Introduction

As agricultural producers strive to develop a more sustainable agriculture, the potential of animal manure to recycle nutrients, build soil quality, and maintain crop productivity becomes more important. At the same time, however, the nature of modern animal agriculture, with its highly concentrated production facilities and reliance upon feed supplements to maintain animal health and productivity, has raised serious questions about the effects of animal manure on the quality of our soil, water, atmosphere, and food supply. Because land application is the only practical alternative for much of animal-based agriculture, the cornerstone of most manure management programs will be a solid understanding of how animal manure and manure-amended soils affect agricultural production and the surrounding environment.

All manure must be handled properly if the environment and public health are to be protected. Runoff from cropland, feedlots, and confined animal operations has the potential to harm surface waters and the plant and animal life that lives in or depends on those waters. It also has the ability to affect groundwater quality and could impact the drinking water on your land or your neighbor's land.

All water received at the soil surface evaporates, soaks into the soil, or runs off the land. Water that does not evaporate either moves as surface runoff into streams, rivers, and lakes or percolates through the soil. The movement of water on the land, in the ground, and through the air is termed the hydrologic cycle (Figure 30-1).

Rainfall runoff from managed fields, forests, and pastures can be environmentally acceptable, but runoff from a surface manure application to land is not acceptable. Therefore, the job of the manure manager is to select a manure application rate that

- Supplies the crop's nutrient needs without buildup of soil nutrients.
- Prevents runoff to surface water.
- Minimizes percolation to groundwater.
- Does not exceed the rate at which the soil will accept and process the manure.

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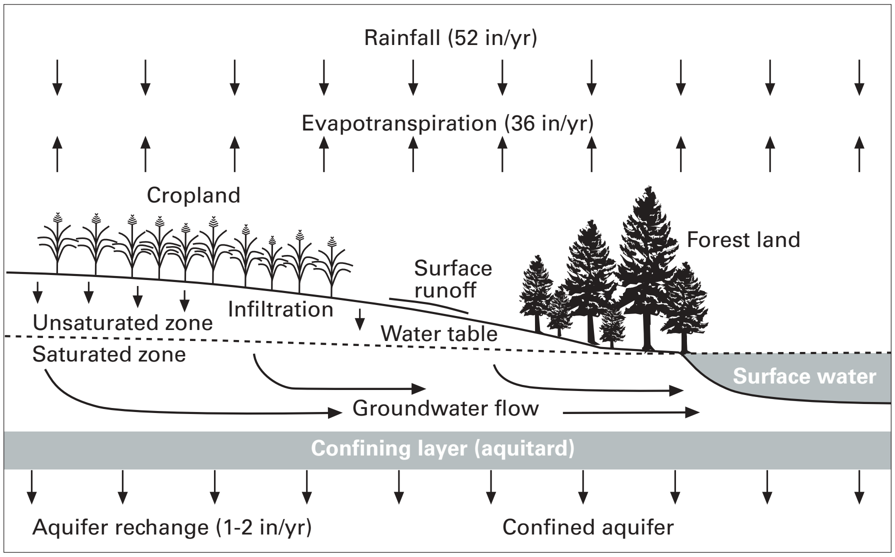

Figure 30-1. The hydrologic cycle.

Nonpoint source (NPS) pollution takes place over a broad area and results in the release of pollutants from many different locations.

Pollution sources

Sources of pollution are usually divided into two categories: (1) Point source pollution is a single identifiable source of pollution, such as a pipe through which factories or sewage treatment plants discharge treated wastewater into surface water. (2) Nonpoint source (NPS) pollution takes place over a broad area and results in the release of pollutants from many different locations. Runoff from agriculture, forestry, highway, and residential and urban development are examples of NPS pollutants (Figure 30-2).

Eutrophication

Eutrophication is the slow nutrient enrichment of streams and lakes and is responsible for the "aging" of ponds, lakes, and reservoirs. Excessive amounts of nutrients from point and NPS pollution, especially nitrogen (N) and phosphorus (P), speed up the eutrophication process. Rapid eutrophication is usually associated with increased algae growth. As more and more algae grow and then decompose, they deplete the dissolved oxygen in slow-moving water. This condition may result in fish kills, offensive odors, unsightliness, and reduced attractiveness of the water for recreation and other public uses. However, this condition occurs only when excessive nutrients are present. A certain amount of N and P is essential for any life to exist in water.

Other manure components also affect water quality. Animal manure contains pathogens (protozoa, viruses), bacteria, ammonia, organics, and a variety of other chemicals that may impact plant and animal life in the river. Additionally, the pathogens have the potential to infect humans who use the water for fishing, recreation, or drinking water supply.

Environmentally safe disposal of agricultural manure depends on landscape features and on soil physical and chemical properties. This lesson describes soil properties and characteristics that affect soil suitability and

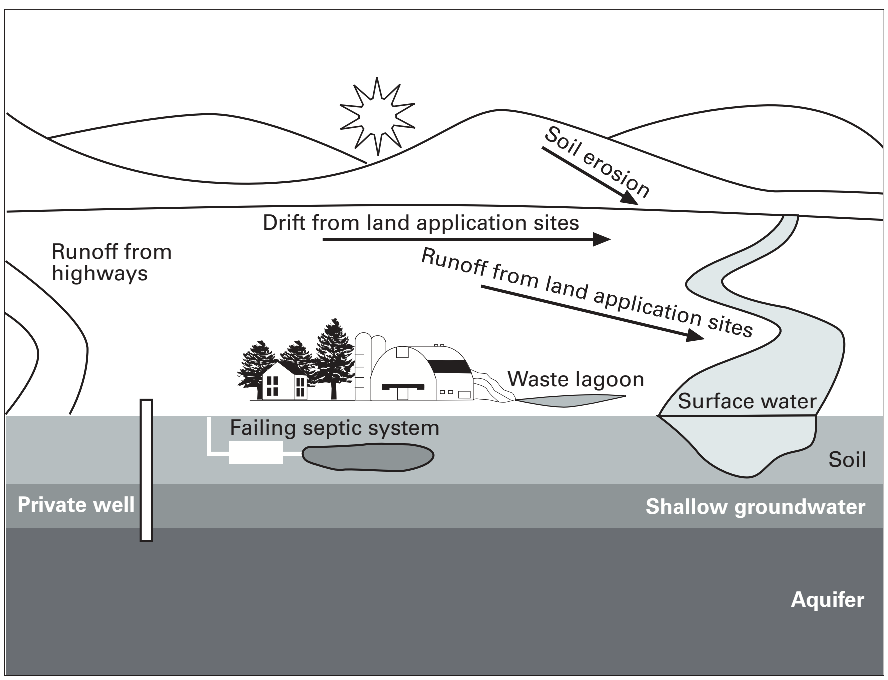

Figure 30-2. Potential sources of NPS pollution. Note: This drawing is not to scale.

limitations for manure applications. Agricultural manure management systems should not be implemented without adequate and complete soil maps or soil interpretive information.

Soil components

Soil is a heterogeneous material made up of three major components: a (1) solid phase, (2) liquid phase, and (3) gaseous phase. All three phases influence the supply of plant nutrients to the plant root.

The solid phase is the main nutrient reservoir. Negatively charged clay particles in the soil hold nutrients in the cation form (positively charged ions), such as potassium, N (as ammonium), sodium, calcium, magnesium, iron, manganese, zinc, and cobalt. Anionic (negatively charged ions) nutrients, such as N (as nitrate), P, sulfur, boron, and molybdenum, are largely held by the organic fraction or mineral complexes. Nitrate is held very loosely to the anion exchange sites of the soil and can move readily with percolating soil water. If the soil organic fraction decreases due to poor farming practices, the soil's ability to hold these elements is drastically reduced. Phosphorus is often fixed to the mineral soil fraction containing iron, aluminum, and carbonates. The amount of plant available nutrients held by a soil depends on each soil's unique chemical and physical properties. These properties can be defined by a soil's cation-exchange capacity, pH, organic matter content, bulk density, and water-holding capacity.

The liquid phase of the soil, the soil solution, is responsible for nutrient transport in the soil. Oxygen and carbon dioxide can be dissolved in the soil solution and transported to and from the system. A large percentage of liquid manure is composed of water. Depending on the type, timing, and method of delivery of manure, this water can be used to supply a small part of the plant's moisture as well as nutrient requirements.

The gaseous phase mediates the exchange of gases that occurs among the numerous living organisms in the soil. Nitrogen, oxygen, water vapor, and carbon dioxide are the primary gaseous by-products of the soil and plant system. Gas exchange affects denitrification, mineralization of organic material, and the soil microorganism growth rate.

As issues related to the soil utilization of manure are discussed in this lesson, you, the producer, are encouraged to evaluate the soil characteristics of manure application sites that your operation uses to better understand their environmental strengths and weaknesses. This can be done with the aid of an environmental stewardship assessment (see Appendix A) and a regulatory compliance assessment (see Appendix B in Lesson 33, Selecting Land Application Sites) for soil characteristics.

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