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Conservation Agriculture in India -A Need

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Introduction:

Traditional agriculture has been criticized for soil erosion issues, surface and groundwater water contamination, and increased water utilization because it is heavily mechanized and based on tillage (Wolff and Stein, 1998). Additionally, it contributes to concerns with global warming, the loss of wildlife, and the loss of biodiversity and wildlife habitats (Boatmann et al., 1999). Therefore, conservation agriculture (CA) is a way of farming annual and perennial crops that relies on managing crop residues and cover crops to provide a permanent soil cover and a naturally rising level of organic matter in the soil's surface horizons. It is based on zero and conservation tillage, which involves no vertical disturbance of the soil. With the aim of providing the farming and scientific communities with a summary of the existing studies and documentation, the primary environmental effects of this technology have been researched internationally. It emphasizes how much better it is for the ecosystem overall (soil, air, water, and biodiversity) to cultivate conservatively than to practice conventional agriculture (Derpsch et al., 2010; Derpsch et al., 2011).

A method for planning and managing agricultural systems that are sustainable and resource-conserving is known as conservation agriculture (CA). Through the integrated management of soil, water, crops, and other biological resources in conjunction with chosen external inputs, it aims to improve, preserve, and make better use of natural resources. With such a technological setup, agriculture may be resource-saving and effective while also improving production in a sustainable way. Direct planting through crop residue, minimum tillage, organic soil cover, improved on-farm water management, and suitable crop rotations to prevent disease and pest issues are all components of conservation agriculture. The

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widespread practise of burning crop wastes (such as in the rice-wheat cropping system) contributes to pollution, greenhouse gas emissions, and the loss of important plant nutrients. Initiating processes that improve soil quality and boost resource quality when crop residues are left on the soil surface and no tillage is used. In order to fulfil the goals of sustainable agriculture production, CA has evolved as a new approach. It's a significant step in the direction of sustainable agriculture. Therefore, there are major benefits to CA. Direct advantages to farmers include i) lower cultivation costs due to manpower, (ii) time, and farm power savings, and (iii) increased input usage efficiency. More importantly, CA techniques stop the depletion of resources. By increasing nitrogen balance and availability, soil infiltration and retention, lowering water loss due to evaporation, and enhancing the quality and availability of ground and surface water, CA results in long-term gains in the effective use of water and nutrients (Singh and Meena., 2005).

Conservation agriculture:

Conservation agriculture is a type of land management that involves surface-retention of agricultural residues with no, very little, or very little tillage. Conservation agriculture (CA), is not "business as usual," based on optimizing yields while utilizing the resources of the land and agro-ecosystem (Dumanski et al., 2006) as shown in Figure 1. A balance of agricultural, economic, and environmental benefits is achieved by CA by optimizing yields and profitability. It argues that the social and economic benefits of both production and environmental preservation—including lower input and labour costs—are larger than those of production alone. By using pesticides, fossil fuels, and other harmful substances, as well as by preserving the integrity of the environment and its services, farming communities may provide a wider population with better hygienic living conditions.

Table 1: Some distinguishing features of conventional and conservation agriculture systems

Sr. No.	Conservation agriculture	Conventional agriculture
1	Least interference with natural processes	Cultivating land, using science and technology to dominate nature
2	No-till or drastically reduced tillage (biological tillage)	Excessive mechanical tillage and soil erosion

3	Low wind and soil erosion	High wind and soil erosion
4	Surface retention of residues (permanently covered)	Residue burning or removal (bare surface)
5	Infiltration rate of water is high	Water infiltration is low
6	Use of in-situ organics/composts	Use of ex-situ FYM/composts
7	Brown manuring/cover crops (surface retention)	Green manuring (incorporated)
8	Weeds are a problem in the early stages of adoption but decrease with time	Kills established weeds but also stimulates more weed seeds to germinate
9	Controlled traffic, compaction in tramline, no compaction in crop area	Free-wheeling of farm machinery, increased soil compaction
10	Diversified and more efficient rotations	Mono cropping/culture, less efficient rotations.
11	Mechanized operations, ensure timeliness of operations	Heavy reliance on manual labor, uncertainty of operations
12	More resilience to stresses, yield losses are less under stress conditions	Poor adaptation to stresses, yield losses greater under stress conditions
13	Productivity gains in long-run are in incremental order	Productivity gains in long-run are in declining order

Sowing directly in the stubble, several agricultural benefits are listed below.

i. Increased soil fertility.

ii. Increased organic matter and humus.

iii. Increased microbial activities favorable to culture.

iv. Reduced soil compaction.

v. Low oxidative stress of the soil.

vi. Lower risk of surface water stagnation.

vii. Minimum soil erosion.

Economic benefits.

i. Reduced working time required for soil processing.

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ii. Significant fuel economy for soil processing.

iii. Increased interval.

iv. Reduced number of machines.

v. Smaller economic risks in extraordinary climate events.

Environmental benefits: -

i. Maximum expression of conservative agriculture.

ii. Soil as a stock of CO2.

iii. Reduced gas emissions in climate change.

iv. Prevented soil degradation and erosion (for slope soils).

v. Reduced destruction of structural soil colloids.

Tillage and Planting:

A key component of CA crop management is soil tillage, which can be accomplished using three basic soil management techniques connected to NT, MT, and ridge tillage (RT) technique (Hobbs, 2007). While MT (also known as reduced tillage) management practices are well defined, NT (also known as zero-tillage) management practices represent a remarkable variety of equipment and operational approaches, which also prevents a clear assessment of their effectiveness in realizing the agro-environmental benefits of the CA.

Zero Tillage:

One of the primary causes of low wheat yields in the rice-wheat cropping system is delayed planting of wheat due to the region's previous rice crop's late maturation, in addition to the high cost of soil preparation and other inputs. In usually, there is enough moisture left behind after rice harvest to start a fresh crop. Conventional tillage speeds up soil moisture evaporation and necessitates more irrigation water to restore the field to something resembling a seedbed. Significant delays in wheat seeding result from this, which ultimately reduces crop yields. It is well known that the delayed sowing causes wheat yield to decrease by 1% per day after mid-November. Improved crop yields are one benefit of the innovation known as zero tillage, which also promotes the conservation of water and energy resources. This technology had long been in use in various regions of the world before being introduced in India. Initial trials were restricted to forward-thinking and substantial farmers. Singh et al. (2007) found that although farmers had a positive attitude toward zero tillage technology, non-adopters needed to be persuaded to do so. Due to its role in lowering production costs, resource conservation, and increasing yields, zero tillage technology has been quickly adopted by farmers.

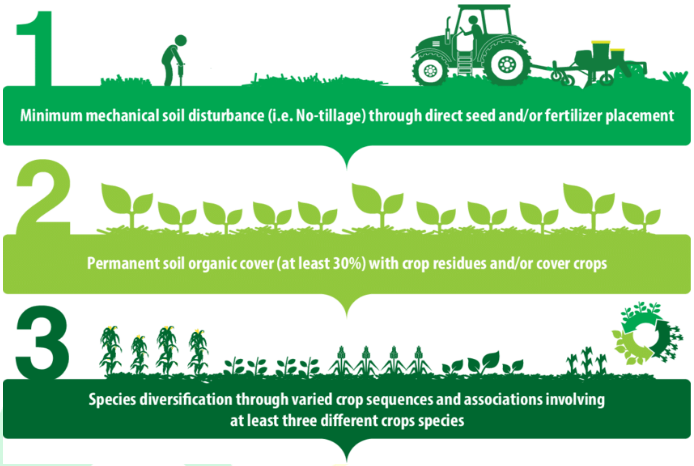

Fig.1: Principles of Conservation Agriculture

Bed and furrow planting:

Crops can be grown on beds with minimal water using bed and furrow planting techniques. For other crops, including wheat, maize and rice this method has been tested and has shown to be highly effective. Following are the benefits of crop production using bed and furrow method:

I. Saving of about 30 percent irrigation water.
II. Less reduced chances of plant submergence due to excessive rain or over-irrigation.
III. Lesser crusting of soil around plants and, therefore, more suitable for saline and sodic soils.
IV. Adaptable for various crops without changing basic design / layout of farm.
V. Enhanced fertilizer use efficiency due to local application.
VI. Minimum chances of crop lodging.

Cover Cropping:

Crop rotation, cover crops, cultivations, weeding, flaming, bio control, weed seed predation, smoother crops, competition, mulching, natural pesticides, and allelopathy are just a few of the numerous techniques used in sustainable weed management (Flamini, 2012) as shown in Figure 2. In particular, CC offers benefits that fall under the CA principles, such as protection against soil erosion, nutrient enrichment, opposition to compaction, regulation of soil moisture, and an increase in organic matter. Indirect effects on crop productivity are determined by the application of CC, which favourably affects soil particle aggregation and the bio-geochemical cycles of carbon and nitrogen. Additionally, the use of several plant species as cover crops that are alternated over time on the same plot enables a variable root depth (and consequently a dispersion of new humus), with significant impacts on physical and chemical fertility (Gabriel et al., 202).Additionally, CC prevents soil temperatures from increasing, especially in hot, dry environments, and protects the soil from erosion, leaching, compaction, and surface crusting phenomena, which helps with water infiltration, retention, and aggregate stability.

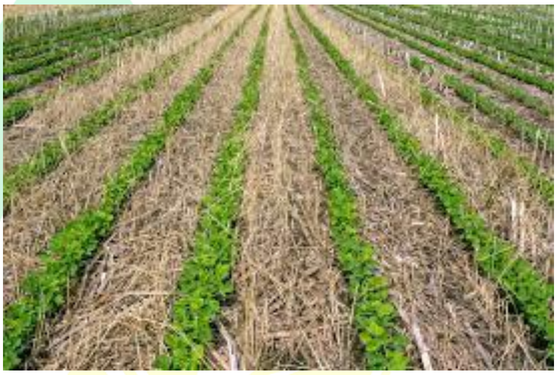

Fig. 2: Cover crop

Manual and Animal-Traction Seeders

The majority of manual and animal-traction seeders are compact, lightweight, of a simple design, and are simple to produce, use, and maintain. Small farms and steep terrain almost always employ these seeders. The most fundamental level of mechanization is the use of manual equipment, and improved equipment designs are meant to increase productivity in terms of energy efficiency and ergonomics. Adoption of improved human- and animal-dragged equipment requires demand-driven development and an innovation system.

Mould Board Plough:

This is used for primary tillage operations. It cuts trash and buries it completely. It is also used for turning green manure crop for decaying under the soil, which adds humus to the soil as shown in Figure 3.

Advantages of MB Plough:

i. It smoothes the soil's surface and breaks up the thick clods in the soil.
ii. The plough will automatically locate the necessary depth if it is properly set; additional weight is not necessary to obtain the appropriate depth.

iii. Plowing improves the soil's ability to drain.
iv. The MB Plough works best in regions with a high rate of weed revival because it buryes weeds that usually emerge after harvest. Until the next growing season, the MB plough effectively inverts the soil to stop weed development.
v. The MB plough also helps to keep the farm free of pests and to provide conditions that are better for plants to grow healthily.
vi. The mouldboard plough improves decomposition by burying agricultural residues deeper into the field, which speeds up soil surface warming.

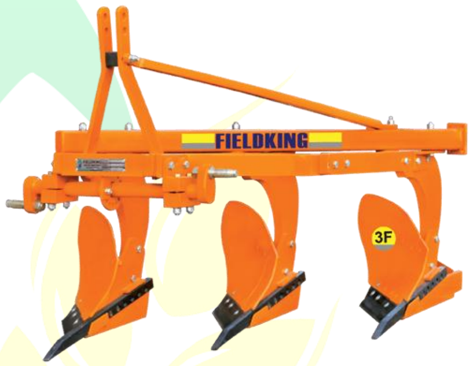

Fig. 3: Mould Board Plough

Chisel ploughs:

Chisel ploughs are commonly used to achieve deep tillage with little soil disturbance. The primary purpose of this plough is to aerate and loosen soils while leaving crop residue on top of the soilas shown in Figure 4. Utilizing this plough will assist break up ploughpan and hardpan as well as lessen the impacts of compaction. The chisel won't flip or turn the dirt, unlike many other ploughs. Due to this quality, it has proven to be a helpful complement to no-till and limited-tillage farming techniques that aim to maximise the benefits of maintaining organic matter and farming residues on the soil surface throughout the year in terms of erosion prevention. A chisel plough's use is considered by some to be more sustainable than other methods due to these characteristics.

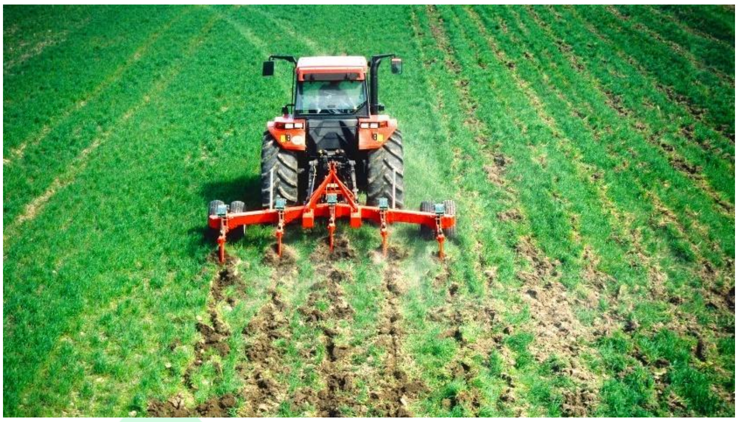

Fig 4. Chisel Plough

Conclusion:

The traditional perspective for agricultural research and development, which was primarily focused on meeting particular food grain production objectives in India, has been replaced by a new approach that promotes conservation agriculture. It is increasingly essential for continuous productivity increases to incorporate issues of productivity, resource conservation, soil quality, and the environment. The knowledge base required to develop and promote CA systems will be quite challenging. By lowering cultivation costs and increasing resource use efficiency, competitiveness, and sustainability in agriculture, conservation agriculture provides a chance to prevent and reverse the downward spiral of resource degradation. The new mission must "conserving resources and increasing production''.

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