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Conservation agriculture for improving productivity and Sustainability

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Conservation agriculture (CA) is a concept for resource-saving agricultural crop production that strives to achieve acceptable profits together with sustained production, while concurrently conserving the environment. CA is characterized by three interlinked principles, namely minimum mechanical soil disturbance (*i.e.* no tillage) through direct seed and/or fertilizer placement, this reduces soil erosion and preserves soil organic matter, permanent soil organic cover (at least 30 percent) with crop residues and/or cover crops. Maintaining a protective layer of vegetation on the soil surface suppresses weeds, protects the soil from the impact of extreme weather patterns, helps to preserve soil moisture, and avoids compaction of the soil. Species diversification through varied crop sequences and associations involving at least three different crops. A well designed crop rotation promotes good soil structure, fosters a diverse range of soil flora and fauna that contributes to nutrient cycling and improved plant nutrition, and helps to prevent pests and diseases.CA is considered a suitable technique for soil erosion control, productivity enhancement, and improved economic benefits. CA based best-bet crop management practices may increase crop and water productivity, crop residue retention, and crop rotations while conserving and sustaining natural resources and soil erosion control. The CA practice such as zero tillage and residue mulching is an ecological approach for soil surface management and seedbed preparation. It is energy efficient and beneficial to environment as compared to conventional practices. However in CA, the requirement of nutrients may differ from conventional agriculture practices and the initial 3–4 years of adoption, zero tillage reduces N mineralization by decreasing decomposition of soil organic matter, while the crop residues influence N dynamics from immobilization and volatilization.

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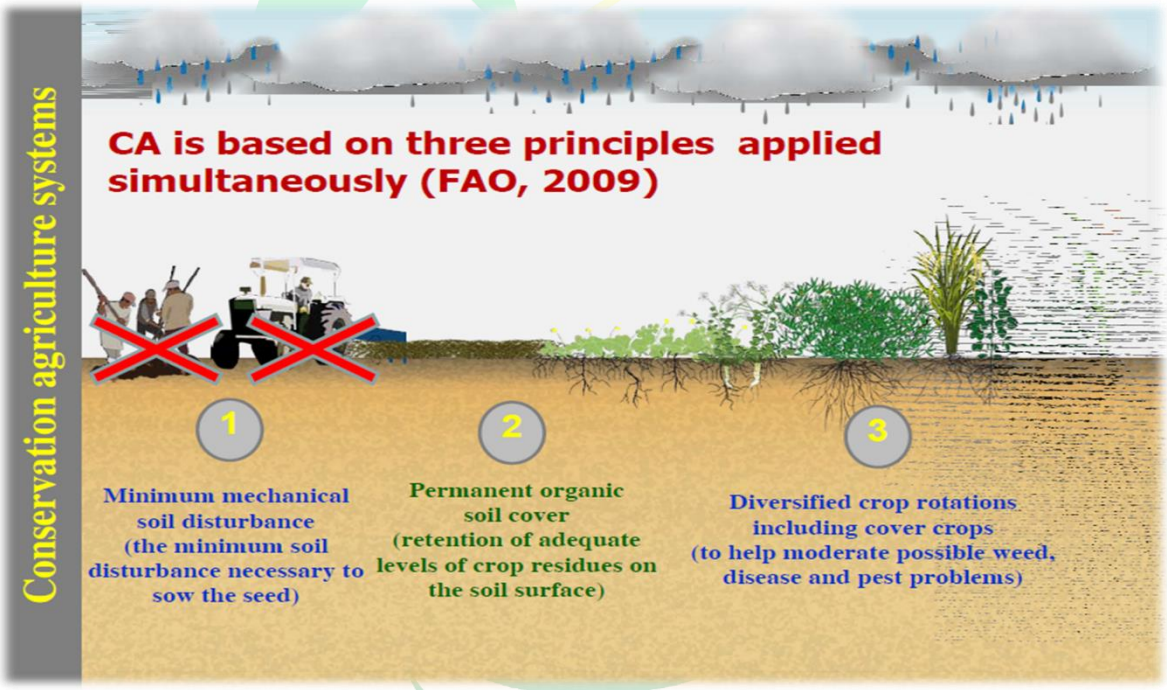
Objectives

Its objectives are to improve agriculture production by adopting economically, ecologically and socially sustainable methods with aims to conserve, improve and make more efficient use of natural resources. It contributes to environmental conservation as well as to enhanced and sustained agricultural production for farmers.

CA principle

Conservation agriculture is based on the principle of providing continuous soil cover (crop residues, cover crops), minimum soil disturbance, and crop rotations and has a high potential to increase productivity while protecting natural resources and environment.



CA Advantages

1. Building up the soil organic matter also retains nutrients and improves the micro-flora in the soil, a vital component of living soil. The soil is richer and darker, and there are more earthworms, beetles and other creatures that help keep the soil fertile.
2. Soil organic matter can hold many times its weight in water, therefore building up the organic matter in the soil results in greater water retention.

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3. When soil organic matter is built up through Conservation Agriculture, applied fertilizers work better.
4. Different crops have different root structures – some have deep taproots and others have fibrous roots at the surface. Through crop rotation, organic matter is placed in different soil strata, thereby making the soil more fertile.
5. It allows rainwater to seep deep into the soil, and then keeps it there so crops can use it.
6. It improves the soil structure: it breaks down the hardpan and it makes the soil looser, making it easier for roots, water and air to penetrate the soil.

CA Disadvantages

1. Conservation Agriculture is generally a win-win situation, but that does not mean there are no difficulties. It requires a major change in mind-set of farmers. In general, farmers need to be more careful about timing of agricultural operations under Conservation Agriculture.
2. Special attention has to be paid to weed control, either through hand weeding or by judicious use of herbicides. Once the environment has been stabilized however, farm production tends to be more stable than under conventional agricultural methods. So far there have been no pest problems that cannot be overcome in Conservation Agriculture.

CA and Sustainability

Conservation Agriculture provides a truly sustainable production system, not only conserving but also enhancing the natural resources and increasing the variety of soil biota, fauna and flora (including wild life) in agricultural production systems without sacrificing yields on high production levels. As CA depends on biological processes to work, it enhances the biodiversity in an agricultural production system on a micro- as well as macro level. CA in the context of sustainable agricultural mechanization is more than just a mechanical technique, such as no-till and direct seeding. It represents a fundamental change in the soil system management and in the cropping system design and management, which in turn lead to consequential changes in the required field operations and the related mechanization solutions. When a tillage-based production system is to be transformed into a CA-based system, it involves a shift in the prevailing on-farm mix of mechanical technologies, some of which will remain but with only marginal use in future and there will be development of completely new set of mechanical technologies, changes in farm power requirements and in

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land use suitability for sustainable intensification. The main barriers to the adoption of CA practices continue to be knowledge on how to do it (know-how), mindset (tradition, prejudice), inadequate policies, for example, commodity based subsidies (India, EU, US) and direct farm payments, unavailability of appropriate equipment and machines (many countries of the world) and of suitable herbicides to facilitate weed and vegetation management (especially in developing countries). Conservation agriculture is by no means low output agriculture and allows yields comparable with modern intensive agriculture but in a sustainable way, yields tend to increase over the years with yield variations decreasing.

Conclusions

A healthy soil is fundamental for sustained agricultural productivity and the maintenance of vital ecosystem processes. Arable lands are prone to severe soil degradation. Thus, crops require ever-increasing input to maintain yields, even in high-yielding areas where soils are moderately degraded. Therefore, agriculture should not only be high yielding but also

sustainable. Conservation agriculture involving continuous minimum mechanical, oil disturbance, permanent organic soil cover and diversified crop rotations provides opportunities for mitigating greenhouse gas emission and climate change adaptation. CA has the capacity for short-term maximization of crop production as well as the potential for long-term sustainability *i.e.*, C storage. Soil C sink capacity depends on several factors including climate, soil type, crops and vegetation cover, and management practices. Recycling organic resources containing polyphenols and lignin may affect the long-term decomposition

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dynamics and contribute to the buildup of SOC. Hence, it is important to explore a wide range of adaptation strategies, which could reduce the vulnerability of agriculture to climate change. A wide adoption of CA will reduce the cost of labor, fuel, and machinery, while conserving water, reducing erosion, and sequestering C.