SUSTAINABLE AGRICULTURE TECHNIQUES

EM 8939-E • October 2007

The Phosphorus Dilemma

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Figure 1. A drain ditch with too much phosphorus runoff provides the perfect habitat for algae.

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Phosphorus is essential for life

Phosphorus is an essential building block for all forms of life, from plants to animals, including humans. Because phosphorus is closely tied to land productivity and plant growth, many homeowners apply phosphorus fertilizers liberally to lawns, while growers add them to cropland. However, in certain environments, too much phosphorus can be devastating to aquatic organisms.

What happens when there is too much phosphorus?

The overabundance of phosphorus, in combination with warm temperatures and sunlight in surface water, promotes algae growth (Figure 1). When too much phosphorus and nitrogen from human activities find their way into freshwater, they can cause a sharp increase in algae production, known as an algae bloom.

During the day, algae produce oxygen through photosynthesis and help keep the water oxygenated. During the night, they remove oxygen from the water because they continue to respire but no sunlight is available for photosynthesis. Oxygen is reduced further after the algae die. When a large mass of algae dies, a vast amount of oxygen is used in its decomposition, leaving little or no oxygen for fish. This process is called eutrophication. Eutrophication can also occur when the upper, algae-laden layers of water become inverted with deeper water, resulting in rapidly increasing demand for oxygen.

All aquatic organisms, including fish, need oxygen in order to live. When oxygen levels drop too low, fish may die.

Dissolved oxygen enters the water in two ways: through absorption from the atmosphere and as a by-product of photosynthesis. Water can hold only a limited amount of oxygen. Oxygen levels in water are also affected by the temperature of water; warm water holds less dissolved oxygen than cold water.

Aeration of water, either naturally (by wind or stream rapids) or artificially (by aeration machines), can help mix the higher concentrations of oxygen from the air into the water, which has significantly lower oxygen levels. Aeration allows

more oxygen to dissolve in water because it provides more surface area on which the oxygen can diffuse and more stirring of water.

How does phosphorus enter surface water?

Phosphorus can enter surface water in two ways: through point sources and nonpoint sources. Point sources originate from a single identifiable source, such as a municipal waste water system, residential septic system, industrial site, feedlot, or manure pile. Nonpoint sources have widely dispersed origins and often vary depending on the season or temperature. Examples of nonpoint sources are erosion from farmland, runoff water from agricultural land, and livestock grazing along lakes and streams.

Growers add phosphorus to soil to help assure good crop yields. Excessive phosphorus applications, however, increase the risk of phosphorus loss. Most phosphorus in soils is bound to soil particles. The runoff created by furrow irrigation erodes the soil and washes the soil and phosphorus out of the field and into the tail water, which in turn can be flushed into nearby rivers, where it promotes algae growth (Figures 2 and 3).

Why should we be concerned with high phosphorus levels in surface water?

It's important to keep our surface waters as clean as possible, both for native plant and wildlife needs and for human use. As consumers of water, we are all affected by high levels of phosphorus in our rivers and lakes. Nobody wants to go swimming or rafting in an unsightly river. We need to take care of our water resources in order to protect water quality for fish, aesthetics, recreational purposes, and other uses.

What can you do about it?

Because phosphorus enriches the soil and encourages healthy plant life, we need to take precautions and learn to manage it to achieve maximum benefits without adverse consequences. In some ways, the reduction of phosphorus losses from land is a matter of common sense. Anything that reduces runoff and soil loss will reduce phosphorus losses that might reach streams and lakes. Below we suggest some specific ways to reduce phosphorus losses.

Figure 2. Algae growing in a slow-water oxbow of the Snake River.

Figure 3. Runoff ditch water rich in phosphorus promotes algae growth.

Homeowners and commercial property managers

- Limit phosphorus fertilization of landscapes.
- Choose low-phosphorus detergents.
- Minimize water runoff.
- Improve landscape irrigation efficiency.

Some fertilizers are rich in phosphorus. Limiting the use of these fertilizers reduces the amount of phosphorus washed away in runoff. Likewise, regulations that eliminate phosphorus in detergents reduce the amount of phosphorus that is flushed out through septic systems and into surrounding bodies of water. Good design and management of landscape irrigation can minimize the amount of runoff water, thus limiting phosphorus losses.

Irrigated row crop growers

- Manage nutrients, especially phosphorus.
- Convert from furrow irrigation to drip, sprinkler, or gated pipe irrigation.
- Level fields.
- Use polyacrylamide (PAM).
- Use straw mulch.
- Use filter strips.
- Build sediment retention ponds.

To avoid overfertilization, it is important to test the soil before applying fertilizer. Excess phosphorus provides no additional benefit to crop plants and increases phosphorus loss to surface water.

Much of the phosphorus lost from farms and fields is attached to soil particles. Surface broadcast applications of phosphorus have a much greater risk of loss to runoff than incorporated phosphorus. Phosphorus that is subsurface banded along plant rows has little risk of immediate loss and may be better utilized by plants.

Figure 4. Runoff from an onion field with no erosion protection.

Any method that captures sediment or retains soil reduces phosphorus losses. For example, furrow irrigation washes soil and nutrients out of the field (Figure 4). Converting from furrow irrigation to drip, sprinkler, or gated pipe irrigation conserves water and keeps more phosphorus in the field. Likewise, fields that are leveled to a gentle slope irrigate more uniformly and do not suffer as much irrigation-induced erosion as fields with greater slope.

By using PAM, the sediment that normally would be washed away in runoff water instead settles to the bottom of the furrow or ditch, preventing excess phosphorus loss (Figure 5). Straw mulch slows the water, spreads water in the furrow, and traps soil before it leaves the field.

The vegetation in a filter strip acts as a barrier and slows fast-moving water laden with sediment. As water runs through the filter strip, the sediment settles and is trapped in the strip (Figure 6).

Figure 5. Clean runoff ditch water from furrow-irrigated fields treated with PAM.

Figure 6. Runoff from an alfalfa field with excellent vegetative cover, which intercepts sediment.

Sediment ponds collect water and soil that have left the field. Soil in the pond accumulates for future recycling. Nutrient-rich pond water can be pumped back onto cropland. After the irrigation season, the accumulated sediment can be applied to crop fields.

Dryland farmers

- Minimize tillage.
- Leave crop residue on the field.
- Apply only as much phosphorus as needed based on soil tests.
- Band apply phosphorus.

Reduced tillage and maintenance of soil cover minimize water and soil loss. Since phosphorus is mostly bound to soil particles, phosphorus losses are also greatly reduced.

As with irrigated row crops, it is important to test the soil before applying fertilizer in order to avoid overfertilization. Excess phosphorus fertilizer provides no additional benefit to crop plants and increases phosphorus loss. Surface broadcast applications of phosphorus have much greater risk of loss to runoff than incorporated phosphorus. Phosphorus that is subsurface banded along plant rows has little risk of immediate loss and may be better utilized by plants.

Ranchers

- Carefully plan riparian grazing.
- Manage livestock access to surface water through fencing and cattle guards.
- Place livestock salt and water away from riparian areas (Figure 7).
- Minimize runoff from manure piles.
- Minimize irrigation runoff from irrigated pastures.
- Maintain soil cover.

Figure 7. Provide water away from riparian areas to reduce livestock traffic in and around streams.

The planning and management of riparian grazing is important in order to maintain vigorous vegetative cover and minimize disturbance of stream banks. Good cover holds soil (hence phosphorus) in place and keeps it out of the water.

Avoid excessive irrigation of low-lying pastures containing manure. Flooding low-lying pastures allows wastes to be carried by runoff into nearby streams.

Confined animal feeding operators (CAFOs)

- Manage manure.
- Formulate livestock diets to animals' requirements, avoiding phosphorus excess.
- Conform to CAFO guidelines.

Minimizing losses of manure, water, and soil eliminates most phosphorus losses from confined animal feeding operations.

Published October 2007.