Editorial

Tillage and soil quality
Tillage practices for sustainable agriculture and environmental quality in different agroecosystems

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For centuries tillage has been used to prepare suitable seedbed to grow crops, and to control weeds and incorporate fertilizers, pesticides, manures and other amendments. In early years conversion of native ecosystems by tillage helped to unlock nutrients stored in soil organic matter, and thus ‘mine’ naturally fertile soils to grow crops with minimum inputs for the growing population. However, at the same time, tillage was insidiously destroying soil organic matter and soil structure, and in this way, accelerating soil erosion and breaking the web of soil life itself (Papendick and Parr, 1997). The results of exploiting agricultural systems without consideration of the consequences of soil degradation caused by soil preparation are evident in those regions where soil is cultivated intensely and continuously (Derpsch and Moriya, 1998). Soil inversion and pulverization by repeated tillage accelerates decomposition of organic matter thus affecting soil physical, chemical and biological properties, the key attributes of soil quality (Cannell and Hawes, 1994). For the past thirty years, land management systems have been developed that minimize the need for soil tillage. Techniques such as no-tillage leave plant residues on the surface, protecting the soil from erosion. Many studies have shown that with continuous no-tillage soil organic matter increases, soil structure improves, soil erosion is controlled, and in time crop yields increase substantially from what they were under intensive tillage management (Cannell and Hawes, 1994; Papendick and Parr, 1997; Reeves, 1997). There is overwhelming evidence from several scientific studies that continuous no-tillage is the most effective and practical approach for restoring and improving soil quality, which is vital for sustained food production and a healthy environment. No-till farming has gained wide acceptance in Australia and North and South America but although the advantages of no-tillage are widely recognized, adoption of this technology has been very slow elsewhere. In May 1996, the International Soil and Tillage Research Organization (ISTRO) Board proposed and agreed to organize a symposium on Tillage and Soil Quality as a part of its 14th ISTRO Conference held in Pulawy, Poland from 27 July to 1 August, 1997. I was asked by the Secretary-General, Warren Dick to organize this symposium. The objective of this symposium was to invite and bring together scientists working in soil tillage research in different parts of the world and to deliberate and discuss their findings in relation to the impact of different tillage systems on soil properties, crop production and environmental quality.
symposium and discussion with the editorial staff of Soil Tillage Research, it was decided to pursue publication of the invited papers after the usual peer review process. Following reviews and revision, these papers were accepted for publication in this Special Issue. The paper by Rasmussen reviews the work done by his colleagues in Denmark, Finland, Norway and Sweden on the impact of reduced soil tillage on crop production. He points out how the level of success in no-tillage planting varies with crop species, soil type, climatic conditions and variations in the length of the growing season, which is very short in the northern part of Scandinavia. Satisfactory yields were obtained after ploughless tillage in winter wheat (Triticum aestivum L.), winter oilseed rape (Brassica napus L.) and late harvested potatoes (Solanum tuberosum L.). The degree of success depends on the preceding crop. The paper by Tebrugge and During reviews the results from a long-term study in the central German state of Hesse. The data in this paper shows the positive effects of decreasing tillage intensity on physical properties of soils ranging in texture, and under different crop rotations. Their data demonstrate that soils with no-tillage had increased biological activities, especially increased earthworm populations, which promotes macroporosity and improves infiltration and soil structure. Their study also indicated decreased lateral movements, but increased vertical mobility, of agrochemicals in the no-till soil. The paper by Ball et al. compares the N₂O, CO₂ and CH₄ emissions from the two field experiments, one involving soil compaction plus residue incorporation and the other involving no-tillage and two depths of mouldboard ploughing of a former grass sward. Their data indicate that both N₂O and CO₂ fluxes were episodic and strongly depended on the intensity of rainfall, which affects gas diffusivity and air-filled porosity. The authors, while including limited data on CH₄ fluxes, point out the need for further research on methane oxidation rates in relation to soil types and tillage practices. Arshad et al. summarize data on the influence of conventional and no-tillage on soil structure and crop yield in far northern regions of western Canada, where a short growing season is generally considered a barrier to adoption of no-tillage systems. Presenting a combination of a review and their original data, the authors demonstrate how no-till management of the predominantly small grain region of western Canada has the potential to curb soil erosion and improve soil quality for sustained long-term productivity with minimal negative environmental impacts. Chan and Hulugalle from Australia, evaluated the changes in physical and chemical properties of soils located in rain-fed, hardsetting red Alfisols and in irrigated, self-mulching Vertisols. Their research, conducted on several on-farm studies, showed that while deterioration in soil quality (characterized by an increase in hardsetting behaviour and acidity, and a decrease in organic C, total N and aggregate stability) was caused by intensive tillage of previously untilled Alfisols, a significant improvement in the chemical quality (characterized by an increase in organic C and a decrease in exchangeable sodium) occurred with adoption of minimum tillage practices. Kaihura et al. evaluated the impact of topsoil depth and management on properties of eight major agricultural soils with different degrees of erosion, in three eco-regions in Tanzania. The management strategies included the applications of farm yard manure, N and P fertilizers, tie-ridging and farmers’ conventional practices of shallow tillage and hand hoeing to a 10–15 cm depth. Their data showed that soil organic C, N and P were most adversely affected by erosion. They concluded that farm yard manure was a better soil input than N and P fertilizers in improving soil quality.

I hope that these papers will serve as a useful overview of no-tillage and soil quality in different ecosystems and foster an increased understanding of the tillage-soil interactions. Furthermore, I hope that this special issue will stimulate new researchers to pursue many unresolved problems in adopting no-tillage technology; certainly much more needs to be done. I thank the authors and referees for their contribution to this important and timely topic.

References


