PRESIDENT'S MESSAGE

By Al Tucker

Phosphorus – Why are we wasting a critical life-giving resource?

This question arises because it is estimated that the world's supply of easily mined phosphate rock will last only about 100 years at the current rate of usage. Phosphate rock is a nonrenewable resource that constitutes one of the three primary components of modern inorganic fertilizers.

The easy availability of phosphate rock supports the green revolution and makes it possible to feed the world today. Along with nitrogen and potassium, it is a key fertilizer component that enhances crop yields. Almost all life on the planet relies on it. Phosphate and sugars form the backbone of DNA, and adenosine triphosphate (ATP) transports chemical energy within the cells. This molecule consists of only three elements: oxygen, nitrogen and phosphorus. Plants manufacture this molecule by photosynthesis, through which they extract phosphate from soil. Animals, on the other hand, obtain it by consuming plants or other animals.

Why is phosphorus important? It is this life-giving property of phosphorus that gives rise to problems in the Bay. One of the key nutrients leading to the degradation of the Bay is phosphorus (often just referred to as "P"). It contributes to the algal blooms and oxygen depletion. Hence, we tend to think of it as more of a pollutant and not as a key element that sustains life. We treat it as a waste product that must be curtailed. In the Bay watershed states, we have banned household products and home lawn and garden fertilizers containing phosphorus. Farmers are required to develop nutrient management plans that limit nitrogen and phosphorus applications to their fields. But! We should think more about the sustainability of this important element. In the Bay watershed, farmers limit their phosphate use to meet regulations for a clean Bay, not to conserve phosphate.

What is the problem? Phosphorus is one of the most common elements found on earth, but it is widely dispersed in many different chemical forms that are not easily refined. Only in phosphate rock are deposits found in a readily available and easily processed form. The world's reserves of phosphate rock are concentrated in fundamentally one country, Morocco, with 75% of the total global supply. The next largest reserve resides in China with 6%, and the remaining 19% are in scattered deposits of 3% or less. The U.S. has about 2% of this supply. In 2017 there were 11 active phosphate mines, with 5 located in Florida, 5 in Idaho, and 1 in North Carolina. Surprisingly, the single mine in North Carolina makes the state the second largest producer of phosphate rock in the U.S. Prior to 1996 the U.S. was a net exporter of phosphate rock. Since then the U.S. has become a net importer of the raw material, but it has become a net exporter of processed phosphate. At the current rate of use, U.S. reserves will last about three decades, and then the U.S. food system will have to rely on the global supply.

How do we waste phosphorus? Our understanding of the global cycle for phosphorus is quite limited. Prior to modern farming, the primary source of phosphorus in soils derived from plant decomposition and animal waste. Hence, phosphorus uptake from soil and its re-deposition there recycled phosphorus. With the advent of modern agriculture, phosphorus is now transported globally to farms with phosphate deficits. In turn, these farms produce feed for animals and processed foods for people in urban areas.

In the first step of the process, only 10% to 15% of the phosphorus used in agriculture becomes available to the plants. The remainder undergoes chemical reaction that converts it into forms that bind to the soil or, in sandy soils, are rapidly transported away from root zones. Modern techniques can increase this efficiency to about 45%; however, these procedures are expensive to implement and are beyond the reach of most farmers.

In the next step, humans and animals excrete almost all the phosphorus they consume. Finally, the phosphorus then finds its way into the effluent of wastewater facilities or into the huge manure flows from confined animal feeding operations or poultry production. Poultry manure, by the way, contains one of the highest concentrations of phosphorus. It is estimated that animal waste contains 40 - 50% of the amount of phosphorus that is applied by inorganic fertilizer. If, by some technological miracle, we could capture all of this waste, we would still require the mining phosphate to supply the remaining 60-40% to maintain the current food supply. However, this would only delay the inevitable by extending the time to exhaust the global supply of phosphate rock.

Unfortunately, the current conditions are not static. Developing countries like China and India, where the efficiency of use is much lower than the U.S., have become the primary consumers of phosphate.

What can you do to preserve the phosphorus resources?

1. Change your diet. Eat more vegetables and less meat. When we consume meat, domestic animals waste phosphorus just like humans. When you consume vegetables, you eliminate a major inefficient use of phosphorus in the food supply chain.

2. Advocate for farmers to increase the efficiency of fertilizer use. Programs are needed to inform farmers about the tools and techniques that improve the efficiency of phosphorus uptake. The current Bay programs restrict the use of phosphorus, but do not address how farmers can improve the bioavailability of it in their soils.

3. Extend global supplies by recycling. Many wastewater plants in the Bay watershed remove phosphorus by sludge sedimentation. This removes only 10-15% of the phosphorus. New ENR (Enhanced Nutrient Removal) facilities will reduce this amount by a factor of ten. But the technology to recover phosphorus from wastewater plants remains even more expensive and would require extensive and expensive renovation of existing wastewater facilities.

4. Support and advocate for science and technology to improve recovery rates of phosphorus. It is clear that scientific and technological breakthroughs will be required in the near future to conserve and recycle phosphorus. Every step in the chain of its use must be examined and the losses curtailed. Techniques to improve its bioavailability to plants must be developed. (This has the added benefit of reducing P runoff into waterways.) New technology to recover almost all the phosphorus still remains elusive.

And perhaps, the best contribution we can make at the moment remains to eat less meat.