil.

Many chemists worked on this problem, prominent among whom was Gilbert of Rothamsted, England, who, with Lawes, for more than fifty years did such magnificent work in agricultural research both in the laboratory and field, and placed the whole world for all time under a debt of gratitude; for their work above that of all others has furnished the foundation of agricultural science upon which others of all nations have built and still are building. Unfortunately, Gilbert just missed the solution of the problem, chiefly through imperfect apparatus. It was a great disappointment to him. The discovery was made by Hellriegel and Wilfarth, who conclusively showed that the legumes obtained their nitrogen, or in part at least, from the nitrogen of the atmosphere, not of themselves, but through the agency of certain nitrogen-fixing bacteria in the soil, which attach themselves and reside in nodules or tubercles upon the roots of the legumes, passing on their elaborated nitrogen to their host—it appears to be a case of symbiosis—for the building up of its tissues of root, stem and leaf. Without the aid of these bacteria the legumes, like all other plants, must draw upon the nitrates of the soil for their supply of this important element. As I was in England and Germany at this time (1888), I had an excellent opportunity of learning at first hand the various steps of this discovery, which, for its far reaching effects and the practical results that have followed, must be regarded *the* agricultural discovery of the century. It is interesting to note that Gilbert subsequently repeated Hellriegel's and Wilfarth's work and confirmed their conclusions.

The next and most logical step was the preparation of cultures of these useful bacteria by the bacteriologists, and these cultures are today in extensive use for inoculating the seed and soil for the growing of legumes in districts found to be lacking in the nitrogen-fixing organisms.

A further step was the discovery by the chemists that clover and alfalfa and many other valuable legumes would not thrive in acid-reacting soil, that there was no development of the nodules in such soils. Thus was brought in the now common practice of testing the soil upon which it is wished to grow a legume and the application of lime or ground limestone to correct acidity if such be found.