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Conservation Agriculture: Principles and Advantages

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In recent years, intensive farming for higher food production has been linked to a number of negative consequences for soil systems, including decreased soil organic matter (SOM), increased risks of wind and/or water erosion, decreased soil biological diversity, increased degradation of soil physical quality, lower nutrient-use efficiency, increased risks of groundwater pollution, falling water tables, increased salinization and waterlogging, and in-field burning of crop residues. These negative consequences need an objective evaluation of ideas for developing sustainable management practises that could not only maintain soil health and food security, but also increase carbon sequestration, reduce GHG emissions, and provide cleaner and better ecosystem services.

Conservation Agriculture (CA) is a farming technique that emphasises little soil disturbance (i.e., no tillage), the preservation of a permanent soil cover, and plant diversity. It improves biodiversity and natural biological processes above and below ground, resulting in more efficient water and fertiliser usage, as well as enhanced and long-term crop production (FAO 2012). CA is gradually being adopted due to its apparent benefits, and it presently covers around 180 million hectares (Mha) worldwide (Somasundaram et al., 2020).

CA adoption is still in its beginning phases in India. The use of zero tillage and CA has increased to over 1.5 million hectares in recent years (Jat et al., 2012). The most common CA-based technology used in the Indo-Gangetic plains (IGP) is zero-till (ZT) wheat in the rice-wheat (RW) system. Traditional agriculture-based crop management approaches are gradually shifting from intensive tillage to reduced/zero-tillage operations in various crops and cropping systems. India, which has recently become recognised for its rapid economic growth and growing population, demands increased food production and is also a hotspot for CA technology adoption. As a result, the purpose of this article is to objectively examine the possibility, scope, prospects, obstacles, and benefits of CA in India.

Principles of Conservation Agriculture

Conservation agriculture is based on ecological principles and is utilised in many places around the globe to make land use more sustainable (Lal, 2015). Adoption of CA for improving Resource Use Efficiency and crop productivity is urgently needed as a powerful tool for natural resource management and agricultural sustainability. CA is based on three concepts; these are the following:

A. Continuous minimal soil disturbance

Minimum soil disturbance ensures optimal proportions of respiration gases in the rooting zone, moderate organic matter oxidation, porosity for water movement, retention, and release, and restricts weed seed re-exposure and germination.

B. Permanent soil cover

A permanent soil cover is necessary to protect the soil from the damaging effects of rain and sun, to provide a constant supply of "food" to the micro and macro-organisms in the soil, and to change the microclimate in the soil for optimal growth and development of soil organisms, including plant roots. As a result, soil aggregation, biological activity, biodiversity, and carbon sequestration improve (Ghosh et al., 2015).

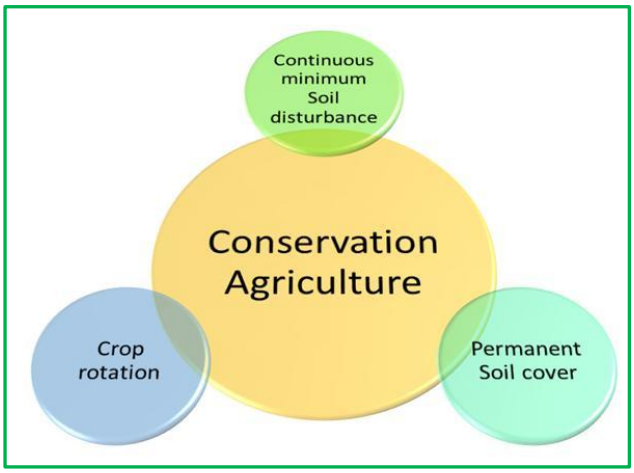

Figure 1 Principles of conservation agriculture

C. Crop rotations

Crop rotation is required not just to provide a variety "diet" for soil microorganisms, but also to explore different soil strata for nutrients that have been leached to deeper layers and can be "recycled" by rotation crops. In addition, a diversified crop rotation results in a diverse soil flora and fauna. Through life cycle disruption, biological nitrogen fixation, off-site pollution control, and biodiversity enhancement, legume cropping sequences and rotations serve to keep insect population growth to a minimum (Kassam and Friedrich, 2009; J. Dumanski and R. Peiretti, 2013).

Advantage of Conservation Agriculture

1. Reduction in cost of production
2. Enhancement of soil quality i.e. the physical, chemical, and biological characteristics of the soil
3. Saving in water and nutrients
4. Long-term C sequestration and soil organic matter build-up provide a viable method for reducing Green House Gas emissions and increasing production system resilience to climate change-related aberrations
5. Leducing the prevalence of weeds in the different crops
6. Increased production and productivity (4%– 10%)
7. Advanced sowing date
8. Reduced greenhouse gas emissions and improved environmental sustainability
9. Avoiding crop residue burning reduces loss of nutrients and pollution, reducing a serious health hazard
10. Providing opportunities for crop diversification and intensification
11. Enhanced resource use efficiency through residue decomposition, soil structural improvement, increased recycling, and plant nutrient availability
12. Use superficial residues as mulch to reduce weeds, moderate the soil temperature, reduce evaporation of water, and improve microbes' activity
13. Environmental benefits — Zero-till and surface-managed crop residue systems provide a good opportunity to minimise crop residue burning, which contributes to huge volumes of greenhouse gases such as CO_2, CH_4, and N_2O. Burning crop leftovers also results in a significant loss of plant nutrients, which may be recycled if handled appropriately. Burning crop leftovers on a large scale is also a severe health danger. etc.

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