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Editorial

Soil Management for Sustainable Agriculture 2013

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Agricultural sustainability can be defined as the ability of a system to maintain stable levels of production and quality in the long term without compromising economic profitability or the environment. The conservation of soil quality is fundamental to agricultural sustainability. The soil provides, amongst other things, a substrate for plant anchorage, a buffered supply of essential mineral elements and water, a repository for carbon, a reservoir of functional biodiversity, and a filter for reducing the pollution of air and water by agrochemicals.

This is the second special issue on soil management for sustainable agriculture. It comprises ten papers describing (1) the preservation of soil organic matter and the phytoavailability of essential mineral elements in soils through the recycling of organic residues to agricultural land, (2) the effects of agricultural management on the accumulation of potentially toxic mineral elements in soils and plants, (3) agricultural practices that reduce losses of organic carbon and nitrogen from soils, restrict soil erosion, and maintain agricultural productivity, and (4) agronomic strategies to manipulate soil chemistry to reduce the abundance of problematical weeds.

Better soil quality is generally associated with greater concentrations of soil organic matter (SOM) and a plentiful supply of essential mineral elements. Thus, the recycling of organic matter and mineral elements from crop residues to soil often benefits agricultural sustainability. R. de Mello Prado et al. review the use of by-products of the production of sugar and alcohol from sugar cane as soil improvers and substitutes for mineral fertilizers. They report that the recycling of filter cake and vinasse can increase SOM, the phytoavailability of mineral elements, and crop yields. However, they caution that these crop residues must be applied judiciously to avoid possible environmental damage. Similarly, R. García Moreno et al. discuss the opportunities for managing the phytoavailability of selenium, which is not thought to be required by plants but is essential for animal health, through the recycling of organic matter to soils. They observe that the application of chemically recovered selenium to crops is nonsustainable. Nevertheless, animal manures and sewage sludge often contain significant amounts of selenium, and increasing SOM prevents selenium leaching to deeper soil horizons. Thus, the application of organic residues to agricultural land can increase soil selenium content and retention, increase selenium concentrations in edible produce, and, thereby, benefit human health.

Composts and manures also contain appreciable quantities of other essential mineral elements, including the micronutrients iron, copper, zinc, and manganese. However, these elements are potentially toxic to both plants and animals if they accumulate to excessive concentrations. In this special issue G. C. G. dos Santos et al. report that the concentrations and phytoavailabilities of copper and zinc are greater in the acidic vineyard soils of the state of São Paulo, Brazil, than in nonacidic natural soils from the same area, although they do not reach toxic concentrations. They attribute the accumulation of these elements to the application of copper-based fungicides and zinc-based agrochemicals and to management practices leading to soil acidification.

Anthropogenic contamination of agricultural land is not just restricted to the application of manures or agrochemicals, but can also be a consequence of dumping industrial wastes. To return agricultural soil to crop production, F. A. Gabos et al. have evaluated the potential for ameliorating soils polluted with automobile scrap by diluting them with uncontaminated soil and liming. Unfortunately this strategy was not successful in reducing the phytoavailability of potentially toxic elements in the soils they studied or in preventing their phytotoxicity to maize.

Soil microbes influence crop production and agricultural sustainability both through their direct and indirect interactions with plant roots and their effects on the biogeochemistry of carbon compounds and mineral elements in the soil. In this special issue, S. P. Val-Moraes et al. describe the contrasting fungal communities of native forest soil and soils cultivated with tomatoes or vegetable crops along the Taquara Branca river basin in Brazil. They speculate that the prevalent fungal community is related, in part, to SOM, tillage, and soil fertility. The fungal communities are also, of course, influenced by the application of fungicides.

The cultivation of grasslands causes a rapid loss of carbon and nitrogen from the soil, which results in both a decline in soil quality and an increase in the emission of greenhouse gasses (GHG). In this special issue, L. A. Milesi Delaye et al. assess the effects of agriculture on soil organic carbon (SOC) and soil organic nitrogen (SON) in grasslands of the Argentine Rolling Pampa over a 140-year period. They combine data from land surveys and experimental trials to develop a simple model simulating changes in SOC and SON in the Rolling Pampa following altered tillage practices. They report an "active" pool of SOM, representing about 50% of SOC and SON in the native prairie soil, with mean residency times of 9 years when soils were tilled and 13 years without tillage. Both SOC and SON could be increased by incorporating organic residues to the soil. Increased cultivation has similarly reduced SOC in tropical soils. In this special issue, W. Mekuria and A. Noble review the impacts of agriculture on SOC in the tropics, concluding that, although improved agronomic practices such as no till, crop rotation, growing cover crops, and the use of mulches, composts, and manures can increase SOC and agricultural productivity, this increase is often short lived. However, they suggest that the production and management of biochar, in both local and global contexts, might be used to increase carbon sequestration in agricultural soils, improve their quality and productivity, and reduce GHG emissions from agriculture in the long term.

Soil erosion is a serious problem in many areas of the world. In principle, it can be reduced by conservation tillage systems that maintain crop residues on the soil surface. The results of a 24-year study on the effects of three conservation tillage systems on SOC and crop yields in Southern Illinois, USA, are presented by K. R. Olson et al. These authors report that a no-till system preserved more SOC than ploughing with a mouldboard, which in turn preserved more SOC than chisel ploughing, over the 24-year period. Commercial yields of maize and soybean from all three systems were similar. The susceptibility of the soils of the Haean catchment in South Korea to erosion was studied by M. Ruidisch et al. in the context of the sustainability of current practices for vegetable production. In this region, soil depth is maintained by spreading sandy material on fields and crops are cultivated in ridges using plastic mulches. This practice results in poor soils with low SOM that are highly susceptible to erosion during the monsoon. They conclude that a more sustainable agricultural system is urgently required.

In the final paper of this special issue, B. Kone et al. have investigated whether the management of soil chemistry might be used to control problematical weeds in West African rice producing areas. It has long been known that soil chemistry can influence plant species' assemblages and this study observed that the abundance of speargrass (*Imperata cylindrica* L.) was positively correlated with soil potassium concentration and negatively correlated with soil calcium and iron concentrations, whereas the abundance of *Cyperus* spp. was positively correlated with both potassium : magnesium and calcium : magnesium ratios in the soil. The authors suggest fertiliser management strategies to exploit these phenomena to control the abundance of these weeds.

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