

"3. That there is a connection between root tubercles and this acquisition of nitrogen is clearly demonstrated. What this connection is, what are the relations of micro-organisms to the root tubercles and the acquisition of nitrogen, and in general how the nitrogen is obtained, are questions still to be solved.

"4. The cereals with which experiments have been completed have not manifested this power of acquiring nitrogen, nor do they have such tubercles as are found on the roots of legumes.

"5. In the experiments here reported, the addition of soil infusions did not seem necessary for the production of root tubercles. A plausible supposition is that the micro-organisms or their spores were floating in the air and were deposited in the pots in which the plants grew.

"6. As a rule, the greater the abundance of root tubercles in these experiments, the larger and more vigorous were the plants and the greater was the gain of nitrogen from the air.

"7. In a number of these experiments, as in similar ones previously reported, there was a loss of nitrogen instead of gain. The loss occurred where there were no root tubercles; it was especially large with oat plants, and largest where they had the most nitrogen at their disposal in the form of nitrates. As the gain of nitrogen by the legumes helps explain why they act as renovating crops, the loss in the case of the oats suggests a possible reason why they should appear to be an exhaustive crop.

"Practical inferences.—The ability of legumes to gather nitrogen from the air helps to explain the usefulness of clover, alfalfa, pease, beans, vetches and cow-pease as renovating crops and enforces the importance of these crops to restore fertility to exhausted soils. The judicious use of mineral fertilizers (containing phosphoric acid, potash and lime) will enable the farmer to grow crops of legumes which, after being fed to his stock, will, with proper care to collect and preserve all manure, both liquid and solid, enable him to return a complete fertilizer in the shape of a barnyard manure to his land. A further advantage of growing these crops is that the nitrogenous material, protein, which they contain in such great abundance, is especially valuable for fodder."

From the foregoing it seems that, in the present condition of our knowledge, the conclusion may fairly be drawn that the atmosphere stands ready to furnish the farmer gratis with all the organic constituents which his crops require, provided always that he, on his part, will exercise a sufficient amount of skill and intelligence in appropriating and retaining on his farm the fertilizing materials, and especially the nitrogen. If he does this, all that it is necessary for him to provide, in order to replace the losses which his farm sustains from the sale of stock or produce, are the inorganic or mineral constituents of these, and especially the phosphoric acid and potash. There is much in all this to remind one of Sprengel and Liebig's teaching of fifty years ago, according to which a plant cannot thrive if its soil does not contain all the substances which are to be found in its ash. As regards the cheapest forms in which these inorganic constituents can be applied to crops, there is no doubt that these are high grade superphosphate or Thomas phosphate powder for the available phosphoric acid, and kainite for the potash. There does not appear to be any reason why these substances should not be introduced into the stable manure in the same manner as in the case of the ground plaster above mentioned. Some of the salts contained in the superphosphate and kainite would be useful with the sulphate of lime in fixing the ammonia, as soon as formed from the organic nitrogen. Should this suggestion be found to have practical value, there is no doubt that our fertilizer manufacturers would be found able to supply our farmers, at a very moderate cost, with a mixture of ground plaster, superphosphate and kainite, in such proportions as experience might show to be most advantageous.

I have the honour to be, Sir,

Your obedient servant,

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