Utilization of Biosolids in Forage Production Systems in Florida[1]

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This publication provides basic information about land application of biosolids to pastures and hayfields in Florida. The information contained in this document should be of interest to stakeholders, biosolids managers, students, and scientists interested in topics related to biosolids management practices and the potential benefits and risks associated with biosolids land application.

What are "biosolids"?

Biosolids are solid, semi-solid, or liquid materials resulting from the treatment of domestic sewage sludge. The term "biosolids" was introduced by the wastewater treatment industry in the early 1990s and has been adopted by the United States Environmental Protection Agency (US EPA) to distinguish high quality, treated sewage sludge from raw sewage sludge and from sewage sludge containing large amounts of pollutants. **Raw sewage sludge must be processed to meet US EPA criteria before being called biosolids**. Unlike other organic materials, such as animal manure, biosolids are subjected to strict regulations that control their use and disposal. Physical, chemical, and biological processes are often employed to reduce the pathogen levels, odor, and vector attraction of domestic wastewater. Anaerobic and aerobic digestion, alkaline stabilization, dewatering, composting, and heat-drying are some of the treatments that biosolids may undergo before they can be land applied. The type and extent of treatment affects biosolids composition and nutrient availability; thus, biosolids should be analyzed prior to application to determine appropriate application method and rates.

Types of Biosolids in Florida

The most common biosolids types in Florida are class AA and class B residuals. Class AA biosolids contain no detectable pathogens and minimal heavy metals and can be used with minimal restriction. Certain class AA biosolids are labeled as fertilizers and marketed to the public. There are no grazing, harvesting, or public access restrictions associated with class AA biosolids. Class B biosolids are treated to significantly reduce pathogens, but some pathogens may still remain in the residue. Thus, class B materials are subjected to more strict restrictions, including a 30-day restriction on grazing following applications of class B biosolids to pastures. The time restriction allows for the destruction of pathogens not controlled during the wastewater treatment process. Regardless of the class, pathogens present negligible risk to grazing animals when biosolids are properly handled and applied.

Both class AA and B materials also pose very small risks of heavy metal contamination. Extensive research has shown that heavy metal availability and potential toxicity to plants and cattle grazing, biosolids-amended pastures are extremely limited and easily managed (Lane 1988; Tiffany et al. 2000a, 2000b; Gaskin et al. 2003).

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Biosolids Regulations in Florida

Land application of biosolids is often subjected to federal, state, and local regulations. These regulations contain numerical limits for heavy metals and prescribe pathogen reduction standards, site restrictions, crop harvesting restrictions and monitoring, and record keeping and reporting requirements. In Florida, biosolids application is regulated by the Florida Department of Environmental Protection (FDEP) in accordance with Chapter 62-640, F.A.C., biosolids rule. Although state regulations were initially developed based on federal regulation (Part 503), they often exceed federal requirements. For instance, state regulations include additional management requirements and site restrictions, a nutrient management plan, and an assessment of the potential for phosphorus movement from each application zone. Land application of biosolids in Florida can also be subjected to local ordinances. About one third of Florida's counties have developed and implemented local ordinances that are more restrictive than state-level regulations. In addition, biosolids land application in some areas of the state (Lake Okeechobee, Caloosahatchee River, and St. Lucie River watersheds) is not allowed unless a net balance between phosphorus and nitrogen imports relative to exports is achieved. For additional detailed information regarding biosolids regulations in Florida, please refer to Chapter 63-640 (F.A.C., 2010) or, for a quick reference, please visit Hallas et al. (2015a, 2015b).

Major Benefits

The majority of the biosolids recycled in Florida is currently applied to beef cattle pastures. When properly applied, biosolids are safe for forages and animals and beneficial to pastures. One of the main benefits of biosolids is the fertilizer effect. Biosolids contain essential plant nutrients (i.e., nitrogen, phosphorus, sulfur, and micronutrients) that can improve forage production and nutritive value. Because some nutrients in biosolids may not be immediately available to the plants, biosolids can act as "slow release" fertilizer sources by releasing nutrients more slowly than commercial fertilizers. This may also improve nutrient uptake efficiency by plants and, consequently, reduce the environmental risks associated with nutrient losses to water bodies. In addition to providing nutrients, biosolids can also increase soil organic matter content and, consequently, improve soil quality by improving the physical, chemical, and biological properties of the soil.

Land application of biosolids is an ecologically and economically sound means of disposal for municipalities. Because these materials are often obtained at little or no cost, utilization of biosolids by forage producers may also represent an economic benefit by reducing fertilizer costs. Some biosolids are lime-stabilized and can increase soil pH and reduce costs associated with liming. However, caution should be exercised when making repeated applications of biosolids in order to avoid excessively high soil pH and rare molybdenum toxicities.

Potential Risks

Despite the vast scientific literature on issues related to land application of biosolids, public concerns remain about the risks associated with the practice. Although heavy metal contamination continues to be a source of popular concern because of widespread publicity on the subject in the past, biosolids currently produced and marketed in Florida contain very low concentrations of heavy metals and are seldom a cause for concern. Other challenges that limit land application of biosolids in Florida include public perception regarding the potential pathogen contamination risks, odor and other nuisance issues, variable chemical composition and nutrient availability, cost of transport and spreading, grazing restrictions, and environmental regulations. Potential accumulation of nutrients in the soil (particularly nitrogen and phosphorus) due to repeated application of biosolids, and subsequent off-site losses to water bodies, represent major challenges that prevent biosolids from being applied in certain areas of the state.

Repeated applications of lime-stabilized biosolids have led to the over-liming of pastures and the decline and death of bahiagrass stands, particularly in the central region of the state. In order to avoid the danger of over-liming, ranchers should require that they be given the calcium carbonate equivalence (CCE) of the materials applied to their land. This information will allow them to calculate and control the amount of lime applied. It is also critical to closely monitor pH after biosolids application by testing the soil regularly.

The variable chemical composition and lack of proper balance of nutrients in biosolids rarely fully meet crop requirements. Biosolids often contain smaller nutrient concentrations than commercial fertilizers, so much larger quantities of material must be transported and spread in order to meet the fertilization requirement of a crop. For example, approximately 10,000 lb/A of fresh biosolids (5% total nitrogen, 80% moisture) will supply 60 lb/A of plant-available nitrogen to a forge crop, while 272 lb/A of ammonium nitrate (33-0-0) provides the same amount of nitrogen. However, since hauling and spreading of biosolids is ordinarily done by contractors, this is seldom a major concern for the forage producer.

Application Rates

Biosolids are typically applied to pastures at rates designed to meet the nitrogen needs of the forage. However, because biosolids typically exhibit unbalanced nitrogen to phosphorus ratios compared to the crop nutrient requirements, N-based biosolids applications typically lead to excessive phosphorus accumulation in the soil. Current Florida legislation requires that biosolids be applied based on crop phosphorus requirements in sensitive watersheds. This approach significantly limits the rates that biosolids can be recycled in Florida and, in many cases, obliges municipalities to dispose of biosolids in landfills. When biosolids are applied at phosphorus-based rates, additional nitrogen fertilization is required to meet the forage needs, which may increase production costs. Application rates based on forage phosphorus requirements may be so low that they are often impractical. Despite the fact that certain biosolids contain very low concentrations of available phosphorus due to the treatment process (i.e., heat dried, aluminum-enriched materials), all biosolids types are treated similarly from a regulatory perspective. This is in part due to the fact that biosolids are regulated based on their total concentrations of nitrogen and phosphorus. Because only a small percentage of the nitrogen and phosphorus present in the biosolids may be plant available, total nutrient concentration is often a poor indicator of nutrient availability.

Application rates, based on crop nutrient requirements and soil characteristics, are designed to avoid nutrient excesses that could potentially damage plants or water bodies. Application equipment should be calibrated to assure uniform application over the application zone. Biosolids application is not allowed near streams, surface waters, or water wells. The appropriate application rate is determined by considering biosolids composition, decomposition (mineralization) rates, forage nutrient needs, and regulations limiting phosphorus application. The rate of nutrient release, or mineralization, is also affected by the treatment process. Reported average nitrogen mineralization rates can range from 8% of the total nitrogen for composted biosolids to about 50% of the total nitrogen for aerobically-digested biosolids. Assuming an average of 50% mineralization of total nitrogen in the year following application is a good first approximation of mineralization rate. However, whenever more specific information is available, it should be used to more accurately approximate mineralization rates under specific conditions of the material, management, and environment.

Summary

Land application of biosolids to pastures and hayfields is an environmentally and economically sound waste management alternative. Forages are ideal candidates for application of biosolids. When properly managed, biosolids can provide forage crops with essential nutrients and organic matter, improve forage production and nutritive value, and promote soil quality.

Proper utilization of biosolids in forage production systems requires a complete analysis of the material that will be land applied. Knowledge of the soil and the crop receiving the material is also necessary to determine the adequate application rate, method, and timing so that biosolids are utilized in an environmentally safe manner. Additionally, soil and tissue testing should be used to monitor changes in soil fertility resulting from biosolids application.

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