from Chile are already in store and importation continues.

"Sulphuric acid will continue available for superphosphate production and will not be requisitioned for nitric acid manufacture as was the case in the World War. Our phosphate rock reserves are enormous and our production capacity far exceeds any possible domestic demand. In addition our exports of phosphate rock to Germany, our largest foreign customer for this material, have been interrupted by the British blockade.

"Production of ammonia solutions, now equal to the peace-time demand, can be easily and quickly increased to meet an increased war-time demand. Larger quantities of by-product sulphate of ammonia will undoubtedly be available as steel production forces the coking of more coal for blast furnace coke.

"Organic sources of nitrogen, such as vegetable meals and tankages, largely by-products of other industries, will be available in larger quantities as their respective industries increase operations. At present, for tenable reasons, organic materials are the only ones that have risen greatly in price.

"We have a surplus of cotton for bag manufacture and we have available paper bags if the importation of jute for burlap bags should be interrupted, or prices be unduly raised.

"In short, we seem to have on hand or in sight all the materials and supplies necessary for a normal fertilizer season next spring. If production costs increase because of general economic conditions, because of transportation costs, or because of general wage increases, then naturally the cost of fertilizer production will also increase."

As a result of these facts the conclusion is drawn that, "There seems to be no need, either on the part of the manufacturer or the consumer, to lay in extraordinary or unseasonable supplies of fertilizers or fertilizer materials for fear of shortage or unwarranted price increases."

---

## BALANCE SHEET FOR PLANT NUTRIENTS

An interesting balance sheet regarding the annual losses from and additions to the soils of the United States of six of the plant food elements was published by the late Jacob G. Lipman in a New Jersey Agricultural Experiment Station Bulletin. Data were taken from 14,500 analyses of topsoils from all parts of the United States, from census figures of 1930, and from reports of the United States Department of Agriculture, the Geological

Survey, the Department of Commerce and Navigation, the Custom House and the Patent Office. From these data Dr. Lipman, in the light of his wide experience in the problems related to soil science, made the estimates which are included in the following table.

The figures in the table apply to the 1,455,390,414 acres which are considered to be agricultural land. This includes 413 million acres of harvested crop lands, 464 million acres of pastures on farms, and 578 million acres of pastures not on farms such as the large western grazing areas. The remaining land area of 450 million acres is omitted from consideration because of being definitely non-agricultural. It includes forest areas, urban and industrial areas, roads, railroads, parks, deserts, marshes and all waste lands.

The net annual loss of nitrogen is given in the table as somewhat more than 6.5 million tons, but Dr. Lipman considered that 10 million tons would be a reasonably conservative estimate of the annual loss from our crop lands. From figures given elsewhere in the article it is shown that this is 30 times the amount of nitrogen which is supplied annually in fertilizers.

Attention was drawn by the author to the net losses of calcium, potassium and magnesium, the removal of which involves a gradual increase in soil acidity. With the loss of the basic substances of which these elements are a part, there is more intense loss of phosphorus. Dr. Lip-

BALANCE SHEET FOR PLANT NUTRIENTS IN THE SOILS OF THE UNITED STATES IN 1930. ALL FIGURES ARE GIVEN IN TONS

| Nutrient Element | Losses (from harvested crops, grazing, erosion, and leaching) | Additions (from fertilizing and liming materials, manures and bedding, rainfall, irrigation waters, seed, and nitrogen fixed by microorganisms) | Net annual losses |
|---|---|---|---|
| Nitrogen | 22,899,046 | 16,253,862 | 6,645,184 |
| Phosphorus | 4,221,302 | 1,447,835 | 2,773,467 |
| Potassium | 50,108,560 | 5,151,076 | 44,957,484 |
| Calcium | 68,185,730 | 12,561,673 | 55,624,057 |
| Magnesium | 24,557,881 | 4,040,813 | 20,517,068 |
| Sulfur | 12,043,911 | 9,029,690 | 3,014,221 |

man emphasizes that our soils are suffering a net annual loss of about 3 million tons of phosphorus, or almost 10 times as much as is supplied annually by chemical fertilizers.

Another table gives the sources of the nutrients and the amounts added from each source. It is interesting to note from this table the large amounts of all of these elements except phosphorus which are added to the soil annually in rainfall. In 1930, there were added through rainfall to the agricultural lands in the United States 3,347,395 tons of nitrogen, 1,529,400 tons of potassium, 5,735,250 tons of calcium, 2,294,100 tons of magnesium, 5,768,900 tons of sulfur and no phosphorus. In that year, the rainfall contributed appreciably more calcium, magnesium and sulfur than did any other one source of these elements. The greatest amounts of nitrogen came from the fixation of atmospheric nitrogen by the micro-organisms in the root nodules of legumes and by those living in the soil itself. Large amounts were added also in rainfall, animal manures, and chemical fertilizers. The major additions of phosphorus were credited to animal manures and commercial fertilizers. The largest amounts of potassium came from animal manures, rainfall, and chemical fertilizers.

## NITROGEN OF THE AIR IS NOW A SOURCE OF FERTILIZER

The air over a single acre of soil contains approximately 31,000 tons of free nitrogen, none of which is available to the majority of plants until it is "fixed" in a form which can be used by plants and applied to the soil as a plant nutrient. The bacteria in the nodules of legumes, such as clover and alfalfa, and certain micro-organisms living in the soil have the peculiar ability to "fix" the nitrogen present in the air of the soil and thus enrich the soil in which they grow. Before the World War this was the only way in which this universally distributed source of nitrogen was tapped in the United States for agricultural purposes.

For our nitrogen compounds we were dependent on the great natural deposits such as those of nitrate of soda in Chile. According to figures in a report on Chemical Nitrogen issued by the United States Tariff Commission, in 1900 two-thirds of the world's supply of nitrogen came from the deposits of nitrate of soda in Chile. The remaining one-third was produced as a by-product in the manufacture of coke and gas from coal.

Since 1915, however, procedures have been perfected for the commercial "fixation" of nitrogen of the