FERTILIZER DEVELOPMENTS

FERTILIZER INDUSTRY MAKING ADJUSTMENTS TO COMPLEX ECONOMIC REQUIREMENTS

Fertilizers as a means of increasing total crop production have little appeal under present conditions of agriculture, with large surpluses being produced in many instances at a cost exceeding the value of the products. As a means, however, of reducing the cost of production, they are of special interest. That the cost of fertilizers to the farmer might be reduced, the elimination of inert materials accompanying the plant food elements has long been advocated; but, primarily because of the nature of the materials available, this could not be accomplished. Improvement in commercial fertilizers has gradually gone forward but the greatest advance has been made since the World War.

The earlier industry was founded on the exploitation of natural deposits of phosphates, nitrates, and potash, and on the utilization of waste or by-products from other industries, so that the technology of the industry prior to the twentieth century consisted principally of hand mixing of the various available materials. The only chemical process involved was the manufacture of sulphuric acid used in converting phosphate into superphosphate. The principal part of the industry was in assembling and mixing the materials and in distributing the products. Mechanization of the plants and, in many instances, combination of sulphuric acid and superphosphate manufacture with mixing and distribution plants, were natural steps in the development.

Character of Goods Produced

Under this system the total of plant-food constituents in mixed fertilizers was limited to about 20 per cent because of the low percentage of these constituents in many of the basic materials, none of them carrying over 20 per cent with the exception of some of the potash salts. The treatment of phosphate rock with sulphuric acid gave a product with one-half the phosphoric acid content, diluted with calcium sulphate. Materials obtained as by-products from other industries were diluted by accompanying substances, which in the great majority of cases were of little crop-producing value. When more concentrated materials were available, the mixtures were diluted with filler to make them correspond to the customary formulas.

Influence of Nitrogen Fixation

The Fertilizer and Fixed Nitrogen Unit of the Bureau of Chemistry and Soils and its predecessors in the Bureau of Soils and the Fixed Nitrogen Research Laboratory, have been engaged for a number of years on problems involved in the production of concentrated fertilizers, including the fixation of nitrogen and the conversion of nitrogen products into substances suitable for fertilizers. The development of nitrogen fixation since the war has exerted a profound influence on the fertilizer industry and is transforming it into a chemical manufacturing industry. Before the war calcium nitrate and calcium cyanamide were the only fixed-nitrogen products entering American fertilizers, but since they could be used in only a limited amount, their effect on the industry was small. Since 1918, however, the production of ammonia by the direct synthetic method has made it possible to prepare a number of materials of high concentration containing one, two, or even all three of the principal fertilizer elements. The products from the nitrogen-fixation industry are characterized by concentration. Ammonia is the most concentrated nitrogen product, but since it can not be employed directly, it is transformed into products suitable for fertilizer use. By oxidation it is transformed to nitric acid. From nitric acid, with limestone, calcium nitrate is formed; and with soda ash, synthetic sodium nitrate. Ammonium nitrate is formed by combination of ammonia with nitric acid, or ammonium sulphate with sulphuric acid, and ammonium phosphates with phosphoric acid. Various combinations of these with each other and with potash salts are being produced or are suitable for utilization as fertilizers.

The development of more concentrated phosphates has been going forward simultaneously. The production of triple superphosphate for fertilizer use has been a reality for years and the production of phosphoric acid both by furnace processes and by chemical means gives promise of its more extensive employment in the near future as a carrier for the other two fertilizer elements. This use is already an actuality, but expected developments in the production of cheaper phosphoric acid will accentuate the employment of ammonium and potassium phosphates and similar compounds. A further recent development has been the direct addition of ammonia to superphosphate, whereby part of the phosphate is transformed into ammonium phosphate. The addition of ammonia is limited to rather small percentages but the increase in plant-food content is quite advantageous.

Higher-Analysis Fertilizers

The availability of more concentrated materials is resulting in the production of mixed fertilizers of higher concentration. While it was not advantageous and often not possible to make mixed goods of high concentration with materials from the older sources, with the new synthetic materials, mixtures carrying as much as 70 to 75 per cent of plant food may be made. A change to the production of more concentrated fertilizers is taking place as is evidenced by the fact that the average plant-food content of fertilizers in the United States in 1914 was about 12 per cent, while in 1930 it was 18 per cent. (Fig. 204.) This 50 per cent increase in plant-food content represents an increase of 486,500 tons of actual plant food in the fertilizer consumed in 1930 over what would have been contained in the same tonnage of

12 per cent fertilizer. Or it means some 4,000,000 fewer tons of mixed fertilizer to handle and on which to pay freight, than would have been necessary with 12 per cent goods. At an average freight charge of $3 per ton, this is a saving of over $12,000,000. With higher concentrations the savings will be increased proportionately.

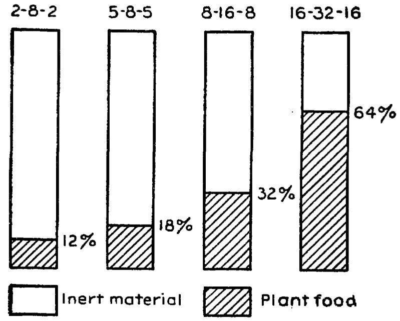

FIGURE 204.—Relative amounts of plant food and inert materials in ordinary, high-analysis, and concentrated fertilizers

Concentrated Fertilizers

The present day high-analysis fertilizers are only a step in the production of concentrated fertilizers. They may be made up from high-grade materials handled in the same way as the low-analysis goods, but the production of concentrated fertilizers involves new adjustments in manufacture, the solving of distribution and handling problems, the determination of agronomic relations and the education of the farmer in their use. That these changes are gradually taking place is revealed by a comparison in Table 12 of the new materials with the earlier materials employed.

TABLE 12.—*Comparison of sources, composition, and other characteristics of older and newer fertilizer materials*

Type of material	Source	Composition: Nitrogen	Composition: Phosphoric acid	Composition: Potash	Remarks
		Per cent	*Per cent*	*Per cent*	
Older materials:					
Sodium nitrate	Chile	15-16			
Ammonium sulphate	Gas plants and coke ovens	20			
Blood	Animal refuse	13-15			
Tankage	do	4-12			Naturally occurring, or by-product and waste materials.
Cottonseed meal	Oil mills	7-8	2-3	1.5-2	
Fish scrap	Fish	7-10	5-7		
Garbage	City waste	3.5	0.1-1.4	2.25-4.25	
Bone meal	Animal refuse	2-3	23-25		
Superphosphate	Phosphate rock		14-18		
Potassium muriate	German mines			50	
Potassium sulphate	do			48-51	
Manure salt	do			25	
Kainit	do			14	
Newer chemical products:					From chemical processes:
Sodium nitrate	Germany and United States.	16			Nitric acid added to sodium carbonate.
Calcium nitrate	France and Norway	13			Nitric acid added to calcium carbonate.
Do	Germany	15.5			Nitric acid added to 5 per cent ammonium nitrate.
Calcium cyanamide		20.5-25			First fixation product used as fertilizer.
Ammonium nitrate	Germany and United States.	34-35			Ammonia and nitric acid.
Urea (Floranid)	Germany	46			Ammonia and carbon dioxide.
Cal-urea	do	34			Urea and calcium nitrate.
Urea-phos	do	18	45		
Potassium nitrate	do	13.5		46	
Cal-nitro	do	20.5			Ammonium nitrate added to calcium carbonate.
Leuna saltpeter	do	26			Ammonium nitrate added to ammonium sulphate.
Ammonium sulpho-nitrate	France	25.5			Do.
Ammophos	United States	{ 13 20	48 20 }		Ammonium phosphate and sulphate.
Leunaphos	Germany	20	20		Diammonium phosphate and ammonium sulphate.
Phosphazote	France and Switzerland	7-12	12-15		
Treble superphosphate	United States		45-47		Phosphate rock added to phosphoric acid.
Diammonium phosphate		23	47		Ammonia and phosphoric acid.
Potassium-ammonium nitrate		16		25-28	Ammonium nitrate added to potassium chloride.
Nitrophoska	Germany	15-17.5	11-30	15-26.5	5 formulas from mixtures of diammonium phosphate, ammonium nitrate, or urea and potassium chloride or sulphate.
Ammophosko	United States				Mixture of Ammophos, potassium sulphate, and ammonium sulphate.

As a chemical industry, the manufacture of fertilizers is related to highly technical processes as the source of materials and to agriculture in the disposition of its products. The industry must meet the competition of older materials as well as that of new chemical processes and better methods of manufacture. The consumption and distribution of its products will be determined by the relation of their prices to those of agricultural products as well as by the efficiency of the goods in crop-producing power, while existence as a chemical industry will depend upon production costs at least as low as those of the natural materials. Intensive study of problems associated with concentration is being made by the Fertilizer and Fixed Nitrogen Unit of the department and by various other agencies in this country and abroad. The preparation of concentrated fertilizers was initiated in this country and their utilization has been taken up in other countries, especially Germany. The advantages of the concentrated materials are apparent, and their extensive employment here will gradually follow the solving of problems encountered under American conditions.

R. O. E. Davis, *Bureau of Chemistry and Soils.*

FERTILIZER SOURCES AMPLE FOR MIDWEST, COST CUT BY HIGHER CONCENTRATION

The American farmer, in his agricultural operations, applies 8,000,000 tons of fertilizers annually. It is frequently pointed out that this is an average application of 40 pounds for each acre of land under cultivation in this country, as contrasted with 500 pounds for the Netherlands, where intensive farming is generally followed. But it is not necessary to go to Europe to find comparisons, for in this country there are even more widely divergent fertilizer practices between the Southeast and the Middle West, as illustrated by comparing Florida, with an average of 794 pounds per acre, with Kansas, with an average of only 1 pound per acre.

To account for this wide divergence, many factors must be considered. Some are the nature of crops, soil types, and geographical locations with respect to sources of fertilizer supply. While the staple crops are different in the different regions, yet there are few crops that do not respond to fertilizer use. While there are differences in soil types, yet there are few soils on which fertilizers do not give good results. Native fertility is no absolute safeguard against soil depletion, as has been amply demonstrated in agricultural experience. Unless provision is made for restoring to the land the plant food lost through the activities of various agencies, the best of soils may decrease in productivity through loss of some element of its fertility.

To prevent soil exhaustion is a function of fertilizers. To conserve labor, to permit the production of a crop unit with a reduced land unit and labor unit, in other words, to produce a crop unit at a reduced production cost, is the function of most immediate interest to the individual farmer.

Can there be any geographical limitation to these functions? Are they not of the same importance to the Middle West as to the Southeast? In accounting, therefore, for this wide divergence in fertilizer use, can the answer be found in sources of supply of fertilizer materials, and if so what can be done to meet the latent fertilizer requirements of the Nation's greatest agricultural region?