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Conservational Agriculture

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Introduction

Achieving food security for a growing population and alleviating poverty, while ensuring the sustainability of agricultural systems, is a major challenge facing most Asian countries in the current context of depleting natural resources, the negative impacts of climatic variability, rising input costs, and volatile food prices. In addition to these challenges, key indicators of the non-sustainability of agricultural systems include soil erosion, a decline in soil organic matter, and salinization. Therefore, it is essential to bring about a paradigm shift in farming practices by eliminating unsustainable aspects of conventional agriculture, such as ploughing or tilling the soil, the removal of all organic material, and monoculture, in order to enhance future productivity gains while preserving our natural resources. Conservation agriculture (CA), which has evolved in response to global concerns about agricultural sustainability, has steadily gained ground worldwide, covering approximately 8% of the world's arable land (124.8 million hectares) as of 2012, according to the FAO. CA is a resource-saving agricultural production system designed to achieve production intensification and high yields while promoting the responsible use of natural resources. This is achieved by adhering to three interconnected principles, in addition to other good production practices related to plant nutrition and pest management.

Status of conservation agriculture in India and abroad

- Globally, Conservation Agriculture (CA) is practiced on approximately 125 million hectares (as shown in Table 2). The leading countries in terms of CA adoption are the USA (26.5 million hectares), Brazil (25.5 million hectares), Argentina (25.5 million hectares), Canada (13.5 million hectares), and Australia (17.0 million hectares). However, in India, the adoption of CA is still in its early stages.
- In recent years, the use of zero tillage and CA has expanded to encompass around 1.5 million hectares (as reported by Jat et al., 2012; www.fao.org/ag/ca/6c.html). One of

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the primary CA technologies being implemented is zero-tillage (ZT) for wheat in the rice-wheat (RW) system of the Indo-Gangetic plains (IGP).

- For other crops and cropping systems, there is a gradual transition from conventional agriculture, which heavily relies on intensive tillage, toward reduced or zero-tillage practices. Beyond ZT, other CA concepts need to be integrated into the system to further enhance and sustain productivity and explore new avenues for agricultural growth.
- The adoption of CA also provides opportunities for much-needed diversification through crop intensification, including relay cropping of sugarcane, pulses, and vegetables alongside wheat and maize, aiming to intensify and diversify the RW system.
- Furthermore, CA-based resource conservation technologies (RCTs) play a vital role in integrating research on crop, livestock, land, and water management in both low and high-potential environments.

Potential benefits and adoption of conservation agriculture

Adoption and spread of zero tillage wheat has been a success story in North-western parts of India due to

- A reduction in production costs by Rs 2,000 to 3,000 per hectare (equivalent to $33 to $50).
- Enhancement of soil quality encompassing improvements in soil physical, chemical, and biological properties.
- Long-term carbon sequestration and the accumulation of organic matter in the soil as a practical approach to mitigate Greenhouse Gas emissions and increase the resilience of production systems to climate change-induced disruptions.
- Decreased prevalence of weeds, such as Phalaris minor in wheat crops.
- Improved water and nutrient utilization efficiency.
- Augmented production and productivity, with gains ranging from 4% to 10%.
- Implementation of advanced sowing dates.
- Lowered greenhouse gas emissions and enhanced environmental sustainability.
- Prevention of crop residue burning, which reduces nutrient loss and environmental pollution, consequently mitigating a significant health hazard.

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- Opportunities for crop diversification and intensification, particularly in sugarcane-based systems, mustard, chickpea, pigeon pea, and others.
- Improved resource utilization efficiency through residue decomposition, enhancement of soil structure, increased recycling, and greater availability of plant nutrients.
- Utilization of surface residues as mulch to control weeds, moderate soil temperature, decrease evaporation, and enhance biological activity.

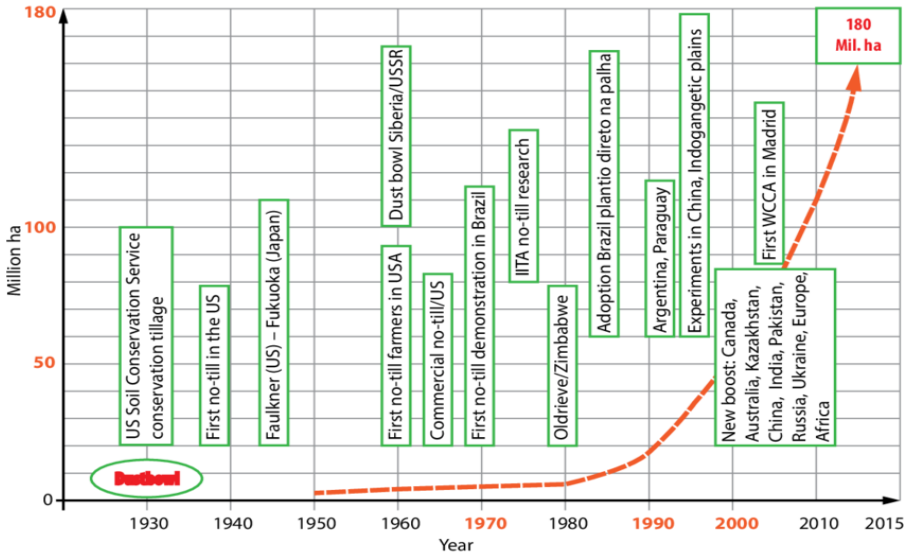

Fig 1: Global adoption of conservation agriculture

Because of the ZT wheat benefits, the CA based crop management technologies have been tried in other cropping systems in India but there are large knowledge gaps in CA based technologies which indicates there is a need to develop, refine, popularize and disseminate these technologies on a large scale. A reduction in production costs by Rs 2,000 to 3,000 per hectare (equivalent to $33 to $50).

- Zero tillage is a farming technique that involves the direct seeding of crops in a single tractor pass using a specially designed seed-cum-fertilizer drill. This is done without any prior field preparation, even in the absence of leftover crop residue, and is ideally performed when the soil moisture level ranges from optimal to slightly wet.
- Experiences garnered from various locations in the Indo-Gangetic plains have demonstrated that the adoption of zero tillage technology empowers farmers to achieve significant cost savings in land preparation, amounting to approximately Rs. 2,500 ($41.7) per hectare, while also reducing diesel consumption by 50 to 60 liters per hectare.

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- Additionally, zero tillage facilitates the timely sowing of wheat, ensures uniform seed drilling, enhances the efficiency of fertilizer use, conserves water, and boosts crop yields by up to 20%. Notably, successful implementations of this technique have been observed in bed planting for crops like wheat, cotton, and rice, leading to reduced irrigation water requirements, improved fertilizer utilization, and minimized soil crusting.

Conclusion

CA technologies offer numerous benefits, including cost reduction in production, conservation of water and nutrients, increased yields, crop diversification, resource efficiency, and environmental preservation. Nevertheless, several challenges persist in the promotion of CA technologies, such as the absence of suitable seeders, particularly for small and medium-scale farmers, competition for crop residues between CA practices and livestock feeding, the burning of crop residues, the need for skilled and scientifically trained personnel, and the necessity to overcome biases and traditional beliefs about tillage. Therefore, there is an urgent need to establish a comprehensive policy framework and strategies to advance the adoption of CA in the region. This article delves into the emerging concerns arising from the continued reliance on conventional agricultural systems and provides an analysis of the constraints, opportunities, policy considerations, and research requirements for the promotion of conservation agriculture in India.