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Sustainable Management Systems for Improving Soils and Environmental Quality

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Abstract—*Intensive tillage, imbalanced use of fertilizers and pesticides in cropland, heavy metal contaminants from industrialeffluents, and accelerated soil erosion are the primary causes of soil and water quality impairments in watersheds located within the Midwest USA. A total of more than 1.7 billion tons of soil are eroded by water and wind each year from the US croplands. The other major challenges that reduce soil and water quality include intensivegrazing, land use change, deforestation and drainage problems. Several conservation-effective practices have been identified and tested. Important among these are conservation tillage systems, biochar amendment, cover crops, and diversification of cropping systems. These practices can improve soil organic carbon (SOC), reduce erosion, and improve the quality of soil and water resources. In Ohio, a study showed that SOC improved with usage of 47 years of no-till (18.5 g kg^{-1}) farming compared plow-till (13.9 g kg^{-1}) systems in the top 20 cm depth under poorly-drained soils. Similarly, SOC under long-term (49 years) NT (16.4 g kg^{-1}) systems increased by 30% compared to plow-till (11.8 g kg^{-1}) in well drained soils of Ohio. Cover crops are also beneficial in improving soil quality and reducing transport of agricultural chemicals in water runoff. Crop rotation with leguminous cover crops reduce N inputs, and can extract plant-available N which was unused by the previous crop, thus saving additional synthetic nitrogen fertilizer use, and reducing N losses. Cover crops used in high corn residue removal improved SOC (27 g kg^{-1}) by 6% compared to that without cover crops (25.4 g kg^{-1}) in South Dakota. Conducting field experiments for assessment of long-term benefits of conservation systems is expensive and takes significant time to show impacts on soils and water quality improvement. Further, these conservation practices are site-specific and one-size-fits-all recommendations for these practices are inappropriate because of varying soil type, management and climate. Therefore, models are very useful tools for simulating the long-term impacts of best management practices for improving soil and environmental quality under diverse environmental conditions. For instance, a hydrologic modeling study conducted in Missouri shows that rotational grazing reduces surface runoff by 10% compared to intensive grazing. This study also concludes that installing agroforestry buffers at the edge of grazed watersheds (with no cattle access) reduces surface runoff by 57% and sediments by 49% compared to the watersheds without buffers. Another modeling study conducted in Ohio showed that use of cover crop in corn-soybean rotation under no-till and plow-till showed 37 and 19% lower mean annual runoff, respectively, compared to continuous corn under same tillage systems.In conclusion, modifications in current conventional soil and management systems, diversifications of cropping systems and an integrated research and modeling approach is needed for improving crop productivity, SOC, and water quality.*