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REVIEW ARTICLE **OPEN ACCESS**

Restoration of Overburden Coal Mine Spoil

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ABSTRACT

Mining of mineral resources results in extensive soil damage, altering microbial communities and affecting vegetation leading to destruction of vast amounts of land. Reclamation is the process to restore the ecological integrity of these disturbed mine land areas. It includes the management of all types of physical, chemical and biological disturbances of soils such as soil pH, fertility, microbial community and various soil nutrient cycles that makes the degraded land soil productive. Productivity of soil can be increased by adding various natural amendments such as saw dust, wood residues, sewage sludge, animal manures, as these amendments stimulate the microbial activity which provides the nutrients (N, P) and organic carbon to the soil. The top soil gets seriously damaged during mineral extraction. The consequences of physical disturbance to the top soil during stripping, stockpiling, and reinstatement cause unusually large N transformations and movements with eventually substantial loss. Management of top soil is important for reclamation plan to reduce the N losses and to increase soil nutrients and microbes. Revegetation constitutes the most widely accepted and useful way to reduce erosion and protect soils against degradation during reclamation. Mine restoration efforts have focused on N-fixing species of legumes, grasses, herbs, and trees. Metal tolerant plants can be effective for acidic and heavy metals bearing soils. Reclamation of abandoned mine land is a very complex process. Once the reclamation plan is complete and vegetation has established, the assessment of the reclaimed site is necessary to evaluate the success of reclamation. Evaluation of reclamation success focuses on measuring the occurrence and distribution of soil microflora community which is regulated by interactions between C and nutrient availabilities. Reclamation success also measures the structure and functioning of mycorrhizal symbiosis and various enzymatic activities in soil.

Keywords- *Topsoil, Restoration and Mycorrhiza.*

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INTRODUCTION

Land is one of the most important resources on which human beings depend. The rate of consumption of mineral resources is continuously increasing with the advancement of science and technology, economic development, industrial expansion, acceleration of urbanization and growth of population. Growth of our society and civilization thus heavily rely upon the mining industry to operate and maintain comfort. The end result for mining activities on the surface is mining wastes and alteration of land forms which is a concern to the society and it is desired that the pristine conditions are restored. The mining disrupts the aesthetics of the landscape along with it disrupts soil components such as soil horizons and structure, soil microbe populations, and nutrient cycles those are crucial for sustaining a healthy ecosystem and hence results in the destruction of existing vegetation and soil profile. The overburden dumps include adverse factors such as elevated bioavailability of metals; elevated sand content; lack of moisture; increased compaction; and relatively low organic matter content. Acidic dumps may release salt or contain sulphidic material, which can generate acid-mine-drainage [1]. The effects of mine wastes can be multiple, such as soil erosion, air and water pollution, toxicity, geo-environmental disasters, loss of biodiversity, and ultimately loss of economic wealth [4]. It is imperative from the above that the mineral extraction process must ensure return of productivity of the affected land.

MANAGEMENT OF MINE SPOIL

Management includes the following:

1. Rebuilding Soil Structure

The first soil component addressed during reclamation is the structure of the soil itself as it is replaced onto the reclamation site. Soil structure includes soil aggregation, or the way in which soil particles are held together, and the size of the particles comprising the layers at different depths. Gypsum has traditionally been used to improve sodic media for plant growth. It can be used to improve the structure of poorly structured sodic soils. Gypsum is normally incorporated into soil at about 5-10 tonnes/ha. Application of gypsum results in replacement of sodium with calcium ion the soil exchange surfaces, which can improve the soil structure, reduce surface crusting and increase water infiltration. It may also reduce the pH of sodic soils (soil with pH>8.5) [1]. An exchangeable sodium proportion of greater than 6% can indicate an unstable soil structure.

Management of Soil pH

Acidic mine soils can be effectively neutralized once they have been again spread at the reclamation site by applying either cement kiln dust (CaO) orlimestone ($CaCO_3$). Lime application rates must account for both past and future pyrite oxidation in order to maintain neutral soil pH levels over time. Lime addition is a common method to decrease the heavy metal mobility in soils and their accumulation in the plant as it increases the pH of soil. Plants like *Gravellia robusta*, can be planted at acidic dumps (pH 3.6-3.9), which increases the soil pH [2]. Organic amendments such as woodchips, composted green waste or manure, biosolids etc also increases the soil pH, in addition improves soil structure, water holding capacity, cation exchange capacity, provide a slow-release fertilizer and serve as a microbial inoculums.

Increase Soil Fertility and establishing nutrient cycles

Areas reclaimed for agriculture or other intensive use will normally require maintenance of the fertilizer programmed. There are also certain amendments which have shown promise for improving spoil as a plant growth medium. Saw dust has been shown to increase the survival rates of certain trees, forbs and. Smith *et al*., (1985) observed that the addition of woodchips to bare spoils was second only to topsoil application for increasing plant establishing and their growth. Amendment with wood residue with N increases the effects of fertilizers such as N, P, K or gypsum while amendments with gypsum increases the level of soluble salts Majority of N needed to supply plant/soil community comes from N-fixation and subsequent mineralization of organically combined N. Therefore, maintenance of a vigorous legume component within the plant community is critical for reclamation success. Saw dust and sewage sludge have been widely recognized as effective short-term fertilizers and sources of long term slow release nitrogen besides serving as microbial inoculums. In addition, organic matter improves soil structure, reduces erosion, and increases infiltration. Furthermore, organic wastes can increase the water holding capacity of mine spoils. Therefore, use of these materials assoil amendments will also require heavy fertilization with N- fertilizer. The maintenance of plant available phosphorus (P) in mine soils over time is hindered by two factors: (i) fresh mine spoils are generally low in readily plant available (water soluble)P; (ii) as mine soils weather and oxidize they become enriched in Fe-oxides that adsorb water soluble P which is then "fixed" into unavailable forms.

RE-VEGETATION AT ABANDONED MINE LAND

Vegetation has an important role in protecting the soil surface from erosion and allowing accumulation of fine particles. They can reverse degradation process by stabilizing soils through development of extensive root systems. Once they are established, plants increase soil organic matter, lower soil bulk density, and moderate soil pH and bring mineral nutrients to the surface and accumulate them in available form. Their root systems allow them to act as scavengers of nutrients not readily available. The plants accumulate these nutrients redeposit them on the soil surface in organic matter from which nutrients are much more readily available by microbial breakdown . The revegetation of eroded ecosystems must be carried out with plants selected on the basis of their ability to survive and regenerate or reproduce under severe conditions provided both by the nature of the dump material, the exposed situation on the dump surface and on their ability to stabilize the soil structure [2].Normal practice for revegetation is to choose drought-resistant, fast growing crops or fodder which can grow in nutrient deficient soils. Selected plants should be easy to establish, grow quickly, and have dense canopies and root systems. In certain areas, the main factor in preventing vegetation is acidity. Plants must be tolerant of metal contaminants for such sites. Role of exotic or native species in reclamation needs careful consideration as newly introduced exotic species may become pests in other situations. Therefore, candidate species for vegetation should be screened carefully to avoid becoming problematic weeds in relation to local to regional floristic. For artificial introduction, selection of species that are well adapted to the local environment should be emphasized. Indigenous species are preferable to exotics because they are most likely to fit into fully functional ecosystem and are climatically adapted. Grasses are considered as a nurse crop for an early vegetation purpose. Grasses have both positive and negative effects on mine lands. They are frequently needed to stabilize soils but they may compete with woody regeneration. Grasses, particularly C4 ones, can offer superior tolerance to drought, low soil nutrients and other climatic stresses. Roots of grasses are fibrous that can slow erosion and their soil forming tendencies eventually produce a layer of organic soil, stabilize soil, conserve soil moisture and may compete with weedy species. The initial cover must allow the development of diverse self-sustaining plant communities . Trees can potentially improve soils through numerous processes, including maintenance or increase of soil organic matter, biological nitrogen fixation, uptake of nutrients from below and reach of roots of under storey herbaceous vegetation, increase water infiltration and storage, reduce loss of nutrients by erosion and leaching, improve soil physical properties, reduce soil acidity and improve physical properties, reduce soil acidity and improve soil biological activity. Also, new self-sustaining top soils are created by trees. Plant litter and root exudates provide nutrient-cycling to soil. On mine spoils, nitrogen is a major limiting nutrient and regular addition of fertilizer nitrogen may be required to maintain healthy growth and persistence of vegetation. An alternative approach might be to introduce legumes and other nitrogen-fixing species. Nitrogen fixing species have a dramatic effect on soil fertility through production of readily decomposable nutrient rich litter and turnover of fine roots and nodules. Mineralization of N-rich litter from these species allow substantial transfer to companion species and subsequent cycling, thus enabling the development of a self-sustaining ecosystem.

CONCLUSION

In conclusion, I would reiterate that we would also need to draw on the cultural resources such as local knowledge and skills to help address the challenge of mine-spoil restoration. A broader vision alone can address the productivity enhancement of wastelands such as mine-spoil, and can contribute to overall approach for ecological, economic and social sustainability in India. A holistic approach suggested here is a step in that direction.

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