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Conservation Agricultural Techniques for Improving Soil Health

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INTRODUCTION

Jethro Tull who is considered as "Father of Tillage" gave the tillage concept by considering the importance of pulverizing the soil for the cultivation of crops. Traditionally, agricultural techniques have long relied heavily on tillage. It is the manipulation of soil for crop growth, eradicates weeds, and regulates the movement of air and water in the soil. However, in the long term, continuous intensive tillage applications have many adverse effects such as breakdown of aggregates, soil carbon loss, soil compaction, low infiltration and soil erosion which effect the soil health. Burning of crop residues is the main practice which follows in this system. Environmental pollution, stagnation of yield and global warming are the other impacts of the conventional tillage systems. In order to reduce it, it is necessary to think about an alternative solution which will conserve natural resources while sustaining the soil health. Conservation agriculture has proven to be an effective solution for combating the negative impacts of intensive agriculture systems.

Conservation Agriculture

Conservation Agriculture is a resource-saving agricultural crop production system that aims to manage agro-ecosystems for improved and sustained productivity while conserving the environment. Three principles of conservation agriculture (CA) are minimum mechanical soil disturbance, permanent soil organic cover with crop residues or cover crops and diversified crop rotations include legumes or cover crops.

Conservation Agriculture Techniques

Conservation agriculture techniques based on above discussed three principles helps in optimizing the crop production while maintains the soil health. Zero tillage/ No tillage, minimum tillage, strip tillage, ridge tillage, reduced tillage, mulching and cover crops are the conservation techniques followed under conservation agriculture.

Examples of cover crops are buckwheat, sorghum sudan grass, wheat , rye etc. A minimum of three different crops need to be included in the rotation. Agroforestry component in which various trees like *Dacryodes edulis, Faidherbia albida, Tectona grandis, Populus deltoides, Phyllostachyus nigra, Salix alba* can also be grown along with main crops in the field. Planting green is a new technique of growing cash crop in the standing cover crops instead of more common practices of planting into desiccated cover crops. Various resource conservation technologies based on conservation agriculture can also be used for conserving the water and soil resources. Aerobic rice, direct seeded rice, in-situ water harvesting (compartmental bunding, broad bed furrow method, ridge and tie method, flat bed method, furrow irrigated raised bed and reservoir tillage), laser land leveller, micro-irrigation systems, and agrotextile/geotextile are some of the techniques that can be used for water management. In order to manage the nutrients in soil various techniques can be employed such as site-specific nutrient management (SSNM), nutrient expert, leaf colour chart, SPAD meter, fertigation and biochar. Machineries like zero till seed drill, slit till drill, happy seeder, turbo seeder, baler implement and Super straw management system (Super SMS) used to manage the crop residues either by spreading it evenly in the field without setting the stubble on fire or by making bales of compressed hay for storing purpose. In addition, these machineries can also be used for seeding in the loose and standing residue.

Effect of Conservation agriculture techniques on soil health

Physical, chemical, and biological characteristics of the soil that must be kept at their highest levels in order to sustain productivity over the long term. Due to minimum disturbance of soil, CA techniques improve the physical properties of soil by enhancing the proportion of micropores, increasing the water-holding capacity and infiltration rate, decreasing the bulk density (less compaction) and improving the aggregate stability. Crop residue and other surface mulches alter the thermal characteristics of the soil and reduce evaporation from the soil surface. Chemical property like soil organic carbon can be increased by retaining crop residues which contain carbon and nutrients at the soil surface layer under conservation agriculture. Due to a greater amount of residue addition and input of nutrient-containing organic material into the soil, CA techniques improve soil organic carbon levels, which in turn can affect plant nutrient availability. The incorporation of stover or straw into a deep soil layer causes quick decomposition and may also cause the leaching of mineralized nutrients in even subsoil, reducing the amount of available nutrients in conservation agriculture. Conservation agriculture techniques also improve the biological properties of soil by increasing the population of beneficial microorganisms. The soil organic carbon found in CA systems provides soil microbes with a good source of energy, promotes their growth, and therefore influences their distribution.

CONCLUSIONS

Tillage is used to soften soils for uniform seed germination, the release of plant nutrients and incorporation of crop residues. But frequent intensive tillage in long term leads to soil compaction, land degradation, stagnation of yield and environmental pollution. A Better understanding of sustainable land management practices helps in combating these trends by improving the soil health. Conservation agriculture is different from the conventional one that offers a new paradigm for agricultural research and development, which mainly aims at achieving higher grain production while maintaining the soil health. Conservation agriculture techniques are based on three principles viz. minimum mechanical

disturbance, permanent soil organic cover and diversified crop rotation. In addition to these, various resource conservation technologies can also be used under the conservation agriculture system for managing the soil and water resources. Therefore, conservation agriculture-based crop production system is one of the pathways for improving productivity while sustaining the physical, chemical and biological properties of soil.

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