

## ***Are There Cheaper Inputs? A Look at Municipal Biosolids for Forages***

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Good soil fertility is essential for maintaining productive pastures. In addition to commercial fertilizer inputs, there are many different byproducts that have been used in Georgia to maintain fertility. One of the most common is municipal biosolids or treated sewage sludge. Biosolids are beneficial in supplying nutrients, some liming potential, micronutrients, and organic matter; however, because they are not specifically formulated for a particular site's nutrient requirements, they may require special management considerations.

### **Municipal Biosolids**

There are several municipal byproducts that are used in agriculture including biosolids, drinking water residuals, and composts from municipal solid wastes or yard wastes. Of these, biosolids are most commonly used in Georgia. Approximately 30% of the municipal biosolids in Georgia are land applied and most of these are land applied on pastures and hayfields. Many producers in Northwest Georgia, the Macon, and the Burke County areas have had good success using biosolids as a pasture fertility amendment.

Many people think municipal biosolids are the same as raw sewage. This is not the case. Biosolids are treated and stabilized sewage sludge that is suitable for land application. The treatment process begins with the raw sewage being screened to remove large trash and debris. Then microbes use the raw organic material to grow and reproduce. As these microbes die their bodies become part of the raw sewage sludge. The raw sewage sludge can be further digested by microbes, thickened, or dewatered. These processes further stabilize the organic matter to reduce odors and reduce pathogens. If these treatment processes result in an organic material that meets regulatory requirements for use land application, then these are known as biosolids.

The land application of biosolids is regulated by the US EPA under Part 503 of the Clean Water Act. The Part 503 regulations set pollutant limits, operational standards, and management practices for the land application of biosolids. In Georgia, the municipal wastewater plants wanting to land apply their biosolids must have each field that will be receiving biosolids permitted by the Department of Natural Resources Environmental Protection Division (EPD). The wastewater treatment plant is responsible for testing the biosolids for nutrients and metals, and for tracking the amount of biosolids applied to each field. The wastewater treatment plants are also responsible for periodic soil testing to ensure the soil pH is maintained at 6.5. Data on the amount of biosolids applied, soil pH, and other testing are reported to EPD yearly.

Biosolids are a good source of nitrogen (N) and phosphorus (P). They also contain some potassium (K), calcium, sulfur and other micronutrients such as iron, copper, zinc, manganese, chloride, boron, molybdenum, cobalt, and selenium. The typical fertilizer value of biosolids is 4-6-0.5. This translates to 80 lbs N, 120 lbs P<sub>2</sub>O<sub>5</sub>, 10 lbs K<sub>2</sub>O per ton. The advantage and disadvantage of the material is that most of the N is in an organic form, which means it has to be converted to ammonium or nitrate before it is available to the forages. How fast this occurs depends on both moisture and temperature as well characteristics of the biosolids themselves. The conversion or mineralization will occur more quickly under moist, higher temperature conditions. Although this means that the full amount of nitrogen present in the biosolids will not be immediately available like commercial fertilizer, it also means that nitrogen is available over the entire growing season as the organic nitrogen mineralizes.

There are some potential management issues with using biosolids. With biosolids and all organic amendments, you get what's in the byproduct rather than nutrients specifically formulated for the fertility needs of your site. Land application of biosolids is permitted based on the nitrogen need of the crop. When biosolids are applied at the needed nitrogen rate, phosphorus is overapplied and potassium underapplied.

For example, extension recommendations for hybrid bermudagrass hay grown on fields with low soil test phosphorus and potassium are 300 lbs/ac N, 80 lbs/ac P<sub>2</sub>O<sub>5</sub>, and 250 lbs/ac K<sub>2</sub>O. We will assume biosolids at a typical nutrient concentration of 4% N, 2% P, and 0.5% K will be applied to satisfy the nitrogen need of the crop. We will also assume 1.5% of this nitrogen will be ammonium-nitrogen and 20% of the organic nitrogen will be mineralized during the year. This means 7.5 tons per acre of biosolids would need to be applied to meet the forage nitrogen need. At this application rate, 300 lbs/ac of P<sub>2</sub>O<sub>5</sub> would be applied, resulting in an overapplication of 220 lbs/ac. Only 75 lbs/ac of K<sub>2</sub>O would be applied, which results in an underapplication of 175 lbs/ac.

One further point, the 7.5 tons/acre application rate would only be applicable for the first year. The regulations for land application of biosolids assume only 20 to 30% of the nitrogen is available the first year, this means there is still about 300 lbs/acre of organic nitrogen in the field left to mineralize. This residual nitrogen has to be accounted for and application rates reduced during following years. The wastewater treatment plant will calculate the new loading rate that accounts for the residual nitrogen.

Another advantage of using biosolids is that the wastewater treatment plant usually supplies lime or limes the fields where the biosolids are applied. This is due to the EPD permit requirement to keep the soil pH at 6.5.

We've discussed several things you should be aware of: phosphorus overapplication that can lead to environmental problems, potassium underapplication that can lead to winterkill of bermudagrass, and the residual nitrogen left in the soil. There are also

other concerns. These include metals, man-made organic chemicals, pathogens, and odors.

Biosolids do contain metals. Many of these metals are also micronutrients needed by plants or animals for good health. The key to whether metals are a problem is the loading or the amount present in the soil that is available for plants to use. The US EPA Part 503 regulations set levels for eight metals: arsenic, cadmium, copper\*, lead, mercury, molybdenum\*, nickel\*, selenium\*, and zinc\*. The starred metals are either plant or animal micronutrients.

Metals are present in biosolids, animal manures, and in some commercial fertilizers (Table 1). The metal concentrations in biosolids are typically higher than those for animal manures. Phosphate fertilizer can have higher concentrations of arsenic and cadmium than biosolids, but the amount applied per acre is much less, creating a lower loading. Again the loading, which is the amount of metal per acre, is an important factor along with how available the metal is to plants.

**Table 1. A comparison of metal concentrations in municipal biosolids, animal manures, and phosphate fertilizer. All values in mg/kg. Loading from phosphate fertilizer would be much lower than for biosolids and manures on a nitrogen basis.**

<b>Metal</b>	<b>Biosolids<sup>1</sup></b>	<b>Poultry Litter</b>	<b>Dairy</b>	<b>Phosphate Fertilizer<sup>2</sup></b>
Arsenic	3.6	15.7 <sup>3</sup>	1.0	11
Cadmium	2.26	2.5	0.2	8.1
Lead	64.9	36	2.0	5.7
Mercury	1.54	NA	0.02	0.03
Zinc	705	338	162	82

1. Data adapted from Stehouwer (2000)

2. Data adapted from McBride and Spiers (2001)

3. Data from Jackson et al. (2003)

Although there is not data available for Georgia, studies in other parts of the United States show that metal concentrations in biosolids have been decreasing over the past thirty years (Table 2). Metal concentrations are well below the level the US Environmental Protection Agency has set as safe. This is the result of required pretreatment programs for industries that discharge to municipal wastewater treatment plants that limit the amounts of metals that can be released.

**Table 2. Selected metal concentrations in municipal biosolids over time. The 2000 data are the medians from a Pennsylvania study by Stehouwer (2000). The 1990 data are the means from 1990 National Sewage Sludge survey. Table 3 Limit is the lower threshold for metals set by the US EPA Part 503 Rules.**

<b>Metal</b>	<b>2000</b>	<b>1990</b>	<b>Table 3 Limit</b>
	----- mg/kg -----		
Arsenic	3.60	9.9	41
Cadmium	2.26	6.94	39
Lead	64.9	134.4	300
Mercury	1.54	5.2	17
Zinc	705	1,202	2,800

The bigger question for cattle producers is, “Will I have metals in my forages?.” There are several studies on how biosolids effect forages in the Southeast. Some of these studies have found higher metals in forages where biosolids were used as a fertilizer, but the increases were small. A study in Burke County, Georgia found no difference in overall forage quality in bermudagrass forage from fields fertilized with commercial fertilizer and those that had received biosolids for more than six years. None of the studies have found metal concentrations in forage near levels that would be toxic to cattle. These studies indicate that applying biosolids at the nitrogen need of the forage and according to the Part 503 regulations should not create a metals problem for cattle producers. Some studies have seen a change in copper to molybdenum ratios in the forage or an increase in the sulfur content. A low copper:molybdenum ratio and higher sulfur content can induce a copper deficiency in cattle. Because our soils are naturally very low in copper, it is a good idea to feed mineral supplements with sufficient copper to ensure good nutrition. Animal scientists at UGA recommend mineral supplements with 2000 to 2500 ppm copper for cattle.

Man-made organic chemicals are a source of concern for some people. The 1990 National Sewage Sludge survey found low concentrations of most organic chemicals in biosolids. Due to these low concentrations, currently there are no pollutant limits for organic chemicals in the Part 503 regulations. However, studies are underway to evaluate the levels of organic chemicals in biosolids, better understand what types of chemicals are not broken down during the treatment process, and what types of risks they may pose.

Biosolids also can potentially contain pathogens such as *Salmonella* sp., *E. Coli.*, *Shigella* sp., *Hepatitis A*, or *Gardia lambia*. Pathogens in the raw sewage are greatly reduced by the wastewater treatment processes and the Part 503 regulations have standards that must be met for pathogen treatment; however, pathogens can still be present in biosolids that are land applied. Most biosolids

land applied in Georgia are Class B. This means that site restrictions are used to prevent direct contact with the biosolids after land application. Cattle are restricted from grazing for 30 days on fields where Class B biosolids have been applied. Public access is also restricted for 30 days after land application. Although research is ongoing, the studies available generally do not indicate properly treated and land applied biosolids pose a large risk to human or animal health. There are case studies that attribute human health effects to land applied biosolids and the risk to people with compromised immune systems, such as those undergoing chemotherapy, is unknown.

A more common problem may be odor. The Part 503 regulations require that the organic matter in biosolids be stabilized to reduce potential odor; however, biosolids do have an odor when first applied. This should disappear after a few days or after the first rain. Setbacks from neighbors who might be sensitive can help prevent complaints.

Setbacks are also required by Georgia EPD from surface water bodies such as streams and ponds, wells, and houses. These setbacks should be followed to minimize potential surface water or well water contamination. More information on the use and regulations pertaining to biosolids can be found in the Resources and Links sections under Land Application at the [www.agp2.org](http://www.agp2.org) website.

### Good Management Practices

Municipal biosolids can be effective fertility amendments for pastures and hayfields when handled and applied properly. Although the wastewater treatment plants have primary responsibility for this when land applying municipal biosolids, the producer should make sure proper management practices are being followed. These include:

- Ask for a report showing the amount of nitrogen, phosphorus and potassium supplied by the biosolids. If metals are present in the biosolids above what is known as the “Pollutant Concentration”, the report will also have the amount of each metal applied to each field. You should also be able to get a copy of the soil test results. This will tell you the pH of each field and if more phosphorus or potassium is needed. Soil pHs at 6.0 to 6.5 keep most metals from being readily taken up by plants.
- Don't apply additional nitrogen to biosolids applied fields unless you receive information that the application rate will not meet forage nitrogen requirement, and then only apply what is needed to fulfill the deficit.

- Do apply the needed potassium fertilizer to prevent winterkill.
- Be aware of conditions that cause excessive nitrates in forage, such as lush growth after a drought period.
- Feed animals the proper mineral supplements to ensure good nutrition. Cattle need supplements with additional copper.
- Make sure proper setbacks are flagged and followed to avoid application near sensitive areas such as streams or wellheads.
- Be sensitive to neighbor concerns with odors or water quality. Communicate when you will be applying and the importance of fertility in maintaining healthy pastures and hayfields.