Necessity for Expanding Fundamental Scientific Investigations in Agriculture

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It may be trite to state that applied research is mostly the application of principles discovered as a result of fundamental investigations into the phenomena of nature. However, recognition of this fact is so important to research scientists in agriculture that it should be repeated again and again. It is not always possible to distinguish between applied and fundamental investigations. Fundamental study implies a systematic search for principles of nature, not a haphazard search for knowledge. Applied research suggests a search for the solution of a practical problem. The realms of both fundamental and applied studies are traversed as progress is made from the unknown to a product of almost unlimited practical value. Synthetic nitrogen fertilizer is an excellent example of this. Its use today adds hundreds of millions of dollars each year to the wealth of the nation, both agricultural and industrial. Agronomists have played a big role in pointing the way to the practical utilization of a tremendous supply of fixed nitrogen. Most of these agronomic investigations have been in the realm of applied research.

But the productive agronomic research in the utilization of nitrogen fertilizers could not have come to pass nor would it have been important without first having available many principles resulting from productive fundamental studies. First of all, the elements, nitrogen and hydrogen, had to be discovered, such discoveries having been made in the 18th century. Each element had to be characterized. Gas laws had to be developed and elucidated. The critical temperature and pressure for the liquefaction of various gases had to be determined. Catalytic action had to be understood. In addition, mechanical devices capable of containing the gases under the correct pressure and temperature had to be available. The latter required a knowledge of the tensil strength of various materials. Probably all of these and other related studies prior to the actual fixation of nitrogen in a combined form could be classed as fundamental.

But what about the research which actually led the artificially combining nitrogen with hydrogen? Was it fundamental or applied research? Certainly it was done in an effort to solve an urgent practical, namely a shortage of combined nitrogen in gunpowder. Did the knowledge gained in determining the temperature and pressure which gave the first increments of prepared ammonia constitute a principle? Perhaps. Perhaps the applied research, so far as production of nitrogen is concerned, was the solution of a whole series of problems from test tube to factory.

Principles are not the product of fundamental or applied research. They are the result of experimental research not based on established physical, chemical, or economic principles. They are the result of the "trial-and-error" approach. This type of approach is not based on fundamental research. It is usually an effort to solve an urgent practical problem. It is done in an effort to test tube to factory. The "trial-and-error" approach is not always successful, and it is not always based on an understanding of the phenomena of nature. Fortunately, much progress has been made in the understanding of the phenomena of nature; yet in spite of all advance, the unknown far exceeds the known. An example of this is the wheat-breeding program. The wheat breeder knows a great deal about the available parent materials, but he does not know much about the available parent materials. He recognizes major problems and they possess some knowledge of the genetic makeup of the crop. The art of crossing is possessed by many workers. Yet wheat breeders have not been able to make progress in the breeding of all the accomplishments and knowledge of the art of crossing is still not far above the true "trial-and-error" type of experimentation. Each year several hundred crosses are made in the United States out of which may be selected different strains of wheat segregate. For example, the wheat-breeding program is said to have made tens of thousands of crosses. From this great mass of segregating material less than a half dozen some variety would be expected. More complete knowledge of the genetics of wheat, including a map of the genes in the chromosomes and a thorough study of breeding methods, would increase the efficiency of the wheat breeding program. The wheat breeder would be able to increase the efficiency of the wheat breeding program. The wheat breeder would be able to increase the efficiency of the wheat breeding program. The wheat breeder would be able to increase the efficiency of the wheat breeding program. The wheat breeder would be able to increase the efficiency of the wheat breeding program. The wheat breeder would be able to increase the efficiency of the wheat breeding program. The wheat breeder would be able to increase the efficiency of the wheat breeding program. The wheat breeder would be able to increase the efficiency of the wheat breeding program. The wheat breeder would be able to increase the efficiency of the wheat breeding program. The wheat breeder would be able to increase the efficiency of the wheat breeding program. The wheat breeder would be able to increase the efficiency of the wheat breeding program. The wheat breeder would be able to increase the efficiency of the wheat breeding program. The wheat breeder would be able to increase the efficiency of the wheat breeding program. The wheat breeder would be able to increase the efficiency of the wheat breeding program. The wheat breeder would be able to increase the efficiency of the wheat breeding program. The wheat breeder would be able to increase the efficiency of the wheat breeding program. The wheat breeder would be able to increase the efficiency of the wheat breeding program. The wheat breeder would be able to increase the efficiency of the wheat breeding program. The wheat breeder would be able to increase the efficiency of the wheat breeding program.