

USE OF ANIMAL WASTES ON CROPLAND

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In recent months, environmental issues relating to land application of animal and industrial wastes have been widely debated in Kentucky. On several occasions, members of the University of Kentucky Agronomy Department have been asked to provide scientific information and technical interpretation related to these complex and controversial issues. To be certain that the public and policy makers are provided with consistent and scientifically sound information, the Agronomy Department has decided to release consensus statements on some of the major agronomic issues involved. These statements reflect our best scientifically based interpretations of these important subjects. Several of our faculty with long experience and outstanding expertise in soil chemistry, soil microbiology, soil fertility, water quality, forage production systems and animal waste management participated. They were assigned the task of preparing two statements:

1. A discussion of phosphorus reactions in soil, particularly as related to the phosphorus content of animal manures.
2. Accumulation of nutrients in soil as this affects the allowable frequency of application of animal wastes.

The two statements, printed as follows, represent a collective analysis and interpretation of these issues by numerous expert faculty in the Agronomy Department.

Reactions and Potential Loss of Phosphorus Added to Soil as Animal Waste

When animal waste is applied at rates calculated to supply the nitrogen needs of crops, the amounts of phosphorus (P) applied are likely to be more than are needed for maximum crop yields. Questions are often raised about the potential impact of this P on soil productivity and environmental quality. This paper discusses the fate of P from animal waste after it is applied to soil. We also consider practices which can be used to minimize the risk of P loss from soils.

Phosphorus Reactions in Soil

When soluble P is added to soil, it reacts quickly with soil compounds. These reactions cause it to be relatively insoluble. For example, if P is applied to the soil surface, most of it will remain in the top two or three inches for years. In tilled soil, it becomes mixed with the soil to the depth of tillage, but moves very little below that depth.

Since P compounds are not very soluble in the soil, P concentrations in the soil are very low. In fact, the soluble P in soils (the part available to plants) is so low that it must be replenished several times a day just to supply the P needed by a growing crop.

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This low solubility of P is the reason very little P is lost to leaching via percolating soil water.

The chemical reactions of soluble inorganic P applied in animal waste are very similar to those of P applied as fertilizer. The major difference between the two P sources is that some of the P in animal waste is in an organic form. The liquid portion of animal lagoon waste would contain less organic P. Much of the organic P is in the solid fraction that settles out. When animal waste is land applied, P is released as the organic fraction decomposes. As this P becomes mineralized and soluble, it also becomes "fixed" by soil compounds.

Potential Losses of P from Soil

Since P becomes a part of very insoluble compounds in the soil, there is very little movement with soil water. As a result, very little P is lost from soil through leaching. This is why P can be applied to the soil about any time of the year and will still be there for the next crop to use. There is a potential for P loss from soil if surface runoff occurs during, or soon after, animal waste is applied. The highest risk is when animal waste is applied to frozen ground. In most cases, soluble P moves quickly into the soil where it is held tightly.

The greatest potential for loss of P from soil is through erosion. Any time soil particles move from a field through soil erosion, the P adsorbed to these particles moves with them. Large amounts of P can be lost from fields with high soil test P levels if erosion is not controlled.

Reducing the Potential for Loss of P from Soils

There are several alternative ways to reduce the risk of P loss from soils.

Following are some that may be used if a specific site needs them:

1. Risk of P loss is significantly less when animal waste is applied to non-frozen soil.
2. The chance of P moving into water is reduced by avoiding applications of P in, or at the edge of streams, waterways or sink holes.
3. Practices that prevent soil erosion such as residue management, cover crops, contour farming, no-till, waterways, etc. will minimize surface losses of P.
4. Use of buffer strips of permanent vegetation adjacent to streams, ponds and sink holes will remove sediment from runoff and reduce the risk of off-site P contamination.

Frequency of Application of Animal Waste to Agricultural Land

When animal wastes are applied to agricultural land, some of the nutrients are not immediately available to crops and can be carried over and released in future years. With continued annual applications of waste, some nutrients can accumulate and need to be accounted for when deciding how much and how often wastes should be applied. The purpose of this paper is to discuss the factors that influence nutrient accumulation in soils as a result of applying animal wastes and suggest ways to plan for long-term use of waste on agricultural land.

Nutrient Accumulation in Soils:

Agronomically, soil is defined as "a medium for plant growth." In this context, soil is the medium from which plants extract both water and nutrients to meet their metabolic demands. The amount of plant nutrient elements in soil is quite variable.

Also, nutrients occur in both the mineral and organic fractions of soil. While the total soil content of nutrients is often very large, only a small fraction of this total is actually available for plant uptake at any given time. The amount of one or more nutrients available from soil at any one time is often insufficient for good crop production. This requires frequent replenishment from slowly available fractions of the soil's "reservoir." In many soils, this reservoir is not sufficient to supply adequate amounts of nutrients as fast as the crop needs them. In these cases, it is necessary to add nutrients. These are usually added as commercial fertilizers. Application rates of these materials are in tons per acre instead of the usual pounds per acre associated with commercial fertilizers. Although the plant nutrient concentration of those various waste materials is lower than that of most commercial fertilizers, the total amounts of plant nutrients applied to land may be large. However, not all of the plant nutrients contained in these materials are immediately available for plant uptake. The amount immediately available to plants varies with water content, how the material is stored and handled, application methods and rate of decomposition in the soil. Those plant nutrients which are immediately available chemically react with soil in much the same manner as those same nutrients contained in fertilizers.

The organically bound nutrients in waste slowly become available over an extended period (months or years). Continued applications of animal waste result in increased amounts of available nutrients in the soil over time, even to the point that availability of some nutrients no longer limits plant growth.

All nutrients added to soil in animal wastes may accumulate to some extent, increasing potential release in plant available forms in subsequent years. However, N is usually considered to be the most critical nutrient in terms of residual effects. This is because N is most likely to have a significant impact on crop growth and excess N can be lost from the soil and affect water quality. This is one reason why land application rates of waste are often based on crop N needs. The magnitude of N accumulation and residual release in soil cannot be predicted with absolute certainty. These processes will be dependent upon weather, soil conditions and other factors. The suggested options below account for our best estimates of these processes.

Planning for Long-term Land Application of Animal Waste

In planning for the land area needed for long-term animal waste utilization, the accumulation of residual N must be taken into consideration. Our best estimate is that about 25 percent more land will be needed than would be calculated for the first year of application. This can vary considerably depending on the type of animal waste, application methods and rates, cropping system, etc. If the 25 percent is used as a minimum, it should be adequate for most situations. Two options farmers could use to decide how much and how often to apply animal waste to a field are:

1. Apply animal waste at a rate calculated to supply the N needs of the crop. Then, as N carryover levels increase, additional land would be needed to utilize the waste. After six to ten years, this would amount to about 25 percent more land.
2. Apply animal waste annually on more land at a rate that would supply about 75 percent or less of the N needs of the crop the first year and use fertilizer N to make up the difference. Gradually, the amount of fertilizer N would be reduced based on the amount of N accumulated in the soil.

These two options can be used by farmers to determine the frequency of application and rate of animal waste needed to meet crop needs on their farms. Other options such as the use of larger acreages of land and applying lower rates or not applying waste in some years could also be used.