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Sustainable crop productivity and environmental safety through zero-tillage

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Zero tillage (ZT) is also known as no till and direct planting. Zero tillage implies planting crops in previously unprepared soil by opening a hole, narrow slot, trench or band of the smallest width and depth needed to obtain proper coverage of the seed. It is a practice adopted by farmers since ancient days and it continues to be followed by farmers in developing countries to date. The modern concept of ZT tends to imply seeding a crop mechanically in undisturbed soil covered with plant residues. 'Though the name refers to only one practice, no till actually is a farm management system that involves many agricultural practices, including planting, residue management, weed and pest control, harvesting, and rotation. The agriculture sector accounts for about one fifth of the annual anthropogenic increase in greenhouse forcing, producing about 50 to 75% of anthropogenic methane and nitrous oxide emissions and about 5% of anthropogenic CO_2 emissions. Ploughing or soil inversion is a principal cause of CO_2 emission from croplands. There is scientific evidence that soil tillage has been a significant component of the increase in atmospheric CO_2 which has occurred in the last few decades. Zero-tillage (ZT) adoption is an essential step to sustainable agricultural development worldwide. ZT is primarily used as a means to protect soils from erosion and compaction, to conserve moisture and reduce production costs. The use of ZT significantly improved soil aggregation and carbon and nitrogen sequestration in the surface of the soils. In both tropical and temperate soils, a general increase in C levels was observed under no-tillage compared with conventional tillage. No-tillage can improve soil structure and stability thereby facilitating better drainage and water holding capacity that reduces the extremes of water logging and drought. Particulate organic matter was a more sensitive indicator of soil quality changes under different tillage and stubble management than total organic carbon. These improvements to soil structure also reduce the risk of runoff and pollution of surface waters with sediment, pesticides and nutrients. Under no-tillage, a richer soil biota develops that can improve nutrient recycling and this may also help combat crop pests and diseases.

Within the context of conservation agriculture, ZT implies the retention of crop residues as mulch on the soil surface and its year-round application to all crops in the cropping cycle. ZT of wheat is particularly appropriate for these systems and addresses four important constraints. First, rice-wheat systems are characterized by late planting of wheat, which significantly reduces wheat productivity. The delay in planting the wheat crop is mainly due to the late harvest of the previous crop and/or a long turnaround time. The late harvest of the previous rice crop can be linked to both the late rice establishment and the duration of the rice crop. Farmers perceive the need for intensive tillage due to the difference in soil management practices for rice and wheat - the former being grown under anaerobic conditions and the latter under aerobic conditions. ZT greatly reduces the turnaround time, allowing wheat establishment in a single pass almost immediately after the riceharvest. Second, continuous rice-wheat cultivation has led to a build-up of biotic stresses. The major weed affecting wheat in the IGP is Phalaris minor, which shows emerging resistance to isoproturon herbicide after repeated and widespread use. By reducing soil movement ZT serves as an effective control measure of P. minor. Third, rice-wheat systems have led to land degradation. ZT drastically reduces machinery use and the cost of the tillage operation - a major cost of crop production in the IGP. Compared with broadcasting, the ZT drill saves seed and fertilizer, placing them at the desired depth and vicinity and in the right quantities. The advantages of ZT technology are thus manifold. On the one hand, this practice generates higher yields at lower production costs; on the other, it is an environmental friendly practice that saves water and soil(Hobbs et al., 1997).ZT potentially includes savings in energy, water, labour and other inputs.

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