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DEPARTMENT OF AGRONOMY

Considerations for Direct Land Application of Organic Waste Products

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High costs and capacity pressures on landfills and wastewater treatment systems have caused many managers of these systems seek alternatives for organic waste. Composting has become a popular option, but it can be expensive and does not work well for processing high-moisture waste. Increasingly, direct land application of organic waste is seen as a low-cost option that allows a waste product to be used beneficially for crop production.

Many types of organic waste products are being directly applied to land. Agricultural waste such as manure and livestock bedding has been land applied for centuries. Land application is the primary method of utilizing sewage sludge biosolids from more than 130 Kansas wastewater treatment systems. Farmers are accustomed to dealing with manure, and sewage sludge application is highly regulated. Today however, waste products considered for land application include yard waste, supermarket vegetable waste, restaurant and institutional food waste, grain handling waste, a wide variety of waste products from the food processing industry, and many other sources. Most farmers are unfamiliar with land applying these products that are, for the most part, unregulated, or for which specific standards are not established.

Organic waste products tend to vary widely in content. It ranges from nearly dry products to materials that are mostly water. The only thing the products have in common is that they all contain at least some organic material, and they may contain from minute to significant amounts of nutrients beneficial to plants.

Organic waste products also may contain components that can be detrimental to crop production and soil health, such as soluble salts, fats, weed seeds, and pathogens, and may vary in pH (relative acidity or alkalinity). Some may have a wide carbon-nitrogen ratio (C-N) so that microbial action may temporarily tie up plant available nitrogen in the soil water. Wastes from processing operations could potentially, though rarely, contain heavy metals and many other com-

Know the product. Know the soil. Know the crop.

1. Get analysis of waste product.
2. Determine potential harmful components.
3. Obtain soil tests.
4. Determine crop needs.
5. Estimate benefits and costs.
6. Investigate need for required permits.
7. Establish application methods and timing.

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pounds, depending on the particular process and product. Some products may result in objectionable odors or may attract rodents, birds, or other animals.

Because of the wide variation in composition, it is impossible to make specific recommendations that apply to all organic waste products. Nevertheless, there are some general factors that should be considered in making land application decisions.

Nutrients

Know what nutrients are present in the organic residue. Have the material tested for nitrogen, phosphorus, and potassium. This, along with soil tests on the land where application is intended, will provide the information needed to determine the appropriate application rate. If too little is applied, it will be necessary to add other fertilizer for optimum crop production. If too much is applied, nutrients may be wasted and, in some cases, be environmentally harmful. Nitrogen supplied in excess of crop needs can result in residual nitrates that have the potential to leach into the groundwater given the right soil and climate conditions. Excessive phosphorus may move with runoff water and contaminate surface bodies of water.

Nitrogen is usually of greatest concern. It may occur in several forms in organic material. Plants utilize nitrogen either as ammonia or nitrate. Usually nitrate nitrogen is present in only small amounts in organic waste. Ammonia is most likely to be present in high-moisture waste products. Most nitrogen, however, will be in organic compounds.

Soil microorganisms break down organic material, using carbon compounds as an energy source and nitrogen compounds for synthesis of proteins that are part of the organisms' bodies. When an organic waste with a wide C-N ratio (low nitrogen) is applied to the soil, microorganisms will satisfy their nitrogen needs for protein synthesis by using nitrogen already existing in the soil in the nitrate form. As microorganism numbers increase, nitrogen is tied up or immobilized. With time, as the carbon source is depleted and microorganisms die, that immobilized nitrogen will mineralize into the form needed by plants. However while of rapid decomposition of high-carbon material, nitrogen available for plant use may be limited unless supplemental nitrogen is supplied.

When organic waste with a narrow C-N ratio is land applied, nitrogen in excess of what the microbes and crop need has the potential to leach into the groundwater as nitrate. Ammonia nitrogen can be lost or volatilized into the atmosphere, especially when high moisture waste products are applied to the surface and not immediately incorporated into the soil. Nitrogen should not be applied to soil in excess of expected crop utilization. The Kansas Department of Health and Environment, Bureau of Water, has developed a worksheet used in calculating the nitrogen agronomic rate for sewage sludge biosolids application. This worksheet should work equally well with other land applied materials containing nitrogen (Contact the Kansas Department of Health and Environment, Bureau of Water, 785/296-5520, for a copy of the agronomic rate calculation worksheet "LA-ANR")

Some wastes have very low nutrient content and contain little organic matter. Those that are mostly water may only have value as supplemental irrigation water. Though the substances may not be harmful, farmers will have to decide whether applying low nutrient content materials is worthwhile without special compensation.

Soluble salts and pH

Some organic waste products, particularly food processing waste, can contain considerable soluble salts. Soluble salts in the soil are measured by determining the capacity of a solution extracted from a saturated paste of a soil sample to conduct electricity. Salt concentration is directly related to electrical conductivity, usually expressed in millimhos per centimeter (mmhos/cm). Crops commonly grown in Kansas are not significantly affected on soils with salt levels of 0 to 2 mmhos/cm.

Growth of most plants is progressively reduced as the salt level in the soil increases. Some areas of Kansas have large areas of soil naturally high in soluble salts. Both the soil and the waste should be tested for soluble salts before application. High-salt wastes should be applied with care to soils that are already above the 2 mmho/cm level. For other soils, regular soil tests for soluble salts should be used to ensure that salt levels do not rise to a level that limits plant growth.

Most crops prefer a fairly neutral soil pH level. At normal application rates, organic waste usually will not have a major impact on soil pH. Nevertheless, to be safe, test both the soil and the waste for pH to ensure that the applied material will not further aggravate an existing very high or low soil pH.

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Other contaminants

Most organic waste products will probably be relatively free of heavy metals and chemical compounds. However, manufacturing processes could introduce contaminants into some organic waste products that may be harmful to plant growth or the environment. It is important to ask a lot of questions about the source of the material and how it was produced. If in doubt, ask for a laboratory analysis of the heavy metal content of the material. Standards have been developed for metal concentrations of sewage sludge biosolids allowable for application to agricultural land. It is recommended that those same standards be used in determining the suitability of other organic wastes that are land applied. (Contact the Kansas Department of Health and Environment, Bureau of Water, 785/296-5520, for "Kansas Sludge Reporting Forms" used in determining allowable biosolids application rates based on metal content.)

Odors, pests, and pathogens

Odors can be a problem when some organic wastes are applied to land. Some material may have inherent unpleasant odors. Other material may become more odorous after it is applied and begins to decay. It is helpful to immediately incorporate any applied material into the soil. Some material applied in large amounts or containing large pieces, may require several tillage passes for incorporation. Pre-shredding may be necessary. Subsurface injection of liquid materials, usually to a depth of six or more inches, will significantly reduce odor problems. Sometimes odors are difficult to avoid, but complaints can be minimized by providing adequate buffer zones between the application area and residences or other human activity. Transportation routes should be followed that avoid passage though concentrated residential areas.

Some organic material, especially food waste, may attract rodents, birds, and other animals. Again, incorporation into the soil is the best practice.

Effective composting destroys most weed seeds and pathogens. Farmers should be aware that some directly-applied untreated organic waste products may contain one or both. Pathogens are most likely to be present in untreated processing wastes, especially those containing animal products. Weed seeds may be found in unprocessed plant materials, such as yard waste. Be aware of the source of the waste material and be prepared to manage it accordingly.

Application equipment

Frequently, application of waste material will require the use of specialized equipment not available on many farms. Liquid materials can often be injected directly into the soil. Injectors will need to be adjusted or specially adapted to the type of material. Very wet solids can be difficult to spread evenly. Typical manure spreading equipment may work for this type of material, but will often require adjustment or adaptation, especially if the material contains large pieces, as in some food waste. Bulky materials, such a yard waste, also can present special challenges in application. The best approach may be to require the provider of the waste material to be responsible for application in accordance with procedures set by the farmer.

Effects on the soil

Of course, the goal of applying waste residues to land usually is to improve the soil. In the best of worlds, the application process will add useful nutrients to enhance plant growth or increase organic matter that will have a positive effect on soil physical and biological characteristics. However, even the application of beneficial material also can have a negative effect on the soil.

Land application of wastes will usually mean more trips across the land with machinery. A major concern is soil compaction, which can be minimized by following several steps: 1) Make as few trips across a field as possible, 2) Keep large trucks and other road transportation equipment off the field if possible, 3) Use field equipment that minimizes soil compaction, and 4) Do not apply waste products when the soil is wet.

Land application of waste can have an impact on residue management. Incorporation activities will often destroy much of the surface crop residue, leaving the soil more susceptible to wind and water erosion. Even injection destroys a significant amount of residue. It is recommended that most land application requiring incorporation be done on less erodible land and, if possible, near the time a crop will be planted.

Laboratory analysis

The farmer should not hesitate to ask for a laboratory analysis of any material for which there is concern about what it may contain. Typically such analysis would include, at a minimum, the nutrients nitrogen (total, organic, and ammonia), phosphorus, and potassium, and pH. Percent organic matter or organic carbon also may

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be useful. Electrical conductivity should be included if high salts are suspected. If it is a limey material, information about the calcium carbonate equivalent would be helpful in proper management. For high-solids organic waste products, request information on the carbon-nitrogen ratio. Finally, if there is any reason to believe that heavy metals may be present in the material, ask that they be included in the analysis.

Permits and regulations

Being aware of possible regulations that may apply to land application of various types of waste is important. Land application of any material containing sewage sludge biosolids and wastewater is highly regulated and permits will be required. Land application of agricultural waste, including manure, is not highly regulated. Questions about materials containing either biosolids or animal waste relating to permits, rates, or environmental concerns, should be addressed to the Kansas Department of Health and Environment, Bureau of Water (785/296-5500). Permits may be required for application of material normally considered part of the municipal solid waste stream. This includes food waste, yard waste, processing or industrial waste, and other waste products that have been traditionally disposed of in landfills. Questions relating to those materials should be addressed to the Kansas Department of Health and Environment, Bureau of Waste Management (785/296-1600).

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