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Overview of Vol.5, No.3 - Amendments and Techniques for Restoring Soil Quality

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Soil is the foundation of terrestrial ecosystems. It is a primary source of energy and nutrients for the biota. It houses microbes which perform essential functions such as nitrification and decomposition. Plants depend on soil to root in and to obtain water and nutrients. Some animals depend on soil for shelter and all terrestrial animals depend on plants growing in the soil for food and shelter. Because soil is such an important component of the ecosystem, many restoration projects begin with restoring soil quality.

Soil degradation can occur for several reasons resulting from human activities. Urban and industrial development often cause soil compaction. Compaction reduces soil's pore space, making it difficult for plants to take up water and nutrients and reducing available oxygen for plant roots. Conventional agricultural practices often deplete the soil of necessary nutrients and may alter soil pH and cation exchange capacity. Practices such as tillage and pesticide applications reduce the amounts of soil animals, especially earthworms, which are necessary for developing soil structure (Killham 1995).

Agricultural practices can also cause salinization of soils because irrigation water often contains salt. If agricultural sites are not properly drained, evaporation will increase, bringing salts to the top soil layers with the water. Salinized soil increases osmotic pressure on plant roots which is detrimental to plant growth. Bahner's paper discusses techniques to reclaim soils affected by salinization. Reclamation of these soils is possible if the site has good drainage capabilities and if an adequate supply of low-saline water is available to leach the soils. If the site does not have adequate drainage capabilities, techniques exist that can improve drainage such as subsoiling, augering and adding amendments.

It is necessary to consider the desired end product when restoring soil. This decision can be made by examining soils on nearby undisturbed sites. Soil surveys can be consulted as well. Factors to consider are structure, pH, cation exchange capacity, water holding capacity, bulk density, nutrient content, microbes, organic matter content and texture.

Galajda addresses several of these soil quality factors, specifically relating them to reclaiming soil in abandon coal mines. Coal mine operators are required by federal law to reclaim the areas that were disturbed by mining. These lands have often been drastically altered and many issues need to be considered. Galajda's paper explains the physical aspects (soil structure), biotic aspects (microorganisms), and chemical aspects (nutrient cycles) that must be considered when reclaiming soil in abandon coal mines. Several reclamation techniques are explained including limestone applications and bark amendments.

The most ideal means of restoring soil quality is to bring healthy soil from another site and add it to the degraded site (Bradshaw 1997). However, this is not often possible because transporting large amounts of soil is expensive and extra soil may not be available. Another possible solution to restoring soil quality is to incorporate amendments into the soil. Soil amendments are used in

agriculture and can be used for restoration and reclamation purposes as well. Soil amendments include a variety of things; synthetic fertilizers, liming materials, composts, manures, sewage sludges and more. Soil amendments can improve soil structure, alter soil pH, provide essential plant nutrients and more.

Schaefer's paper explains how sewage sludge is used for soil remediation. Galajda's paper also mentions sewage sludge, stating that it is useful in coal mine reclamation because it stimulates soil bacteria. Sewage sludge is a byproduct of wastewater treatment. It is often rich in nutrients and hence can be a valuable soil amendment.

However, sewage sludge can contain undesirable products such as pathogens and heavy metals that cannot be applied to the land. The Minnesota Pollution Control Agency has set rules regarding the maximum amounts of pollutants and pathogens that can exist in sewage sludge and still be used for purposes of agriculture, forestry, reclamation or similar purposes (Minnesota Pollution Control Agency 1997). It is often difficult to determine the content of pollutants and pathogens in sewage sludge without close analysis.

Due to the problems associated with sewage sludge, other soil amendments may be more desirable. Using compost in restoration projects has several benefits in addition to improved soil quality. These benefits include increased plant establishment, reduced erosion, toxic metal immobilization and supplying of microbes (Alexander 1999). Landmark discusses several products that can be composted and used as organic soil amendments such as agronomic plant residues, cottage cheese whey, papermill and cardboard sludge.

Soils that need to be restored often lack an organic layer. Byproducts from agricultural and industrial practices, as well as sewage sludge, provide high amounts of organic matter to soils. Organic matter is important for several reasons. It improves many physical properties of soil including increased water and nutrient holding capacity. Increasing the organic matter content also increases the soil's cation exchange capacity. Organic matter often has carbon:nitrogen ratios that are low enough to release nitrogen through mineralization. Landmark explains that papermill sludges are high in organics and have low C:N ratios. For example cardboard sludge has a C:N ratio of 7:1. Bahner's paper states that some organic materials can be added to salinized soil to increase infiltration and enhance leaching.

An additional benefit to using many of these soil amendments is that using them for restoration or agricultural projects avoids the need to landfill or incinerate these products. Some states including New Jersey and North Carolina have banned the majority of sewage sludge from being sent to the landfill (Hue 1995).

There are drawbacks associated with using the products discussed in both Schaefer's and Landmark's papers. For materials that need to be composted, space needs to be available for compost sites. Collection and transportation of materials can be quite expensive if large areas of land need to be reclaimed. These challenges must be addressed in order to make it more feasible to use waste products as soil amendments.

Soil amendments are often a necessary first step for restoration and reclamation projects. Soil amendments can improve all aspects of the soil; biological, chemical and physical. A variety of amendments exist and should be carefully evaluated in order to determine which amendment will be most favorable for a particular project. Once the soil is amended, further work can be done on the site such as plant and animal reintroductions.

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