

# chapter two

## Nutrient Management and Water Quality Concerns

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One of the primary goals of nutrient management planning is to minimize any detrimental effects that nutrients can have on the environment. Maintaining the quality of surface and groundwater is of key concern. On livestock farms, the proper management of nutrients in manure is an important environmental issue since managing nutrients in manure can be more challenging than in commercial fertilizer. Manure contains nutrients and organic matter that normally benefit the environment, but, if improperly managed, can reduce water quality.

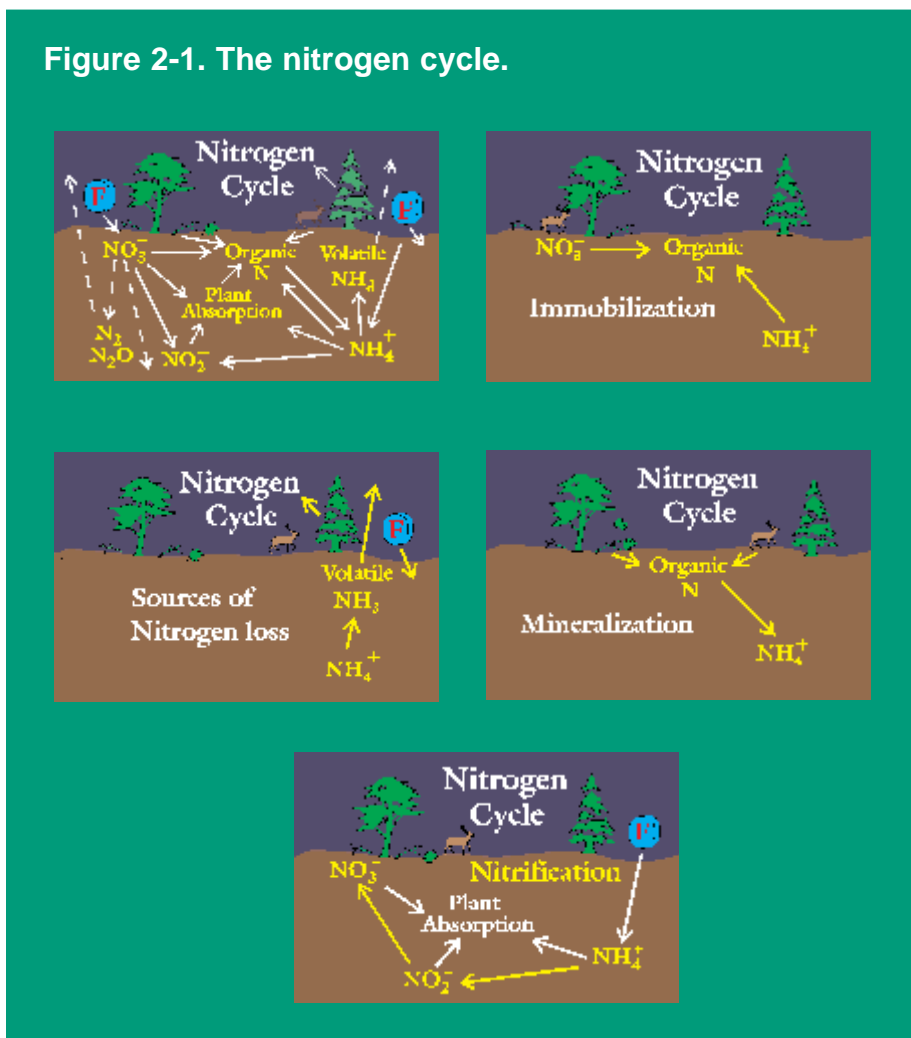
- manure storage facilities are not properly sealed,
- nutrients are applied too closely to sinkholes or rock outcroppings,
- excessive nitrogen applications beyond the crop's needs,
- nitrogen application just prior to large runoff-producing storm events.

### Concerns from Nitrates

Nitrogen in manure can be in different forms, but under the right environmental conditions most forms will eventually be converted to the nitrate ( $\text{NO}_3^-$ ) form (Figure 2-1). Nitrate is highly soluble and since it is negatively charged, it is not readily adsorbed to soil particles. This makes it susceptible to leach through the soil and into groundwater where it can accumulate. Groundwater quality can be reduced if contaminated by nitrates. High nitrate levels ( $> 10$  ppm Nitrate-N) in drinking water may lead to health problems such as methemoglobinemia ("blue baby syndrome"), especially in young infants. In this case, elevated nitrates in humans interfere with the body's ability to transport oxygen in the blood stream.

Excessive nitrates in groundwater derived from livestock operations is possible for a variety of reasons:

Figure 2-1. The nitrogen cycle.



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One purpose of nutrient management planning is to identify management practices that minimize the risk of these things happening. Due to the human health concerns from nitrates, nutrient management plans, until recently, have focused historically on managing nitrogen with little regard to other nutrients with respect to water quality.

One major consideration in northern Arkansas that can affect nitrate contamination is karst topography, limestone formations characterized by sinkholes, springs, caves, fractured rocks, etc. The concern here is that karst formations often have direct pathways from soil and land features to groundwater with very little filtration from soil. In severe cases, it can be like pouring the nitrates through a pipe directly into the groundwater or introducing them directly into a well. Much of northern Arkansas is karst topography and special attention needs to be heeded when developing nutrient management plans in this region.

### Concerns from Phosphorus

Phosphorus (P) is a naturally occurring element in the environment and is an essential nutrient for plant and animal life. Over the past twenty years, P has become an increasing environmental concern as it can accumulate in and degrade the quality of freshwater streams and lakes. Phosphorus is not considered a human health issue and would not be a problem, except that P is the nutrient that most often limits biological activity in most of our clear water lakes and streams. Nitrogen and potassium generally occur naturally in the environment in sufficient quantities to support algae and plant growth in water bodies. Insufficient P in most inland water bodies keeps the clear water lakes and streams from being congested with algae and aquatic vegetation.



The P requirement for aquatic plants is orders of magnitude smaller than for terrestrial plants. Very small increases in P in freshwater can trigger unwanted algae and vegetative growth. This can lead to the acceleration of eutrophication, the natural aging process of a lake that is characterized by excessive biological activity. Consequences of accelerated eutrophication include degradation of recreational benefits and drinking water quality. Excessive algal growth and decay can cause drinking water to have a foul odor and an “off flavor” taste, which raises treatment costs to correct for human consumption. Advanced eutrophication can also reduce aquatic wildlife populations and species diversity by lowering dissolved oxygen and increasing the biological oxygen demand (BOD).

Eutrophication from excessive P has not generally been considered a public health issue like other contaminants derived from agricultural runoff, such as nitrates or pathogenic bacteria. However, there are toxic algae that can flourish with increases in available nutrients. Researchers are focusing more attention on the isolated events occurring in other states.

### The Fate of Phosphorus Applied to Pastures

Most forms of phosphorus are readily adsorbed by soil particles in a very stable chemical bond. For this reason, phosphorus historically has been considered immobile in runoff unless it moved with soil particles during soil erosion. The conventional wisdom was that if good ground cover was maintained, then appreciable amounts of phosphorus should not move and would not harm water quality. Since most non-legume forage crops require much more nitrogen than phosphorus, nutrient management plans have been based on nitrogen needs of the crop rather than P. When an unbalanced fertilizer such as poultry litter is being utilized which contains nearly as much P as N, the crop is supplied with 3 to 4 times more P than is needed.

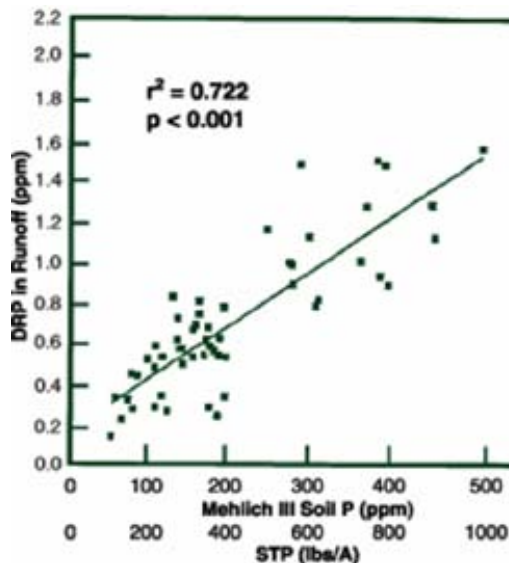
Repeated application of manure based on N needs causes P to accumulate in the soil. In some cases, 10 years of repeated manure applications has caused very high soil test phosphorus (STP) levels, particularly on pasturelands where crops have not been removed. Phosphorus in pastures that are grazed is generally recycled through the grazing animal and deposited back on the pasture. In the past, this buildup has not been a cause for concern. Phosphorus is a

naturally occurring nutrient and, even at high levels, is not usually detrimental to crop production.

For land with high STP levels, it is now known that appreciable amounts of soluble P can be removed from pastures in runoff water even in the absence of additional manure applications. Looking at the top one inch of the soil profile, recent research has shown that the concentration of P in runoff increases as STP increases (Figure 2-2).

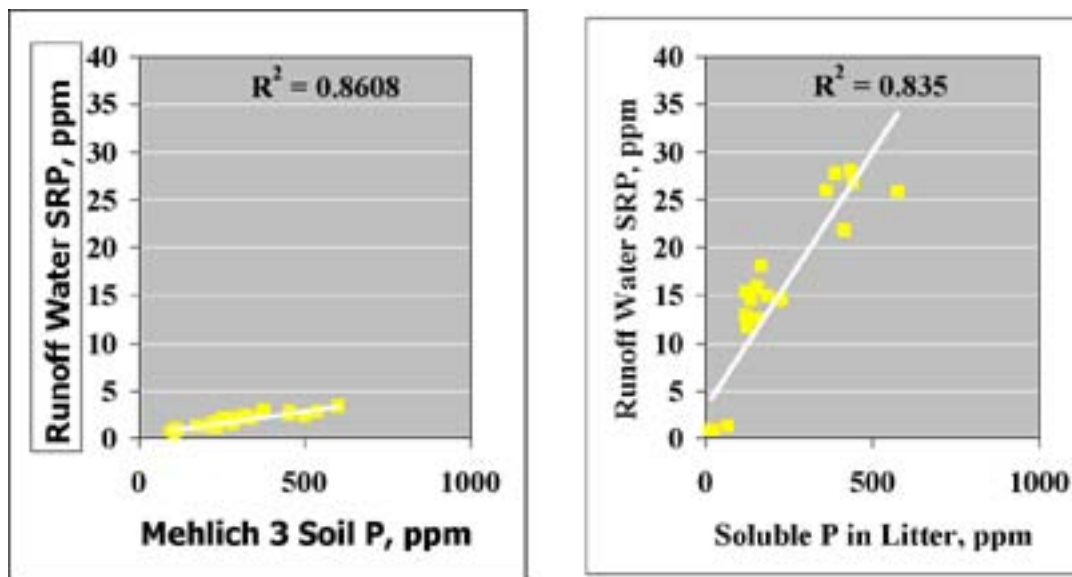
More recent research has shown that P losses from pastures can be dominated by soluble P losses from freshly applied poultry litter in runoff from storm events soon after application (Figure 2-3). These losses from the litter can be up to five times more than soil derived P losses even for extremely high soil P levels.

Figure 2-2. Relationship Between Mehlich 3 Extractable P in Captina Surface Soil and Dissolved Reactive P (DRP) in Runoff (based on STP levels in the top 1 inch of soil).



Source: Pote et al., 1996.

Figure 2-3. Comparing the losses of soil-derived phosphorus and soluble phosphorus in poultry litter from pastures.



Source: DeLuane and Moore, 2001. Better Crops. Vol. 85(4):16-20.

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These research findings along with water quality monitoring (Figure 2-4) have led to increased focus on developing and implementing management practices that reduce phosphorus inputs to streams and lakes. Reducing P in runoff from confined animal operations has become of primary concern with state and federal agencies. Therefore, new State and Federal regulations require that nutrient management plans be written based on a phosphorus risk assessment rather than agronomic nitrogen needs of the crop.

**Figure 2-4. Research and water quality monitoring is helping to assess the impact of nutrients derived from animal manures on water quality of streams and rivers.**



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