Restoration Notes

Restoration Notes have been a distinguishing feature of *Ecological Restoration* for more than 25 years. This section is geared toward introducing innovative research, tools, technologies, programs, and ideas, as well as providing short-term research results and updates on ongoing efforts. Please direct submissions and inquiries to the editorial staff (ERjournal@aesop.rutgers.edu).

New Approaches to Enhance Eco-Restoration Efficiency of Degraded Sodic Lands: Critical Research Needs and Future Prospects

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Over the last few decades, restoration of sodic land has gained considerable attention to meet the increasing demand of food, fuel, fodder, fiber, fruit etc. Approximately 581 million (M) ha of sodic lands are found worldwide in arid and semi-arid regions, and occurring disproportionately throughout Australasia (340 M ha), North and Central Asia (120.1 M ha), South America (59.6 M ha), Africa (27 M ha), Europe (22.9 M ha), North America (9.6 M ha), and South Asia (1.8 M ha) (Rengasamy 2006). Land salinization is not a new aspect, as it has threatened civilizations from ancient to modern times. Now increasing soil sodicity has become a major issue in natural resource management worldwide. Soil salinization has attracted increasing awareness from researchers, farmers, and policy makers, who have been tackling the problem over the last few decades. Some of the research articles provide status and perspectives of sodic land reclamation programs in various countries like India, Pakistan, and Australia. However, soil sodification still exists as a major issue and is now exacerbated by massive desertification and green house effects.

There are many potential approaches for the reclamation of sodic lands through phytoremediation practices. The best example is a novel model of developing a man-made forest ecosystem with multiple species, which has been successfully carried out during the 1960s at Banthra Research Station of the National Botanical Research Institute (NBRI) at Lucknow, Uttar Pradesh, India (26°45' N, 80°53' E). The work has been performed on an approximately 12-ha parcel over a period of 50 yr. Where highly sodic soils existed now stands a complete ecosystem with overstory, understory, and ground layer vegetation, which exhibits a structure and function similar to that of a natural forest ecosystem (Tripathi and Singh 2005). This forest ecosystem acts as a potential sink in carbon sequestration to mitigate environmental CO_2. It has been observed that this forest consisted of a significant amount of biomass, energy, and carbon in its standing stock at 40 yr of age (Table 1). In this mixed forest, soil organic carbon (OC) and calcium content increased exponentially over 5 decades, whereas sodium content decreased exponentially. Soil pH decreased in a polynomial order (zigzag) (Figure 1a–d). As the monoculture plantations grew over the years, OC and total nitrogen in the soil increased successively (Figure 1e–f).

There is an urgent need to develop effective approaches for restoration and reclamation of barren sodic land for multiple benefits in terms of ecological, environmental, and food production requirements. The purpose of restoration must be defined clearly as the different sectors need variable strategies to rehabilitate such land for effective uses. The keen interest in sodic soil restoration is mainly inspired by soil carbon sequestration (Lal 2002), soil quality improvement, reduction of net CO_2, food security, bio-energy (petro-plants, fuel-wood etc.), fiber producing plants, land use management, economic development, and soil rehabilitation. This restoration note describes the further critical research needs for developing and implementing more efficient tools for successful soil restoration protocols to enhance the biological productivity on this once sterile land:

- The effect of sodicity on soil carbon dynamics is not well established. Any attempt for reclaiming sodic soils affects soil carbon dynamics, recovery of microbial populations, and microbial biomass. Sometimes gypsum addition in sodic soil causes a decrease in microbial activity, while it tends to increase the soil microbial biomass for the

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