Conservation agriculture as a strategy for recovery from COVID-19 in the Indo-Gangetic Plains

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Policy solutions to enhance conservation agriculture:

- Research and development of scale appropriate machines for seeding, and rice transplanting.
- Support to farmers for the uptake of mechanization.
- Developing community-wide ownership and sharing of various machines for the groups of small farmers who cannot own the machine on individual basis.
- Development of effective appropriate herbicides – possibly organic herbicides, and support for research.
- More demonstration of the benefits of CA in various famers' fields.

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COVID-19 shocks on agriculture

As growing dependence on global food systems has become risky, challenges created by COVID-19 have led us to think differently about agriculture. COVID-19 situation has also revealed that the local self-sufficiency in food production is important to cope with the pandemic.

But then, most of the farmers in the Indo-Gangetic Plain (IGP) of which Nepal's Terai plain region is a part of, are smallholders practicing traditional farming systems who cannot meet their food requirements from their farms alone. This is also true in developing countries generally, where smallholder agriculture is still dominant. Therefore, there is an urgent need to increase food security. Can food security be enhanced through sustainable farming practices? We address this question taking the case of Nepal.

> **Traditional farming practices are more resilient to face various crises like the pandemic or adverse impacts of climate change.**

It is seen that the traditional farming practices - which are diversified, mixed and integrated and helpful in producing indigenous foods to meet local food culture - are more resilient to face various crises like pandemic or adverse impacts of climate change and disasters. But its capacity to produce more has been limited. Conservation Agriculture (CA) – a new approach to farming without disturbing the soil and microenvironment by using zero tillage (ZT) and direct seeding- would help produce more food with less cost and could be useful for making smallholder farming sustainable by helping them cope with disasters like the COVID-19 pandemic. Given that CA combines many of the features of traditional farming systems, its adoption by smallholders should also be smooth without disrupting their regular farming activities.

What is conservation agriculture?

CA approach, in essence, prevents soil erosion and loss of soil organic matter through use of ZT. It also promotes permanent soil organic cover through residue retention and crop diversification [1]. Crop residues and cover crops maintain a protective layer of vegetation on the soil surface, suppress weeds, and protect the soil from the impact of extreme weather patterns while preserving the soil moisture and avoiding soil compaction. This approach can be applied to a vast array of agrarian landscapes [2]. In a way, these are also the basic features of traditional farming systems in which seasonal crops are grown in fields surrounded by shrubs and multi-purpose trees.

How did CA become popular worldwide?

Formal adoption of CA in scientific discourse began after Dust Storm destroyed farming in the mid-western USA – the grain basket - in early 1930s. Total removal of trees and plowing the soil and making it fine with widespread mechanisation had caused this storm.

In his noble-prize winning book 'The Grapes of Wrath', John Steinberg describes through fiction how corporate ownership of land (the land-owners are always absent and work just through banks and agents), and its cultivation for solely for short-term monetary benefits disregarding sustainable practices like crop rotation, diversified cropping, and love and respect to the land and people working on the land had led to this storm making the lives of real farmers miserable. Eventually, in the late 1940s, Edward Faulkner described in his famous book "Plowman's Folly" (1943) to replace tillage with plow by reduced tillage [3]. This led to the development of a seeding machine in the 1940s

Comparison of ZT vs CT in farmer's field in Nepal: ZT has good plant population and is planted in rows while CT is scattered planting (Credit: Mina Devkota, Agronomist, ICARDA)

and of herbicides in the 1960s, creating an environment for widespread evolution of CA [4].

In the early 1970s, the no-tillage practice reached Brazil, but it took two decades to be significantly adopted by farmers after the development of improved farm equipment and agronomic practices, which later led to the spread of CA in Southern Brazil, Argentina, and Paraguay. Slowly, in the late 1990s, CA got attention from other parts of the world and international organizations working on food security and poverty alleviation [2].

CA technology, such as ZT, has shown many advantages, which have been observed globally [5]. Historically the development of ZT took place since 1940's due to the appropriate knowledge from research results and farmers' experience under different agro-ecological and socio-economic conditions, the availability of suitable crop varieties, low-cost herbicides, the availability of appropriate machines at reasonable prices, and the practice of appropriate and diversified crop rotations including green manures and cover crops [3]. This development has been more prevalent in developed countries (America, Australia, UK) where mechanization was already underway with the proper facility of chemicals for weed control. But, in Asian and African developing countries, it has not spread so widely until this date, with the only limited area covered by ZT practice.

Conservation Agriculture in the Indo-Gangetic Plains

In 1994, Rice-wheat Consortium (RWC) was established to promote resource-conserving technology such as ZT practice in the Rice-Wheat (R-W) belt of IGP of South Asia and China [6]. This initiative led to a massive change in farming practices, particularly in northwest India, for a wheat crop as ZT showed a considerable reduction in the cost of production and tillage intensity. Zero-tilled wheat (ZTW) replaced the conventional method of tillage (CT) among 620,000 farmers covering 1.7 M ha area in the R-W belt of IGP by 2008 [7].

However, the diffusion took off only after decades of initiation. According to Erenstein and Laxmi (2008), ZT was introduced in 1970 in India, but due to a lack of machines and herbicides, it did not spread fast [8]. Its broad diffusion happened only after the ZT seed drills were introduced in 1997. ZT has shown a reduction in irrigation water use by 20-35% with improved soil structure and yield gain by 6-10% as it helped in early planting of wheat [9]. Subsequently, there has been the introduction of direct seed rice (DSR) to replace puddled transplanted rice (PTR), and data from Borlaug Institute of South Asia (BISA) showed that DSR is more suitable in the dryer, arid region of Pakistan and Northwest India with similar yields for ZT and CT [10].
Later, adoption of ZT has also shifted to the Eastern IGP - characterized as a less favorable weather conditions, small farm sizes and diverse socio-economic conditions and lack of infrastructures than the Western IGP - as a result of the development and dissemination of several CA management practices by various national and International partners promoting ZT in rice-based cropping systems [11].

Besides the R-W system, the rice-maize (RM) cropping system under CA practices in the Eastern IGP showed improved profitability and productivity [12],[13],[14]. The establishment of RWC was aimed at the welfare of small farmers in the IGP region through reduced production cost and increased production and income.
Since then, the adoption of CA practices has increased among smallholder farmers of IGP, but has only confined to India and Pakistan, and has slowly reached Bangladesh.

> **Adoption of CA practices has increased, but has only confined to India and Pakistan, and has slowly reached Bangladesh.**

The adoption of CA practices in Nepal has instead taken a slow pace than other IGP countries despite the fact that it was associated with the RWC from its inception and many other CA-based initiatives were introduced and tested for long.

Since 2009, Nepal has been actively involved with the CA-focused Cereal System Initiative in South Asia (CSISA) project led by the International Maize and Wheat Improvement Center (CIMMYT), International Food Policy Research Institute (IFPRI), and the International Rice Research Institute (IRRI).

CSISA has been working in the mid and far-west Terai of Nepal to promote sustainable crop intensification systems such as CA and seed and fertilizer technologies among smallholder farmers. It has also been providing strategic support to the Government of Nepal on Prime Minister's Agriculture Modernization Project (PMAMP) to develop scaling strategies for new technologies and innovations in the

Comparison of DSR vs TPR in farmers' fields in Nepal: DSR is already matured while TPR is still green (Credit: Mina Devkota, Agronomist, ICARDA)

agriculture sector [15]. CSISA introduced a range of CA practices such as zero tillage and DSR in both research stations and farmers' fields in Central and Western Terai districts since 2009. Though trial results were promising, farmer adoption was poor. In 2013, CSISA demonstrated DSR technology which reduced labor use and ensured timely establishment while increasing profitability by approximately 150 USD ha-1 compared to conventional transplanting method [16]. Later in 2017/18, CSISA demonstrated ZT in wheat cultivation with two or four-wheel tractor in the western Terai region, which resulted in yield advantage of ZT over CT of 0.5 Mt ha–1 from farmer-managed fields [17]. However, the adoption of CA practices is less in the farmer's field mainly due to the unavailability of machines and herbicides. Therefore, CSISA and PMAMP have been collaborating with private machinery dealers, which have made a substantial increase in the availability of two and four-wheel seed drillers in the western Terai Region. Between 2015 and 2019, CSISA and PMAMP have supported the development of 101 seed drill service providers with 185 seed drills now in operation in farmers' fields [15].

Similarly, in the eastern Terai region (ETR) of Nepal, Sustainable Resilient Farming System Intensification (SRFSI) project was initiated between 2014 -2018. This project was conducted by CIMMYT and funded by ACIAR to improve productivity, profitability and the sustainability of rice-based cropping systems in the Eastern IGP (eastern India, Nepal Terai, and northwest Bangladesh). The experimental research and development activities under the project were conducted in eight districts (Rajshahi and Rangpur in Bangladesh; Malda and Coochbehar in West Bengal, and Purnea and Madhubani in Bihar, India; and Sunsari and Dhanusha in Nepal). The project had conducted activities in five nodes in each of these districts and then used those as training grounds for the up-

scaling of project methodologies and out-scaling of technologies [18], [19]. However, the actual effect of this project is yet to be flourished in Nepal.

What constrains conservation agriculture?

Though CA, and in particular ZT practice, has spread among the large holding farmers in developed countries, it is only practiced in about 0.3% of area by smallholder farmers of South America, South Asia and China in 2010 due to underlying problems such as lack of mechanization, irrigation facilities, and agriculture inputs and particularly herbicides [20]. In particular, in Nepal, the agriculture sector is at a low development stage, and agriculture productivity has not been able to reach its potential. Farm machinery use is only in 23.2% of farms of Nepal [21] which is mostly confined to the Terai region. The four-wheel rotavator is widely used in the Eastern Terai region due to Nepal's land border with India, where four-wheel rotavator is popular. This four-wheel rotavator is economically viable for large and plain farmland only [22].

Besides, according to Nepal's 2016 Agricultural Mechanization Subsidy Operational Guidelines (AMSOG), a 50% subsidy on most machines favoured large farmers despite the majority of farmers have an average of 0.67 ha farm size [21]. Likewise, appropriate herbicides required to control weeds in ZT fields are not easily available in Nepal. Unless these underlying constraints or limiting factors are resolved, the adoption of CA technology is a great challenge, even after the positive results obtained from the experimental trials.

Challenges in the adoption of CA in IGP

- Small farm sizes
- Lack of appropriate mechanization like seed-drills, tractors
- Lack of herbicides to remove the weeds
- Government policies not favouring the small farmers, which dominate the farming sector

Conservation agriculture for recovery from COVID-19?

Fit with labor scarcity

In addition to underlying constraints to adoption of CA, the year 2020 has been tragic for South Asia. The surge in the return of migrant workers from a foreign land, rise in COVID-19 cases, high unemployment rate, country's agriculture production failing to meet demand, compounded by a shortage of agricultural inputs and restricted import revealed that the agricultural system of Nepal needs more sustainable farming practices. As agriculture still plays an important role in the economy of Nepal and there is a need to feed growing population even in a period like COVID-19 when food imports are difficult, resilient and sustainable farming is essential [23]. In this context, resource-efficient and sustainable farming practices like CA could be important – which could reduce the production cost and labour inputs, but at the same time, increase production.

Resilience to climate change

CA also has high adaptability in various climatic conditions and soil types. The experiments done in Western and Eastern Terai Nepal demonstrate these facts. However, further refinement in CA practices like development of appropriate cropping patterns and local

Good plant population in ZT wheat (left) and ZT maize (right) in a farmer's field in Nepal (Credit: Mina Devkota, Agronomist, ICARDA)

products and methods that could help in weed control and scale-appropriate mechanization along with mixing of food producing shrubs and trees could improve its adoption across the country including hills and mountains. As farm sizes are small in Nepal, appropriate machine/tool-sharing mechanism could be useful to reduce cost and to use them efficiently.

> **Many technological breakthroughs have been achieved, especially in developing good seeds and potent inputs like fertilizers and chemicals.**

Minimizing risks

Increasing the production and reducing its cost on a sustainable basis through conservation of resources like soil and water are important for farmers and society as a whole.

Many technological breakthroughs have been achieved especially in developing good seeds and potent inputs like fertilizers and chemicals. But increase in cost and uncertainty of markets have put many farmers in risks, which sometimes led to farmers' suicides.

This is seen in India as well – even though there was adoption of modern technology. As CA helps improve production and reduce cost, and helps conserve soil resources through zero-tillage, cover crops/trees, mulching, and diversified and sustainable rotations, it seems most appropriate for risk-averse small farmers that dominate agriculture in the Indo-Gengetic Plains.

A rice transplanter for transplanting rice seedlings under unpuddle and puddle fields in Nepal (Photo credit: Shikha Thapa Magar)

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