

For centuries, farmers have realized the need to maintain soil fertility to sustain or improve crop yields. The history of the production and use of inorganic fertilizer can be traced back to the nineteenth century when Justus von Liebig established the theoretical foundations of agricultural science and when John Bennett Lawes began producing fertilizers containing phosphorus (Smil, 1997). By accident or by trial and error, it was found that applications of various organic wastes or naturally occurring mineral substances, such as manure, compost, fish remains, ashes, saltpeter, and other materials, would sometimes increase crop yields or apparently restore the fertility of the land. The German scientist Liebig recognized the value of elements derived from the soil in plant nutrition and correctly deduced the necessity of replacing those elements in the soil to maintain soil fertility. While carbon, hydrogen, and oxygen, which collectively make up 90%–95% of the dry matter of all plants, are provided by the atmosphere, other essential nutrients are derived from the soil. These nutrients are classified as primary nutrients (nitrogen, phosphorus, and potassium) and secondary nutrients (calcium, magnesium, and sulfur). The use of fertilizer to replenish these nutrients results in many benefits to man and the environment, including:

- o Increased agricultural outputs (mainly food and fiber). In 1840 Liebig published a recommendation that pulverized animal bones be treated with sulfuric acid to make the phosphate more readily available to plants. Plants also need micronutrients (boron, chlorine, copper, iron, manganese, molybdenum, and zinc) in much smaller amounts. As the science of chemistry progressed and more and more chemical elements were discovered, the relative importance of various elements for plant growth and yield was identified. Nutrients taken up by crops must be replenished to maintain soil fertility and productivity and prevent land degradation.
- o Reserving lands marginally suitable for agriculture for other uses.
- o Increased water-holding capacity