Will We Run Out of Phosphorus?

By David W. Dibb

The question occasionally arises as to whether the world will eventually use all the supply and reserves of an essential nutrient such as phosphorus (P). This article gives a brief explanation of why there is no danger of running out of P sources.

Will we run out of P fertilizer for food production? The short and definitive answer is "no." How can that assertion be absolute? Phosphorus is one of the most abundant basic mineral elements on the earth. Phosphorus is a necessary component for all living organisms. The form of P can be changed, the location can be changed, but the total mass (the total existing amount of P) is unchanged.

The availability of P for use in food production…and thus availability to living organisms…depends on our ability to recover P from wherever it resides and place it near the plants that produce food and become the energy source for all living things…in a form plants can use.

Currently, there is abundant P available to produce food. In large part, this is because we have learned to extract P from large mineral phosphate rock deposits, convert it to a form that is more available to plants, and deliver it to farmers, who apply the P to their crops and produce our food. This process is the foundation of the current commercial P fertilizer industry.

Concentrated phosphate rock deposits are the main source of P fertilizers today.

Some of the P we need to make our bodies function properly comes to us directly in vegetables, fruits, grains, etc. Some comes to us indirectly through animal products such as meat, milk, and eggs. Some is consumed in vitamin or mineral supplements. All of this P originally came from one of the naturally occurring mineral P deposits…whether from the sources that were concentrated in phosphate rock deposits, or from those diffused in soils during their natural development processes. As crops are grown and as P is removed from soils, P has to be replaced to sustain the potential to produce more food. This replacement represents the current practice of crop fertilization.

But, what about when all of these mineral deposits we are mining are depleted? Will that happen soon? When it does, will we run out of P for food production? Again, the definitive answer is "**NO**." To understand why, we need to take a look at historical uses and sources of P for food production, what is happening today, the current reserves of P, and some possible other sources of P for the future. With this perspective, we will be able to understand why the world will not run out of P.

First, consider the historical use of P in food production. We all know the story of how the Native Americans showed the early Pilgrims in colonial times how to put a fish in the hole where corn seeds were planted in order to produce more abundant crops. As the fish decomposed, needed P

and other nutrients were supplied to the corn plants. Others learned that manures from animals would also supply some of the P needs for crops. Crop residues contain P and, if returned to the soil, helped maintain the P supply. As human and animal populations increased, there were not sufficient supplies of fish, manure, or crop residues to maintain soil fertility and productivity. Many soils were depleted of P and other nutrients. In fact, the early migration of people from the east coast of the U.S. to more fertile lands further west was in part because of the depletion of soil fertility of those early-farmed lands. The inability of those who grew crops to replace the nutrients they had removed resulted in those lands, which were depleted of nutrients, being abandoned for more productive lands in the frontier.

New sources of P were found. Bones were known to be rich in P. Ground bonemeal from slaughtered animals became a source of nutrient P. Blood meal, fishmeal, and other sources of P became commercially available. Supply was insufficient to sustain P levels and the productivity of soils declined. Advances in chemistry opened up a new, abundant source of P. Newly discovered concentrated phosphate rock deposits could be treated with acids similar to those occurring naturally in soils. Phosphorus could be made available to plants and could be concentrated and transported in a highly efficient form to the farmer. This was the birth of today's commercial P fertilizer businesses. Some phosphate rock deposits have been mined and depleted and other commercially viable deposits have been located and started into production. Other deposits remain unused… and under current economics are not considered useful. Under newer extraction and process technology, and with different economics, many of these deposits will later become sources of P.

As part of our historical look at P, compare today's known phosphate rock reserves to those of 50 years ago, and what the usage was then and now. See **Table 1.**

Several interesting facts emerge from this table and from supporting data:

- Since 1953, the world has mined a total of 5.5 billion tons of phosphate rock.
- Known reserves with today's economics are very large, about 3.3 billion tons more than they were 50 years ago.
- As economics and technologies change, additional known reserves will be made available, just as they have been since 1950.
- Reserves plus all other mineral P rock deposits that may potentially be economically feasible at some time in the future have been conservatively estimated at over 100 billion tons.

In today's economic environment, no one has any great incentive to explore for new P reserves. Any P reserves found today are probably the result of exploration for other products, such as petroleum, natural gas, and precious metals. With a specific focus on looking for P reserves, additional finds are possible.

Even if no other reserves are found and these known reserves are ultimately depleted, will we run out of P for food production? Again, the definitive answer is "**NO**." New technologies are even now being developed that could exploit other large sources of P. A couple of examples can give insight into where some of that P might come from.

Phosphorus exists naturally in all productive water bodies. If P were not there, aquatic life would not exist. Some water

Table 1. World reserves and annual mine production of phosphate rock.

Year	World reserves[1], billion metric tons	World mine production, million metric tons
1953	46.7	27.2
2003	50.0	138.0[2]

[1]World reserves include resources (measured plus indicated reserves and reserve base) that are exploitable with today's economics and technology, or have a reasonable potential for becoming economically available.
[2]Estimated

bodies have enhanced levels of soluble P, which could be 'mined' or extracted. Seawaters contain abundant dissolved P...estimated conservatively at more than 90 billion metric tons. Seawater is currently being processed to provide fresh, potable water through desalinization processes. Perhaps a simple additional step, when economically feasible, could be to extract and separate P, somewhere during this process, for later use in crop production. Similarly, wastewaters from sewage treatment plants can contain even higher levels of P. Technology is available for extraction of this P. Its development into fertilizer P and its return to replenish soils and produce food is only constrained by today's economics.

Just as the major source of P has changed from fish and manures in pilgrim times to processed rock phosphates in our time, the future may see a shift to P extraction from municipal waste waters and ocean waters as major sources...or through some other currently unknown process or procedure, from some other source. More likely, in the future, there will be a combination of all of these mentioned sources plus some new ones.

Just as today, when the more ancient methods are still incorporated with current methods to meet total needs, so will newer technology extract the P from where it resides, dependent on the economics, efficiencies, and ecology of each source. The P will be there for our use to produce the needed food. As in the past, human ingenuity will provide the answer. Will we run out of P for food production? The answer is sure and simple: **"NO."** BC

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