REMEDIATION TECHNIQUES FOR MANURE NUTRIENT LOADED SOILS

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Many soils in the United States contain excessive levels of nutrients, especially phosphorus (P) due to repeated heavy applications of animal manure. Also, soils with a history of long-term poultry litter or swine manure applications have been found to have elevated levels of copper (Cu), zinc (Zn), selenium (Se), and arsenic (As). Runoff and eroded soils can carry soluble and bonded nutrients to water bodies and degrade their quality. Manure-treated fields can also impair air quality by emitting odorous compounds and dust. Several best management practices (BMPs) have the potential to reduce nutrients in runoff water and loading to surface waters. They can be grouped into two broad categories: (1) technologies to reduce excessive nutrient levels in the soil, and (2) technologies to reduce edge of field discharges of nutrients via runoff or sediment loss from over-application of manure or other organic biosolids. Potential remedial approaches for nutrient-loaded soils include:

- ❑ Phytoremediation (P, nitrate, metals) with plant species that preferentially bioaccumulate nutrients or metals and use of deep-rooted crops in novel rotations for subsurface nitrate-N recovery;
- ❑ Soil amendments with P immobilization chemicals and municipal or industrial by-products to reduce dissolved reactive P and metal bioavailability (water treatment residuals, aglime, coal combustion by-products);
- ❑ Addition of polyacrylamide polymers to reduce sediment and particulate nutrient offsite discharges (organic matter, N, P, metals);
- ❑ Deep tillage to dilute near-surface zone elevated nutrient concentrations and reduce odor emissions (P, metals, odor, trace greenhouse gases); and
- ❑ Conservation buffer strips to remove dissolved reactive P from runoff and reduce edge-of-field losses of sediments and particulate nutrients.

Growing high biomass yielding plants can remove large amounts of nutrients and may be a promising remedial strategy to export and reduce excess soil nutrients. Bermudagrass and certain warm-season annual grasses produce large dry matter yields, and thus, take up large quantities of applied nutrients. Cool-season grasses and certain legumes have a higher uptake of certain nutrients, such as P and may remove more specific nutrients than bermudagrass, although their yield potential is not as high.

Various plant species, including Brassica, preferentially concentrate Cu, Se and As from high metal soils. Using forage to extract P and specific metals in problem soils has been an effective approach, but is slow to lower soil levels. Grazed-only systems will not effectively remove nutrients from an over-application site since most of the applied nutrients, especially P and K, are recycled to the land during grazing.

Using soil amendments, research has shown that land application of drinking water treatment residuals potentially reduces dissolved P in runoff water by up to 70% from land with excessive levels of soil test phosphorus. Other materials such as fly ash from coal combustion in electric power generation and aglime are readily available and also effectively reduce P solubility in manure and manured soils, thus reducing the potential loading of agricultural P to nearby streams and lakes.

In addition to reducing runoff of dissolved nutri-

ents, reducing particulate nutrient transport from nutrient-loaded fields depended heavily upon soil erosion control practices. The most widely studied and used methods to control soil erosion by water and wind involve a variety of conservation tillage methods for a wide range of soils and climatic conditions. Polymeric sediment flocculants are a promising component of an effective set of management tools to decrease sediment and sediment-associated nutrient loss. Land management practices such as deep tillage and conservation buffers also provide relief from offsite discharges and reduce the ecological risks of excessive nutrient levels.

Many remedial technologies exist to reduce the environmental degradation caused by agricultural land with excessive nutrient loads due to manure applications. We strongly feel that critical areas of needs for further soil remediation research and technology transfer exist and should include urgent efforts to:

- ❑ Identify and develop efficient nutrient and metal accumulator plants and profitable crop rotations for efficient nutrient and metal removal;
- ❑ Identify and develop efficient nutrient immobilizing chemicals and by-products for manure-derived P and metals;
- ❑ Identify and develop soil treatment and recovery technologies to produce value-added specialty products;
- ❑ Develop and apply geo-reference techniques to target remediation on field and watershed-scales; and
- ❑ Develop and evaluate the effectiveness of specific BMP systems in reducing manure nutrient export to the surrounding environment.

Integrated solutions are needed for managing excess manure nutrients in crop and livestock production systems. A combination of load reduction techniques and structural and cultural practices may be required to balance effectively the need to reduce soil nutrient levels and discharges from nutrient-loaded fields with the benefits of sustainable production of food and fiber and the need to protect natural resources and the environment for future generations.

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