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Interventions to Achieve the Untapped Potential of Conservation Agriculture in India

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Abstract

With the increasing population, dependency on natural resources are surging exponentially, especially agriculture resources are declining in a diminishing way. The researchers have developed many concepts to conserve the resources while increasing the productivity. Among the many initiatives, conservation agriculture gained more attention due to its efficiency and positive impact on soil health. Conservation agriculture (CA) is a new paradigm for agricultural research and development in India, as opposed to the traditional one, which was primarily focused on meeting specific food grain production targets. A paradigm shift has become necessary to increase production with little damage to available natural resources and the environment. Integrating productivity, resource conservation, soil quality and environmental issues is now essential for long-term productivity increase. However, how best the CA technologies can be adopted by farmers will mainly depend on socio-economic and biological feasibility apart from the adjustment in existing systems and issues related to risk management.

1. Introduction

Real-world agricultural challenges are resource fatigue with declining factor productivity, rising costs of cultivation and socio-economic changes (Nayak et al., 2019). The past strategies used for increasing food grains production have resulted in the massive exploitation of natural resources and excessive use of fertilisers caused environmental instability. Crop production in near future will have to be efficient in the utilization of natural resources to meet the population demand, with minimal impact on the environment. Thus, there is a dire need for an energy, water and labour efficient alternate system that helps to sustain soil and environmental quality and produce more at less cost (Vijayakumar et al., 2019). All the stakeholders must have to focus on natural resources, *viz.*, soil, water, forest and wildlife resources and their conservation at large and the effects of human population on these resources as well as on the atmosphere.

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1.1. Major issues associated with present-day agriculture

i. Ecological issues

Environmental pollution, declining underground water table, groundwater pollution, diverse weed flora, invasive and new diseases and insect pests and reduced biodiversity

ii. Agricultural issues

Deteriorating soil health, large management yield gaps, residue management (burning of crop residue), labour shortage and declining crop response

iii. Technical issues

Low mechanization, lack of appropriate seeders especially for small and medium scale farmers, lack of adoption rate

iv. Social issues

Population expansion, farmer's mindset with traditional practices, youth moving away from farming, land holding- getting smaller and fragmented

2. Conservation Agriculture

Conservation agriculture (CA) has the potential to halt and reverse the downward spiral of resource degradation while also lowering cultivation costs and making agriculture more resource-efficient, competitive and long-term C sequestration and build-up in soil organic matter (Kumar et al., 2015). The CA offer a new paradigm for agricultural production different from earlier systems, which mainly intended to achieve specific production targets. Developing and promoting CA necessitate considerably increased scientific capacity to handle challenges from a systems viewpoint, as well as strengthened knowledge and information-sharing platforms with farmers and other stakeholders.

CA is defined as integrated production systems consisting of minimum soil disturbance (Figure 1 and 2), appropriate crop rotation or intercropping (Figure 3) and continuous organic soil cover (Das et al., 2017). CA builds based on the decades of research in more large-scale and mechanized farming systems in which zero- or minimum-tillage systems were developed and combined with crop rotation and residue retention or cover cropping to reduce soil erosion and related declines in soil and natural resource quality (Nayak et al., 2020). Retaining residues on the soil surface protects the soil from nutrient losses, improve soil fertility in the long run. Recently these concepts have been adapted and applied to smallholder cropping systems, where conventional Green Revolution approaches to improving crop yield (better seed, higher input rates, mechanization) is unfeasible or have been unsustainable.

Figure 1: Zero till direct seeded rice

Figure 2: No puddle transplanting

Figure 3: Rice fallow pulse

Over the last few years, farmers of North-West India have rapidly adopted zero-tillage cum fertiliser drills for planting wheat and other crops after rice. It has been estimated that close to 13.2 m ha have been covered with zero-till planting (2015–16), in Asia. The rapid adoption and spread of zero tillage among the northern states are attributed to benefits resulting from the reduction in production cost, weed incidence, savings in water, nutrients and other environmental benefits. The emerging trends are noticeable in South Asia (India, Pakistan, Nepal and Bangladesh). The spread of CA technologies has also encouraged the growth of private sector input providers. It has also given impetus to farm mechanisation which is expected to play a major role in future agriculture in India.

3. Constraints for the Adoption of CA in Present Day Agriculture

i. Lack of stake holder's involvement in the development of CA

ii. The resource poor and small holder farmers in India do not have economic access to new seeds, herbicides and seeding machineries etc. This calls for a policy framework to make easily available critical inputs

iii. Dominance of perennial weeds and shift in weed flora. Only very few selective herbicides are available in the market to control weeds in CA (Jinger et al., 2016, Saravanane et al., 2021)

iv. Agronomic management practices like irrigation, nutrient management, weed control, insect and disease control should be developed to match the new system. Site-specific nutrient management in conservation agriculture is highly required to minimize fertilizer related problems in agriculture (Kumar et al., 2014)

v. Lack of support from the government for the adaptation and validation of CA technologies in local environments

vi. Lack of capacity building programmes for CA

vii. Lack of Credit and subsidies facilities

viii. Most of the available CA implements and equipment are imported. Tariffs on imported CA equipment are very high which makes it not ideal for marginal and small farmers

ix. The latest machineries like the happy seeder, turbo seeder and laser land leveller are effective in CA practices, however, these devices are better suited to wealthy and medium to big farmer groups (Vijayakumar et al., 2021)

x. For smooth operation in field situations, these machines require higher horse power (>50hp). Small and marginal farmers with small properties and limited financial resources cannot purchase such large machines. They require smaller copies of these devices, which necessitates local policy backing for manufacture (Vijayakumar et al., 2021)

xi. Lack of policy intervention to restrict unscientific practises such as residue burning and extensive tillage by imposing a fine

4. Promotion of CA in India

Designing successful policies to promote CA starts with a thorough understanding of farm-level conditions.

4.1. Scaling up conservation agriculture practices

Need to consider the issues that arise at the implementation level and design a strategy involving all people concerned. Multi-location demonstration on CA will become the main strategy to familiarize the technology among farmers. The list of stake holders will include agricultural scientists, extension personnel and farmers. One of the causes for the slow adoption of technology by farmers was due to the previous prejudice or mindset toward tillage.

4.2. On-farm research to encourage farmer's participation in CA research

Farmer's participatory research would appear promising for identifying and developing crop varieties suited to a particular environment or location. Farmer's participation in on-farm research to assess the technology in the early years, followed by large-scale demonstration in the later years, is required. In India, attempts are being made through a network research project to evaluate and demonstrate CA technology on-farm to promote it.

4.3. The government policies to promote CA

Policies directly or indirectly affect crop diversification are pricing policy, tax and tariff policies, trade policies and policies on public expenditure and agrarian reforms (Nayak et al., 2019). It offers opportunities for diversified cropping systems in different agro-ecosystem and alternate to crop burning menace in the wheat-rice system of northern parts of India. Policy to impose fine to the farmers for burning of crop residue and practising intensive tillage in the field.

4.4. Developing suitable cultivars and site suitability

CA technologies have a tremendous impact on the micro-environment in which plants thrive. The requirement of plant types suited to the new environment and to meet specific mechanization needs could be different. There is a need to develop complementary crop improvement programmes to develop more straw/stalk generating crops, aimed at developing cultivars that are better suitable to new systems. Developing a network programme to assess the suitability of technology to particular regions and sites for better use of it.

4.5. Organizing training programme on CA for capacity building

One of the greatest hurdles to CA adoption is the lack of skilled human resources and knowledge sharing partners on the ground. Skill and capacity development training on CA should be encouraged at grass root levels. Efforts should be undertaken in relevant agencies to adequately teach all new and existing agricultural extension staff on CA.

4.6. Public-Private-Partnership

The approach of scientists, farmers, extension agents, policy makers and other stakeholders in the private sector in partnership mode will be important in developing and promoting new technologies. The linkage between research organizations, educational institutes, extension wings and farmers must be very strong to launch any technology.

4.7. Institutionalize CA

CA must be integrated into relevant ministries or departments and it must be backed up by adequate material, human and financial resources to ensure its long-term viability. Local, national and regional policymakers and decision-makers could lead and assist the conception and development of scaling-up strategies and procedures. It will ensure effective and timely support to farmers from well trained and motivated extension staff.

4.8. Support the development of CA equipment

Most of the available CA implements and equipment are imported. Tariffs on imported CA equipment and implements should be removed or reduced to encourage and promote their availability. Although great efforts have been made in India to develop, refine and promote the second generation zero-till multi-crop planters, quality assurance on standards and their availability at the local level with after-sale services and spare parts remain a problem. It will be critical to ensure equipment quality and availability through proper incentives. Subsidy support from the national or local government for building low-cost machines will aid in the marketing of CA technologies in present scenarios (Vijayakumar et al., 2021).

4.9. Credit facility to farmers

Another critical component for effective CA adoption is the availability of credit at reasonable interest rates for farmers to purchase equipment, machinery and inputs through banks and credit agencies. At the same time, government need to provide a subsidy for the purchase of such equipment by farmers.

4.10. Encourage the monetary benefit/subsidies to CA practitioners

CA supporters help the environment by sequestering carbon, preventing soil erosion and encouraging groundwater recharge. CA provides ecosystem services and farmers should be compensated for these services, which have a significant impact on everyone's quality of life.

4.11. Custom hiring centres to facilitate/prmote mechanization in CA

Custom hiring centres (CHCs) enables farmers to rent farming equipments, such as tractors, tillage equipment and combined harvesters and so on instead of owning it. CHCs for farm implements could empower farmers to tide over the shortage of labour and improve efficiency of agricultural operations. CHCs offers prospects for facilitating rapid mechanization of agricultural systems in the region. CHC needs to promoted in a big way. Enabling Environment for Custom Hiring of Agricultural Machinery seen as one of the most cost-effective approaches to enabling farmers, particularly small-holders, to benefit from agricultural mechanization and other adaptable technologies.

5. Conclusion

In India, CA ensure enhanced and sustainable production without disturbing the environment over conventional practices. But acceptance and diffusion of this technology among the farmers is largely influenced by the government policies. However, documentation of CA results in multiple location with location-specific CA practices, cropping systems is important for developing a mechanism to scaling up the untapped potential of CA technology to next level. Also the generation of residue and their availability for each regions need to be worked out.

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