

Conservation Agriculture: A Novel Approach for Sustainable Crop Production

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Introduction

The increasing world population projected to reach 9.7 billion by the year 2050, humanity faces the challenge of securing food resources to meet future demand. Day to day climate is changes due to human interferences in environment (Talaviya and Patel, 2021). Conservation agriculture approach is a combined approach of farming practices or farming system that tools are importance as reduce the antagonistic impacta of agriculture on the environment ecosystem while maintaining or improving crop productivity and soil sustainability (Choudhary *et. al.*, 2017). Conservation agriculture based on 3 basic principles/ objectives as minimum disturbance of soil (no till), permanent grazing and soil cover and crop diversification as crop rotation. These basic principles/ objectives of conservation agriculture are conserve the natural resources and provide beneficial impact on ecological, social and farmers environment through soil health management practices as soil erosion management, soil compaction of sandy soil/ poor soils as improve soil structure, increase water infiltration and water holding capacity, crop residue management for nutrient recycling and soil moisture retention and weed management. The different conservation practices improved the content of soil organic matter, nutrient status of soil, water holding capacity, and restoration of nutrients by nutrient cycling. Conservation agriculture is a practice for sustainable crop production in order to understand how one could possibly attain higher yields with less labor, water, and fewer chemical inputs. In spite of these challenges, conservation agriculture is spreading to farmers throughout the world as its benefits become more widely recognized by farmers, researchers, scientists and extensionists alike. It was estimated since 2008/2009, conservation agriculture (CA) cropland area has been expanding global an annual rate of more than 10 M ha per year. In 2015/2016, the total CA cropland area was 180.4 M ha, corresponding to 12.5% of global cropland area. In 2018/2019, the total cropland area was 205.4 M ha, corresponding to 14.7% of global cropland area (Kassam *et al.*, 2022).

Goals of Conservation Agriculture

The main fundamental goal of conservation agriculture is the integration approach of nutrients to conserve the natural resources as soil, plant and environment kingdom. Minimize the outside input sources and increase the use efficiency of natural resources. It provides sustainability in farming production through maintaining the quality of natural resources by stable or semi-stable organic cover to soil.

1. Achieves acceptable profit to farmers
2. It is source of Alleviation of hunger
3. Large and small scales farmers CA sustained production potential.
4. By the high yielding and crop production impart the role in the food security
5. Its cost-effective technology so that reduce input and labour costs and increases the net returns of crops.
6. Its sustained natural environment for such as carbon sequestration and climate change and nutrient recycling in the soil-plant-environment ecosystem.

Conservation Agriculture Objectives/ Principles

Conservation Agriculture is promotion of minimum soil disturbance (i.e. no tillage), maintenance/management of a permanent soil cover and diversified cropping system of plant species. It is a completely farmer aspect profitable farming practices and also promote bio-diversification (Biodiversity) and natural biological processes above and below the ground surface, which contribute to increase the use efficiency of water and nutrients for sustaining the crop production and soil health management. Farmers

are increasingly adopting conservation agriculture practices. This sustainable farming as conservation agriculture method is based on three Objectives/principles (FAO, 2014a):

1. Minimal soil movement: This practice of conservation agriculture is also known as minimum mechanical operation in the field for soil disturbance (Soil structure) as no-tillage practices or minimum tillage. Its promote to opening the slot in the field with the help of khurpi as manual or any other equipment and putting the seed in it or direct seeding or broadcasting of seed which leads to minimum soil disturbance. The disturbed area must be less than 15 cm wide or less than 25% of the cropped area (whichever is lower) (FAO 2014b). In the field for sowing practice is direct planting and row seeding manually for growing crops with minimum soil disturbance from field preparation to till harvest of crop. CA done with manually or mechanically practice to protect against water and wind erosion as long term and improved the infiltration rate or water retention and conserves soil moisture and increased the organic matter content in soil (Talaviya and Patel, 2021).

2. Permanent soil cover: it is a live mulching practice in this field covered by organic inputs (Natural resources). Permanent covering of soil is protect wind and water erosion by the covering crop residues. The crop residues is a main source-sink as provide food and energy source for microbial community in the soil environment. Three groups are well known: (1) 30–60 %, (2) >60–90 %, and (3) >90% cover of ground, calculated without delay following the direct seeding process. CA does not include area <30% soil cover (Kassam *et al.*, 2015).

3. Crop diversification: Crop diversification means growing more than one crop in an area and crop grown by nutrient aspect as rotate the growing crop. Diversification in crop production system and farming system by mean adding more crops into an existing rotation. Minimum of three different agricultural crops should be included in rotation. However, cycling of cropping of wheat, maize, rice or pulses and intercropping is not an omission factor for collection of data in this purpose, but rotation is recorded where practiced (Kassam *et al.* 2015).

Advantages and Benefits of Conservation Agriculture at Global, Regional, Local and Farm Level (Blind *et al.*, 2009 and Sala Enric, 2023)

1. Conservation agriculture practices provide cropping and environmental Sustainability for best crop production.
2. Conservation agriculture promotes and enhanced natural biodiversity in the soil-plant-environment ecosystem.
3. It is a most important practice for Soil creation. Restoration of natural habitat. Trees, grasses, pollinator habitation.
4. Conservation agriculture promoted natural farming through localized practices of farmers.
5. Its potential input in the building and improvement of the soil health.
6. It's improved the soil fertility by reducing erosion and runoff.
7. Through conservation agriculture we can improve the water infiltration and water retention of soil.
8. Improvement of soil structure, and thus rooting zone.
9. Improvement in air and water quality.
10. Conservation agriculture conserve the natural environment and enhanced crop productivity and stability by reduced labor and input costs
11. It is cost effective approach for crop production sustainability.
12. Conservation agriculture sequestrates the carbon into soil and enhanced the soil organic matter content in the soil.
13. Increased the organic matter in soil thought conservation agriculture than the microbial activity, microbial nutrient transformations by nutrient cycling, protecting the soil surface from wind and water, reducing evaporation and improving the physical condition of soil.
14. Conservation reduced insect and pest disease infestation and finally the reduction in the uses of pesticides and insecticides for healthy crop production.

15. Conservation agriculture is conserving the natural nutrient resources in the soil environment and ultimately reduces the dependency of chemical fertilizers.

16. It's also minimized the natural vegetation and weeds and increased the diversified crop production.

17. CA in its applicable implemented package and compatible with the realities of the production environment in small scale irrigated wheat based sequential cropping systems or farms.

18. As with any new agricultural technology, CA methods are most effective when used with skillful management and careful consideration of the many agro-ecological factors affecting production on any given farm or field.

Conclusion

Conservation Agriculture (CA) minimal soil disturbance fosters improved soil health, boosting fertility and crop resilience. This approach decreases the need for chemical inputs, lowering costs and environmental impact. By incorporating practices like cover cropping and no-till farming, CA also acts as a carbon sink, combating climate change. Ultimately, CA harmonizes farming with nature, yielding a sustainable canvas that benefits farmers, the environment and future generations.

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