

ACIAR SDIP Analytical Component

A study on value chain and policy interventions to accelerate adoption of zero tillage in the-
farming systems across the Indo-Gangetic Plains



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Analytical Component

A study on value chain and policy interventions to accelerate adoption of zero tillage in rice-wheat farming systems across the Indo-Gangetic Plains

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EXECUTIVE SUMMARY

How can the adoption of zero-till technology be accelerated to provide a viable option for farmers across the Indo-Gangetic Plains?

The severe impact arising from the seasonal practice of burning rice stubble by farmers in north-west India results in poor air quality to the detriment of human health, including respiratory complications, increased human fatalities and injuries from road accidents, and disruption to road and air transportation. Areas most severely impacted include the agricultural areas of Haryana and Punjab, and the nation's capital New Delhi. Stubble burning takes place within a concentrated time-frame of 20 to 25 days in the month of November and is triggered by the need for farmers to rid their fields of previous rice crop residues so that they can cultivate and sow wheat crops using traditional establishment practices.

Stubble burning, combined with the traditional practice of heavy tillage prior to crop establishment, has a detrimental impact on soil health and quality. The development of Conservation Agriculture (CA) practices, characterised by the direct sowing of crop into standing (retained) stubble using Zero-Till (ZT) techniques, provides a real alternative to burning and traditional tillage techniques. The Happy Seeder (HS) is a ZT drill developed specifically for the intensive rice-wheat cropping system of the Indo-Gangetic Plains (with significant project investment by ACIAR) has proven capacity to directly sow wheat crops into standing rice stubble. As State Governments move towards enforcing a ban of the burning of stubble across India, it is likely that there will be an increased motivation by farmers to adopt ZT/HS technologies. The Government of India has committed funding of INR 1152 crores (A\$ 223 m) to establish farm machinery banks for custom hiring of in-situ crop residue management machinery. Financial assistance of up to 80 percent of the project cost is provided to the cooperative societies of the farmers, farmer producer organisations, self- help groups, registered farmers societies/ farmers group, private entrepreneurs, group of women farmers through the scheme. Financial assistance of 50 percent of the machinery/equipment cost is provided to individual farmers too. However, the implementation of such schemes takes time and capacity building of the implementation agencies and groups.

A series of recommendations has been developed, based on analysis of the ZT and HS value chains (including all stakeholders involved in technology manufacture, supply, research, extension, financing, purchasing and regulation), paired with detailed survey information from farmers to explore key issues associated with their decision to adopt the technology or not.

The following key recommendations are targeted to State Governments to create enabling environments that support the accelerated adoption of ZT and HS technologies:

RECOMMENDATION 1: Implement an awareness raising strategy incorporating innovative digital media approaches that support the adoption of ZT/HS technologies, as a long-term opportunity to create positive motivation for on-farm adoption.

RECOMMENDATION 2: Expand the Innovation Platform approach from Eastern Gangetic Plains (EGP) regions to other targeted regions as an immediate priority to support the introduction and implementation of ZT/HS related technologies, facilitated through KVKs and Farmer Producer Organisations (FPOs).

RECOMMENDATION 3: Provide machinery manufacturers with financial incentives to assist them in providing a larger network of retail agents, service centres and farmer training schools (focusing on the maintenance and operation of equipment), in addition to introducing random market place quality checks for equipment to help support the adoption of ZT/HS seed drills.

RECOMMENDATION 4: Establish a collaborative platform with representatives from the highest level of Government, responsible ministries and the manufacturing sector to help ensure that long-term relationships and the needs of the industry sector are clearly identified and supported to help improve and support the development of effective ZT/HS seed drill supply chains.

RECOMMENDATION 5: Re-orient mechanisms that currently provide direct subsidies for machinery purchase and devise alternative models of support directed towards a range of options. This includes the removal of Government GST on machinery purchase and providing access to affordable finance (consideration towards interest rate subsidies for both manufacturers and purchasers of equipment) in addition to developing business planning skills for custom hire centre operators.

RECOMMENDATION 6: It is strongly recommended that a specific project team and support service comprising State Governments, universities and international experts be established to provide a range of support services for the establishment of Custom Hiring Centres (CHCs), including business and financial planning and governance support, business leadership and technical training.

RECOMMENDATION 7: Maintain a Regional Collaborative Platform (RCP) comprising representatives from the highest level of Government (Agricultural Ministry; research, extension and policy related) for the IGP region (comprising country representation from Pakistan, Nepal, India and Bangladesh). This group will provide a central platform for supporting the development of supporting government policy and the out scaling of ZT/HS technologies through sharing and dissemination of information, knowledge and training resources, on-farm validation of best management practices, and training and capacity building.

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1 The Challenge

The Indo-Gangetic Plains (IGP) of India is an important region for agricultural production and food security, contributing 50% of the total food grain production and supporting food security for about 40% of the population (Pal et al., 2009). Wheat and rice are two of the most important crops grown in this region, which includes much of eastern Pakistan, the northern India states of Punjab, Haryana, the National Capital Region (NCR comprising Delhi), Uttar Pradesh (UP), Bihar and West Bengal, as well as the Bangladesh states of Rangpur, Khulnar and Rajshahi and the Terai region of Nepal. The IGP is therefore an important source of future agricultural production and economic growth in South Asia.

Since the Green Revolution in the 1960s, farmers have readily adopted high yielding, short season varieties that when combined with high inputs, ready access to irrigation and tillage has resulted in improved regional food security. However, this success has come at a cost, since the increased intensification of cropping systems is leading to serious environmental concerns in relation to the long-term impacts on sustainability. The fragility of the farming environment is reflected in the impact of significant air pollution from the burning of crop residues, decreasing soil health (declining soil fertility and soil structure), increased weed and pest resistance (such as herbicide resistance in *Phalaris minor*) and declining water resources and water quality through contamination from nitrate fertiliser and pesticide residues from excessive use.

The nature of the rice-wheat system necessitates a quick turnaround between rice harvest and wheat establishment, and farmers traditionally burn stubble in a concentrated time-frame of 20-25 days in November. The severe impacts arising from the seasonal practice of burning rice stubble by farmers in north-west India includes poor air quality to the detriment of human health, increased human fatalities and injuries from road accidents and disruption to road and air transportation. Areas most severely impacted include the agricultural areas of Haryana and Punjab, and the nation's capital New Delhi.

Farmers are under immense pressure to maintain their livelihoods as increasing costs of production and a lack of market opportunities place them under financial hardship. Maintaining regional food and water security remains a significant challenge under the current environmental conditions that place long-term sustainability on a knife-edge. However, public dissatisfaction is driving a demand for change to address issues associated with stubble burning. The introduction of financial penalties for farmers burning rice straw residues particularly in NW India is likely to lead to a sense of panic and uncertainty amongst farmers in an environment characterised by a low level of awareness of alternative options such as the Happy Seeder (HS).

As part of the Sustainable Development Investment Portfolio funded by the Australian Government's Department of Foreign Affairs and Trade, the Sustainable and Resilient Farming Systems Intensification (SRFSI) project has focused on understanding the bio-physical and socioeconomic settings in the EGP and improving the productivity, livelihoods and resilience of smallholder farmers. This project was led by the International Centre for Maize and Wheat Improvement (CIMMYT), and tested farming systems improvements based on conservation agriculture based sustainable intensification, which incorporates agronomic, socio economic and institutional aspects of food production, including more sustainable agroecosystem management, increased input use efficiency and increased biological and economic

productivity. These are based on the conservation agriculture (CA) principles of minimizing soil disturbance, ensuring soil cover and diversification through rotations – and include improved varieties, better irrigation practices and improved crop management techniques. Within the SRFSI project, the four focus areas are farmer participatory technology generation, local innovation systems which help overcome value chain bottlenecks, enhanced capacity of market and service agents to support farmer innovation, and farmer-to-farmer knowledge exchange.

In this context, there is a need to develop an evidence-based assessment of zero-till (ZT) and Happy Seeder (HS) machinery adoption across the Indo Gangetic Plains region (IGP) of India and Bangladesh, followed by a range of policy options that will allow the accelerated adoption of ZT/HS technologies.

2 Research Approach

Extensive field research involving on-farm adoption studies and a value chain analysis (linked to the supply and availability of ZT seed drills including the Happy Seeder) was conducted amongst farmers and other stakeholders associated with ZT/HS adoption. Using an action research approach, a series of consultative workshops followed that targeted value chain stakeholders as well as senior policy makers in an effort to provide evidence-based policy recommendations that could be implemented by Governments across the targeted regions. In particular, the study identified reasons why policy change is required, what policy changes would be effective, and how best relevant policy could be best implemented.

The study targeted a number of regions across the IGP, comprising NW India (the States of Haryana and Punjab), the Eastern Gangetic Plains (EGP) Indian states of Bihar and West Bengal, and NW Bangladesh. A motivation for the study was prompted by the serious incidence of air pollution shrouding the national capital of Delhi (brought about farmers from Haryana and Punjab burning rice stubble residues prior to sowing of their winter wheat crops). However, the study also included the EGP region as a contrasting area where it was considered that in the future the incidence of stubble burning by farmers would increase as the cropping systems intensify and mechanisation systems are adopted.



Figure 1 Map of the Indo-Gangetic Plains region (source: www.pinterest.com)

3 Research Findings

3.1 Needs in different cropping systems

NW India (Haryana and Punjab)

Long-term sustainability of the intensive rice-wheat cropping systems are being questioned by farmers and agricultural experts. The impact of farmers burning rice straw residues prior to cultivating and sowing wheat is now recognised as a significant environmental problem, affecting the wider Indian community notwithstanding the serious air pollution problems in the nation's capital New Delhi. Despite the Happy Seeder being available commercially for more than 10 years as the only viable option to direct seeding cereal crops into standing crop stubble, there is little farmer awareness of the technology. A lack of awareness and difficulty in accessing information combined with traditional farmer beliefs that crops can only be sown into well-tilled residue free seed beds serve as some of the major constraints to adoption of the ZT/HS seed drills.

The Eastern Gangetic Plains (Bihar and West Bengal)

Increased intensification of cropping systems across the EGP region is being achieved through the introduction of mechanisation in place of manual labour (that increasingly is becoming in short supply and more expensive). Rice straw is regarded as a highly valuable animal feed source. Whilst the manual harvesting of rice crops removes much of the straw, an increasing trend towards the machine harvesting of crops is seeing a greater amount of stubble residue remaining in the field that is being burnt prior to the sowing of the next crop. Wheat straw residue levels, which are less valued as an animal feed source, are also increasingly being burnt in a trend triggered by the introduction of mechanical harvesting. The burning of rice straw residues is becoming an issue in western Bihar (in close proximity to the UP border region), as well as in the Malda district of West Bengal. As mechanical harvesting of rice crops becomes popularised it is anticipated that burning will become a much deeper concern. Availability of HS seeding equipment remains a challenge with poor sales and distribution networks, and very limited capacity in terms of machinery servicing, maintenance and operation.

North Bangladesh

In northern Bangladesh farmers are also intensifying their cropping systems. Whilst rice straw is a valued commodity for animal feed as it is in surrounding regions, the burning of stubble residues will increase where the mechanical harvesting of crops increases. Agricultural mechanisation in the region is largely undertaken using two-wheeled tractors, and there is a localised industry that provides the sales, servicing and maintenance support for the two-wheel tractors. Implements designed and manufactured locally for the two-wheel tractor include ZT seed drills. The smaller tractors are more affordable for the smallholder farmers and are well suited to fragmented land holdings comprising small plot sizes. The two-wheel tractors however require significant physical strength for the operator, placing the four-wheel tractor at a more significant advantage; particularly suited for larger land holdings and/or for use in Custom Hiring Centre operations.

The Terai region of Nepal

Increased intensification of cropping systems across the Terai region of southern Nepal has only in recent years become more of an accepted opportunity. However, the benefits of such intensification is becoming apparent and has been clearly demonstrated through the Sustainable and Resilient Farming Systems Intensification (SRFSI) project. Increased mechanisation offers many advantages to village communities, but the opportunity to access tractors and ZT seed drills remains a significant challenge for most smallholder farmers. The establishment of CHCs at the farmer level presents a real opportunity as part of the out-scaling initiatives associated with sustainable farming systems development. Issues relating to the need to retain crop residues as part of a conservation agriculture-based system will require continued farmer awareness and education. This is due to the conflicting practices between harvesting of straw for livestock production and the risk of stubble residues being burnt as stubble loadings post-harvest begin to build up as mechanised crop harvesting becomes more popularised throughout this region of Nepal. Availability of HS seeding equipment remains a challenge with poor sales and distribution networks, and very limited capacity in terms of machinery servicing, maintenance and operation.

3.2 Recommendations for accelerating adoption

Initiatives introduced to date across the IGP have successfully demonstrated the opportunity and potential for conservation agriculture based sustainable intensification technologies to significantly address cropping systems constraints. The development of ZT/HS seeding systems to sow crops without the need to burn or remove crop residues or cultivate the soil provides an opportunity to sustainably modify traditional farming practices. At the same time, accelerated adoption could significantly reduce crop establishment costs and labour requirements, improve irrigation efficiency and achieve similar crop yields.

Opportunities for the establishment of local service providers (Custom Hire Centres (CHCs)) that capture entrepreneurial spirit assist in providing smallholder farmers with convenient access to the technology, and locally adapted examples are now available. Accelerating rapid adoption by farmers will not be realised unless the constraints to adoption, machinery technology and value chain inefficiencies are addressed. The following recommendations aim to support the development of an 'enabling environment' to assist in the accelerated adoption of ZT/HS seeding systems in an innovation led, farmer driven, participatory environment.

This study has identified a range of recommendations that when implemented offer the best opportunity for accelerating the adoption of ZT/HS seed drills. A number of these opportunities have been identified in the past, but it appears that little action has been achieved on the ground. Whilst research has identified many of the technical improvements that have offered the best chances of developing an integrated approach to conservation agriculture, the complexity of the system has not been fully recognised by policy makers nor decision makers, and hence governments have failed to act on these evidence-based findings. Quick-fix solutions, such as providing subsidised machinery may have increased access to such technologies. However, these schemes have not been properly implemented or adopted at the farmer level, since there has not been an implementation strategy developed that includes how the technology will be implemented and what specific training and capacity building is required

in the adaptation and application of the technologies. As a short to medium term policy recommendation, it will be especially important to focus on skill training with respect to ZT/HS machine calibration and operation, effective crop establishment, and business operations. The recommendations presented from this study aim to provide guidance not only in the 'what', but also the 'how' to develop a strategy and implementation that will help to ensure successful adoption and long-term change.

Consistent and long-term policies are required to achieve change and support the adoption of ZT/HS technologies. The objective is to achieve scaled outcomes across the IGP, with all Governments needing to adopt a long-term planned approach towards providing an enabling environment for the adoption of ZT and HS seed drills. Demonstrated impact and benefits arising from policy implementation need to be integrated into all initiatives, through introducing simple monitoring tools to measure practice change and improvements in environmental sustainability, including the use of GIS and satellite monitoring tools. A 'scorecard approach' applied consistently across the IGP to measure impact and benefits is required to help demonstrate the success and returns to government, industry and farmer investment in CASI related technologies. A major initiative includes developing strategies as to how all stakeholders along the HS/ZT value chain can collectively be engaged in the successful implementation of these technologies that importantly form part of the broader objective of implementing improved production systems across the IGP region.

An overview of the key recommendations from this project are:

Introduction of the 'Zero-burn from Zero-till' awareness raising campaign

A lack of awareness and availability of information relating to ZT/HS technologies amongst farmers across all regions served as a significant barrier to adoption. An awareness campaign, through introducing a marketing campaign 'ZERO BURN FROM ZERO TILL' is strongly recommended, featuring both ZT and HS seeding systems. The environmental, agronomic and economic benefits of these systems need to be highlighted, in addition to addressing common farmer misconceptions that a well-cultivated soil (often using a rotavator) that is also stubble and plant residue free is required to successfully achieve high yielding crops. Awareness raising through social media, traditional media avenues, billboard advertising and the appointment of local 'champion farmers' as local advocates of the technology should be considered.

Innovation Platforms (InP) as an inclusive extension vehicle for ZT/HS technologies be expanded

The introduction of Innovation Platform (InP) groups offers a collaborative framework opportunity to reach common goals. InP groups bring together different stakeholders in the agricultural system and have successfully motivated farmer participants to work more closely with the private sector, and to develop entrepreneurial skills as a means of gaining access to ZT/HS technologies in the EGP. These technologies have been successfully introduced using the skills and experience of local research and extension specialists, supported by farmer advocates and stakeholders associated with the provision of ZT/HS related services, technologies and inputs. This study highlighted the need to firstly create awareness of the HS/ZT seed drills, and secondly the need to change farmer perceptions (and acceptance), most notably misconceptions relating to the requirement to have a residue free, well tilled soil in order to successfully establish a crop.

It is therefore important that governments, universities and the private sector develop a renewed focus for the delivery of extension services based on innovative approaches that includes support for the establishment of InP. The lessons learnt from the SRFSI InP project would assist extension agencies/providers in developing a renewed focus that allows locally based farming groups to form InP groups in partnership with other stakeholders. Forming such groups does not happen on its own, but through the provision of local support, training and capacity building efforts over time.

It is also important that a 'whole of systems approach' is taken to the introduction of such technologies. The development of a conservation agriculture based system is extremely complex, given the transition towards retaining crop stubble residues, an increased reliance upon chemical weed control, and the introduction of cultivars of differing growing season duration as a means to improve overall crop production efficiencies and responses to climate variability.

Building a more effective ZT/HS seed drill supply and service sector

Field studies concluded that there is an urgent need to improve the quality, supply and availability of ZT and HS seed drills to farmers, particularly in the EGP. Additionally, instructions on machinery operation and use, and maintenance of such equipment including the supply of spare parts are critical elements of the system. The development of a series of initiatives supported by Government and manufacturers is an immediate priority in order to ensure the successful introduction of such equipment and minimise dis-adoption. Recognition that the lack of access to manufacturers and skilled technicians/service expertise is important, particularly in the EGP, requires incentives to manufacturers to fill such a void and improve farmer access and the overall efficiency of the value chains associated with the ZT and HS seed drills.

Re-orientation of Government subsidies and support mechanisms

The provision of subsidies for the purchase of machinery provided by government is in urgent need of review, from the perspective of ensuring that funds directed towards incentivising adoption is maximised in a non-discriminatory manner. For example, subsidies provided to rotavators that reinforce poor farming practices need to cease immediately, since this sends mixed messages to farmers. In the long-term, subsidies need to be phased out due to inefficiencies in the allocation of financial resources and the need for all custom hiring centres to be established on commercial cost-recovery/profitable business operating models. The removal of the Goods and Services Tax (GST) in India would also make the equipment more affordable to farmers. It is also important to engage with, and involve the finance sector to provide farmers (through CHCs) with improved access to finance for the purchase of machinery, which in turn should be based on soundly based commercially-driven custom hiring business models as opposed to a subsidy model for machinery provision.

Establishment of profitable and sustainable business models for Custom Hire Centres (CHCs)

CHCs provide the opportunity for smallholder farmers to access ZT/HS seeding services, and are easily expandable to include other technologies that support the development of conservation agriculture based farming systems, including cost-effective cropping inputs, marketing platforms, and training and capacity building services. Once established, and then linked to local InP Groups, CHCs tend to be driven by the entrepreneurial spirit of local community-based operators. These businesses then provide adaptable services and advice to

farmers that in turn builds local capacity. The development of CHCs at the district level is considered to be one of the best ways to achieve widespread adoption and out-scaling of technologies that is affordable and accessible by all farmers regardless of farm size. Properly functioning CHCs need to focus on providing convenient and affordable access to machinery for all farmers, including smallholder farming women, and serve as the gateway to introducing sustainable and profitable conservation agriculture based systems to all farmers. It is important to recognise that many farmers who wish to establish a CHC generally lack sound financial and business management skills to ensure that they can be managed in a professional and profitable manner, and therefore a concerted effort needs to be devoted to the training and upskilling of such operators. This study highlighted the importance of providing technically efficient custom hiring services to farmers in order to maximise the area of crop that can be sown using the HS within the short 'sowing window' available.

Formation of a Regional Collaborative Platform (RCP) for the Indo-Gangetic Plains (IGP)

Establishing a RCP for the IGP region (comprising country representation from Pakistan, Nepal, India and Bangladesh) provides a central platform for supporting the out scaling of ZT/HS technologies. The sharing and dissemination of technical research and extension experiences, knowledge and resources is critical to addressing the regional challenges associated with ensuring widespread adoption of conservation agriculture based farming systems, and active engagement and participation by all stakeholders in particular the private sector, farming women and other marginalised stakeholders. RCP membership should include: Principal Agricultural Secretaries at national/state levels; private sector representatives (manufacturers, input suppliers, finance sector), research (national and international), farmer/CHC representatives, and women's groups.

4 Summary and Way Ahead

This study identified a range of opportunities for accelerating the adoption of ZT/HS. Whilst a number of these opportunities have been identified in the past, it appears that little action has been initiated ‘on the ground’. Critically, a lack of awareness and availability of information relating to ZT/HS technologies amongst farmers across all regions served as a significant barrier to adoption. As such, this highlights the need to firstly create awareness of the HS/ZT seed drills, and secondly the need to change farmer perceptions and acceptance of conservation agriculture techniques; notably misconceptions relating to the requirement to have a residue free, well tilled soil in order to successfully establish a crop.

The development of a conservation agriculture based system is extremely complex given the transition towards retaining crop stubble residues, an increased reliance upon chemical weed control, and the introduction of cultivars of differing growing season duration as a means to improve overall crop production efficiencies and responses to climate variability. This will require a coordinated effort to address the complexities of these systems through information, training, and technology exposure. As a short- to medium-term policy recommendation, it will be especially important to focus on skill training with respect to ZT machine calibration and operation, effective crop establishment, and profitable business operations. The recommendations provided in this study aim to provide guidance not only in the ‘what’, but also the ‘how’ to develop a strategy and implementation approach that will help to ensure successful adoption and long-term change.

A sharing and dissemination plan for technical research and extension experiences, knowledge and resources is critical to addressing the regional challenges associated with ensuring widespread adoption and active engagement and participation by all stakeholders—in particular the private sector, farming women and other marginalised stakeholders. These outcomes serve to accelerate the adoption of HS/ZT technology across the IGP for more sustainable food systems.