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prepared by	Dr. Brendan Brown (CIMMYT-Nepal)
contributors	Colleagues from **CIMMYT** (Mahesh Gathala, Manisha Shrestha, Anjana Chowdhury, Emma Karki, Pragya Timsina, Akriti Sharma, TP Tiwari), **UBKV** (A.K.Chowdhury, P.M.Bhattachrya, K.K.Das, T.Dhar, B.Mitra and A.Ghosh), **WB DoA** (Sujan Sen, Rajat Chatterjee), **SSCOP** (Tapan Chowdhury, Amal Roy, Koushik Barman), **BAU** (Sanjay Kumar, Ranvir kumar, Ram Datt Mishra, Pawan Kumar Singh), **iDE** (Abir Ahmed Chowdhury, Farah Kazi Iqbal, Md. Nurul Amin), **CSIRO** (Peter R. Brown, Toni Darbas, Don S. Gaydon, Alison M. Laing, Perry L. Poulton, Rick S. Llewellyn),**BARI** (Md. Shakhawat Hossain), RDRS (Mamunur Rashid, Anup Kumar Ghosh), **Nepal Department of Agriculture** (Ram Khrishna Shrestha) and **UWA** (Fay Rola-Rubzen), with contributions from many more.
collaborators	Colleagues from **Ecodev, NARC, Dreamwork Solutions, DeHaat, Curtin University, IWMI, UQ, Sarkhi Bihar, BARI, UNE, DAE, BARC, ICAR, IFPRI, IRRI** and **JeeViKA.**
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1 Acknowledgments

SRFSI was a regional agricultural research-for-development program that at its heart was about partnership. We acknowledge and sincerely thank every individual and institution who has made any material, intellectual, or in-kind contribution to this program. Due to such a length of project with multiple transitions in focus, naming all individuals who have been involved in SRFSI would be neigh on impossible, but none the less we thank all, even if not by name.

We particularly thank our core partners whose logos are featured below for their dedication to the CASI agenda that SRFSI contributed to. We also thank individuals who saw the vision of SRFSI and became involved of their own accord, often without project incentives. We are grateful for their collaboration in the program. As a research-for-development program that was initially testing unproven technologies, we also thank all the farmers, service providers, extension practitioners and value chain actors who bought into the SRFSI vision and particularly those in the early years that were willing collaborate and take risks in trials of CASI despite it being an unproven technology.

In particular, we must acknowledge the foundations set by Dr. John Dixon who helped envision this program, as well as the dedication during establishing SRFSI undertaken by Dr. Mahesh Gathala who was integral to all the positive outcomes that followed. We wish to especially thank the Australian taxpayers for their financial support through the DFAT Sustainable Development Investment Portfolio. The partnership of DFAT, ACIAR and CIMMYT has been fruitful for all, and we are forever thankful for these opportunities to contribute to more productive, profitable, and sustainable farmer livelihoods across the Eastern Gangetic Plains.

Dr. Brendan Brown, CIMMYT-Nepal, SRFSI project leader (phase 3 from 2019-2021)

2 Executive summary

The Sustainable and Resilient Farming System Intensification in the Eastern Gangetic Plains (SRFSI) project was a regional multi-partnership project (May 2014 – September 2021) funded by DFAT via ACIAR as part of the Sustainable Development Investment Portfolio (SDIP) in South Asia. The project, led by CIMMYT, aimed to reduce poverty in the Eastern Gangetic Plains (EGP: India - Bihar and West Bengal; North-West Bangladesh; and the Eastern Terai of Nepal) by improving the productivity, profitability and sustainability of small farmers while safeguarding the environment.

SRFSI was proposed for two purposes. Firstly, to establish an evidence base that Conservation Agriculture based Sustainable intensification (CASI) systems could provide productivity, profitability and sustainability benefits to smallholder farmers in the Eastern Gangetic Plains. These farmers experience ongoing poverty and limited development. Prior to SRFSI, CASI was seen as a high potential yet unproven system in the EGP for which SRFSI aimed to address. Secondly, SRFSI was tasked with supporting partners to institutionalise CASI and support its widespread adoption by smallholder farmers for their benefit.

To address the first objective, on-farm participatory agronomy trials and demonstrations built a substantial evidence base to support the promotion of CASI in the EGP. This is evidenced in more than 20 peer reviewed publication covering the various benefits of CASI in the EGP (especially yield, profitability, soil, water, disease, labour use efficiencies and other livelihood benefits). An overall summary of findings indicates that moving from a traditional tillage system to a CASI based system can provide a 10% yield increase, 17% water use reduction, 44% labour use reduction, 62% energy use reduction, 16% emissions education and 56% increase in profits (though these results are summarised across location and technology packages). Overall, the research output and results provide a strong justification that CASI can provide multiple benefits to smallholder farmers across the EGP and should be supported and institutionalised into policy and programming across the EGP.

To address the seconds objective, original focus was placed on capacity development as the pathway to CASI institutionalisation. In terms of capacity development, more than 60,000 people received some form of training through the SRFSI project (with approximately 30% identifying as women). These trainings were across a broad range of potential stakeholders including farmers, service providers, extension agents and policy makers. Additionally, support structures were established through innovation platforms that enabled co-learning and improvement of CASI. This was a substantial catalyst required to increase the knowledge base of communities, extension services and policy makers, and the basis for further establishment of enabling environments. This capacity development also led to substantial further investments of governments in CASI-related initiatives. Both the agronomy and capacity development phases were integral to creating local

ownership of CASI, with knowledge and capacity developed at multiple levels through constant collaboration with partners, both academic and non-academic.

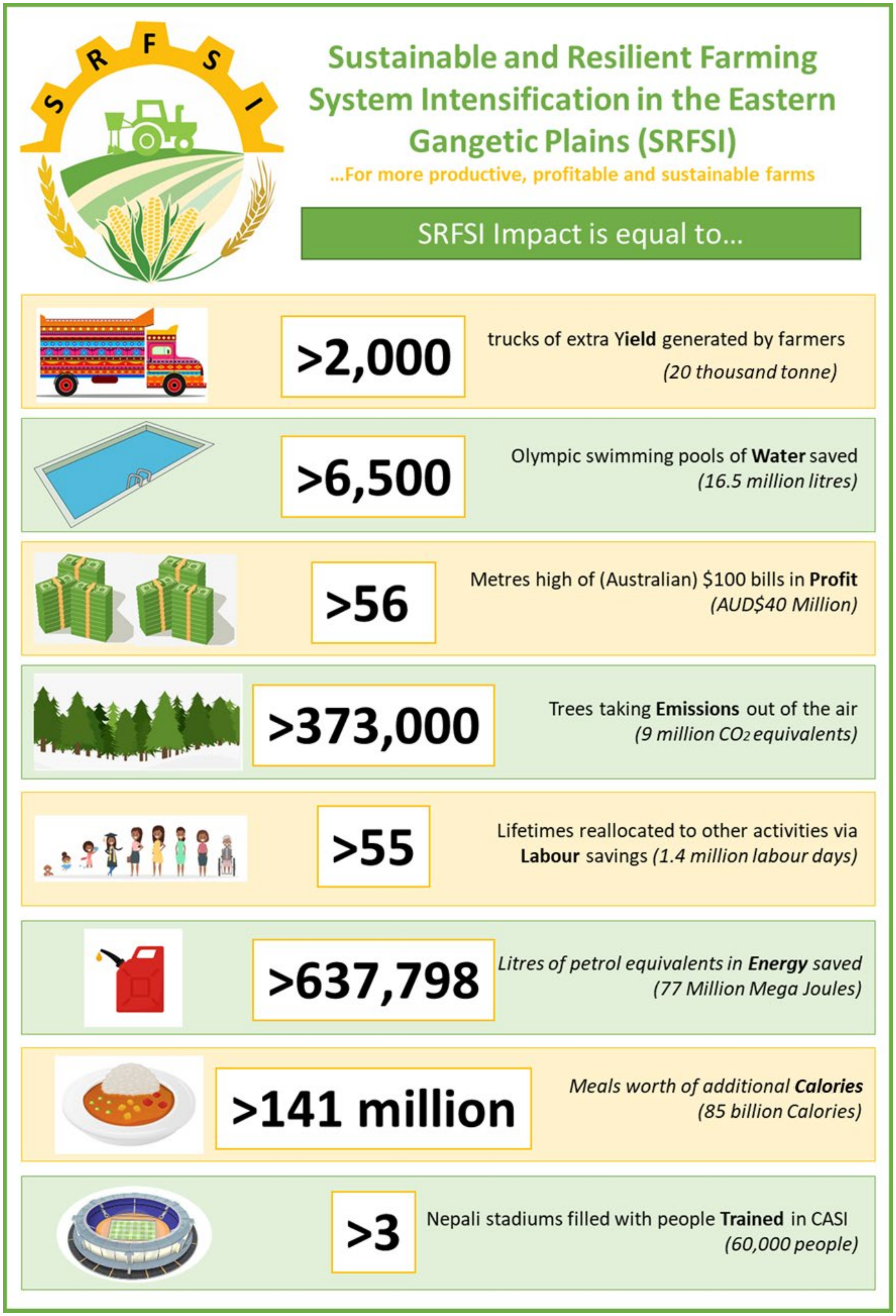
In its final years (and during the ongoing COVID-19 pandemic), SRFSI focused on creating self-sustaining enabling environments for the sustainability of CASI scaling beyond the life of the project itself. Focus was placed in ensuring integration of CASI through convergence with local and governmental programs. This included the commissioning of the regional Centre of Excellence for Conservation Agriculture (CECA). Likewise, huge efforts have been put into development of the SRFSI online digital repository (https://srfsi.cimmyt.org/) to make the learnings of the project accessible to different stakeholders to ensure that such knowledge can continue to be used and institutionalised. This also includes the release of the SRFSI Visual Syllabus for Conservation Agriculture, available in three languages, to provide accessible training materials without the need for comparatively expensive ongoing in-person training once the project has ended. A clear indication of the culmination of these efforts is the convergence evident in West Bengal where state government policy has incorporated CASI in their various operational guidelines and schemes, including the mandatory requirement for three CASI machines in any government supported custom hire centre.

In terms of adoption, estimates collated by partners indicate that more than 116,757 farmers are now participating in CASI planting practices as a direct outcome of the SRFSI project. However, given integration with state programs in West Bengal and Bihar, this number is likely to be substantially larger both now and into the future. The novel adoption pathway analysis also highlights that adoption in some locations is likely to be sustained over the medium term. SRFSI has been a scientific and development catalyst that has already and will continue to be remembered as providing the first steps to CASI adoption and institutionalisation across the region.

In quantifying impact, SRFSI was a worthy investment. The initial project investment of AUD$9,669,770 generated for farmers directly approximately AUD$40,000,000 in savings and additional yield benefits. This is a direct return of investment of 4:1 and does not account for additional indirect returns. Considering approximately 1.4 million days of labour saved through CASI across the life of the project, and that SRFSI showed that this saved time is often reallocated for compounding economic benefits, the indirect return on investment is likely to be considerably more. Comprehensively, this created financial benefits for the region. In terms of productivity, an extra 20 thousand tonnes of yield was generated through SRFSI. This was done in the context of saving approximately 16,500 ML of water, 76 million MJ of energy and 9 million tons of carbon dioxide equivalents. This shows that SRFSI achieved its aims of more productive, profitable and sustainable systems across the EGP. Looking to the future, 2020 adoption levels generate nearly AUD$11 million in additional profitability to farmers, which will compound the return on investment in future years.

What cannot be quantified is the new and fruitful partnerships that have emerged across the region through SRFSI. For instance, West Bengal farmer association SSCOP is now seen as a regional hub for agri-entrepreneurship with interested regional parties visiting to learn from their CASI and now non-CASI expertise. The CASI expertise built within the academic faculty at UBKV is often asked to present at the Indian central government level on next steps for wider sustainable intensification. Farmers in Bangladesh are in contact with farmers in West Bengal sharing experiences in their common language. Integration of development and research partners in West Bengal has let to stronger and more timely outcomes for farmers beyond CASI. These relationships have the potential for perennial benefits into the future. There are also indications that SRFSI has created stronger opportunities for female agency and empowerment that are not easily quantified.

COVID-19 was present for 18 of the 27 months of the SRFSI ‘scaling’ phase, had considerable implications on planned activities, and no doubt contributed to the plateauing of both awareness and uptake across the region, particularly where additional external support remains required (e.g., in Nepal and Bangladesh). Despite this, the SRFSI project has comprehensively proven that CASI can provide benefits to smallholder communities across the EGP through development of substantial academic outputs. A huge capacity development drive had created a pool of knowledgeable change makers at multiple levels to facilitate both adoption and institutionalisation. Farmers have shown substantial uptake of CASI that is providing them substantial benefits. The establishment of legacy materials and infrastructure provides the basis for long term sustainability of CASI out scaling and impact across the region. A foundation has been set, particularly in West Bengal, for the longevity of CASI usage, built by SRFSI, for more productive, profitable, and sustainable farming systems across the region well into the future.


S R F S I
Sustainable and Resilient Farming System Intensification in the Eastern Gangetic Plains (SRFSI)
...For more productive, profitable and sustainable farms
SRFSI Impact is equal to...
>2,000
trucks of extra **Yield** generated by farmers
(20 thousand tonne)
>6,500
Olympic swimming pools of **Water** saved
(16.5 million litres)
>56
Metres high of (Australian) $100 bills in **Profit**
(AUD$40 Million)
>373,000
Trees taking **Emissions** out of the air
(9 million CO_2 equivalents)
>55
Lifetimes reallocated to other activities via **Labour** savings *(1.4 million labour days)*
>637,798
*Litres of petrol equivalents in **Energy** saved*
(77 Million Mega Joules)
>141 million
*Meals worth of additional **Calories***
(85 billion Calories)
>3
Nepali stadiums filled with people **Trained** in CASI
(60,000 people)

3 Background

3.1 SRFSI's Problem Statement

The EGP encompasses parts of India, Bangladesh and Nepal, and is home to the greatest concentration of rural poor in the world. The rice-wheat cropping patterns which, together with the rice-rice system in West Bengal and North-west Bangladesh, dominate the farming systems of the EGP have very low productivity and yields are too variable to provide a solid foundation for food security (Cornish et al., 2011). Poverty and food insecurity in the region are closely linked to small size of landholding (typically < 1 ha). Farmers have little access to assured irrigation, credit, quality seeds, fertilizers, or formal extension services, relying to a large degree on local and informal advice and knowledge sharing mechanisms. These factors contribute to low adaptive capacity to climate changes and, more generally, limited ability to invest in innovation.

The EGP is prone to climate-related risks and extreme events such as floods (e.g., Kosi flood 2008), drought (e.g. summer rice 2010), and atypical cold waves (e.g. winter maize 2010). More common stresses include the early onset of terminal heat for the winter crop and uncertain timing and duration of the monsoon rains, thereby increasing the riskiness of staple cereal crop production. The EGP is projected to be one of the areas of the world most affected by climate change (Ortiz et al., 2008). Production and market-based failures are already factors that constrain the adoption of improved farming practices. Increased crop yields, coupled with risk-reducing technologies, are urgently needed as a precondition and pathway towards sustainable intensification. Pervasive socio-economic changes have led to large-scale migration and hence labour shortages and the feminisation of agriculture in some locations.

3.2 Research justification for SRFSI establishment

The ACIAR-SRA SRFSI scoping study suggested a prioritisation of CASI, and specifically to investigate if CASI could provide benefit within these pervasive constraints. CASI was selected for prioritisation noting that after local adaptation, CASI practices reduce production costs and risk and stabilize crop yields under conditions of climatic stress (Erenstein & Laxmi, 2008). Furthermore, it was expected that prioritization of support to service providers would in turn help provide broad-based farmer access to new CA component technologies, such as zero tillage, thereby obviating the need for individual small farmers to purchase expensive machinery.

While a body of evidence and uptake of CASI in the more developed western Indo-Gangetic plains had shown a wider regional relevance, at the start of SRFSI this was unproven in the EGP. Hence, the SRFSI project aimed to prove CASI as relevant in the EGP, and then support partners to take it to scale.

4 Objectives

The overall aim of the SRFSI project was to reduce poverty in the EGP by improving the productivity, profitability and sustainability of smallholder agriculture. This was to be achieved through the use of various CASI practices. The project had four objectives to address this:

1. Understand farmer circumstances with respect to cropping systems, natural and economic resources base, livelihood strategies, and capacity to bear risk and undertake technological innovation.
2. Develop, with farmers more productive and sustainable technologies that are resilient and profitable for smallholders.
3. Catalyse, support and evaluate institutional and policy changes that establish an enabling environment for the adoption of high-impact technologies from Objective 2.
4. Facilitate widespread adoption of sustainable, resilient and more profitable farming systems.

5 Methodology

The methodology of SRFSI is based around three key 'phases', each with its own methodology. The initial phase of the project was primarily focused on CASI **proof of concept** to ensure that CASI should be scaled. The second phase of the project was focused on CASI **capacity development** to build institutional knowledge and momentum for scaling. The third phase focused on the **science of scaling** to provide inputs on how to scale and institutionalise CASI. However, each phase contained elements of other phases, and this should be considered the focus and not the entirety of activities. A visual timeline of the project's evolution is given in **Figure 1.**

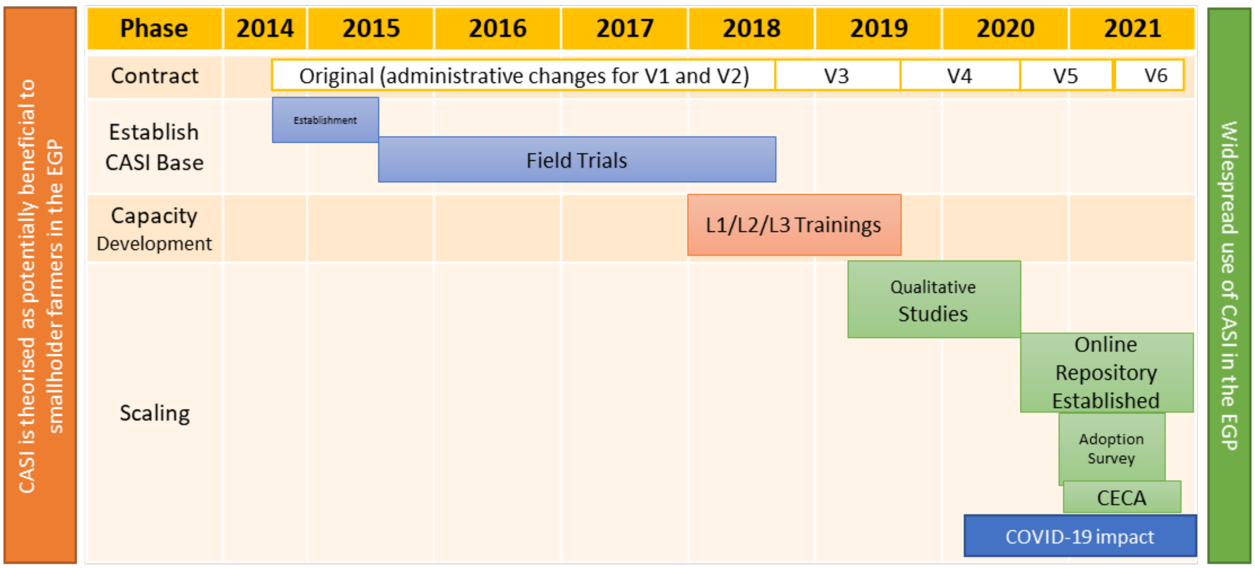
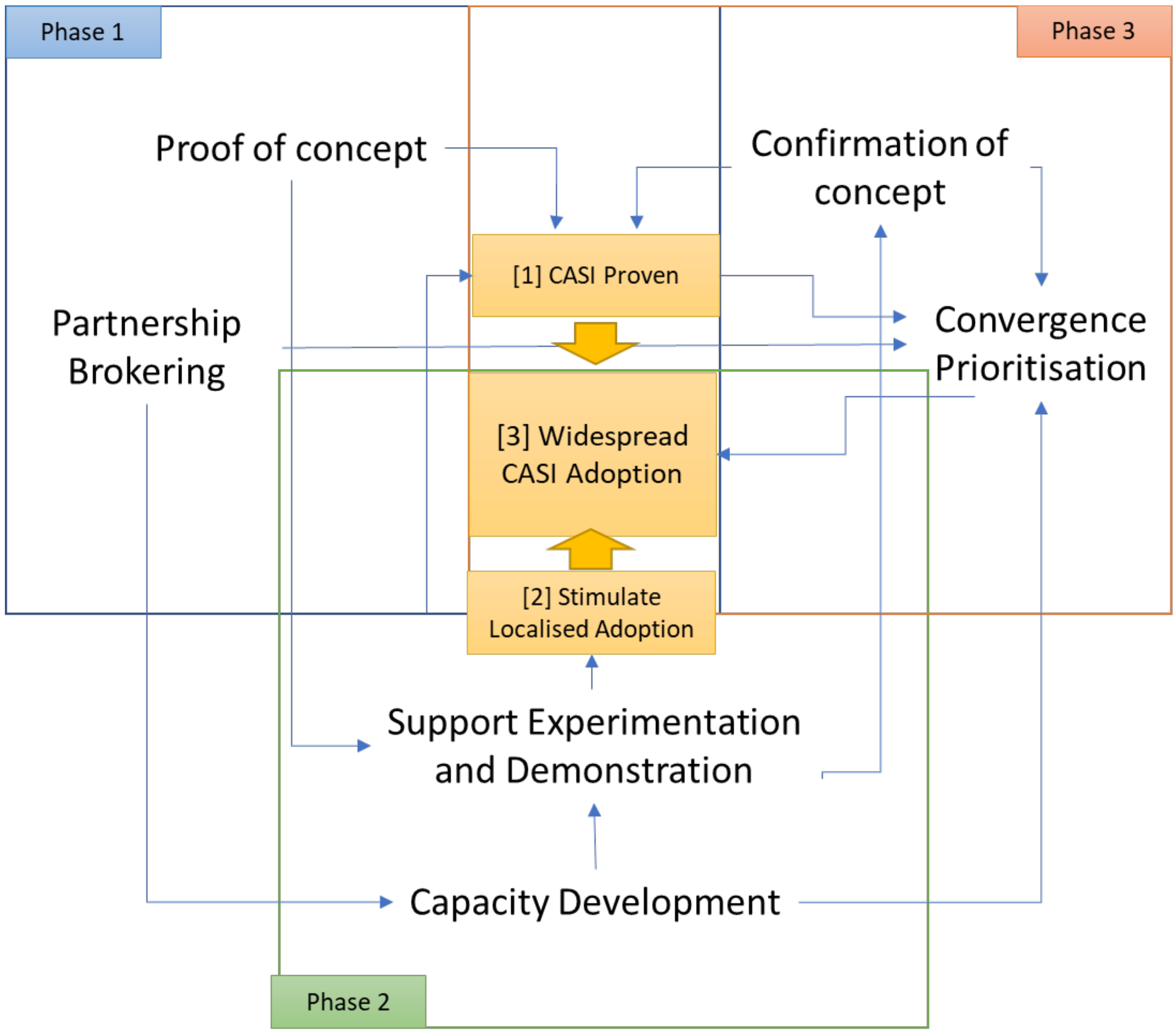


Figure 1: Timelines, phases and key activities through six variations for the SRFSI project

The SRFSI theory of change is non-linear, but ultimately aims to culminate in its two objectives – CASI as a proven set of practices in the EGP and widespread uptake of CASI. Each of the phases are interrelated in creating this theory of change (**Figure 2**). In phase one, two key foci were on experimentation to provide evidence for the benefits of CASI, alongside initial partnership brokering and establishing prerequisite institutional contexts for eventual scaling. In phase two, the two foci were on building on the proof of concept to support farmers to experiment and demonstrate CASI in their contexts, alongside supporting partnerships though capacity development. In Phase three, focus was on supporting partnerships to integrate CASI into their normal programming, alongside confirmation of CASI as beneficial through lived experience. Hence, the theory of change posits that if [1] CASI can be perceived as a proven set of practices in the EGP; and [2] Key brokers are empowered with knowledge of CASI as a proven set of practices, they will integrate CASI into their normal programming which will ultimately enable more sustainable, productive and portable farming systems across the region. SRFSI aims to catalyse both of those assumptions to achieve this theory of change.


Phase 1
Phase 3
Proof of concept
Confirmation of concept
[1] CASI Proven
Partnership Brokering
Convergence Prioritisation
[3] Widespread CASI Adoption
[2] Stimulate Localised Adoption
Support Experimentation and Demonstration
Capacity Development
Phase 2

5.1 Phase 1: Establishment of a CASI knowledge and scaling base

Responsible project leader for this phase: Mahesh Gathala

5.1.1 Purpose

[1] To build a knowledge base that proves CASI should be promoted to smallholder farmers in the EGP; and

[2] to establish partnerships that will ultimately be used to scale CASI regionally.

5.1.2 Background

Implementation of 400 participatory demonstrations across eight locations in the EGP, implemented through and with project partners and overseen by CIMMYT agronomists; and

Establish a broad network of potential CASI scaling organisations from local to national levels for eventual scaling of CASI.

5.1.3 Implementation Details

Protocols for selection of nodes

Eight districts in which to conduct research were selected from within the EGP to capture a range of conditions in terms of socio-economics, agricultural productivity, availability of infrastructure including machinery, climates and geography. Districts were also paired along national borders, where biophysical and climate parameters were the same but governance and cultures varied.

Within each district, the core project team conducted a series of meetings which aimed to engage representatives from all stakeholder groups, farmers, the local community, governance, self-help groups, and extension and NGOs. At these meetings the project objectives and goals were explained and the priority key interventions were identified as per community need. Possibilities to explore existing infrastructure were identified to catalyse research activities and increase efficiency. These meetings were intended to create a sense of co-ownership of the project between the research and local teams: all participants (especially farmers) were considered research partners, not research consumers. Collectively, the core project team and local partners selected the nodes in each district in which the project would operate. Local communities then decided which farmers would participate in the trials based on interest and position within their communities. Field technicians were hired from within local communities: this was critical once the field trials were operational, as farmers had a sense of trust and camaraderie with their local technician and consequently felt more empowered to seek support when needed. Farmers and field technicians jointly monitored day to day field activities.

In all engagement activities the core project team was conscious of facilitating the participation of women and young farmers. The project aimed for a minimum of 33 % women at all engagement opportunities; in practice this was regularly exceeded and most meetings had equal attendance by women and men.

Protocols for Partner selection

Project management appointed the key national partner agencies, considering regional geography and agencies' local research and extension capabilities.

Local research, extension and farmer-support partners were appointed in consultation with farmers, local communities and the national partner agencies. These appointments were informed by the scoping study.

Field level technical and farmer-support partners were nominated by the local communities and appointed in consultation with the local project team and project management

International partners were appointed on the basis of their expertise in key aspects of project research.

Methodology for partnership development

The field trials were underpinned by a very strong monitoring system. Day to day trial monitoring was undertaken by farmer participants, who were supported by weekly monitoring by field technicians. Local research and other stakeholders visited regularly (bi-weekly to monthly), and a core group of project management and international partners visited every field trial site at least twice each growing season.

The field trial monitoring was supported by technical backstopping which enabled farmers to overcome obstacles in a timely manner and so ensure, where possible, that experimental seasons were not lost.

The emphasis on a joint implementation of research, where farmers, technicians, local and international researchers were all equal partners, was key to engaging with local communities and ensuring interest and support of the project goals. While some field trials were implemented consistently across the whole project to examine hypotheses of CASI practice, others were implemented locally to examine regionally-specific options to optimise crop production and increase farm income.

The project emphasised capacity building and developing the knowledge and skills not only of institutional partners and the scientists engaged on the research, but also the farmers, technicians, local communities, extension agents and others. Traveling seminars, farmer-to-farmer knowledge sharing and farmer field days were essential to develop partnerships and share knowledge.

Where possible, the project engaged with existing farmer groups and producer organisations. These had been generally established to promote social welfare by NGOs, local governments or development agencies. By engaging with these local groups, the project was able to streamline its entry into local communities, align with community aims and support groups which were already operating for community benefit. With these groups, innovation platforms could be established. These platforms enabled local partners to lead and coordinate all stakeholders, and to establish rural micro-entrepreneurships to identify and develop emerging employment opportunities. Innovation platforms also underpinned CASI out-scaling activities while focusing on enabling women and youth within communities.

Protocols for long term trials

A comprehensive survey was undertaken in all research districts to enable the project team to understand the interventions that were of highest priority for each community. This underpinned the development of the project research design and field trial selection.

Over a month, a core project team drove from Dhaka to Kathmandu and engaged with local communities in each district to identify, through a workshop and visits to future field trial sites, locally feasible interventions. Three types of trials were identified in all districts:

1. Long-term (4 years) trials which were consistent across all nodes and which would enable the research team to examine the regional performance of CASI across the EGP
2. Mid-term (1-2 years) trials to optimise cropping systems for local conditions. These trials were adjusted to each community’s identified needs and interests and the local agro-ecological environment. For example, intensifying the rice-wheat cropping system was tested at many locations: in drier areas the project tested a rice-wheat-mungbean system, while in wetter regions a rice-wheat-jute system was examined.
3. Short-term (1 season) trials to immediately benefit farmers. These trials were localised and selected according to a community’s preference and included options such as: optimising chemical weed management; intercropping to empower women farmers; and introducing cash crops to increase farm income.

Altogether over 800 trials were conducted. Over 400 of these were the core long term trials and the remainder were short term investigations.

All research trials were designed by the core project team, with input from the entire project team, and considered farmers’ constraints and the need for experimental rigour.

Farmers, local communities, field technicians and local scientists were educated about the trial objectives, their local implementation and data collection. Strong emphasis was given to training in new techniques and the use of new machinery. Technical backstopping was provided as needed throughout the field trial. Trials were jointly monitored by farmers, field technicians, local and international scientists.

Protocols for initial socioeconomic research

The socio-economic research focused on understanding perceptions of farmers on the benefits of CASI technologies as well as the problems with the technologies; understanding farmers risk attitudes; determinants of CASI adoption; reasons for disadoption; and impact of CASI on men and women farmers in the EGP. Focus group discussions and key informant interviews were conducted to determine farmer perceptions on the benefits, advantages, disadvantages and issues with CASI technology. An evaluation of service provider models was also conducted in Nepal, India and Bangladesh. A socio-economic farm household survey across SRFSI research sites in Nepal, India and Bangladesh was also conducted in 2018. Qualitative and quantitative analyses were conducted, results of which have been presented in various reports and papers (some papers have been published while others are still under review or being written up). Field-level experiments were also conducted by farmers, with project researchers gathering farm input and output data. An economic analysis of the combined results from the survey and field-level data was published in a book chapter entitled: Socioeconomic Impacts of Conservation Agriculture based Sustainable Intensification (CASI) with particular reference to South Asia. Strategies to improve women's participation in SRFSI activities (FGDs, KIIs, training, etc.) were also developed and the impacts on participation were monitored.

Relevant manuscript: Saiful Islam, Mahesh K. Gathala, Thakur P. Tiwari, Jagadish Timsina, Alison M Laing, Sofina Maharjan, Apurba K. Chowdhury, Prateek M Bhattacharya, Tapamay Dhar, Biplab Mitra, Sanjay Kumar, Pawan K Srivastwa, Swaraj K. Dutta, Renuka Shrestha, Sarita Manandhar, Shukra Raj Sherestha, Prakash Paneru, Nur-E-Alam Siddquie, Akbar Hossain, Rashadul Islam, Anup Kumar Ghosh, Mohammad Atiqur Rahman, Ujjwal Kumar, Karnena Koteswara Rao, Bruno Gérard (2019) Conservation agriculture based sustainable intensification: Increasing yields and water productivity for smallholders of the Eastern Gangetic Plains. Field Crops Research, Volume 238, https://doi.org/10.1016/j.fcr.2019.04.005. Appendices [A]

5.2 Phase 2: Capacity Development as the pathway to institutionalisation

Responsible project leader for this phase: TP Tiwari

5.2.1 Purpose

To build institutional capacity with key potential CASI actors to enable the institutionalisation of CASI.

5.2.2 Background

After three years of implementing SRFSI, it was found that there was a need to enhance the capacities of key actors to achieve the project's ambitious targets. Strategic partners needed to enhance their capacities to accelerate awareness raising on CASI, improve proper application of CASI and to enable sustainable and responsible scaling of CASI innovations. SRFSI phase 2 aimed to change behaviour at partner and institutional level directly, and indirectly at the level of farmers.

Capacity Development occurs across multiple levels—individual, organizational and institutional—and covers a wider scope than the mere transfer of knowledge and skills through training. More often than not, there is simply an implicit assumption that strengthening the competencies of individuals will enhance the capabilities and capacity of organizations, which in turn will contribute to the emergence of capacity of the system (Capacity For Change, 2016). Individual capacity development should not be attempted without also looking at the organizational setting for the individual(s), and where appropriate integrating organization-level Capacity Development (Almond & Kisauzi, 2005). Capacity Development at institutional level recognizes social, cultural and political structures in which power relations, social and institutional dimensions determine opportunities for different groups of actors in initiating an innovation niche and acting upon the interventions to attain sustainability. As responsibilities for out-scaling and up-scaling are passed on to local partners there will be a need to develop their management skills, and skills resource mobilization and partnership building (Almond & Kisauzi, 2005). Figure 3 shows the multitude of dimensions in Capacity Development and the strong links between the different levels. In the context of SRFSI the focus is on the local level, such as district administrations, local entrepreneurs and other local organizations.

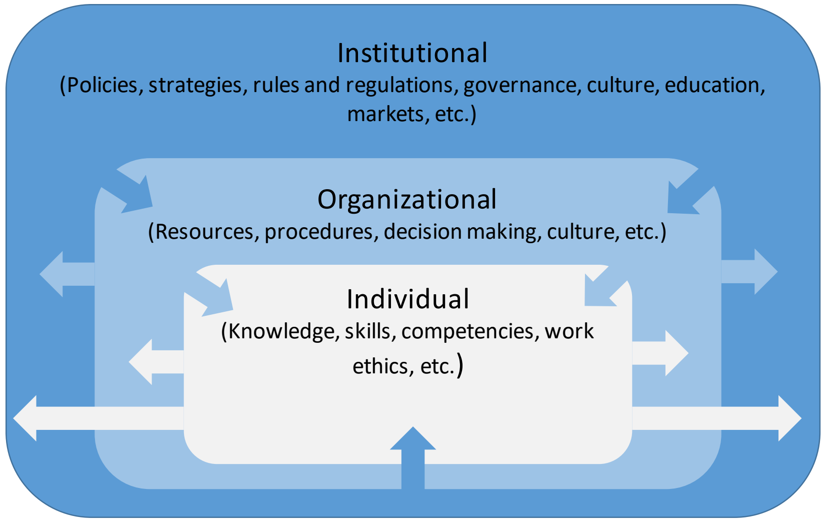


Figure 3: Three dimensions of Capacity Development and what they aim to improve

Important stakeholders and relevant topics were targeted as follows:

- Partners (NGO, University, Extension)- focus capacity development on organizational development, scaling strategies, process documentation, training capacity and quality, etc. to equip the partners to scale CASI beyond the project lifetime.
- Existing and new service providers- value chain and business model development, improved service delivery to farmers (finance, training, inputs), promote linking up with new/different partners (chamber of commerce, banks, etc), etc.
- Decision makers- awareness of problems and solutions around CASI, program design, theories of change and scaling, PPP, institutionalization, etc.
- Farmers- reached through partners with training on access to markets and services, organizational development, etc.)

5.2.3 Implementation Details

This variation to the SFRSI proposal focuses on one core aspect of scaling - that is- **scaling through capacity development** as well as **monitoring and learning from the scaling and adoption process**. This is primarily based around trainings targeted at three levels:

Level 1: '*train the trainer'*- this level will agree on the key technical and management issues to be presented and develop and agree on the 'session plan' for the training; then

Level 2: Level 1 trainers deliver to Level 2 trainers the '*trainer*' program that aims to provide the Level 2 trainers the necessary skills and information to conduct Level 3 training to the farming groups at the node level.

Level 3: Node/community level- training of farmers and communities.

In building the capacity of decision makers who are usually part of level 1 training, a body of knowledgeable individuals are developed who have decision making power for further institutionalisation. In this way the capacity development has both short term impacts on farming communities and longer-term programmatic impacts.

Relevant manuscript: Boa-Alvarado, M., Woltering, L., Stahl, J., Van Loon, J., Hernández, E., Brown, B., Gathala, M., Thierfelder, C. (2021) Capacity development for scaling conservation agriculture in smallholder farming systems: exposing the hidden levels – World Development (Under review - submitted September 2021) Appendices [Z]

5.3 Phase 3: Scaling for impact

Responsible project leader for this phase: Brendan Brown

5.3.1 Purpose

To build a functional understanding of how to enact, and establish prerequisites for, autonomous CASI scaling post-SRFSI project closure.

5.3.2 Background

Given the substantial knowledge base built during phase one of SRFSI and then the substantial built capacity in phase two, the final puzzle piece was that of enacting activities to ensure that there is ongoing momentum for the scaling of CASI across the region, and in particular institutionalisation of CASI in actor programs. This is also built on understanding the status of progress towards CASI scaling. To achieve this, four workstreams were enacted:

Work stream 1: Policy and Convergence Activities

This work stream focused on policy and convergence activities. This addresses the most identified weakness of an analysis of project impacts in the 2018 SRFSI external supplementary review (Appendices Y; pg40) in a lack of alignment of government policies. The status of convergence and next steps for sustained enabling environments were explored through various evaluations. This culminated in location-based scaling reports that provide a pathway for handover and next steps to policy makers and key actors.

Work stream 2: Institutionalisation of CASI capacity development

This work stream focused on the institutionalisation of CASI capacity development activities. This explored capacity gaps for capacity development and established strategies that can address these gaps. It also included the commissioning of the Centre of Excellence for Conservation Agriculture at UBKV, which is intended to become a regional training centres for the entire EGP. COVID-19 meant that assessments with key government and development actors were not possible, as well as final policy workshops, given the complexities of online high-level policy dialogues and interviews. One national policy dialogue did occur at the national Agri mechanisation fair in Nepal in 2019.

Work stream 3: Creation of scaling and legacy products

This work stream focused on the creation of legacy scaling products, and in particular academic, training materials and promotional materials. This workstream addresses the recommendation (iii; pg47) of the SRFSI external review for increased emphasis on communications materials. This also included ensuring that work of academic merit is published and disseminated. This includes the online repository of all partners promotional materials, the creation of the CASI visual syllabus and ensuring academic outputs are completed for publication.

Work stream 4: Adoption and Impact Learnings

This work stream focused on exploring the suitability of CASI though adopter experiences and estimating the extent of current process towards CASI scaling. This also explores decision making processes of non-users to suggest suitable development activities to increase the success of scaling efforts. This includes both a large quantitative impact survey and in-depth qualitative explorations to understand what worked where and why.

5.3.3 Implementation Details

All workstreams aim to explore the question of 'what worked where and why?', and subsequently what that means for future scaling efforts. To do this, two comprehensive assessments formed the backbone of research activities. These were based on two underpinning theoretical frameworks.

Theoretical frameworks underpinning analysis

Beyond binary adoption analysis: the Stepwise Process of Mechanisation (SPM) framework

Investigations of adoption are often framed within static binary 'yes' or 'no' outcomes disallowing a nuanced understanding of adoption processes, particularly at a population level whereby a singular percentage dictates progress and success (Brendan Brown et al., 2017b). To obtain a more nuanced understanding CASI adoption process, the Process of Agricultural Utilisation Framework (PAUF; initially developed in an African context as described in Brendan Brown et al., 2017b) was adapted for the South Asian Context for use in SRFSI analysis. Due to the addition of mechanisation (not present in Eastern and Southern Africa for CASI practices), the PAUF was modified with the removal of certain categories and replacement with relevant alternatives (Figure 4) and named the Stepwise Process of Mechanisation (SPM) Framework. This enables a more nuanced understanding of CASI uptake in a population, by also including ownership components. This adaptation increases the utility of the framework and enables it to capture a slightly different adoption process for the studied context. Note that this framework will be further adapted in final analyses into a pathway approach (see section 7.3.1).

This methodology is published in the following SRFSI publication (though will be further adapted for the Pathway Analysis to be published but presented in the scaling reports)

Relevant manuscript: Brown, B., Prasad, G., Krupnik, K. (2021) Visualising adoption processes through a stepwise framework: A case study of mechanisation on the Nepal Terai (Agricultural Systems – volume 192) https://doi.org/10.1016/j.agsy.2021.103200 Appendices [B]

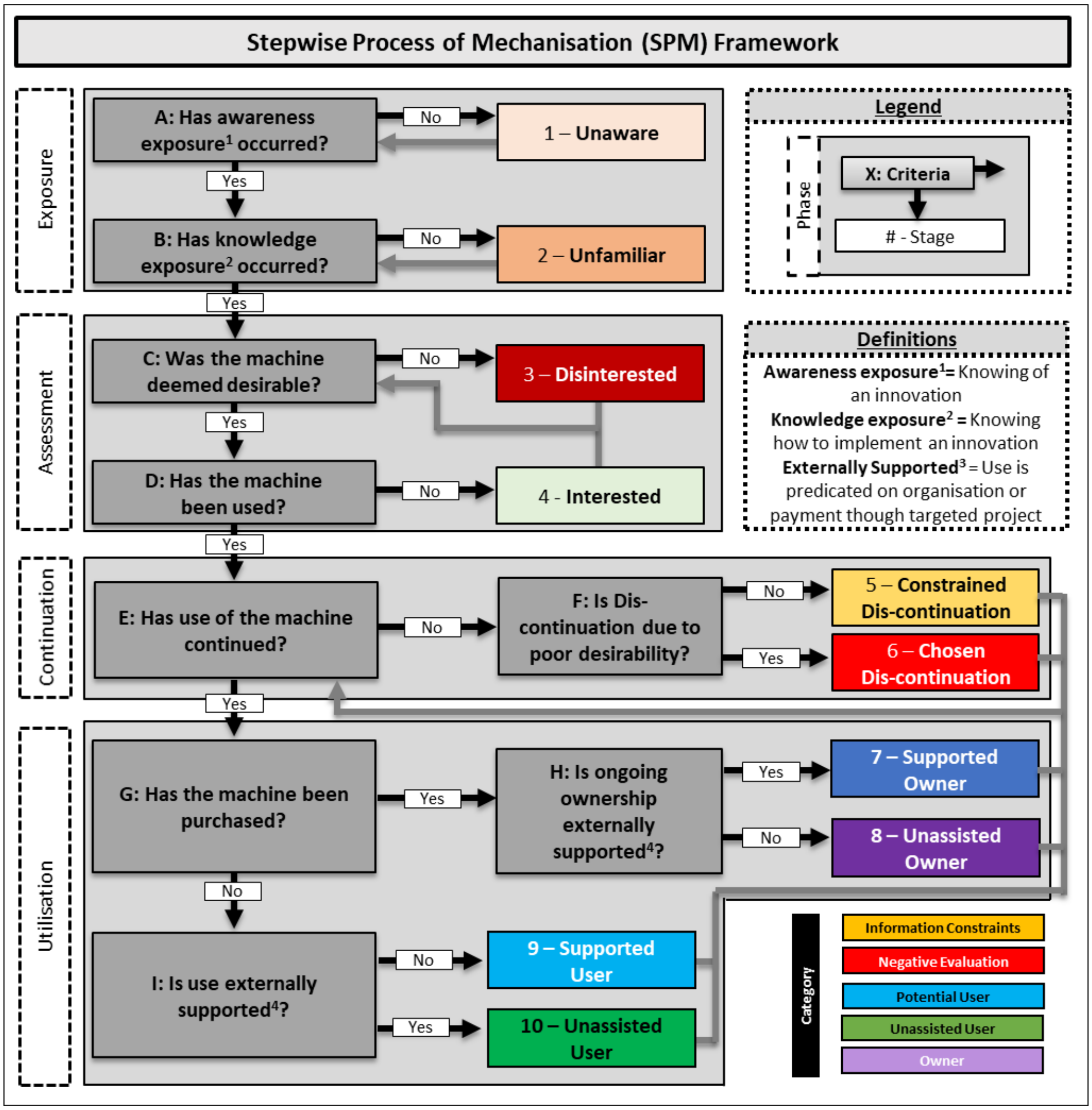


Figure 4: The SPM theoretical framework that enables more nuanced understanding of the status of machinery adoption in investigated populations. Note grey feedback loops facilitate the framework are dynamic, and not a static point in time. Graduation is one directional for the first two phases (i.e. once passed no regression is possible), however Question E (related to continuation) is cyclical, indicating that utilisation includes disconnection as an inevitable outcome. See (Brendan Brown, Paudel, et al., 2021) for more detail.

The SPM Framework assumes that the ultimate desirable outcome achieved by resource constrained smallholder farmers is that of unassisted use, but this is achieved though intermediate steps, and some may also attain ownership of the given machinery. Through understanding the status of machinery uptake in a stepwise process, the progression of farmers within communities (from exposure to assessment and progression and eventual utilisation decisions) can be understood and subsequent strategies formed that aim to move members of a given population from lower to higher stages of the SPM framework.

We therefore assess the status of agricultural mechanisation though classification of farmers in five phases:

1. The *Exposure* Phase that provides insights into information gaps within rural communities;
2. The *Assessment* Phase that provides insights into what happens once exposure occurs;
3. The *Continuation* Phase that provides insight into decision outcomes that occur once progression has occurred;
4. The *Utilisation* Phase that provides insights into what form of adoption is occurring; and
5. The *Ownership* Phase that provides insights into what form of ownership is occurring.

As a further adaptation of this approach, a novel ‘pathway analysis was developed which frames adoption though a series of gates which pass through familiarity, use, support and stoppage in use to create 9 typologies and 10 ratios. This framework forms the basis of all impact assessment as part of the SRFSI end line evaluation. The full methodology has not been published in the academic literature, though this process is ongoing. An example is provided here for context (**Figure 5**; results from a regional analysis of Zero tillage use and non-use).

Practice:		Zero Tillage Drill			Location:			Regional: EGP				
*Sample size = **5,053** respondants (representative of communities investigated)*												
Ratios												
A	*Exposure*	***35%***	*C*	*Approval*	***97%***	*E*	*Intervention*	***60%***	*G*	*Supported Graduation*	***4%***	*Binary Adoptio*
B	*Progression*	***33%***	*D*	*Inhibition*	***62%***	*F*	*Unsupported Graduation*	***76%***	*H*	*Adoption Status Ratio*	***33%***	***9%***

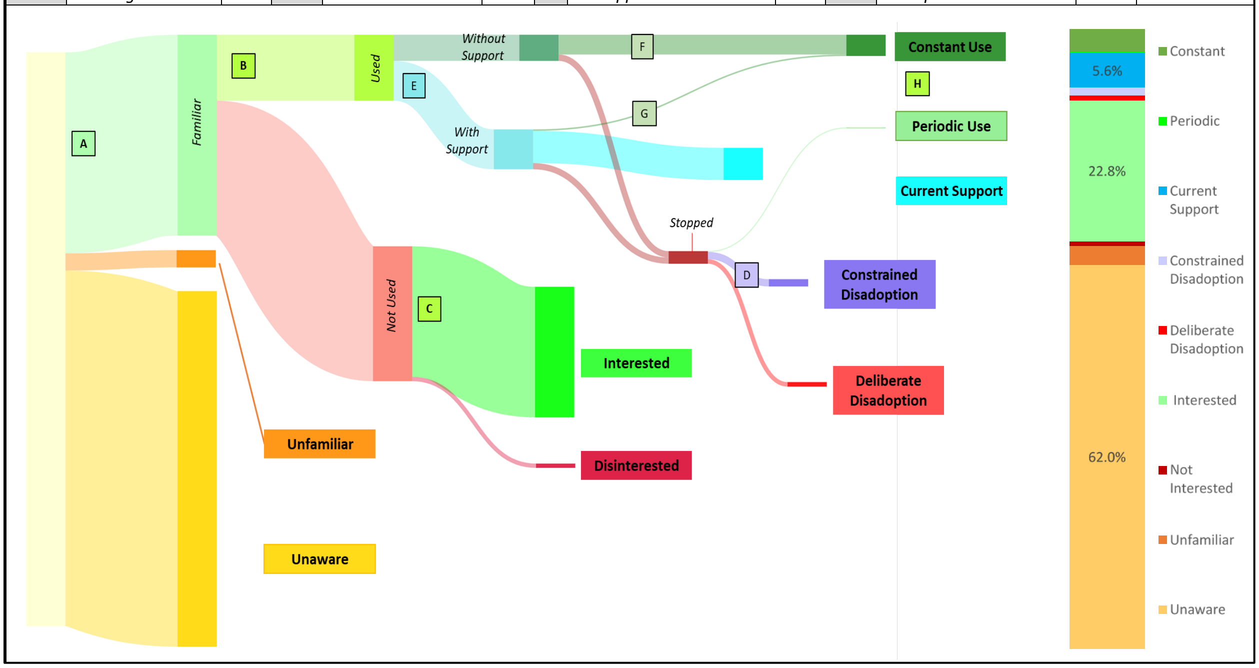


Figure 5: Example output using the novel pathway analysis to frame adoption processes through a series of gateways, population ratios and typologies.

Understanding decision making processes: the Decision-making Dartboard (DmD) approach

In order to cover a wide spectrum of issues involved in the decision making process, SRFSI applies a structured qualitative framework adapted from the Livelihood Platform Approach (LPA; Brendan Brown et al., 2017a) used previously to understand the decision-making processes of smallholder farmers in relation to conservation agriculture in Africa. The LPA builds on the sustainable livelihood framework to explore the uptake of agricultural technologies at individual, household, community, and institutional ‘platform’ levels (Anibaldi et al., 2021). Modifications here enable a deeper understanding of perceptions, abilities and enabling environments in which farmers make technological evaluations and decisions. This approach, termed the Decision-making Dartboard (DmD; **Figure 6**) framework builds on existing LPA and sustainable livelihoods framework theory, but is adapted for deeper exploration of new contexts. The DmD, like the LPA, disaggregates key decision processes into six core questions across four asset categories, which when combined are used to explore the various considerations that individuals considered to reach their eventual typology outcome.

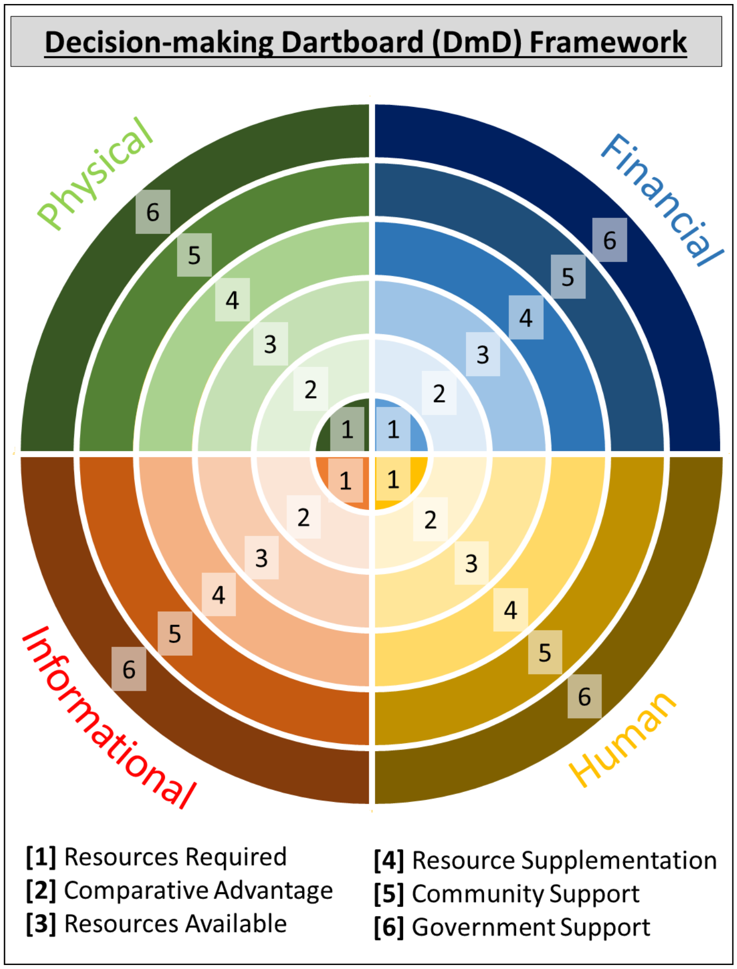


Figure 6: The Decision-making Dartboard (DmD) Framework, an adaptation from the 3 dimensional Livelihood Platforms Approach framework (Brendan Brown et al., 2017a) to 2 dimensions for increased visual clarity and ease of analysis.

Relevant manuscript: Brown., B, Samaddar, A., Singh, K., Leipzig, A., Kumar, A., Kumar, P., Singh., D, Malik, R., Craufurd, P., Kumar, V., McDonald, A. (2021 – Under Review) Understanding decision processes in becoming a fee-for-hire service provider: a case study on direct seeded rice in Bihar, India. Rural Studies Volume 87, Pages 254-266, https://doi.org/10.1016/j.jrurstud.2021.09.025 Appendices [C]

Data Sources used in this Phase

2021 SRFSI Quantitative Impact Survey

The 2021 SRFSI Quantitative impact assessment was designed and implemented between November 2020 and July 2021 (i.e. during COVID-19). The dataset comprises of 6,353 individuals from 5,068 households (note that though design 1,285 households had both the man and woman of the household interviewed for a gendered analysis). The survey comprised of demographics, machinery use and experiences (CASI and Non CASI) and explored aspects of CASI awareness, assessment, use and experience, quantification of extent and type of CASI use, and the implications and livelihood constraints that drive agricultural decision making. Due to COVID-19, data was not able to be collected in Bihar and some elements of training of enumerators meant certain data could not be collected. The intention for a larger survey that incorporated multiple community types for deeper analysis was somewhat curtailed. However, given COVID-19 this is still a huge achievement, and the data will be fruitful in much analysis and learnings (see scaling reports for more information). Covering 57 communities that are either SRFSI original intervention locations, later SRFSI scale out locations of non-SRFSI communities, it is representative of those communities and the region more broadly.

The survey instrument, which was implemented in Bangla and Nepali though Kobo collect, is provided in the Appendices [D] for the household decision maker and Appendices [E] for the household spouse. Note this is KoboCollect code form.

2019/2020 SRFSI Qualitative Experiential Assessment

The 2019/20 SRFSI qualitative experiential assessment consists of 336 Semi structured qualitative interviews across six locations. These occurred with both farmers and service providers, and also targeted 50 households for both household heads perspectives and experiences. The intention was to gather a diversity of experiences across different CASI user typologies through a snowball sampling methodology. The intention of this work was to explore decision making processes. This dataset is targeted at diversity instead or representativeness and is used within the context of the quantitative findings given it is not intended to be representative of populations, but representative of typology experiences. It should be noted that extensive time was put into training staff in implementation of 'truly' semi-structured interviews as shown by the novel 'checkbox' question schedule for head Appendix [F] and female spouse forms Appendix [G]

Other research collaborations

During the course of this phase, similar research questions were raised by other projects though which SRFSI brokered research collaborations Additional datasets include:

- The 2019-2020 Photo voice in depth exploration of CASI implications (with Weeds and Gender project). This used Photography as a means of learning about significant change, as well as in depth periodic interview to estimate labour changes. The methodology is covered in two manuscripts: **Appendices [I], Appendices [J]**
- The 2019-2020 Nepal Terai Machinery Survey (with CSISA USAID Nepal). The methodology is covered in (Brendan Brown, Paudel, et al., 2021). **Appendices [B]**
- The 2019 Direct Seeded Rice Service Provider Assessment (with CSISA BMGF India). The methodology is covered in (Brendan Brown, Samaddar, et al., 2021). **Appendices [C]**

COVID-19 cancelled research activities

The intention of this phase was to triangulate qualitative and quantitative results with final focus group discussions. Due to COVID-19, these have not been possible and this constrains making broader assumptions about the status of and experiences with CASI across the region. However, the above datasets are robust enough to imply findings without the additional level of nuanced explanation and understanding that would have been obtained if the focus group discussions could have progressed. Additional qualitative research was also planned with key supporting actors (including extension, support organisations and policy makers) to assess remaining capacity, policy, organisational convergence and institutional implementation gaps for CASI scaling, but due to COVID-19 this could not be completed.

6 Achievements against activities and outputs/milestones

A summary for each deliverable is given in the 'Summary of completion' column, while the evidenced output is linked by number to the shared repository via the 'Evidence' Column. N.B. Log frame appendices are numbered while non-log frame appendices are lettered.

6.1 Objective 1: Understand farmer circumstances with respect to cropping systems, natural and economic resources base, livelihood strategies, and capacity to bear risk and undertake technological innovation

A complete summary including key methods, results and findings is available in appendices [H].

No.	Activity	Due	Summary of Completion	Evidence
1.1	Identify representative communities, farming systems and farmer requirements in the target districts to orient project activities	July 2014	Focus group discussion, scoping studies, and consultation with partners organizations were organised in order to identify representative communities, farming/cropping systems and related constraints and problems in each jurisdiction. Potential technological options for solutions were prioritized through the same process mentioned above. Information was validated during seasonal planning meetings where different stakeholder including community representatives, development partners and NGOs, cooperatives and private sector representatives participated. The results of the scoping study on socio-economic and biophysical survey were presented in the inception and planning meeting in Sept 2014. Based on the results of this survey and FGDs, 40 nodes were identified and established.	[1], [2], [3]

1.2	Evaluate and document factors influencing household access to irrigation water	Dec. 2015	Two out of five SRFSI nodes were selected from each district in Nepal, India and Bangladesh. Villages were selected based on their representativeness of the ecological and cultural diversity of the region. Exploratory visits to the field sites followed by informal focus groups and quantitative survey collecting key information on agricultural production, cropping patterns, irrigation decisions, land tenure and livelihoods using a flexible interview schedule. Households were sampled randomly, based upon the Panchayat register in the case of India, with every 8^{th} to 10^{th} house being selected so as to create a sample of approximately 100 for each selected node. In Nepal, a similar principle was followed, although as there was not a reliable register of names. In Bangladesh, the absence of a register of names linked to house numbers, and the lack of an exploratory visit meant that farmers were selected randomly at different points in a village, with attention to both men and women's participation in the survey. Survey data was collected in the relevant local languages Maithili, Hindi, Nepali, and Bengali with the support from local partners Bihar Agricultural University, North Bengal Agricultural University (UBKV), Sakhi Bihar, Nepal Agricultural Research Council (NARC) and the Bangladesh Agriculture Research Institute (BARI). Individual interviews were mostly carried out in fields with farmers, while focus groups were usually carried out in public places. A number of short term pragmatic options have been derived which can be considered for SRFSI, and will be relevant to policy makers. Establishment of farmer groups amongst marginal and tenant farmers would facilitate irrigation access as well as reduce bottlenecks to the establishment of CA systems; in SRFSI project sites in Bihar and the Nepal Terai, farmers should be encouraged to pool resources to purchase a tube well or pump set; the pooling of equipment, and collective leasing or voluntary consolidation of land would make group investments in irrigation more feasible; planting of drought tolerant crops or vegetables and careful agronomy planning, building on farmers' indigenous knowledge and the expertise of extension stakeholders, and the use of resource conserving technologies such as zero tillage can reduce irrigation water. Access to flows of knowledge are often restricted, particularly for poorer farmers. As noted above, often tea shops and agro-vet shops are the main sources of information on new techniques and technologies given the weak agricultural extension infrastructure on the ground. In Bangladesh, the level of support to farmers appears to be higher, especially with the creation of the Barind Multipurpose Development Agency (BMDA) with the primary purpose of enabling farmers overcome production challenges. There is considerable scope for cross learning, with successful water management models among participating countries.	[4], [5], [6],[7]

1.3	Characterize and quantify local water resources in the project target areas	Dec 2016	Different methods were used to characterize and quantify water resources, namely 1) remotely sensed images to assess the occurrence, duration and the extent of surface water following monsoons, 2) IWMI's Irrigated Area Maps for South Asia to provide estimates of cropping intensities, 3) historic pre and post monsoon groundwater levels observed by National Agencies to assess groundwater availability, 4) Field surveys and focal group meetings in India and Nepal to gain insights into farmers' preferences for crops and water for irrigation, 5) AquaCrop modelling to assess whether there's timely and adequate supply of water to intensify irrigation without depleting aquifers and 6) secondary data to assess the extent of Arsenic contamination in groundwater, as irrigation water is considered a potential means for Arsenic in the region. Potential to increase irrigation - Except in Dhanusa, and Sunsari Districts. There's an enormous potential to increase irrigated cropping in all districts. Groundwater availability was not a constraint for irrigation. Shallow Tube Well was the primary source of irrigation water, and pumps were mostly powered by diesel, except in West Bengal, where rural electrification is extensive. River pumping is not common in these districts. Those who pumped river water used diesel pumps for extraction to irrigate major crops. Though not common and feasible, however, river water for irrigation may be promoted to mitigate Arsenicosis where possible. Arsenic and fluoride contaminations are prominent water quality issues worldwide, and EGP is not an exception. Study revealed that groundwater arsenic contamination was detected in all the districts with different severity. Malda, Rajshahi and Rangpur are highly affected compared to the other districts. Arsenic contamination of groundwater is not well studied in Madhubani, Purnea and Coochbehar Districts. In Nepal Terai, most of the studies reported that 90% of the groundwater had As<10 µg/l. Fluoride concentration in groundwater in Madhubani and Coochbehar Districts are generally lower than the drinking water standards (F < 1.5 mg/l). High fluoride concentrations are reported for Purnea. In Rajshahi and Rangpur, fluoride concentration is lower than 1.5 mg/l and is within the permissible limit of drinking water. In Nepal Terai, data is not available to assess fluoride concentrations in groundwater. In summary, dearth of data is a major issue in the studied districts, hence limiting to draw a comprehensive result of arsenic and fluoride contamination in groundwater, soil and food chain. High iron contents observed in groundwater in all the districts suggest that the aquifers are in anaerobic condition, which favors reduction processes and subsequently potential release of metals to groundwater, especially arsenic if it is in the soil. Hence, further studies are suggested before implementing intensive groundwater management activities in these districts.	[8],[9]
1.3.1	Assess local water balances, depth of water table, and estimates of ground water availability.	Dec 2015	The average groundwater table levels were determined by measuring twice annually at pre-monsoon and post-monsoon. An assessment of the seasonal recharge/discharge rates was estimated using changes in groundwater levels. The basic methodology for a comprehensive water balance was calculated using the methodology used by Mohammadi, Salimi, & Faghih (2014). PP40 Water table varied across locations: Pre-monsoon ranged from 2 m (Sunsari, Dhanusha and Coochbehar) to 12 m (Malda), whereas post-monsoon ranged from 0.25 m (Sunsari) to 6 m (Malda). Most study districts showed groundwater tables above 9m (effective pumping depth for surface pumping systems) except Dinajpur, Rangpur and Malda. Groundwater for irrigation is a highly underutilized renewable resource for the majority of the study districts, but care should be taken in any new developments in Dinajpur, Rangpur and Malda.	[8a] to [8i]
1.3.2	Quantify surface water resources	Dec 2016	Quantity of surface water each month outside the monsoon documented for each node (2+ years data) (part of 2014; 2014/15; 2015/16)	

6.2 Objective 2: Develop, with farmers more productive and sustainable technologies that are resilient to climate risks and profitable for smallholders

A complete summary including key methods, results and findings is available in appendices [H].

No.	Activity	Completion date	Progress achievements	Evidence
2.1	Assess and document bottlenecks and entry points for the establishment of CA systems through farmer consultations and participatory technology evaluations.	June 2018	This activity aimed to characterise the landscape of actors, their capacities and limitations and to use this information to diagnose the bottlenecks and entry points for scaling out the intensification of smallholder farming systems with adapted CA technologies, and available proved technologies. Desk reviews, interviews with a range of agricultural actors at the district scale and observation of field settings were conducted and the key themes synthesized. Key informants were selected on the basis of their involvement in agriculture intensification in each of the eight districts with the aim of capturing the views of a diverse set of actors. The available institutional analyses of agricultural organizations and their interaction were reviewed to understand the past and present activities of agricultural organizations, mandate and role and strengths and weaknesses. Relevant policy documents were reviewed to assess the policy priorities and actor roles in agricultural intensification. Different districts had different characteristics to enable research and scaling to establish CA systems. The presence of potential partners, both public and private organizations that can promote CA based intensification and diversification is greater in Bangladesh followed by West Bengal, Bihar and Nepal. However, strengthening interactions among and between public and private sectors including farmers' groups will stimulate synergies for upscaling SRFSI interventions. Despite technologies and expertise on the use of CA machinery and crop intensification, little cross-learning of these experiences occurs currently. Systematic involvement of scaling partners is necessary to provide CA machinery subsidies and link into extension programs. A clear and unifying CA policy to drive CA promotion by multiple actors across the public, civic and private sectors is required.	[9], [10], [11], [12], [13], [14a-14e], [15]
2.2	Evaluate costs, benefits, and climate resilience of	June 2018	Focus group discussions (FGDs) were conducted in SRFSI project sites. A total of	As above 2.1

	current and innovative management technologies (e.g. CA, site-specific nutrient management, supplementary irrigation) for different farmer groups through on-farm evaluations and simulation models.		1182 farmers were involved in the FGDs composing 43% female across eight SRFSI districts. The CASI technologies assessed include zero-tillage, strip tillage, direct-seeded rice, rice transplanter, and laser land leveler. Core trials were systematically designed and protocol prepared to calculate profitability. The main problems and issues encountered include weed management (75%), timely availability of irrigation (63%), availability of herbicides (50%), poor germination (50%), and limited skills of machine operators (50%). Limited knowledge on herbicide use (38%), timely availability of machines (38%), seedbed management (38%), seedling uniformity (38%), pests and diseases (38%), inappropriate soil moisture level (38%), land levelling (25%), rat infestation (25%), shortage of labour (25%), training for women farmers (25%), waterlogging conditions (25%), quality inputs and new seed availability were the other issues identified. Advantages included decreased labour use, less drudgery (100%), improved soil health (100%), timely seeding (100%), increased or same production (100%), cost saving (67%), less irrigation (67%), early seeding thereby maturing and harvesting (50%), and less lodging (50%). Disadvantages included more weed infestation (100%), poor or erratic germination (100%), lack of suitable herbicides (83%), lack of skilled skills of operators and suitable mechanics (83%) and less production (33%). Farmers selected CASI technologies based on criteria of profitability and resilience, and they considered mostly the disadvantages when deciding to adopt CA.	
2.2.1	Develop with farmer participation profitable options for the efficient management of CA systems, including site-specific nutrient management and system intensification, especially in the winter.	Each local Annual review meeting	A combination of on-farm and on-station trials were conducted, following site specific protocols. Between 2016 – 2018, (X rabi and X kharif seasons) the following trials were conducted: long-term/core trials to address the regional issues (900), cropping systems optimization (135) and opportunity/demonstration trials (215) that includes intercropping (62). These were designed to address local (district/community) level issues in each year. In monsoon (Kharif) season, only long-term/core trials (360) on rice were maintained. Multicriteria assessment showed an increase in rice equivalent system yield (4%), gross margin (19 - 20%), input water productivity (7 - 9%) and energy productivity (13 - 14%), while decrease in requirements for irrigation	As above 2.1, [16]

			water (15 – 17%), energy (10 – 11%), labour (32 – 38%), production cost (15 – 18%) and CO_2 equivalent emission (8 - 13%) in full CASI over CT.	
2.2.2	Assess the options for increasing system productivity and resilience through strategic supplementary irrigation, and assess the feasibility for different groups of farming households.	Each winter season local annual planning meeting August 2015 onwards. June 2018.	This was addressed through IWMI reports.	[9], [10]
2.2.3	Monitor soil quality and herbicide use in on-farm trials to assess the environmental impact and sustainability of technological options.	June 2018	Soil samples were collected from the long-term/core trials in the 2014-15 and 2016-2017 seasons from both the CT and ZT treatments, as described by Gaydon and Dalal (2015). Briefly, four representative soil samples were randomly taken from each field (<0.25 ha) at 0-15 cm and 15-30 cm depths and composited for each depth. The soil samples were gently broken up, visible plant materials removed, and the soil dried at room temperature (20 - 30°C) for 3 – 5 days. The air-dried samples were ground to pass 2 mm sieve for soil pH, and available P and K measurements, and further ground to <0.1 mm for soil organic C and total N measurements. Samples were analysed using prescribed methodologies. Partial nutrient balance was calculated as the difference between the amount of nutrient added in fertiliser and that removed from the field in grain and straw. Soil pH is generally reduced by CA practices, and this is more marked in soils that are initially acidic. Soil organic carbon is highly variable across locations, but in general improves under CA or remains similar (i.e. does not decline). In West Bengal, partial nutrient balance showed that N and P had a positive balance, while K had a negative balance. Key soil parameters, organic matter, soil pH and plant nutrient availability determine the capacity of a soil to sustain crop productivity. CA and crop diversification and intensification may change these soil parameters, which impacts on sustainability. CASI practices improve soil organic matter and preserve continuity of soil pores. This, together with increasing N fertiliser rates in intensified systems, can contribute to acidification. Widespread acidic soils require immediate	[18a-18g]

			remediation. Site-specific nutrient management is economical and environmentally sustainable and partial nutrient balance can give an early warning for soil health. The inclusion of legumes in rotation will reduce N requirements, and slow acidification.	
2.2.4	Evaluate costs, benefits, risks and resilience of researched technology options with simulation models	Each local AR&PM from April 2015.	Simulation models were parameterised and calibrated for all SRFSI nodes, and the model's performance then validated against data from the long-term core trials undertaken by the project, to ensure it can be used with confidence at that location. In initial stages, the model was used to determine the yield-based performance of different treatments, and the impact of Rabi crop choice as a function of different sowing date opportunities on yield; gross margins; water, energy and labour productivity. The impact of managing crop residues was explored for one location in Bangladesh. The value of retaining an increased percentage of residue levels on soil organic carbon levels and long-term maize production was demonstrated by different scenarios. Crop residues are usually removed from the field by farmers and currently serve other purposes like fuel for heating, cooking and feeding livestock. However if farmers leave a greater percentages of residue in the field which are incorporated back into the soil and cropping system, there are long-term benefits for soil health and crop production levels. In such a situation the optimum trade-off between retaining residues in the field and/or removing it for other purposes can be explained by the model. The fact that APSIM modelling did not find any significant yield differences confirms that CASI is a suitable option for maintaining yield but reducing inputs in most locations. There are opportunities now to use this well tested model to explore alternative impacts and resilience in the long-term. The existing model is being used to estimate the behaviour of greenhouse gas emissions and other inputs; and as a basis for estimating yield gaps (physiologic, economic and sustainable water based) in each location. The DST should be incorporated into a user-friendly version and made available for local extension agents.	[19], [20], [21], [22],
2.2.5	Evaluate farmer appreciation of costs, benefits, risks and resilience.	Each local AR&PM from April 2015.	Three main types of participants in the project were identified—SRFSI core farmers, SRFSI scale-out farmers and non-SRFSI participants. Parameters like yield, labour	[17], [23], [24], [25], [26], [14a-14e]

			use, cash cost, total cost, returns above cash cost, and net income were assessed using various measures including on-farm trials and a semi-structured questionnaire. Yield, cost, and profit are standard measures identified in various reports. Aside from these three measures, labour use (composed of hired and family labour) was also explored, as CASI technologies have direct effects on hired labour use, particularly for land preparation, ploughing, planting, transplanting and sowing. Cash cost is composed of input cost and hired labour cost, and is important for farmer decision making since family labour is often unvalued or undervalued. Total costs include the opportunity cost of family labour. The yield under CASI, in general, was higher by around 10% except for Kharif rice production in Purnea. The cash cost was lower and CASI in general had lower total cost compared to CT for both male and female farmers. The net income performance had the same pattern with returns above cash cost for both male and female farmers. Other benefits included an increase of up to 19% in water productivity and 26% in energy productivity, and gross margin by 12 – 32% on average. The cost of production was reduced by u to 22%. There were reductions of up to 50% in labour requirements. Emissions were reduced by 10 – 17%. In all districts, male SRFSI farmers were less risk-averse than male non-SRFSI farmers. Core farmers are more knowledgeable than non –participating farmers for obvious reasons. With community and governance support, CASI is a feasible and realistic option for smallholders to increase their productivity and profitability, while reducing water, energy and labour requirements, and CO_2-equivalent emissions.	
2.3	Adapt ICT-based decision frameworks for crop and nutrient management in the target regions for maize, rice, and wheat. (Develop decision support tools through crop and soil simulation modelling.)	Sept 2017	A Decision Support Tool (DST) was also developed based on the APSIM model to assist with Rabi crop choice as a function of sowing dateA DST was developed based on APSIM modelling (described in Deliverable 2.2.4). The issue of Rabi crop choice as a function of sowing date opportunities at each location was developed in a spreadsheet form. It can be used to select the sowing date of interest, and rabi cropping options can then be assessed for yield, gross margin, water productivity, energy productivity and labour productivity. The DST compared the rabi crop options (wheat, maize, boro rice) on the basis of yields, gross margin, water and energy	[22]

			productivity and labour productivity, and also allowed comparison of with/without CA technologies. A broad range of potential sowing dates was simulated (from mid-November to late March). Farmers can also enter estimated crop prices and input costs. The model can help farmers make optimal winter crop choices based on available sowing time. Greater the percentage of residue retention in the field more the benefit in long run by improving soil health thereby crop productivity. .	
2.4	Adapt and evaluate CA implements for small tractors.		New prototypes for 2WT attachment (Seeders, bed planters), rice transplanters, reapers, Laser Land Levelers (LLL) demonstrated and evaluated, and attempts made to multiply locally. Happy Seeders were further evaluated in West Bengal, Nepal and Bangladesh and needs based local modification organized on various dates and places. Trainings were imparted to operators for field machinery use and scientists and field based technicians for the use of equipment that were placed in all communities (e.g. planters, sprayers, multiple nozzle booms, GPS, Rain gauges, and other small scientific instruments). As a result of the demonstration/evaluation/modification the equipment are suitable to promote CASI, hence SRFSI work/study was smooth.	[27] plus 2.2 evidence
2.4.1	Acquire promising equipment and new prototypes for evaluation	June 2014	CIMMYT - Equipment/implements are in place in all communities (planters, sprayers, multiple nozzle booms, GPS, rain gauges, and other small scientific instruments) Motorbikes for partners of each districts purchased and handed over.	n/a
2.4.2	Conduct participatory machinery evaluation events	Each season from summer 2014	CIMMYT - Participatory equipment evaluations were conducted in all nodes with farmers and other stakeholders and was an on-going activity. Machinery manufacturers were involved for machine set-up and calibration in some jurisdictions. Nepal: 9 tractor dealers (6 in Dhanusha and 3 in Sunsari) started selling both large and small size tractors, one tractor dealer each in Dhanusha and Sunsari, identified for selling ZT. 20 tractor operators trained on ZT service so far and effort is continuous. India: 1 tractor dealer in Madhubani and 1 in Purnea identified and linked with concern stakeholders. Bangladesh: Small manufacturers and suppliers identified and linked with concerned stakeholders. Dealership network initiated and established	[27]

			in some jurisdictions (Nepal, West Bengal and Bangladesh) and continued establishing new and strengthening the existing ones.	
2.4.3	Support machine development and manufacturing activities.	Aug 2016	CIMMYT -	[27]
2.4.4	Test and demonstrate the efficiencies of laser levelling on small fields.	Dec 2015	Testing and demonstration of the Laser Land Leveler (LLL) were organized across SRFSI locations. Linkage meetings, exposure visits, awareness raising events, interaction and coordination were organized in all countries targeting agriculture mechanization dealers i.e. tractor dealers, tractor operators, agro-vets and inputs dealers including community business facilitators. Trainings for its operations, benefits were organized at various location on various dates. In a few locations hands on training on LLL use was organized in presence of research and development leaders including policy makers. Promoting affordable laser land levelling services is required to increase water use efficiency and better crop establishment. The use of LLL on small-land holdings is often economically and technically infeasible. Therefore, collective leasing or voluntary consolidation of land for a contiguous plot is more appropriate and might encourage farmers for group investments in promoting water efficient technologies.	[27]
2.5	Evaluate pumps including those using alternative energy sources, and water distribution systems adequate for smallholders and service providers in the EGP	May 2014 and later as options become available Mar 2015 June 2015.	Opportunities for the use of surface irrigation water in most working communities was explored, and studies by IWMI and IFPRI suggest that there is not enough surface water for irrigation that could be potentially exploited. Therefore, the testing of pumps was dropped. However, one solar pump as a pilot testing was installed in Gaurangapur, Malda as per instruction provided. Discharge rate and other parameters were measured. The discharge rate is low. Based on the discharge rate, it required 9 to 10 hours to irrigate 1 bigha (1333 sq.m.) of land in the middle of rabi season. Hence, not very convincing to farmers. As activity 1.3.1 found a lack of surface water for irrigation, this activity and associated output was removed as a deliverable.	←

6.3 Objective 3: Catalyse, support and evaluate institutional and policy changes that establish an enabling environment for the adoption of high-impact technologies from Objective 2.

A complete summary including key methods, results and findings is available in appendices [H].

No.	Activity	Completion date	Progress achievements	Evidence
3.1	Assess and document farmer decision processes for investing in key climate-resilient technologies, including the role of risk and perceptions.	June 2018	A survey of 1,780 farmers (15% female) from the EGP was conducted in 2018. Three main types of participants were identified—SRFSI core farmers, SRFSI scale-out farmers and non-SRFSI participants. Data was analysed to assess socio-demographic profiles, farm household decision making patterns and risk perceptions. Risk Behaviour, response to new technologies, and decisions to trial and disadopt CASI were included. The results focused on decision making in terms of project participation leading to technology adoption. Farmers participating in the SRFSI project had higher levels of education than non-SRFSI farmers. Farmers who were members of an organization were more likely to participate in the project and adopt CASI technologies. SRFSI farmers were less risk-averse than non-SRFSI farmers except in Malda, where female SRFSI farmers were found to be more risk-averse than their non-SRFSI counterparts. This implies that risk preference plays a crucial role in project participation, and eventually CASI adoption. Risk taking behaviour of the farmers is associated with continuing adoption CASI technology. This work was completed under the SRFSI qualitative experiential assessment, an additional paper on negative evaluation decision processes is also planned.	[24], [25], [26], [17], [16], [29]

3.2	Initiate and establish innovation platforms in each project district incorporating farmers and agents representing many of the principal components of the main agricultural value chains.	March 2017	The definition and objective of Innovation Platform establishment among relevant stakeholders was clarified in the SRFSI context. Different priority roles were identified for each node, including facilitation, linking and strategic networking, technical backstopping, mediation, advocacy, capacity building, management, and documenting learnings. These roles were transferred to one of the IP members as the IP matured. A node level IP consisted of those persons frequently needed by farmers to help solve their everyday farming and family problems; and participation in the IP was voluntary. The IP approach adopted in the SRFSI project provided to be an effective means for involving multiple stakeholders working together in a highly participatory manner at the local farmer level. As a result 34 Node and 4 District level IPs were established and generated opportunities for rural micro-entrepreneurship. Defining the roles and responsibilities of team members was important from the perspective of everyone knowing specifically what they need to do, as well as having knowledge of what is expected of others in the team. Among others, Satmile Club, DeHAAT, Aranyak are a few examples of successful IPs running as entrepreneurs to scale CASI. The emphasis needs to be on using the IP approach to leverage and strengthen *existing* relationships. The SRFSI IPs aim to become sustainable beyond the SRFSI project by giving stakeholders confidence to use what is a generic methodology for addressing rural and agricultural development problems. IPs were an effective approach to allow widespread uptake of conservation agriculture with benefits to smallholder farmers and input and output suppliers; and as a way to promote entrepreneurs and enable extension systems to be more efficient. But there was variability across locations with respect to the effectiveness of IPs. Capitalising on existing groups and ensuring strong ownership among IP members were key to the success of IPs.	[30], [31], [32], [33], [34]

3.3	Evaluate service provider models and systems for different farmer groups, especially women farmers.	May 2015	Interviews and FGDs were conducted with farmers/key informants either as individuals or in groups with a set of questionnaires/checklist. Service Providers (SPs), village Agrovets, village Community Business Facilitators (CBFs) were also interviewed. Farmers organised into groups in different forms (e.g. self-help group, farmers' club) are more effective in delivering services including technical information, input delivery, bargaining power, attracting resources from public and private sectors including banks. These services prefer to support groups rather than individuals. FC (Farmers group/club) often do not have large numbers of women as members. A positive aspect identified was that most men were in favour of integrating women, and they have helped to establish separate female Farmers' Clubs (e.g. Purnea, Coochbehar). These clubs/groups require considerable investment from government in financial support and training to make it more vibrant to scale CASI sustainably. The expansion of such FC is needed for wider coverage, but need to be managed judiciously to ensure they remain intact and functional. Service provider models that incorporates and encourages to work with and support to the private sector including credit agencies is key to scale CASI technologies Additional work was completed in collaboration with CSISA project on service provision models for DSR in Bihar.	[35], [36], [37], [38], [45]

3.4	Strengthen CA and irrigation business models for service providers to efficiently address the needs of different farmer groups, especially women farmers, through support and training by both the public and private sectors.	Dec 2015	Training on machine operation and business services were conducted by iDE with the help of NARES in Nepal and India and NARES with CIMMYT's help in West Bengal and Bangladesh. Service providers, and agro-vets and CBFs (Community Business Facilitators) were trained on various dates and locations. Training on zero till operation technique to tractor operators; Market management and promotion training to agro dealers; SRFSI recruited and trained CBFs who were trained on entrepreneurial, marketing skills and business planning for farmers. A total of 18 CBFs have been trained and they are now associated with local agro-vets. In general, women have become vocal and capable, to some extent, to take decision independently for farming and their earnings for investment. The project trained over 3400 (9% women) LSPs - mainly machine operators for ZT/ST seed drills, LLL, Rice Transplanters including business models. Rice seedling factory run by women farmers is one of the best examples. Based on the available resources, the project encouraged and supported small and medium entrepreneurs (SMEs) by providing trainings on CASI technologies, and business management and entrepreneurial skills (women group in WB running rice seedling factory), etc. The project imparted training to service providers and agricultural inputs and outputs dealers so as to do the job by themselves appropriately in the community. These events have led to enhance different kinds of skills including business model for various stakeholders and helped to understand the value of scaling high impact CASI technologies that would remain even after the project support is over.	[39]

3.5	Develop markets for inputs and services in the target areas.	August 2015	A list of local agro-dealers was prepared in all districts and linked with large private distributers and manufacturers (e.g. Agro, National in India; Kuber and Son in Nepal; Janata Engineering in Bangladesh). The project team set-up hoarding boards with technological information in key locations in most districts for awareness creation about the services available. Commercial pockets for marketing and demand aggregation were initiated (e.g. Bihar - linkage to maize market; and West Bengal - Godrej, FPO, rice seedling factory, mini daal processing plant). Joint exposure visits for service providers to see key market places and manufacturers were organized. Manufacturers were also invited to develop linkage at the local level. Trainings were organized on market intelligence and business plan on various dates and places. Joint visit developed linkage between farmers and service providers, and raised awareness among private entrepreneurs about the feasibility of agriculture mechanization and development of rural collective center marketing. The purchase of machinery through local distributors helped to disseminate/promote CASI technologies through custom hiring centers. As a result of linkage development and training, Satmile club has a dealership with Agro. National, NABARD, Mahindra, Godrej. Marketing of maize (Aranyak), maize collection center and machinery hub for service provision (DeHaat) are other few examples that are serving smallholders and women. The concept of custom hiring centers is key to promoting CASI. Single window service either by individuals or by cooperatives/communities (e.g. self-help groups, clubs) to fulfil multiple demands of farmers for new technologies (layering of new technologies e.g. machineries, improved seed, CA based crop management practices, quality agro-inputs, etc) is more effective and sustainable. Aggregating small farmers into some form of collectives will reduce the transaction costs and also improve farmers' bargaining power in commercial transactions.	[40]

3.6	Develop policy roadmaps for the sustainable development and use of water resources along with increased market-based access to scale-appropriate agricultural machinery.	June 2017	Various proceedings from policy workshops are shared as evidence of completion. This was also intended to be addressed by a high level South Asia Regional CASI Platform. Due to complications regarding the ownership of this activity by local partners, this was not able to proceed. Discussions held with stakeholders, including policy makers at the local, regional and national levels of policy to develop options to enhance the profitability and sustainability of smallholder agriculture in the EGP. The scaling status reports serve as a precursor for inputs into future policy roadmaps. Access to groundwater is universal across the EGP and groundwater markets have played a big role in securing the universal access. More than 80 percent farmers in the region depend on rental arrangements to irrigate their crops. Diesel and electricity are the two main sources of energy for groundwater pumping in this region. Water markets continue to be expensive, because diesel pump-sets are more expensive and less fuel efficient. A shift to a cheaper source of energy for pumping groundwater is essential to ensure affordable access to irrigation. Machine subsidies should be combined with aggressive extension, especially to promote use of newer technologies and practices like ZT, LLL that reduce irrigation water use in agriculture. Electrification of groundwater irrigation in EGP should be encouraged. Liberalizing machine imports will help speed up mechanization of agricultural operations and ensure more affordable access to machine services for smallholders in EGP, which can reduce agricultural water use. However, subsidies associated with irrigation and mechanization should be designed and implemented judiciously for sustainability.	[41]. [42], [43], [44], [48]
3.6.1	Develop policy roadmaps for the sustainable development and use of water resources.	June 2015 Dec 2016	two stakeholder dialogues held on 20th-21 July and 9th and 10 October 2017 in New Delhi, organized by IFPRI. Outcomes from both events have been published (where?)	[41], [42], [43], [44], [44a]

3.6.2	Assess policies regulating the market availability of small farm equipment and explore with stakeholders options to overcome bottlenecks in equipment availability.	Mar 2016	Discussions were held with stakeholders, including policy makers at the local, regional and national levels on various dates and locations. The policy roadmaps for sustainable water use and scale-appropriate mechanization were discussed in two stakeholder dialogues on 20-21 July, and 9-10 October 2017 in New Delhi. Beside this, UBKV and DoA WB organized the policy dialogues on 13 Jan 2017 and 24 July 2018 for integration and convergence of CASI technologies into government's policy and university curriculum. Similar meetings were held in Bihar (BAU on 3rd Sept 2018) and Bangladesh (27 May 2019). Each and every smallholder cannot afford CASI equipment. Promotion of competitive rental markets in machines, therefore, is key for widespread adoption of small equipment including CASI. Machine rental markets will be more competitive and equitable if landless or near-landless farmers and farmer producer organizations are supported to set up custom hiring centres. Custom hiring centres will support smallholders better if the policy supports small local firms instead of large corporations. Machine reforms focused on local entrepreneurs and farmer institutions will create on-farm employment for youth and allow different rental models to emerge to address diverse needs of stakeholders across EGP. Women have been demonstrated to be able to perform income generating activities that feed into custom hiring centres and service provision. Though technology, policy and institutions are there for undertaking sustainable intensification of agriculture, their effective and speedy implementation at scale is crucial and requires commitment and good leadership. Enabling competitive rental markets is key for widespread access to machinery, including government support for custom hiring centres, building appropriate skills, and links to the private sector.	[40], [46]

6.4 Objective 4: Catalyse, support and evaluate institutional and policy changes that establish an enabling environment for the adoption of high-impact technologies from Objective 2.

A complete summary including key methods, results and findings is available in appendices [H].

No.	Activity	Completion date	Progress achievements	Evidence
4.1	Establish **on-farm technology validation** and learning modules and use these to help build stakeholder capacity.	December 2017	More than 3,000 participatory field trials were conducted in 40 nodes (each node consisting of one or more villages) in eight districts across three countries, and technologies tested were based on CASI principles. Researcher designed and managed on-station learning module trials were also conducted in selected districts to understand more about the technologies. Such trials included: core/long-term, systems and opportunity trials in the farmers fields, and weed management in direct-seeded (DSR) and unpuddled transplanted rice (UPTR) and rabi maize using pre-and post-emergence herbicides available in market on-station. As part of learning modules, date of sowing of wheat and maize, irrigation, tillage and N management in wheat and maize were also conducted to parameterise and validate the APSIM model. UBKV, NARC and BARI developed protocol on various CASI technologies package (for wheat, maize, lentil, mustard, jute and UPTPR) and shared among relevant stakeholders for their use. CASI practices generally resulted in comparable or slightly higher yields than those under CT, with an average 6% increase in yield (t/ha) across all systems. This ranged from -4 – 12% for rice; -1 – 13% for maize; -3 – 14% for wheat and 1 – 24% for lentil. However, the real gains were not in yield, but in the productivity increases that come with using less labour, water and energy. Wheat and maize yields were highest under zero/strip till; for lentils, zero till or relayed management performed best. The use of CASI technologies resulted in labour savings, as well as reduced drudgery, often for women. Average labour savings as a result of using CASI technologies compared to CT were 37% in rice-maize systems, 26% in rice-wheat systems, 34% in rice-lentil systems and 41% in rice-rice systems. Both pre-and post emergence herbicides either alone or in combinations had an effect on both bio-mass and grain yield of direct seeded rice, and Bispyribac 25 g a.i. per ha, applied at 15-25 DAS or at 3-4 stage of leaf) found to be the most effective followed by Bispyribac + Pyrazosulfuron. Grasses and broad leaf weeds were effectively controlled by Tembotrine alone or in combination with Atrazine (as post-emergence), whereas sedges were effectively controlled by Halosulfuron or in combination with Atrazine as post-emergence. Tembotrione alone or in combination with Attrazine seems to a clean winner with respect to maize grain yield. APSIM modelling has indicated that wet-season rice yields exhibit the opposite trend and are predicted to increase in future years, primarily as a result of increased CO_2 fertilisation that overshadows any losses due to increased temperatures and shorter seasons. Besides yield gains, the use of CASI technologies resulted in labour savings, as well as reduced drudgery, often for women. Average labour savings as a result of using CASI technologies compared to CT were 37% in rice-maize systems, 26% in rice-wheat systems, 34% in rice-lentil systems and 41% in rice-rice systems. Weed management using pre- and post-emergence herbicides for DSR and or UPTR, and ZT maize is pivotal for sustainable rice and maize production. Simulations model potentially offer winter season crops and variety for winter crop, and indicated greater GHG emissions from CA management thereby promoting resilience.	[50]

4.2	Develop and enhance the **capacity of local researchers and change agents** from both the public and private sectors to manage the participatory development of sustainable technologies within the context of local innovation systems.		See notes in 4.2.10	
4.2.1	Conduct CA courses for project partners in each country at the start of the project.	May/June 2014	The project partners were trained on CA principles, conduct of CA based trials, use of machines (including calibration) in Bangladesh, India and Nepal. Video clips and Training modules developed under CSISA were also used in SRFSI trainings. Mentoring key players of the project in order to strengthen capacity on gender mainstreaming in the context of CA was a key activity undertaken on various dates and places. Training materials on CASI were made available for use by partners. Training on LLL was organized in Nepal and Bangladesh in the presence of policy makers and extension agencies. Based on the recognized needs and the commitment and resources of public and private sector actors (scientists, officers) were trained on various aspects of CASI in each country on various dates. Training of trainers (ToTs) covered CA principles, conduct of trials, micro-entrepreneurship, CASI service providers (hands-on training on planters, laser land levelling (LLL), CA based crop production techniques and others. Over 1,900 project personnel (11% female) were trained on one or more of CASI technologies.	←, [49]
4.2.2	Provide further training opportunities to potential CA champions through the CA course in India	Each Oct from 2014.	48 Scientists were trained on one or more of the CA courses in India. >20 partners staff (scientists/officers) received an advance CA and SI courses organized by CIMMYT-BISA-PAU-ICAR in Ludhiana. This created resource persons for CASI in the EGP. 6 participants from SRFSI participated in Direct Seeded Rice International training-cum- workshop at Karnal Haryana jointly organized by HAU-Adelaide University. Partners' staff received CA-ASIA advanced training course organized by CIMMYT in India in 2016-17. One participant from WB DoA identified as a key change maker attended this master course as BISA in 2019.	←
4.2.3	Provide further capacity building and stimulus to **outstanding CA champions** in the region.	Each May from 2015	This activity was merged with 4.2.2, because the idea of sending 1-2 CA champions to Mexico was dropped and rather sent to CA training to India. Instead, Support to regional training emphasized, because sending a scientist for a similar advance CA course to CIMMYT Mexico is highly expensive.	←

4.2.4	Support and mentor project partners in key research and capacity building activities through **linkages with Australian university personnel**.	May 2016.	Linkages have been established by BAU and UBKV with Curtin University and the University of Queensland. Two SRFSI partner scientists (one each from Nepal and Bangladesh) have availed the opportunity of John Allwright scholarships in 2016-17 and are studying in Australia. Altogether 6 scientists are undertaking their higher degree through linkages. More than 6 scientists from partner organizations (SRFSI team) have applied for the same scholarships this year. Announcements are forwarded to national partners to grab capacity building/skill enhancement opportunities. Supporting for eligible scientists for seminar and workshop is continuous (e.g. International Tropical Agricultural Conference 2017 (TropAg2017). CSIRO established effective linkages with national research institutions including BISA, CCAFS and CSISA through APSIM. CSIRO provided support in a range of ways, through supervision of PhD students, informal support of in-country colleagues, and through support of in-country training courses. APSIM model training was provided to 5 SRFSI officers, exposing them to APSIM philosophies and technicalities, and bringing their competency level up to a point where they were capable of contributing to future modelling activities in the region. Don Gaydon (CSIRO) was also principal supervisor of PhD student Apurbo Chaki (BARI, Bangladesh) in partnership with Profs Neal Menzies and Ram Dalal at the University of Queensland (UQ) under an ACIAR John Allwright Fellowship. Apurbo conducted a field experiment and modelling-focussed PhD study based on SRFSI work. He has submitted his PhD thesis to positive external examiner reviews and several papers have already been published in high-impact international journals and is currently in process of finalising his PhD qualification. Don Gaydon and Alison Laing also supervised and mentored another SRFSI officer (Dr Swaraj Kumar Dutta) and an Endeavour scholar (Swaraj Kumar Dutta). Both Apurbo and Swaraj have reached a highly competent level of APSIM proficiency and are capable of leading modelling efforts in future work. Peter Brown (CSIRO, with assistance from Fay Rola Rubsen, Curtin/UWA) developed and ran a "WriteShop" with 17 participants. Several papers have been submitted or published from this effort.	←
4.2.5	Make an inventory of capacity development initiatives relevant to SRFSI and with similar target beneficiaries (farmers, self-help groups, local researchers, change agents, service providers, agri-business, value chain actors and decision makers)	Nov 2017	See below	[51]

	Overview of key programs, actors and further initiatives aiming to support CD for sustainable intensification and/or in the EGP	Nov 2017	This is covered in section 4 of scaling reports	[14a-14e]
	Overview, and database, of existing CD materials relevant to CASI	Nov 2017	This has been uploaded to srfsi.cimmyt.org in targeted databases (**https://srfsi.cimmyt.org/repository/)**, as well as the Cimmyt repository https://data.cimmyt.org/dataverse/srfsidvn	[51]
4.2.6	Capacity Development needs assessment for SRFSI target beneficiaries	Nov 2017	A field-based review of the operation of Innovation Platforms (IP) was carried out between August and November 2018. The review examined how IPs are operating, and also included individual interviews (self-assessment) and focus group discussions with different stakeholders involved in supporting IP activities to determine the major competencies required for CASI and IPs. The assessment process was conducted amongst a group of agricultural research and extension professionals, SRFSI project leaders and senior leaders from SRFSI project partners during the SRFSI annual review and planning meeting conducted in Rangpur in September 2017. A copy of the self-assessment form was provided to all participants. This provided the opportunity to identify the most important competencies and skills required to ensure the delivery of successful training and capacity building to support CASI. The future needs of the SRFSI project in meeting ambitious out-scaling targets were also taken into consideration. A total of 25 competencies were identified which are of importance to take CASI scaling agenda meaningfully in collaboration with multiple partners. ICT skills, project management skills, farming systems R&D, adoption characteristics, facilitation skills, CA machinery maintenance were identified as the most important; and agronomic management, influencing government policy, business entrepreneurship and market chain development were identified as less important training areas. Skill enhancement around business management and business entrepreneurship, influencing government policy, market chain development, soil and fertilizer management, ICT skills, CA machinery use and maintenance are key skills recognized as important for out-scaling that determines project success.	[53], [54]
	Capacity gap assessment and CD priorities established with key partners; report and workshop	Nov 2017		[53], [54]
	Assessment of threats and opportunities for scaling CASI innovations and associated capacity gaps	Feb 2018		[53], [54]
4.2.7	Develop a CD strategy and implementation plan in collaboration with partners	March 2018	Based on recognized needs, commitment and resources available, the project developed a capacity development strategy for each of the project scaling partners to organize three level of	[55], [56]

	Capacity Development strategy and implementation plan developed with, and approved by, key partners; report and workshop.	June 2020	trainings (L1 = Sr Scientists/Officers; L2= New Scientists/Officers, and L3 = Field Level for farmers). L1 and L2 were also Training of trainers (ToTs), where the conduct of scaling activities, micro-entrepreneurship and service providers with CASI (hands-on training on planters, laser land levelling, crop production techniques, etc.) topics were covered. L3 trainings were mainly targeted to farmers. Other strategies adopted were to support project personnel (researchers and development officials, extension workers, service providers, micro entrepreneurs and farmers) for regional level trainings, national and international conferences; and equipment and infrastructure support. The CD efforts have helped in changing the mind-set of communities, researchers and development professionals and these have helped in developing confidence and taking ownership of CASI technologies and thereby convergence. ToTs (L1 and L2) are effective in enhancing skills and knowledge required to scale CASI for respective participants. This arrangement helped in entrepreneurship development at the local level that encouraged CASI adoption. The project supported professional trainings for researchers and development officials, extension workers, service providers, micro entrepreneurs and farmers; strengthened the institutional linkages and capacity building; support to researchers for attending international conferences; and equipment and infrastructure support. . This was further revised with the scaling reports (section 4).	, [55], [56],[14a-14e]

4.2.8	Development and set up of a Strategically Commissioned Grant Scheme to finance partner capacity building activities	March 2018.	Broad guidelines for commission grant prepared, call for SCGS was made, guidelines for proposal selection prepared, proposal selection committee formed and awarded 4 partners to drive scaling activities across the region. iDE was also added as a scaling partners focused on value chain and entrepreneurship development. Four partners (EcoDev, DreamWork Solution, RDRS, SSCOP) were selected initially and iDE-B was added later. Subgrants for each selected partner were prepared and signed detailing activities and milestones with budget breakdown. iDE in this assignment was to work closely with SRFSI partners and implement activities collaboratively for market development of SRFSI promoted machinery and other priority value chains in order to commercialize CASI technologies. EcoDev was selected to identify eligible micro entrepreneurs from the existing SRFSI partners by measuring their entrepreneurial capabilities and creditworthiness using mpower-u tool. Dreamwork Solutions worked to develop a digital database of CASI technologies and trained NARC, DoA personnel, and University students about mobile Apps around CASI. RDRS and SSCOP were chosen to implement business skills development training and mechanisms to provide service, awareness creation, capacity building and key market linkages for CASI scaling.	←
	Eligible partners have drawn at least 80% of available funds from the SCGS to implement capacity building activities	June 2019	More than 80% of funded were dispersed under these subgrants, as reflected in final financial report.	←
4.2.9	Develop CD materials that are prioritised to improve the enabling environment for scaling	June 2020	All materials available on the SRFSI repositories. Visual Syllabus CD materials developed for at least 3 priority topics identified by stakeholders. This would have been expanded if COVID had not made such activities impossible. https://srfsi.cimmyt.org/intro-casi-visual-syllabus/	←
4.2.10	Support adoption of CASI innovations through capacity building by qualified trainers	Oct 2017	52,386 benefitted from SRFSI events including 1,177 partners' technical personnel (scientists, extension officers, technical project staff etc.) since the project inception. Of the total beneficiaries until now project trained 6445 farmers (22% female) on various topics (e.g. best-bet agronomic practices, CA based practices, APSIM modelling, etc.); 4329 farmers (28.6% female) participated in exposure/exchange visits, 6889 (43.2% female) farmers attended FGD/Consultation meeting, 12,676 farmers (43.3% female) attended field days, 661 (5.3% female) service providers, 2641 scientists/technicians/ stakeholders (32.7% female) received local/regional/international level IP training imparted by different organizations on various	[57 – see appendix 3]
	Assessment and/or Training of 15 trainers in 4 geographies before the 2017/18 Rabi season	Oct 2017		
	Trainers train 800 beneficiaries before and during the 2017/18 Rabi season	Nov 2017		

	Trained 10 lead farmers, service providers, others to become future trainers (ToT) on CASI technologies.	Sep 2018	dates; APSIM modelling exposure training was conducted at BAU by CSIRO for the research partners in 2016-17; 5 project staff received advance training on irrigation management for maintaining regional food and water security jointly organized by CSSRI (ICAR)-International Agricultural for Development; 6 partner staff received training on advance CA course organized by CIMMYT-BARI in Bangladesh; 4 partner staff were trained for farming systems analysis organized at CSSRI Karnal in 2016-17.	
	Trained 40 service providers and 10 small scale entrepreneurs on priority topics.	Dec 2018		
4.2.11	Implement trainings on priority areas defined with key stakeholders	Jun 2019	See 4.2.10	As above
4.2.12	Monitor, evaluate and learn from Capacity Development measures implemented and ensure feedback to improve processes and allow better integration in programs supporting CASI	From Dec 2017 every 6 months	Capacity Development (CD) activities have been undertaken throughout the project, for example for implementing scientists/officers, input dealers/service providers, community members and government institutions to allow implementation of project activities. Interviews and focus group discussions with the project team, stakeholders and project beneficiaries were organised and feedback from experiences and trial results were integrated to improve project outputs. In 2017, CD this was adopted as the basis of the project's scaling strategy. Plans for CD were based on a skills gap assessment, and targeted training was delivered in 2018. A separate study was commissioned to examine institutional changes experienced as a result of engagement with the SRFSI project, and whether this has contributed to scaling. CD approaches and activities have been a major focus of the SRFSI project. These CD activities have resulted in improved processes and integration with existing and new programs. Good examples of convergence are available from West Bengal. For example, the development of CASI protocols for six crops in West Bengal have been adopted by the Department of Agriculture's extension program and are actively used in project and out scaling blocks particularly in West Bengal. Further, recognising the importance of building skills in CASI along with machinery availability, the GoWB have initiated a CASI Centre of Excellence in CA, to be funded primarily from state funds. See section 3.3 of scaling reports, using Impact survey to evaluate training to outcome	[58], [53],[14a-14e]
4.2.13	Adoption study CASI innovations	September 2021	Impact survey 2021 results are presented in section 2 of the Scaling reports; and will be put into manuscript form and published as per the pending publications list	[14a-14e]
4.2.14	**Scaling pathways** to enhance the adoption of CASI assessed and reported for various farming systems and contexts	February 2018	This is explored in the scaling reports, particularly in recommendations and next steps section.	[14a-14e]
	Implementation of capacity building activities on topics identified in the scaling assessment	June 2020	This was implemented though the CASI visual syllabus, though it should be noted that COIVD-19 affected real implementation on this output. https://srfsi.cimmyt.org/intro-casi-visual-syllabus/	←

	Scaling indicators set up and monitoring system build up around that to learn from different scaling models prevailing in the project area	March 2018	This is addressed within section 9.2 of the scaling reports, which builds on the current status of CASI in each location (section 2.3)	[14a-14e]
	Partners built capacity on principles of scaling and integrate those in their programming	June 2019	ADOPT workshops run in Nepal and West Bengal using the ADOPT tool. ADOPT tool is available to all project participants. COVID did not allow full implementation of final ADOPT workshops.	[59 - "reflections on objective 3"]
	Level and extent of convergence of CASI with NARES plans/schemes assessed and reported.	June 2020	This is addressed in scaling reports (section 6) for each location and regionally.	[14a-14e]
	Scaling assessment report recommending priority areas for capacity development, recommendation for implementation of capacity building activities on topics identified in the scaling assessment.	June 2020	This is addressed in scaling reports (section 3) for each location and regionally	[14a-14e]
4.3	Enhance the capacity of local change agents, including service providers and agro-dealers, to support smallholder farmers through **technical training, business development services, and improved linkages to knowledge providers** in the public and private sector.		Initial training courses for interested agro-dealers and service providers conducted and further business development services and technical training is to be continued and strengthened. iDE organized a training on business plan involving agro-vets and tractor operators from Dhanusa and Sunsari participated. In addition to the above, the project has also recruited and trained 18 community business facilitators (CBF) in the community. CBFs are the agents to the local agro-vets and the tractor dealers Additional targeted materials and support are uploaded to srfsi.cimmyt.org	←

4.3.1	Build the capacity of change agents in the region, especially **agro-dealers and self-help groups**, to facilitate farmer knowledge development, through short courses, field evaluations, farmer discussion groups and access to high quality technical and economic information relevant to the region.	April 2015	The SRFSI project organized a range of training and extension activities throughout the life of the project. Innovation Platforms/Multi Stakeholder Groups were formed to link relevant stakeholders and build capacity for agro-dealers/service providers and self-help groups, community business facilitators in 40 locations across the EGP. Additionally, CD was used as the major scaling pathway from 2018, and training was conducted at different levels (L1 – L3) including training for trainers and farmers and service providers. Content was based on experience within the SRFSI project and a skills gap assessment conducted in 2017. Major areas covered during CD events were linkage development within and beyond IPs, CASI technologies and approaches, and business plan development including entrepreneurship. Exchange visits, FGDs, field days were organized considering the suitability of CASI technologies. Some of the service providers were taken to medium to large scale machinery manufacturers so as to establish links and skills development. The project trained over 7000 IP members, LSPs/input dealers (L2) on various technologies and practices (e.g. CASI, value chain and market development, entrepreneurial skills development, seed systems, etc.) on various dates and in locations. Over 8000 lead farmers and LSPs participated in exchange/ exposure visits, and 9843 attended focus group discussions, (FGDs)/Consultation meetings, and 21,214 farmers/LSPs attended field-days. Additional targeted materials and support are uploaded to srfsi.cimmyt.org	←, [70]
4.3.2	Develop the **capacity of local service providers** to provide efficient irrigation and crop management services that directly and indirectly contribute to resilience, sustainable intensification and increased farm profitability.	April 2015	Nepal: The project organized trainings for tractor operators on ZT operation in NARC Tarahara, Sunsari from 27-29 January 2015 in coordination with Engineering Department of NARC Centre office. 20 tractor operators were trained out of which 30% were disadvantaged group (e.g. Janjati).	←

4.3.3	Build the technical capacity and innovation linkages of local businesses through **training and support on new or modified services** to smallholder farmers	June 2020	SRFSI partners (iDE-N, B; SSCOP, RDRS) conducted training to Business Facilitators, and SHGs leads and individuals on CASI technologies and associated machineries, linkage development and business plan around CASI. EcoDev with its mpower-U tool tried to identify potential entrepreneurial capabilities and creditworthiness for LSPs and lead farmers to be promoted as entrepreneurs to scale CASI using a combination of psychometric testing and data science from the existing pool. They were also taught about how to run enterprise considering associated risks and the mitigation, competition and above all managing cash flow. Linkage development events were organized separately and embedded as one of the sessions while organizing workshops and/or training. Together with machine dealers (e.g. ZT dealers) the SRFSI partners conducted awareness-raising events in the communities to encourage the adoption of CASI within and beyond its project intervention areas. The capacity development efforts of 'how to do effective business' particularly with emerging technologies was done by EcoDev. The organization such as SSCOP conducted Business Plan training using locally available resources for other farmers groups that fall under their jurisdiction. RDRS in Rangpur conducted Business Plan training with iDE. As a result, over 100 service providers provided services in one or more of the CASI technologies across SRFSI locations and were running business in a profitable manner. With various capacity building related activities, linkages, convergences, the project has benefited over 200,000 people (28% female) since the inception and started to radiate the impact to other new locations within and beyond SRFSI locations. Supported primary though the dedicated service provider page of srfsi.cimmyt.org. https://srfsi.cimmyt.org/service-provider/	←
	Stand-alone training modules for service providers are developed and shared within and beyond the project areas.	June 2020	This was achieved via the CASI Visual Syllabus for Service providers. COVID meant that only one chapter could be filmed. https://srfsi.cimmyt.org/intro-casi-visual-syllabus/	←
	Conduct training for Business Facilitators (BF x 8) and assist with deployment across locations	Sep 2018	Covered above	As above
	Conduct business model training with micro-entrepreneurs focussing on business model development	Sep 2018	The was completed though the iDE Business syllabus which was conducted and delivered in West Bengal and Bangladesh. Business readiness assessment, Business accelerator program for Bangladesh and Business accelerator program for India were created.	[60], [61], [62]

4.4	Improve **agro-dealers and service providers' market intelligence** on new opportunities in the target regions through better linkages with 'upstream' value chain actors.	Feb 2015	The deep dive method was used to map the market system in which the project is operating, and the SWOT analysis and value chain study were conducted focusing Bangladesh. Linkage development events between local agro-dealers and seed distributors organised. EcoDev with its mpower-U tool tried to identify potential LSPs (entrepreneurial capabilities and creditworthiness) and lead farmers to be promoted as entrepreneurs to scale CASI using a combination of psychometric testing and data science with a high degree of accuracy and reliability from the existing pool. In order to enhance their knowledge and encourage then in the business, inventoried training materials and information in the form of success stories were also prepared and shared with relevant partners engaged in scaling. The knowledge and level of awareness and understanding about CASI between and among agro-dealers and service providers varied across location, which is dictated by type of technologies, location and socioeconomic conditions of actors, therefore, business plan and value chain around CASI developed for one location may not be necessarily suitable for another location. Engaging more directly with the private sector, through a joint venture or a co-investment model of agreement would be more appropriate that would help build ownership and developing pathways for sustainability. Training materials inventory prepared from different CIMMYT managed project in the region like, CSISA and SRFSI (also consist of business plan development and market development), and distributed for use by scaling partners. Information in the form of success stories were prepared and shared among relevant stakeholders engaged in scaling.	←
	Major distributors and dealers furnished with lists of local agro-dealers prepared to stock and manage updated input inventories.	Feb 2015.	Incomplete deliverable – Requesting Mahesh to provide details.	
4.5	Facilitate farmer-to-farmer information exchange through demonstration plots and field days in each project community where public, private, and NGO partners play roles as facilitators and work to strengthen farmer-to-farmer knowledge exchange.	Summer 2014 and winter 2014/15.	4329 farmers (28.6% female) participated in exposure/exchange visits, 6889 (43.2% female) farmers attended FGD/Consultation meeting, 12,676 farmers (43.3% female) attended field days, 661 (5.3% female) service providers received training.	←
4.6	Through various knowledge/ experiences sharing events and syntheses reports with field level evidence, etc. inform to SDIP II	June 2019	CIMMYT Staff attended annual SDIP Dialogues as requested by ACIAR. Project leaders attended SDIP collaboration events throughout the period and provided inputs as necessary.	[63], [64]

4.7	Facilitate, and participate in, reviews commissioned by ACIAR	Feb 2018	Various reviews have been undertaken during the project, with the major two being the mid term review and the final review, both with submitted documentation provided.	[65], [67]
	Synthesis reports on CASI agronomy and socioeconomic research completed	September 2021	Three key documents summarise research findings: namely the agronomic synthesis report on agronomic findings, the socioeconomic synthesis report with summarises socio-economic research until 2015, and the regionals scaling report which summarises scaling learnings in phase 3 of the project.	[4], [66], [14a-14e], [68]
	Test and evaluating the hypothesis that "knowledge of farmers, service providers and decision makers is a major limiting factor to scaling CASI"	September 2021	This deliverable is addressed within the scaling reports, in particular reference to the scaling status outputs and low rates of exposure alongside rates of not interested and deliberate disadoption rates. Section 2.3 of scaling reports for detail, summarised in section 9.1	[14a-14e]
	Recommendations from Rabi capacity development campaign documented	September 2021	This was integrated thought the 2021 SRFSI impact survey and reported in each locations scaling reports. . Section 4.6 of scaling reports	[14a-14e]

7 Key results and discussion

SRFSI addresses three research questions, which form the skeleton of this section:

[1] Should CASI be scaled in the EGP?

> (i.e. *Would farm management practices based on the principles of conservation agriculture (CA) and the efficient use of water resources provide a foundation for increasing smallholder crop productivity and resilience);* and

[2] How has CASI been institutionalised across the region?

> (i.e. *Would institutional innovations that strengthen adaptive capacity and link farmers to markets and support services enable both women and men farmers to continue to innovate in the face of climate and economic change*); and

[3] Has momentum for CASI been created, and what more can be done to support further momentum building?

7.1 Question 1: Should CASI be scaled across the EGP?

7.1.1 Phase 1 Proof of Concept Results

Results from more than 400 participatory on-farm multi-year field trials demonstrated that CASI practices improved productivity (3 – 6%) and profitability (17 – 41%) while reducing input related emissions (6 – 12%), water (11%), energy inputs (6 – 11%) and labour requirements in rice-wheat, rice-maize and rice-lentil systems in the EGP. When considering CA coupled with diversification from the Rice – Rice systems which are traditional across much of the EGP, the impacts were even more pronounced.

The introduction of CASI practices improved rabi season wheat and maize yields by 5 %; rice yields were unchanged from those achieved under traditional cultivation (Islam et al., 2019). At the cropping system level, yields in rice-wheat rotations were significantly higher (by an average 4.1 %) when CASI practices were implemented in one or both crops than when both crops were grown under traditional management. Similar results were observed for the rice-maize (average yield increase of 4.2 %) cropping system.

Cropping system yield (normalised to rice-equivalent yield, REY, in all crops) was lowest in the rice-wheat system with an average of 8.6 t ha^{-1} (Islam et al., 2019). Other double cropped systems had average yields of 10.9 t ha^{-1} in rice-rice, 12.3 t ha^{-1} in rice-maize and 12.6 t ha^{-1} in rice-lentil. Intensifying the rice-wheat system by including a third crop increased the mean system REY to 13.1 t ha^{-1} in rice-wheat-mungbean and to 13.6 t ha^{-1} in rice-wheat-jute. Rice-wheat-mungbean is a cropping system better suited to the drier areas of the EGP, whereas rice-wheat-jute is an effective intensification option in more easterly wetter regions.

CASI practices significantly reduced the labour required for crop production by an average of 40 % relative to traditional farmer practices (Gathala et al., 2021). Under traditional crop management, a rice-wheat system required an average 131 person-days ha^{-1}, which resulted in a labour productivity of 6.41 USD person-day^{-1}. In contrast, a rice-wheat system under CASI management in both crops required an average of 82 person-days ha^{-1}, which increased the labour productivity to an average 14.0 person-days ha^{-1}. Similar savings were observed in other cropping systems: in the rice-maize system CASI practice achieved average labour savings of 58 person-days ha^{-1} or 39.7 % compared to traditional crop management, while in the rice-lentil system average labour savings of 37 person-days ha^{-1} (37.8 %) were observed relative to traditional crop management. Significant labour savings resulted from the elimination of land preparation before crop establishment, the removal or mechanisation of transplanting rice, and chemical herbicides replacing manual weed control. As a result of the labour savings observed cropping system production costs reduced by an average of 40 % and gross margins increased by up to 25 %.

For individual crops, net income was increased by 17 – 34% using CA techniques, with net income for wheat increased by the highest amount. System level net income is increased by a greater amount, almost doubling for rice-rice systems. Compared to conventionally tilled rice-rice systems, diversifying to alternative crops and using CA techniques can increase profitability by 47 – 168%.

Total water use was reduced by 5 – 13% when CASI techniques were used (Islam et al., 2019). Higher water savings were recorded in wheat, maize and lentil. Mungbean is a short duration, low water use crop in any case and so the opportunities for water savings are lower. Rice crops shown here are rain-fed crops, and there is little opportunity to control water application and hence total water use remains the same. Irrigation water use was reduced by 11% at the system level when CA techniques were used.

Total energy inputs at the farming system level were reduced by 6 – 11% when CA techniques were used. With CA techniques and diversification from Rice-Rice systems, the savings were much greater, between 19 – 60%. Rice-Lentil systems had the lowest energy inputs, likely due to lentils not requiring nitrogen fertiliser. This shows the relationship between yield, income and CO_2-e emissions, clearly demonstrating that with lower emissions, higher yields and profit can also be achieved (Gathala et al., 2020). Similar work on intercropping of maize with leafy vegetables such as potato, peas, spinach and red amaranth showed that these systems were always more profitable than sole maize, although did require higher energy inputs, although this was offset by higher yields.

CASI results in a reduction of input related emissions of between 6 – 18% (Gathala et al., 2020). Maize has the highest emissions on an area basis, followed by wheat, rice and lentil. For individual crops, CASI treatments reduce emissions on average by 14% for wheat, 10% for maize, 18% for lentil and 8% for rice. For cropping systems, emissions were reduced between 9 – 12% through the use of CASI technologies. Rice-Rice systems are the most emissions intensive cropping pattern (even excluding direct methane emissions from flooded paddy), followed by Rice-Wheat-Mungbean, Rice-Maize, Rice-Wheat-Jute, Rice-Wheat and Rice-Lentil. Replacing Rice-Rice systems with any of the other alternatives can reduce emissions by 37% - 65% for two crops, and even when a third crop is added (i.e., Mungbean or Jute), emissions are still 27 – 39% lower.

CASI farming systems were also more profitable (Gathala et al., 2021). For all cropping systems, using CASI practices increased gross margins by 17% – 96% due to reduced input costs associated with these systems. Lowest increases of 17% were found for Rice-Maize and Rice-Wheat-Jute systems, while CASI Rice-Rice systems almost doubled profits compared to conventional tillage. When Rice-Rice systems diversified in the rabi season to a different crop type, increased profitability ranged from 47% – 168%.

Separate analysis was conducted on increases in returns to different categories of households, including female, male and all households. Increases in returns to female headed households ($/ha) were similar to those for all/male headed households. In one dataset covering a range of locations and cropping systems, the average increase in gross margin was $468/ha for all households compared to $461 for female headed households; in some cases returns are larger for women headed than for male headed/all households.

Relevant Report: Jackson, T. M., Tiwari, T. P., & Chatterjee, K. (2018). Contributions to improved food, energy and water security for sustainable food systems. SRFSI Synthesis Report. https://static1.squarespace.com/static/5ad6d42a7e3c3a444757cf50/t/5b1782af03ce6412864ce30d/1528267454339/SDIP1+Synthesis+Final.pdf Appendices [L]

Relevant manuscript: Islam, S., Gathala, M. K., Tiwari, T. P., Timsina, J., Laing, A. M., Maharjan, S., Chowdhury, A. K., Bhattacharya, P. M., Dhar, T., Mitra, B., Kumar, S., Srivastwa, P. K., Dutta, S. K., Shrestha, R., Manandhar, S., Sherestha, S. R., Paneru, P., Siddquie, N. E. A., Hossain, A., … Gérard, B. (2019). Conservation agriculture based sustainable intensification: Increasing yields and water productivity for smallholders of the Eastern Gangetic Plains. Field Crops Research, 238(February), 1–17. https://doi.org/10.1016/j.fcr.2019.04.005 Appendices [A]

Relevant Report: Brown, P. ., Darbas, T., Kishore, A., Rola-Rubzen, M., Murray-Prior, R., Anwar, M., Hossain, M. ., Siddique, M.-E.-A., Islam, R., Rashid, M., Datt, R., Kumar, U., Pradhan, K., Das, K. ., Dhar, T., Bhattacharya, P., Chowdhury, A., Ghosh, A., & Tiwari, T. (2020). Implications of conservation agriculture-based sustainable intensification technologies for scaling and policy: Synthesis of SRFSI Phase 1 socioeconomic studies (2012-17). ACIAR Technical Reports Series, No. 93. https://www.aciar.gov.au/srfsi-tr93 Appendices [M]

Relevant Report: Mahesh K Gathala, Thakur P Tiwari, Saiful Islam, Sofina Maharjan & Gerard Bruno (2018). Research synthesis report: Sustainable and Resilient Farming Systems Intensification in the Eastern Gangetic Plains (SRFSI). https://www.researchgate.net/publication/324517051_Research_Synthesis_Report_Sustainable_and_Resilient_Farming_Systems_Intensification_in_Eastern_Gangetic_Plains Appendices [K]

7.1.2 Phase 3 Confirmation of Concept Results

N.B. This section provides a summary of the SRFSI Impact assessment survey. Due to space limitations only regional analysis is presented.

Yield changes due to CASI

Changing to CASI practices in Rabi season was perceived as overwhelmingly positive on yield outcomes, with 78% of respondents reporting yield benefits from CASI in Rabi and 79% of respondents reporting yield benefits from CASI in Kharif. The scaling reports provide deeper analysis by location and crop, while **Figure 7** presents the distribution for each surveyed CASI practice.

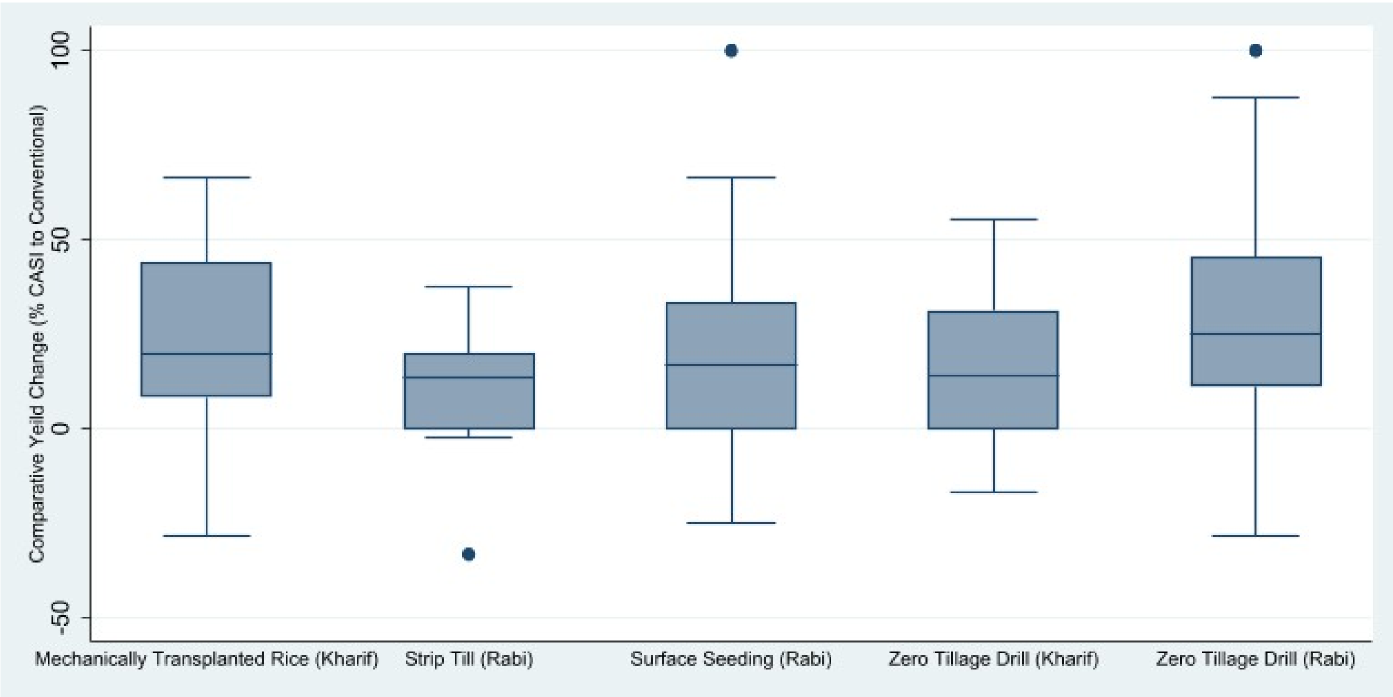


Figure 7: Distribution of yield changes by CASI practice due to change from traditional to CASI practices in Rabi season as perceived by users of each practice.

Experienced Benefits of implementing CASI Practices

Across 15 livelihood challenges, CASI users were asked to classify their experiences implementing CASI. All livelihood challenges except drudgery were found to be beneficial by the majority of CASI users, though it was usual for each of the challenges to have between 5% and 15% of respondents who were disadvantaged. The scaling reports also report against Location and Technology type while the overall CASI experience is presented in **Figure 8.**

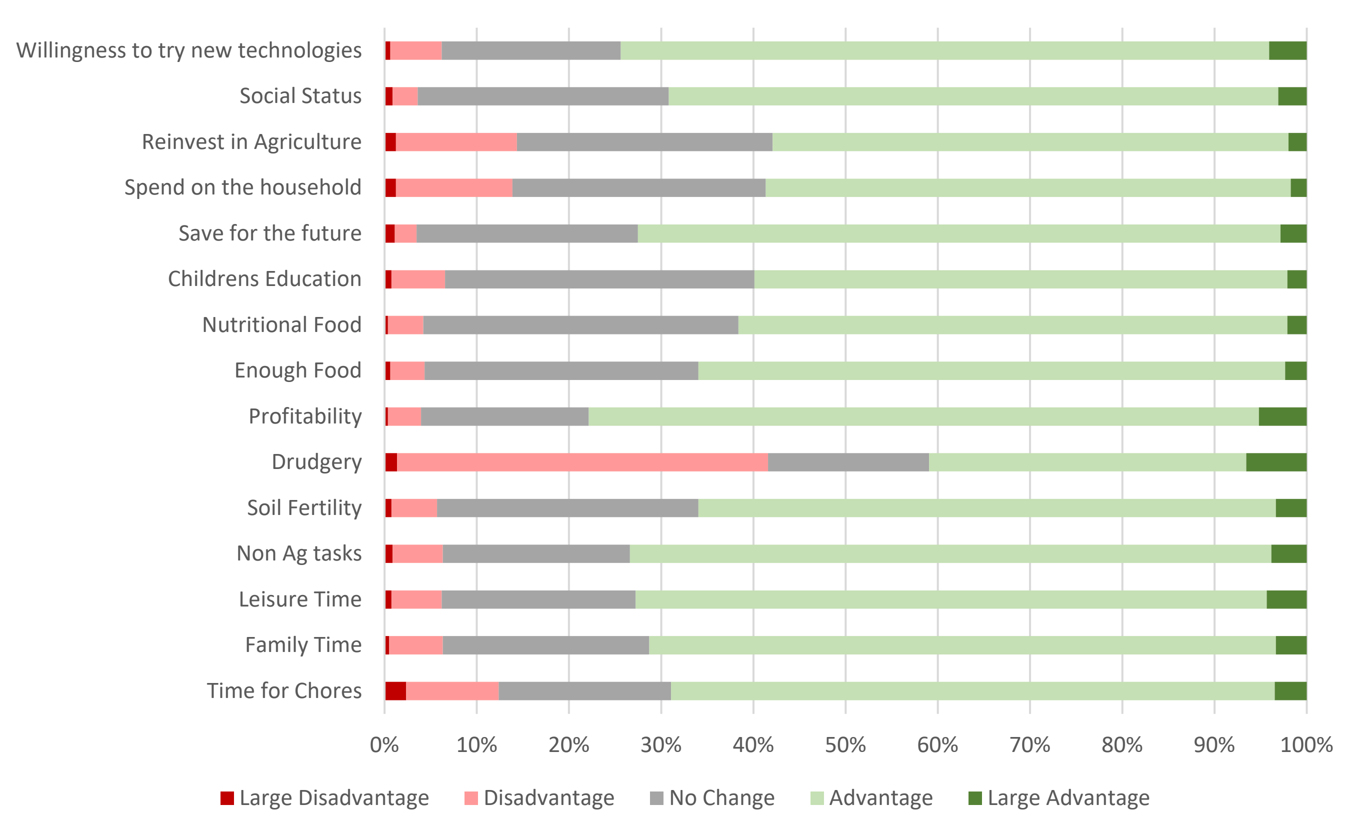


Figure 8: The impact of CASI use on various livelihood constraints as experienced by CASI users (Regional Summary)

Breadth of experienced benefits of implementing CASI Practices

In terms of cumulative benefit, 50% of CASI users regionally experienced benefits in 12 or more of the 15 surveyed challenges though CASI use, highlighting the multiple benefits that are experienced by CASI users. Compounded benefits tended to be higher in Coochbehar and Rajshahi where the majority experienced 12 or more benefits out of 15, while the lowest experiences were in Sunsari and Rangpur where 50% of the population experienced 7 or more and 6 or more of the 15 benefits simultaneously. In terms of disadvantage, in all locations 50% of respondents experienced at least one disadvantage, meaning that it is not a total 'always win' situation. However, the rate of high incidence of compounding disadvantage was low in all locations (**Figure 9**).

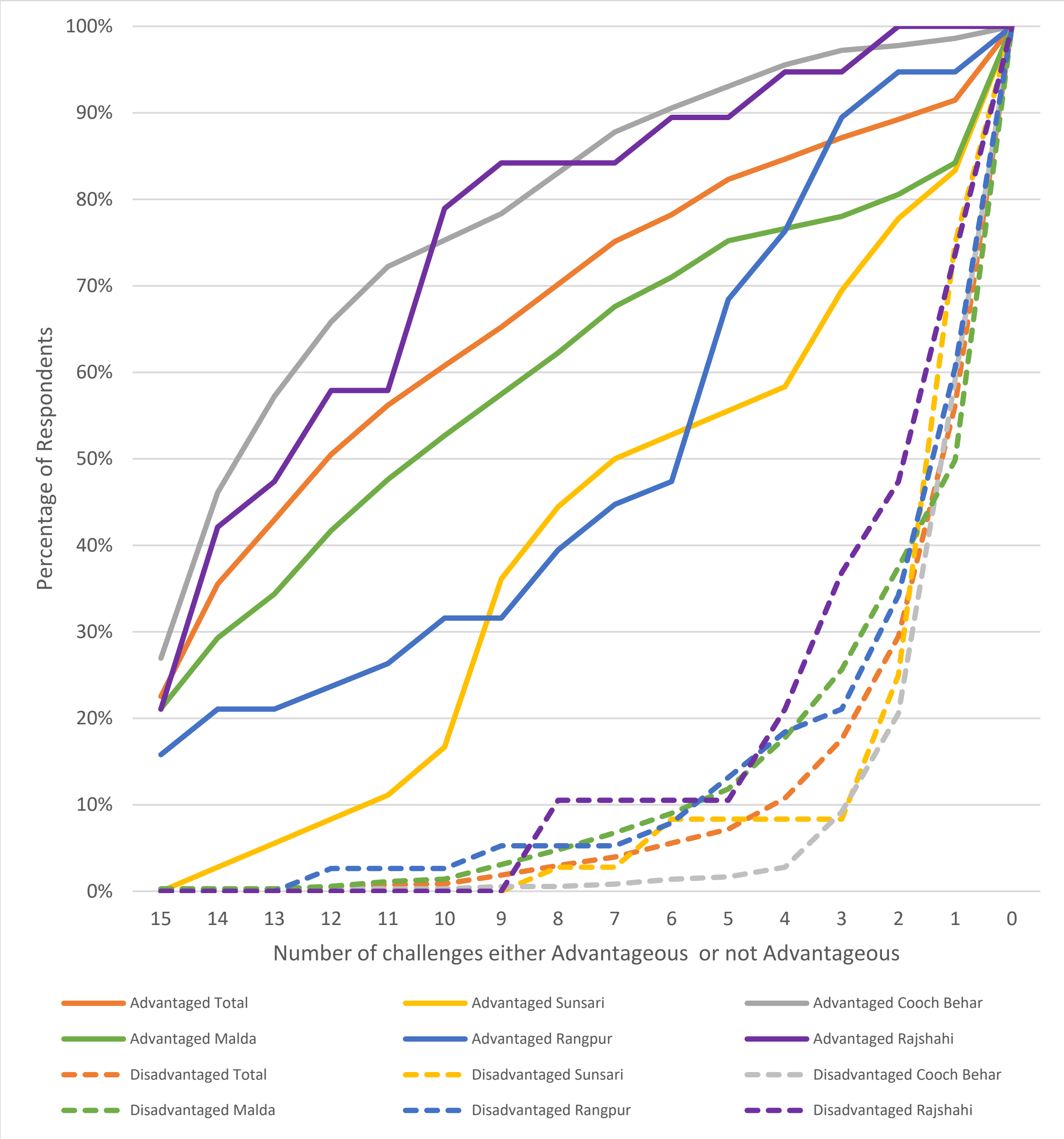


Figure 9: Cumulative benefits of CASI use across 15 livelihood challenges as perceived by users.

Livelihood benefits and relationship to current livelihood challenges

To understand if the livelihood constraints faced by CASI non-users match with the experienced benefits of CASI use by CASI users, a comparison was made. Across 13 livelihood challenges, a pattern emerged of strong livelihood challenges faced by CASI non-users that were paired with potential benefits from CASI practices, as experienced by CASI users (**Figure 10**). This suggests that CASI can provide benefit to common livelihood challenges experiences across the region (i.e. that it is regionally relevant). An analysis by location is available in the scaling reports.

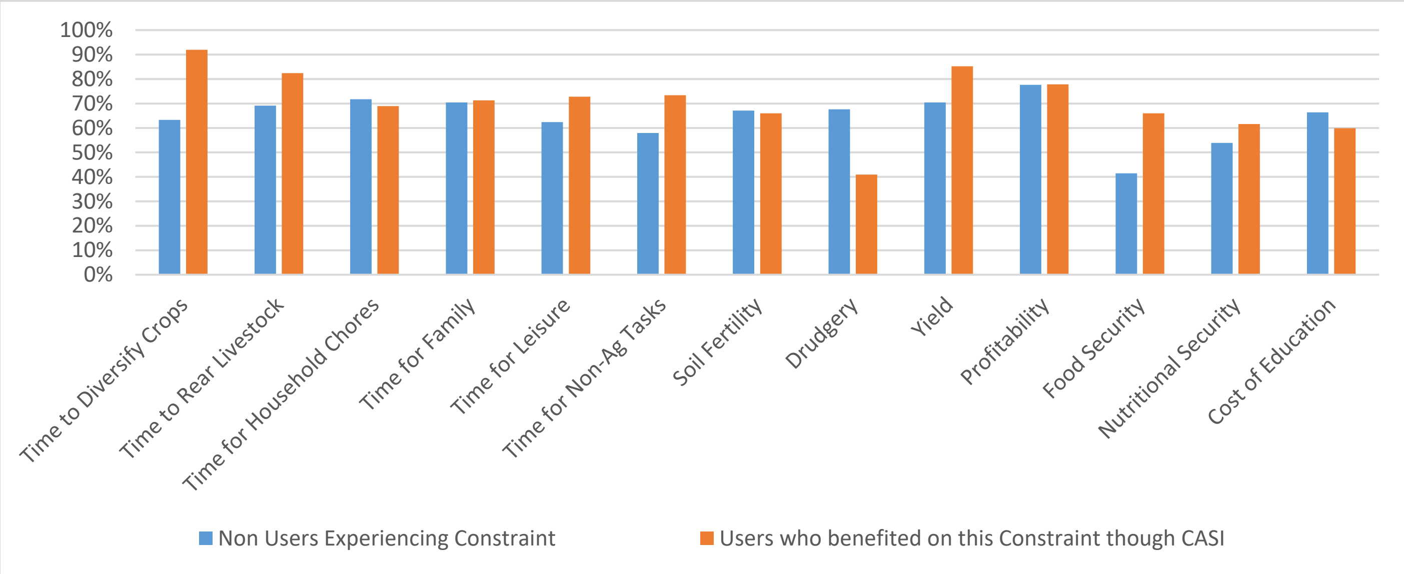


Figure 10: Comparison of current livelihood constraints of CASI and the benefits on each of those livelihood constraints as experiences by CASI users.

CASI as an enabler of Diversification

Based on CASI user respondents, a strong pattern of CASI as an enabler of diversification can be observed. 92% of CASI users identified that CASI use enabled crop diversification, while 82% identified CASI use enabled livestock diversification enabled through CASI (**Figure 11**). The types of crop and livestock diversification by region and practice are elaborated in the scaling reports.

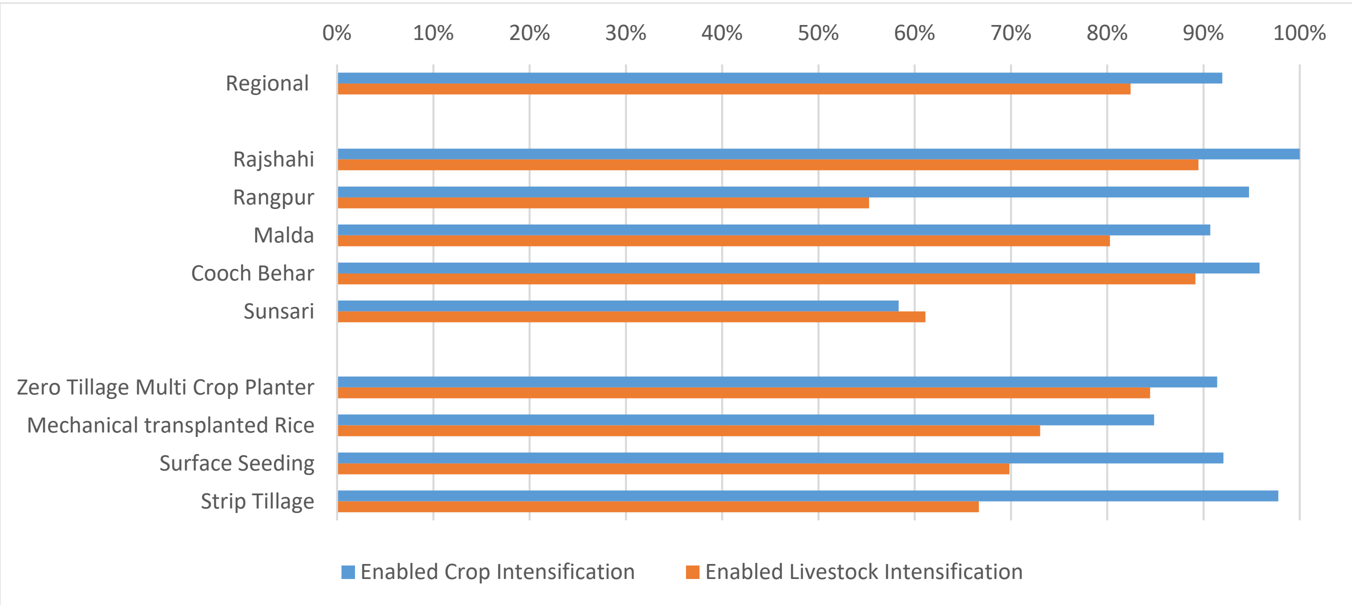


Figure 11: the impact of usage of CASI practices on Livestock Intensification and Crop Diversification

CASI as an enabler of Time Savings through herbicide use

CASI use in the region has the potential to lead to significant reductions for both household heads in time spent weeding in all locations (**Figure 12**). Data collected from the first five weeks post planting during the photovoice experiment indicates that 61% respondents experienced decreased engagement in weeding related tasks due to herbicide use and zero tillage. Only 3% reported increased personal weeding time and 2% for weeding supervision.

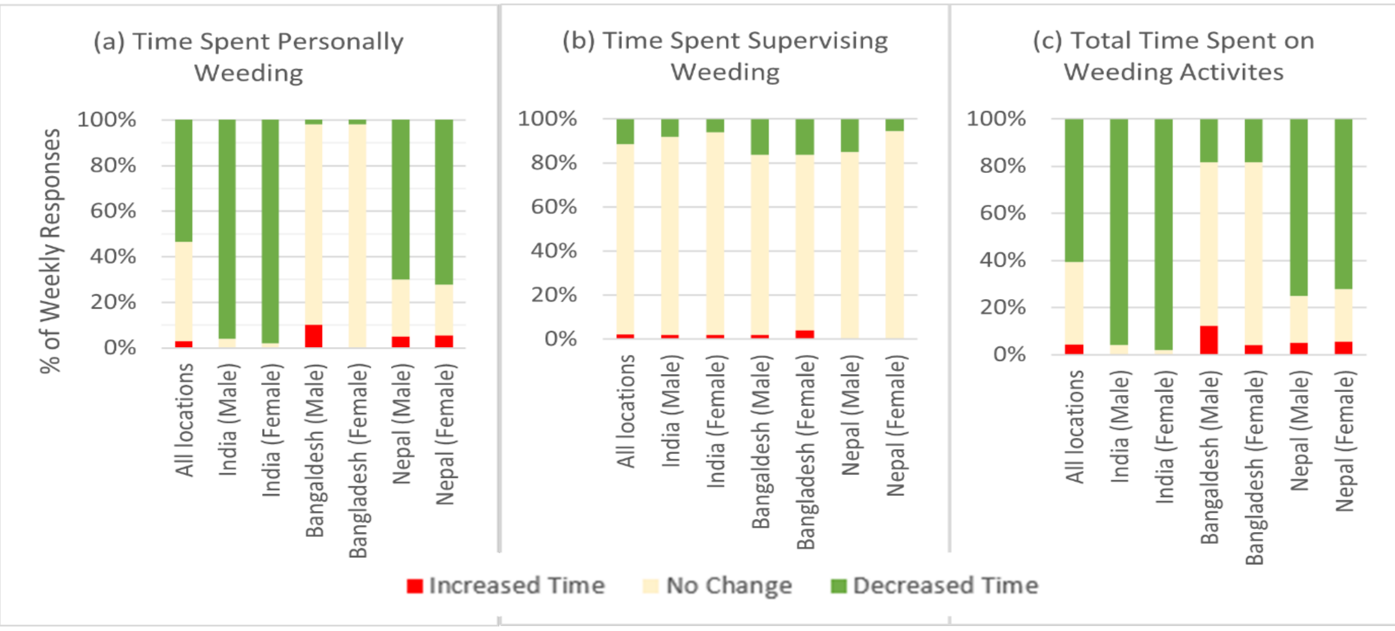


Figure 12: Comparison of Time related outcomes between a ZT and conventional system

In terms of location specific trends, respondents in Nepal and India experienced significant time savings compared to Bangladesh (**Figure 13**). Men in Bangladesh transitioned from supervisory role to personally weeding but still reported decreased time engaged in weed management. Women in Bangladesh did not engage in personally weeding and also spent less time performing supervisory roles in comparison to a conventional system. Respondents in India and Nepal reported substantial reductions in personal weeding time (84% in all but one respondent) with women experiencing more time savings compared to men. Savings largely stem from the shift in weed management practices, from manual weeding to herbicide use. Men are generally responsible for the task of spraying herbicide while women tend to play a supportive role during herbicide preparation. Reductions in time spent supervising can be explained due to time freed from meal preparation for labourers. Women often monitor the work when they deliver meals to the labourers and the use of herbicides has freed their overall workload.

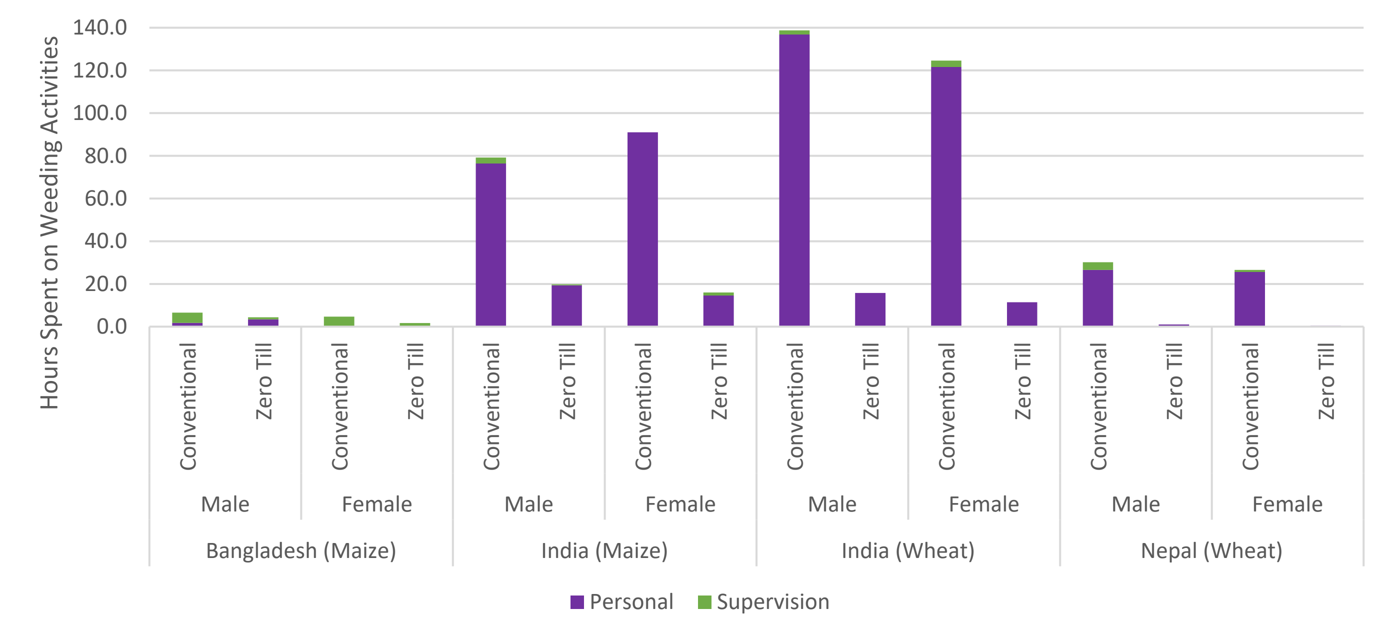


Figure 13: Comparison of total hours spent on weeding related activities in first 5 weeks post planting

Manuscript Reference: Brown, B; Karki, E; Sharma, A; Suri, B; Chaudhary, A (2021) Herbicides and Zero Tillage in South Asia: are we creating a gendered problem? Outlook on Agriculture 50 (3) pp238-246 https://doi.org/10.1177/00307270211013823 Appendices [I]

CASI as an enabler of overall happiness and satisfaction

According to the Photovoice survey, respondents experienced substantial benefits though CASI use, namely time and financial savings, by transitioning to a ZT system (**Figure 24**). Respondents included both household heads in all locations and the benefits and outcomes reflect both men and women's experiences. Both men and women reported utilization of extra time and money to engage in various on farm and off farm activities, such as commercial vegetable farming, livestock rearing as well as investing in agri-business opportunities such as seed production, service provision. Finances were also invested in enhancing the household with construction of cemented homes, toilets, livestock housing and purchase of various modes of transportation for ease in commute. Overall, respondents were able to diversify their income generating opportunities and fulfill both self and family's expectations which further led to increased resilience, improve livelihood outcomes and overall life satisfaction.

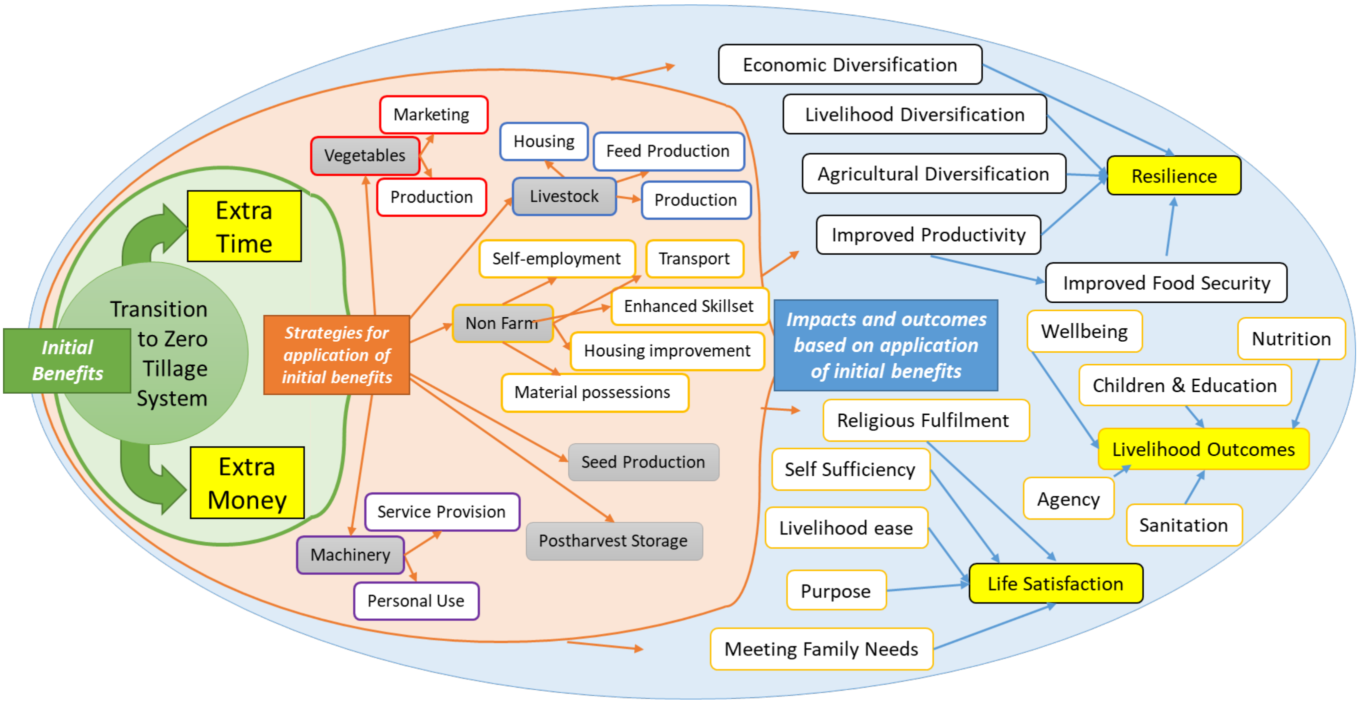


Figure 14: Implications and Outcomes of application of initial benefits in a ZT system

Manuscript reference: Brown, B et al. (2021) From farm benefit to livelihood implications - a photovoice exploration of the wider implications of cereal intensification in South Asia. Journal of Development practice (Under Review - Revision submitted November 2021) Appendices [J]

7.1.3 Is CASI female-friendly?

As a priority topic that was been little explored in the EGP, particularly efforts were put into understanding the gendered implications of CASI on women's livelihoods. This is a topic that has achieved much attention in Sub-Saharan Africa but much less in Asia. Overall, our confirmation of results suggests that CASI does not increase female burdens and does provide new opportunities to increase agency and empowerment.

Quantitative findings from the SRFSI 2021 Impact survey

The Impact survey contains two opportunities for a gendered analysis. Firstly, through 1,285 paired interviews with both man and woman household heads, and secondly by man compared to women headed households (325 women headed households from 5,068 respondents). Unfortunately, due to time limitations that delayed data collection due to COVID-19 in the region this is not yet complete and cannot be reported here.

Qualitative findings from the Photovoice assessment

The findings of the photovoice assessment concluded that CASI does not increase female burden in the first seven weeks post planted of CASI, a usually intensive period of weeding activity. In fact, woman heads tended to benefit from CASI systems more than their man counterparts. These benefits were often linked to compounding benefits for economic opportunity and increased agency. These results were summarised and presented at the 8th World congress on conversation agriculture and received a best poster award (Figure 15).

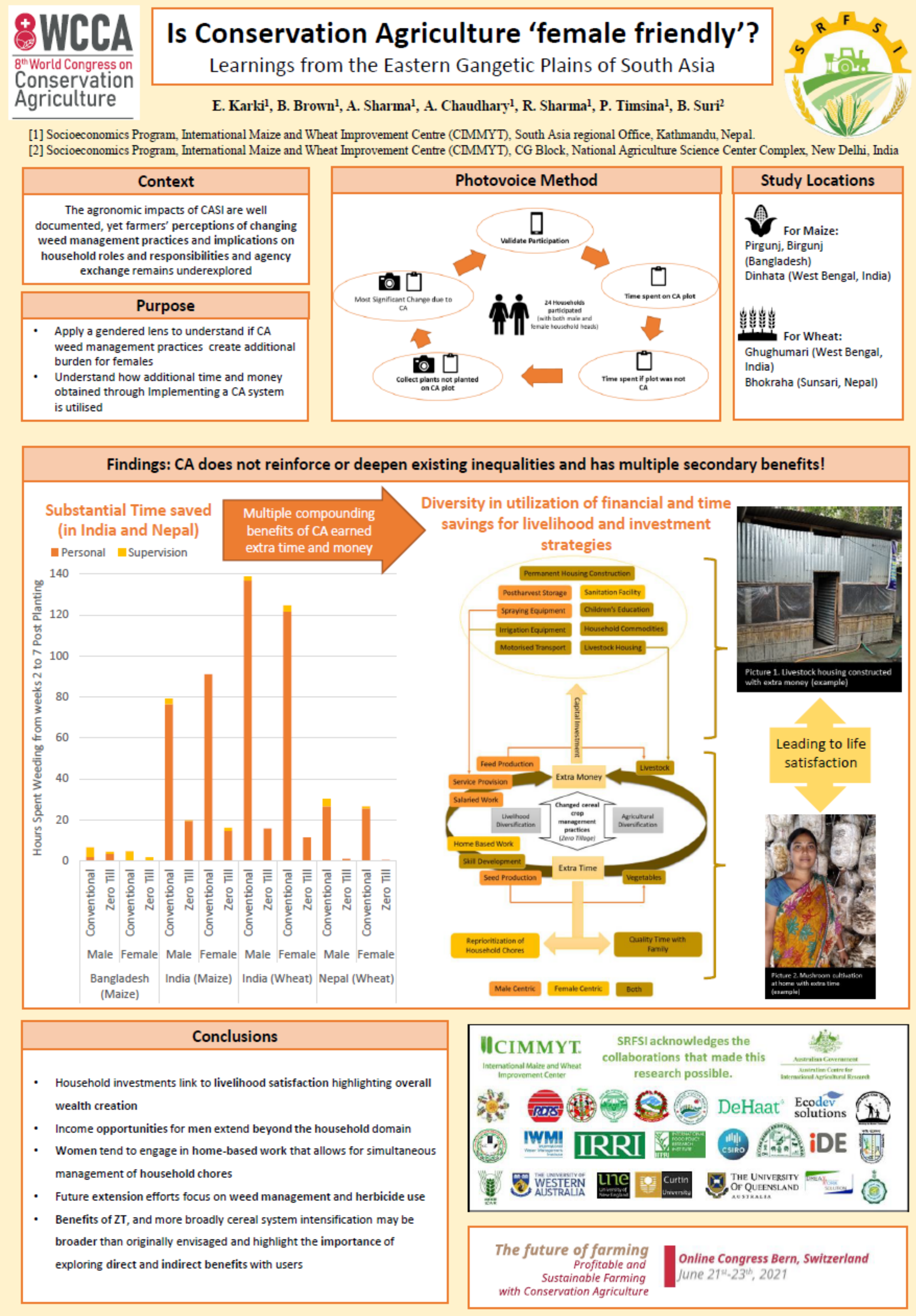


Figure 15: Poster exploring if CASI is 'female-friendly' in South Asia, awarded best poster at the 8WWCA.

Manuscript Reference: Brown, B; Karki, E; Sharma, A; Suri, B; Chaudhary, A (2021) Herbicides and Zero Tillage in South Asia: are we creating a gendered problem? Outlook on Agriculture 50 (3) pp238-246 https://doi.org/10.1177/00307270211013823 Appendices [I]

Manuscript reference: Brown, B et al. (2021) From farm benefit to livelihood implications - a photovoice exploration of the wider implications of cereal intensification in South Asia.. Journal of Development practice (Under review - Revision submitted November 2021) Appendices [J]

Qualitative findings from the SRFSI qualitative experiential assessment

How does Gender affect evaluation of CASI?

Findings from the CASI experience at household level indicate that the household heads are largely in agreeance in terms of their evaluation of benefits of CASI machinery use but there are differences in how the benefits shape their overall experience within the household and in the larger community. Spouses tended to highlight similar agronomic, financial, and labour benefits and based on their experience mentioned several requirements needed to use ZT machinery. However, men were more likely to indicate less direct and visible benefits such as crop strength and resilience against weather damage and also mentioned specific requirements that lead to better ZT results. Divergence was strongest in terms of weed incidence with women more likely to indicate higher weed growth and even emergence of new weed varieties compared to their spouses. While the benefits and requirements were location specific rather than regionally consistent, female spouses were less likely to identify them compared to men. Similarly, while both men and women were acutely aware of the financial savings and benefit, women were less likely to indicate specific savings such as reduced input requirements compared to their spouses indicating future training efforts still need to engage with women to provide formal training to realize the indirect benefits and make informed decisions as a household.

In terms of weed management, women were more likely to benefit from decreased workload due to herbicide use. Men tend to perform the task of spraying herbicide allowing women to engage in more supervisory roles. Many women highlighted freed time from meal preparation and delivery responsibilities for hired labour and were largely not expected to perform agricultural tasks such as manual weeding. However, women from wealthier households who are responsible for post-harvest tasks do not experience any substantial change in roles due to ZT use. Change in status was experienced by both men and women but women were more likely to focus on intra-household dynamics with many indicating better relations with their spouses which led to increased influence in household decision making and gaining respect from other family members. In addition, improvement in household finances, stemming from ZT use and in some instances service provision, women experienced a change in behaviour from community members. However, despite change in status women were less likely to be viewed as ZT information sources, especially in Bihar and Rajshahi. On the other hand, women in Cooch Behar, Malda and Sunsari, were more likely to be sought by other women to learn more about ZT use.

Prioritization of saved finances were largely common across all locations with households spending additional money on fulfilling basic needs followed by investing in children's education, purchasing livestock or building a home. However, women were more likely to highlight saving for future such as wedding or land purchase while men were more likely to focus on purchasing gifts for their wives, buying a television for the family or being able to provide a nutritious meal for the family. Prioritization of extra time due to ZT use also indicated a regional pattern where men were more likely to engage in supplementary employment while women reallocated their time back to culturally prescribed roles such as household chores and childcare. While women were still engaged in unpaid household work, they were largely satisfied with reduced drudgery and their ability to prioritise household tasks. Engagement in income generating opportunities was limited to Cooch Behar and Sunsari where women either participated in skill development via communal group engagement to engage in home based mushroom cultivation or provided support to their household agri-business. However, this indicates that combining skill development training appropriate for home-based work with CASI promotion, particularly in communities with socio-cultural norms that restrict mobility, can provide potential opportunities to women to realize their preferences and priorities.

Manuscript reference: Karki, E; Sharma, A; Suri, B; Chaudhary, A, Timsina, P.; Brown, B (2021- In Preparation) How does gender influence the evaluation of Conservation Agriculture in South Asia? Appendices [N]

Is CASI contributing to changed gender norms in the region?

The majority of the rural Global South continue to depend on agriculture for their livelihoods, either directly or indirectly. Despite the fact that women account for more than half of the world's farmers, they face gender-specific challenges such as cultural and social norms that limit their access to land or assets, financial markets, agricultural training, and information. These challenges result from deeply rooted and culturally defined gender roles for women, and particularly so in South Asia. Women play an important role in these production systems, but their contributions are frequently overlooked, and their needs rarely addressed. Despite these norms, the current trends of increased outmigration, labour scarcity in farming, and increasing requirement of shared responsibilities, are making it likely that women in the Eastern Gangetic Plains will become more active in the agricultural landscape. Through semi-structured interviews with farmers in six locations across the Eastern Gangetic Plains, this study examines how necessity is becoming a driving force in the bending of clearly established agricultural gender norms. Women's participation in agriculture was found to be heavily influenced by social and cultural barriers, and they frequently identified receiving social criticism for breaking the systemic gender norms. However, gender norms are beginning to shift for women, highlighting their participation in agriculture alongside men. This paper emphasises on the growing trend of bending gender norms with recommendations for increasing women's participation and scope in future agriculture development initiatives; particularly those involving technology and mechanisation and taking appropriate steps to encourage their participation through policies and interventions that emphasise gender equality.

Manuscript reference: Timsina, P.; Sharma, A; Chaudhary, A.; Karki, E; Sharma, A; Suri, B; Chaudhary, A.; Brown, B (2021) Necessity as a driver of bending agricultural gender norms in the Eastern Gangetic Plains of South Asia (Under review - Submitted October 2021) Appendices [O]

7.2 Question 2: How has CASI been institutionalised across the region?

7.2.1 Institutionalisation leading to policy convergence

The SRFSI theory of change theorised that building the capacity of large volumes of individuals in potential change making organisations would lead organisations to adopt pro-CASI agendas that would support CASI scaling over the longer term.

To achieve this, more than 60,000 people received some form of training through the SRFSI project (with approximately 30% identifying as women). These trainings were across a broad range of potential stakeholders including farmers, service providers, extension agents and policy makers. Additionally, support structures were established through innovation platforms that enabled co-learning and improvement of CASI practices.

Such efforts can be linked to considerable further non-SRFSI investments in CASI-oriented agenda's across the region. Some examples include:

- The West Bengal Government enforcing all new government supported **custom hire centres** must have CASI machinery as compulsory parts of their subsidised machinery package.
- The Indian Council of Agricultural Research (ICAR) sanctioning and the West Bengal Department of Agriculture funding for the Regional **Centre of Excellence for Conservation Agriculture.** While the project supported with AUD$50,000 for infrastructure, all ongoing costs for machinery, staffing and demonstrations are state funded to the tune of INR 2.98 crore (approx. AUD$5.5 million).
- The Government of Bihar sanctioning and funding of the **Climate Resilient Agriculture Programme (CRAP)** that focuses on zero and minimum tillage planting to adapt and mitigate to climate change. This project has a value of INR 60.65 crore (AUD$ 11,057,842).
- Government of West Bengal has approved and set up 25 **Seedling Hubs with mandatory CASI** in West Bengal under NFSM scheme
- The Government of Bihar funded **Scaling up Climate Smart Agriculture (CSA)** through **Mainstreaming Climate Smart Villages (CSVs)** to promote the use of CA machinery in 300 villages. This project has a value of INR 25 crores (AUD$ 4,557,064)
- Run by the Department of Agriculture in Nepal, locations in Sunsari introduced a "Grow ZT wheat campaign" in 2019 in which subsidized wheat seeds are provided only to ZT growers.
- BARI collaborated with Development Association for self-reliance, communication, and health **(DASCOH) foundation**, a non-governmental organization for continuing the CASI scaling out.
- Ministry of agriculture in Bangladesh provided machineries with subsidies for establishing Farm Service Centers under Farm Mechanization Project comprising of 6 different machines in 1 Upazilla of each district. RDRS collaborated with DAE and supported by capacity building of skilled operators and conducting awareness campaigns to make these service centers operational in 10 upazillas.
- On January 8, 2020, the cabinet approved the framework of the National Agriculture Mechanization Policy for 2019 in Bangladesh. The policy specifically mentions about the benefits of CA and focuses on expansion of CASI. Farmers in the country will be able to acquire modern farming equipment at cheap prices through cooperatives, as well as take out low-interest or no-interest loans.

SRFSI was the primary organisation to promote CASI in the region and primary provider of training through three levels of training, and hence any non-project current and future CASI activities can be directly traced to SRFSI as a catalyst. This then highlights a direct linkage between SRFSIs level one training and the development of various initiatives in the region, highlighting success in achieving institutionalisation.

West Bengal has the strongest and most visible linkage in this process. Block extension officers and various policy makers were invited for CASI sensitisation and training as part of initial effort sot institutionalise CASI. Though this process, eventually Block officers, who have some autonomy is budgetary spending in their locations of work started to integrate CASI into their normal programming (particularly though the ATMA scheme). This process of institutionalisation was presented by the West Bengal team at the 8th World congress of conservation agricultural which was awarded the best poster prize (**Figure 16**).

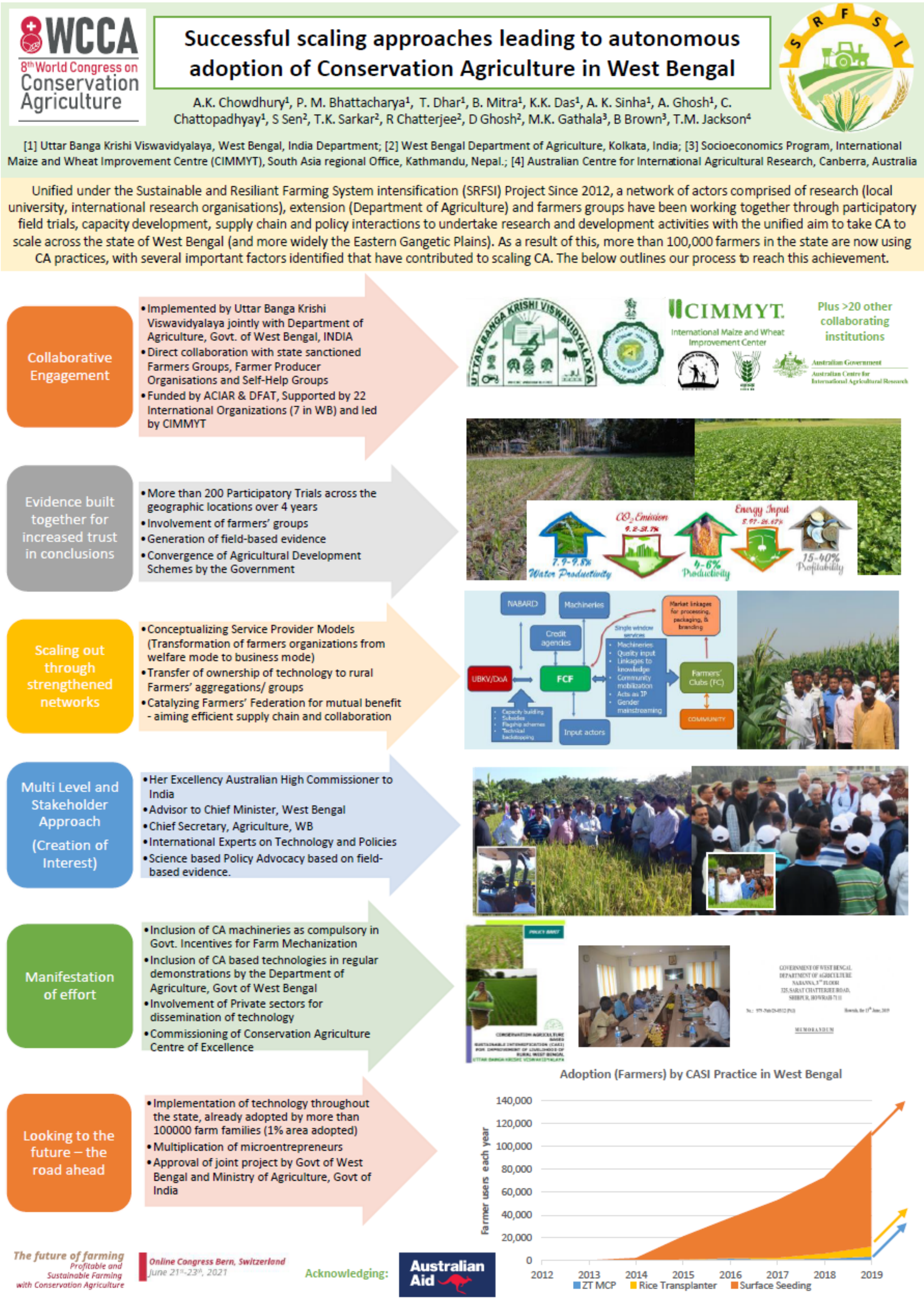


Figure 16: Poster presented at the WCCA.

7.2.2 Farmer recognition of government support

Another way to consider institutionalisation is to explore if farmers believe that the government is supportive (both in principle and in practice) of CASI practices. If the population perceived government support, it is suggestive that some convergence has occurred. Farmer appreciation of the approval of government can also be important in their decision-making processes and assessments (Brendan Brown et al., 2017a)

According to the SRFSI Quantitative impact survey, across the region most respondents believed that their government wanted them to practice CASI technologies, though this tended to be lower in Sunsari and Malda. Respondents who perceived government to support CASI practices were also asked if they believed there was support provided by government to support them use CASI practices. Regionally there was substantial belief that support from governments were available, though this was lower in Rangpur (**Figure 17**). Overall, this suggests farmers perceive government support and convergence which is a positive sign of convergence with government programs.

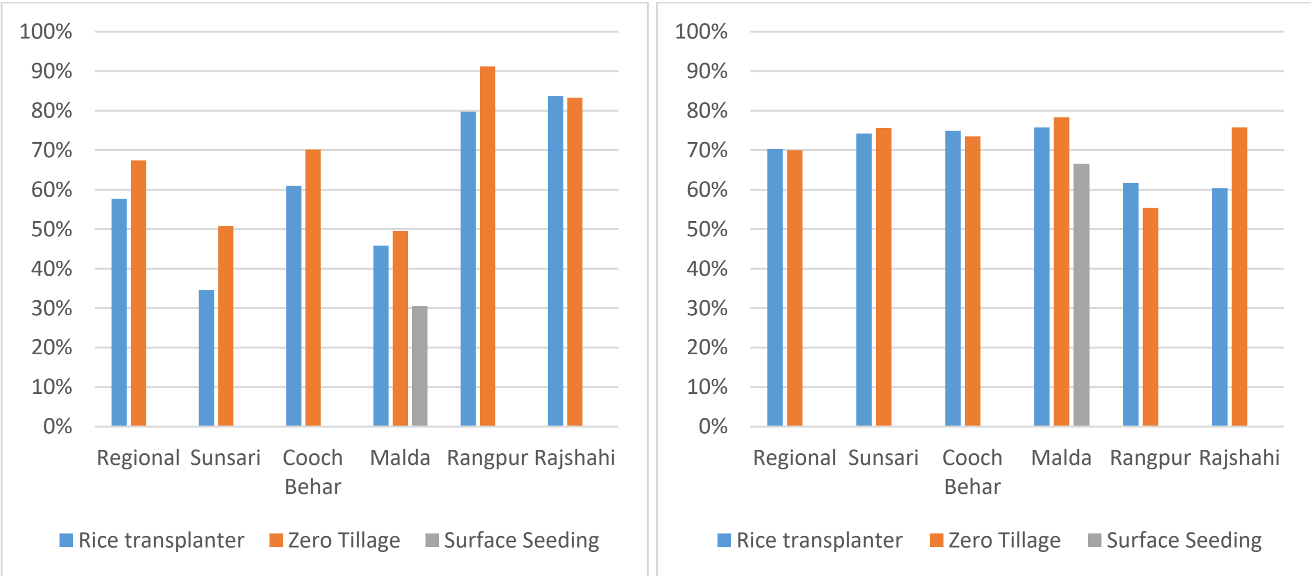


Figure 17: The proportion of populations that perceive that the government wants them to do each CASI practice (left) and the proportion of the population that perceived they can access government to support each CASI practice (right).

7.3 Question 3: Has momentum been created for CASI in the EGP?

7.3.1 What is the current status of CASI uptake in the Eastern Gangetic Plains?

SRFSI partner implementing organisations have been estimating uptake across their jurisdictions since 2012. According to these estimates, there has been varying uptake of CASI practices across the region.

By Farmer implementations

N.B. 'farmer implementations' refers to the decision of a farmer to use a CASI planting practice in any given season. It is framed this way because data has been collected on a seasonal basis and hence some farmers may be double counted if they apply CASI practices in both Rabi and Kharif seasons, if reported on an annual basis.

In total, at least 424,686 CASI farmer implementations have occurred since the inception of SRFSI, with an annual peak of at least 116,434 CASI farmer implementations during 2020 (**Figure 18**). This has primarily been achieved in Rabi season, accounting for 85% of CASI farmer implementations. Surface seeding (i.e., following the principles of zero tillage without machinery) was responsible for 87% of farmer uptake of CASI in 2020. West Bengal dominated with 99% of farmer adoption in 2020 across the region (**Figure 19**).

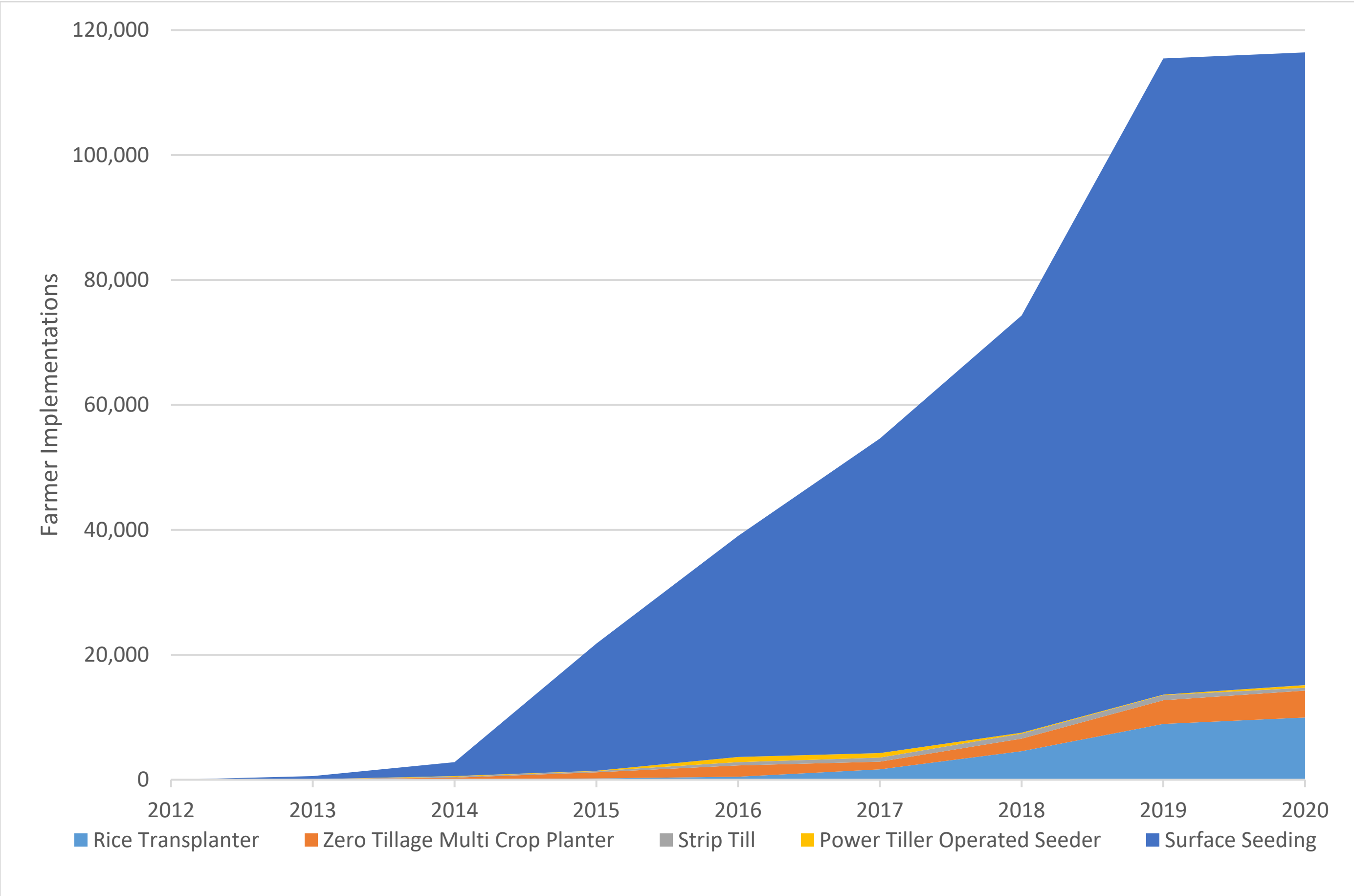


Figure 18: Partner estimates of the extent of uptake of various CASI practices by farmers across the EGP (presented by practice).

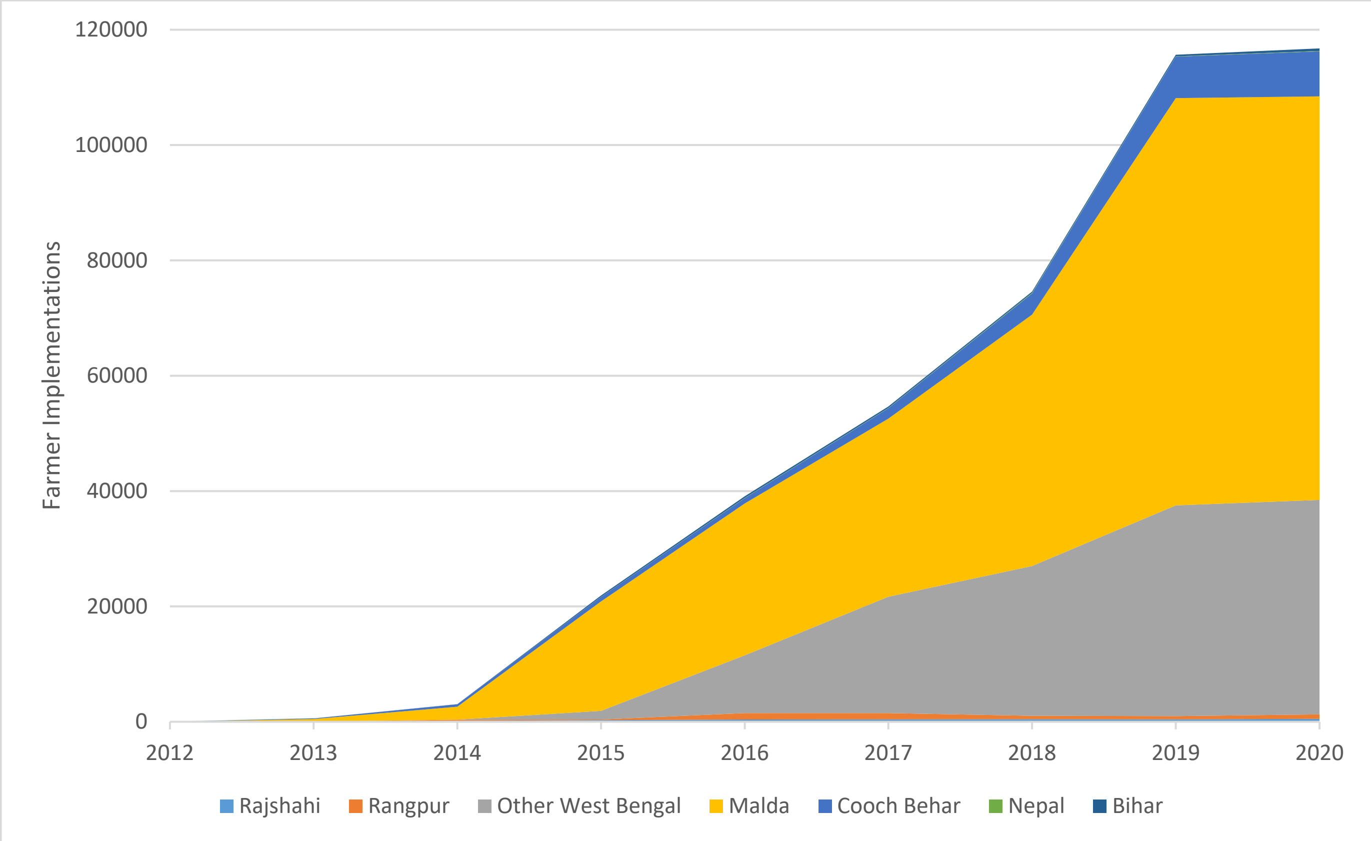


Figure 19: Partner estimates of the extent of uptake of various CASI practices by farmers across the EGP (presented by location).

By Area

In total, at least 150,832 ha have applied CASI planting principles since the inception of SRFSI, with an annual peak of at least 40,148 ha during 2020 (**Figure 20)**. Surface seeding accounted for 86% of total CASI practice by area, making it the dominant CASI practice used across the EGP, followed by the Mechanical Rice Transplanter (7.9% of CASI uptake in 2020) and the Zero Tillage Multi Crop planter (3.7% in 2020). Mustard was the primary crop planted using CASI practices (**Figure 21**).

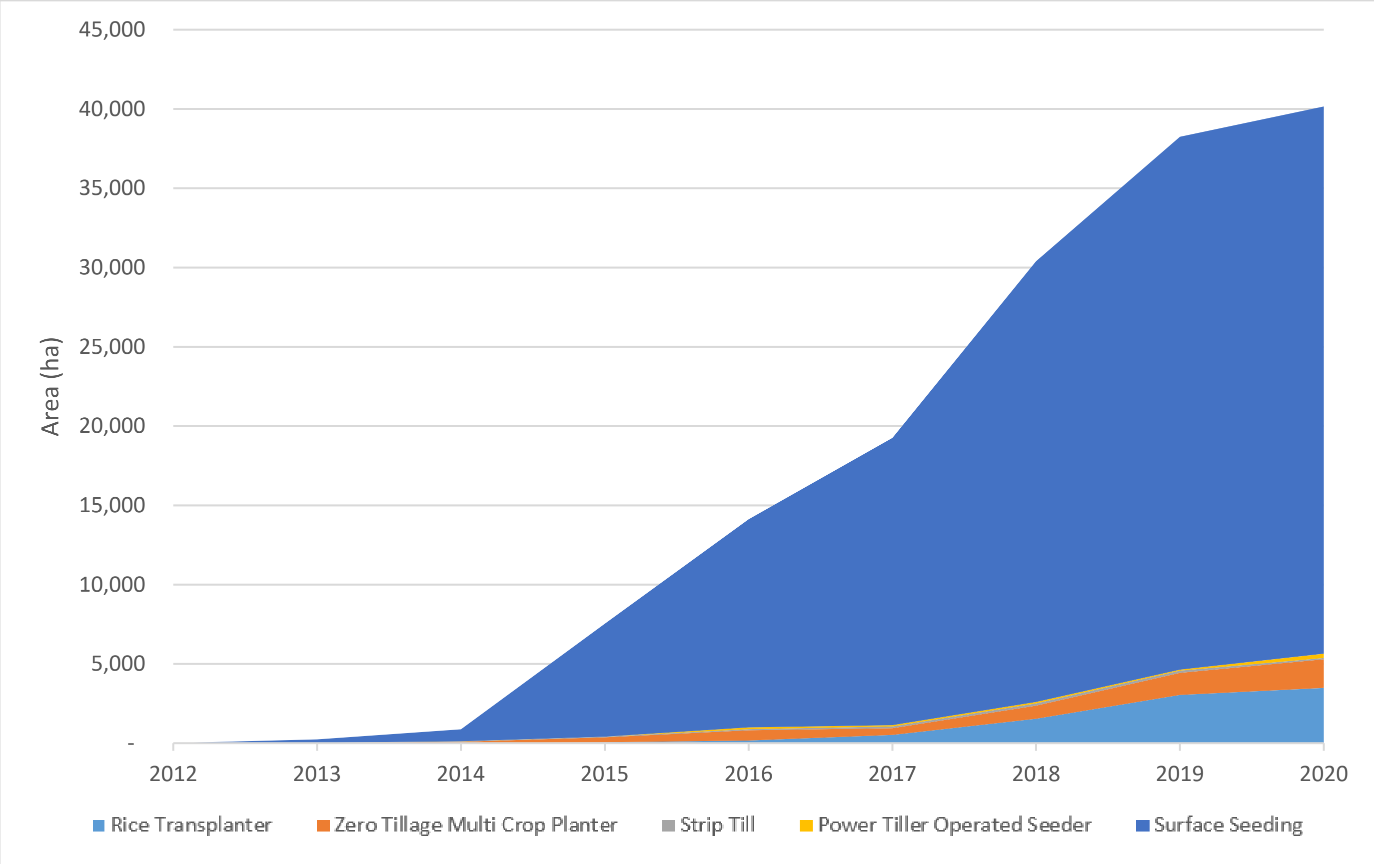


Figure 20: Partner estimates of the extent of uptake of various CASI practices by area across the EGP (presented by practice).

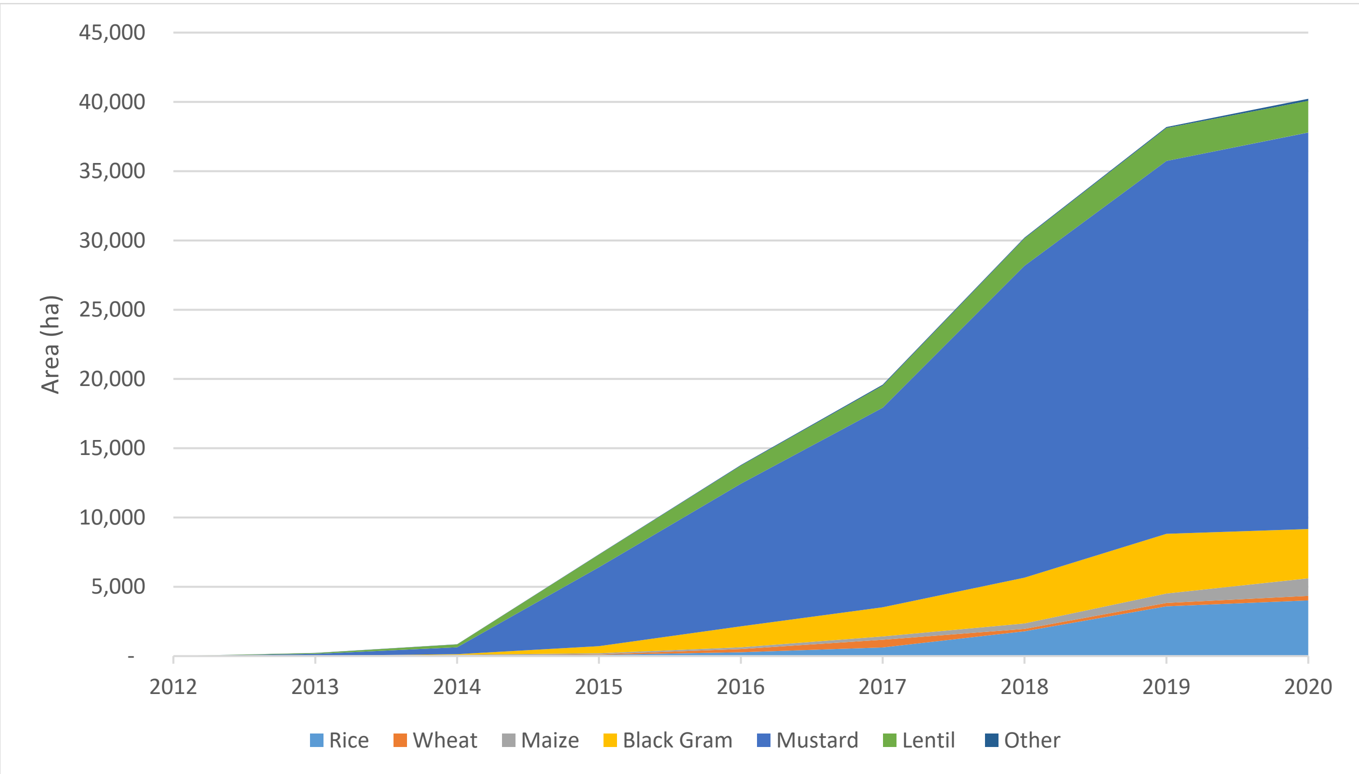


Figure 21: Partner estimates of the extent of uptake of various CASI practices by area across the EGP (presented by crop).

7.3.2 What is the extent of exposure and use across the region?

Adoption rates alone cannot provide a full understanding of the types adoption dynamics occurring communities. To explore this, two different approaches were employed using the 2021 Quantitative impact survey. The first assesses a population in terms of their awareness and use to understand the extent of exposure and use over time. Figure 22 highlights the rates of awareness for each of the CASI technologies by location. In all locations there is an obvious increase in awareness, particularly between 2016 and 2020. This may be related to COVID-19 and the limitations of projects ability to continue extension activities, or that the reach of the project has been reached using current extension methods.

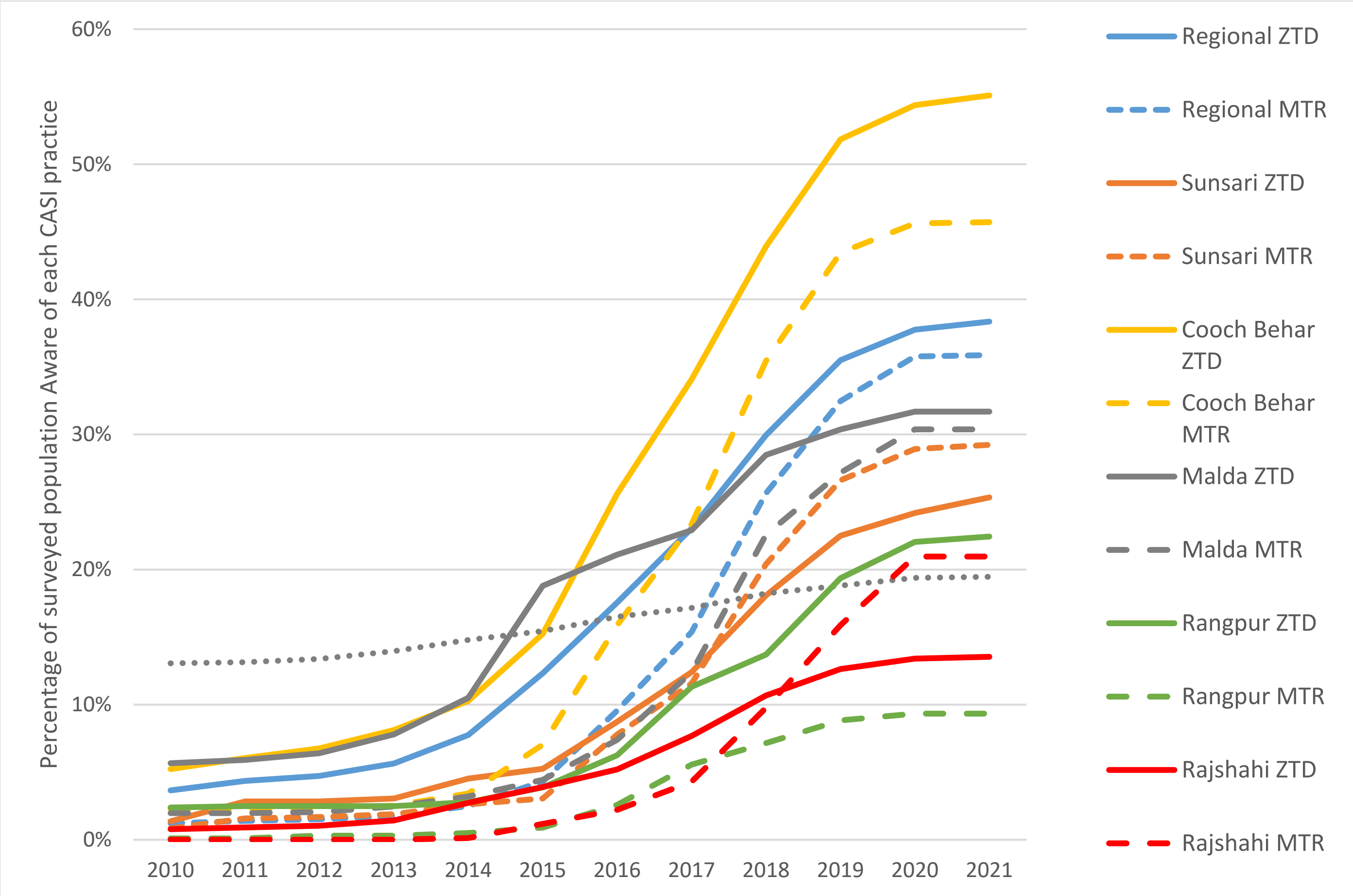


Figure 22: Awareness rates for each investigated Technology from 2010 to 2021 by location. (ZTD = Zero Tillage Drill / Multi-crop planter, MTR – Mechanical Transplanter for Rice)

Figure 23 presents the binary adoption rates for each technology. This highlights that adoption is plateauing in most locations after strong uptake during 2017 to 2019. The zero tillage/ strip tillage drills tend to have higher rates of use then the mechanical rice transplanter in all locations.

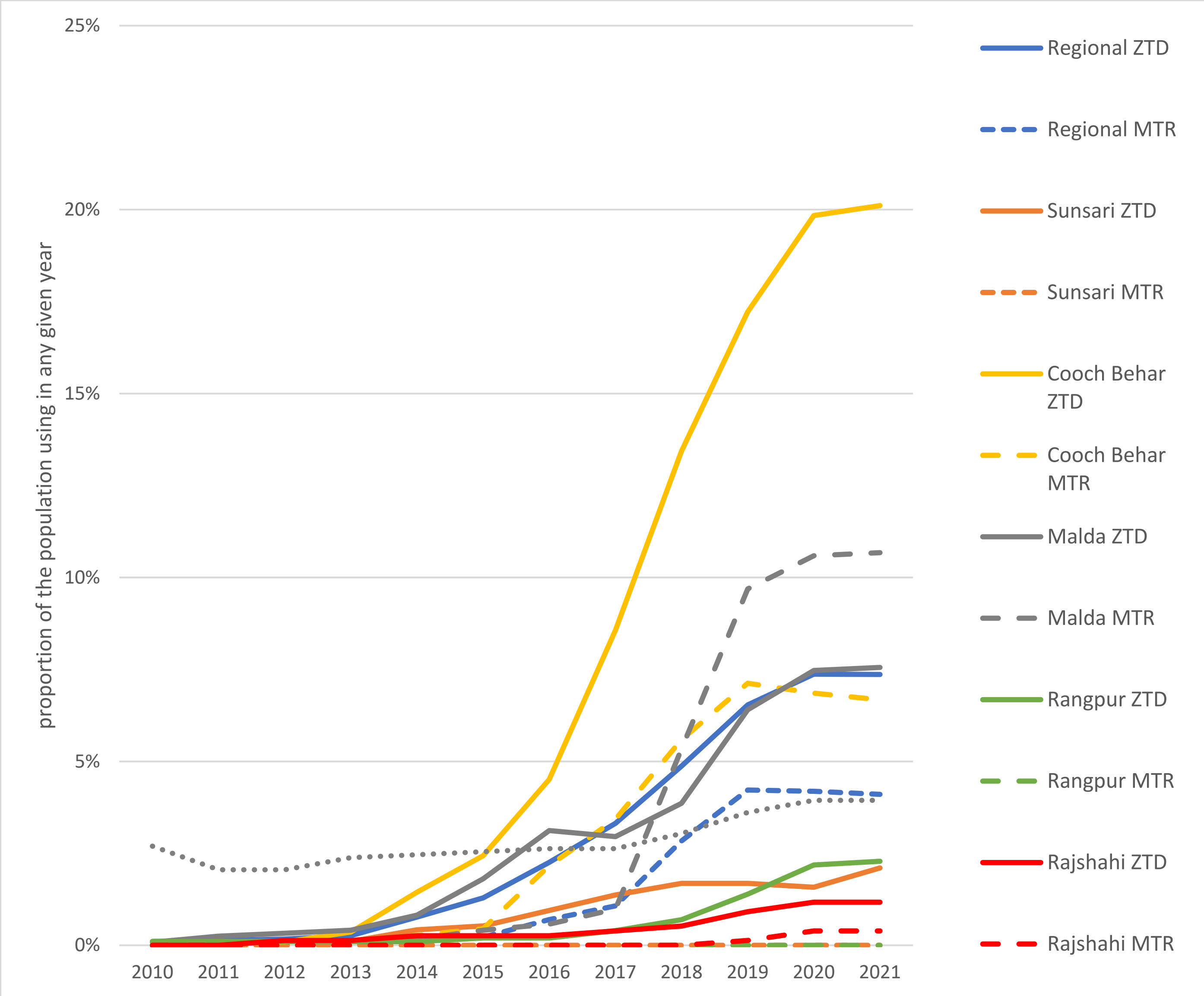


Figure 23: Current usage rates for each investigated Technology from 2010 to 2021 by location. (ZTD = Zero Tillage Drill / Multi-crop planter, MTR – Mechanical Transplanter for Rice)

These results can also be framed proportionally to understand community level dynamics on who is unaware, who is aware without using, who has used and who continues to use. For the zero tillage Drill (ZTD), at a regional level adoption remains constrained. Most respondents in 2021 remain Unaware (**Figure 24**). Across the different locations of the survey, different trends are evident. In Cooch Behar there is substantial though plateauing awareness, while Bangladesh continues to have limited awareness of strip tillage machinery. Despite this, exposure remains the key constraint to further scaling of the zero-tillage drill in all locations.

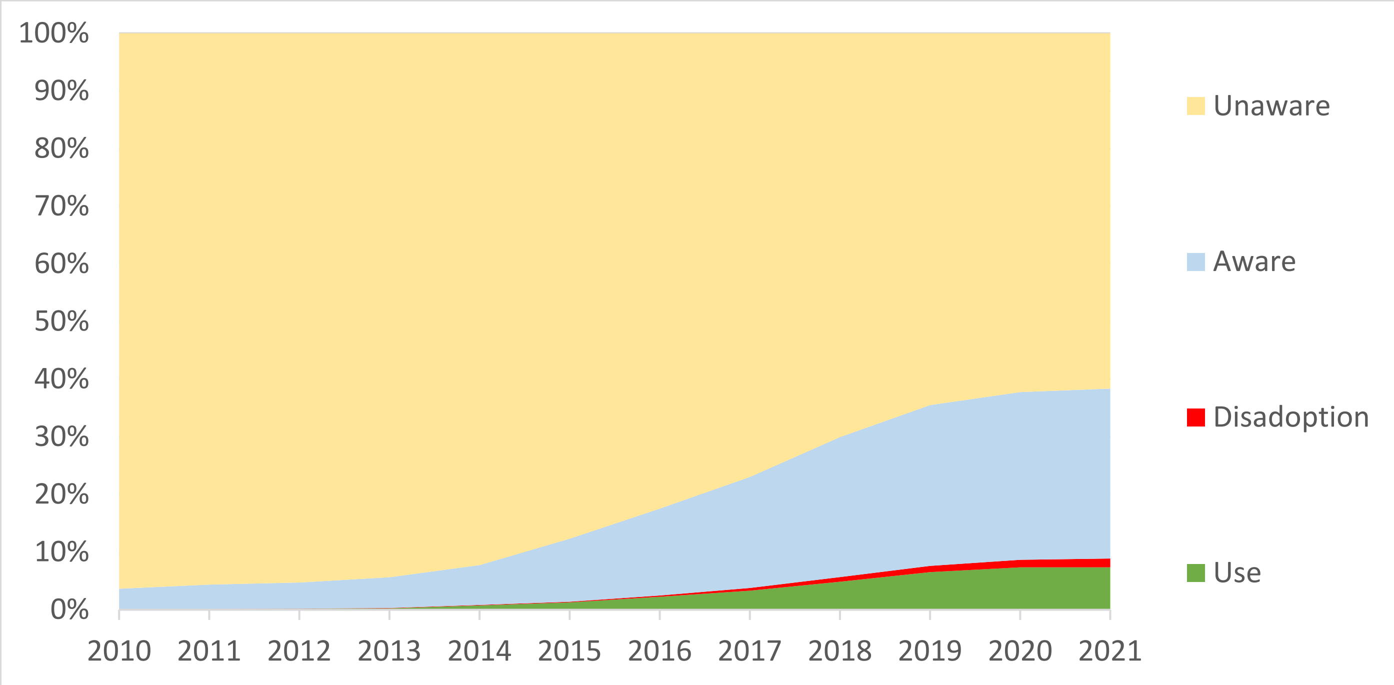


Figure 24: Zero Tillage typologies by year (Regional Summary)

Like the Zero Tillage equipment, Exposure remains the dominant constraint, though there is also a sizable proportion of aware farmers who are not progressing to use (**Figure 45).** Across the region, varying Adoption proportions exist, with particular distinction between West Bengal and the other location.

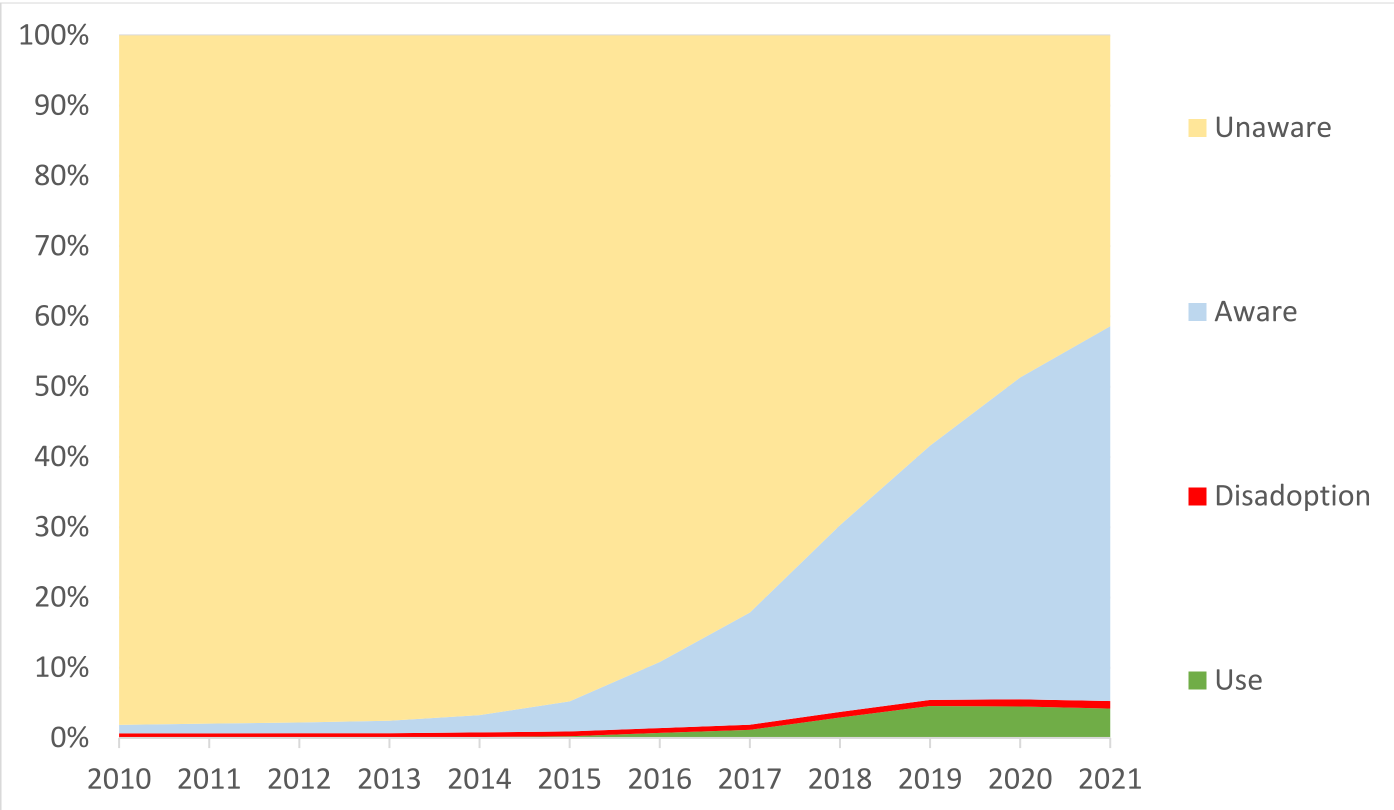


Figure 25: Adoption proportions regionally for the mechanical rice transplanter (regional summary)

Surface seeding has long been used in Malda, but its popularity has grown with the introduction and promotion of Surface seeding as a CASI technology. Overall, 6% of respondents in Malda have at some point used surface seeding, while currently 4% or respondents practice it. Awareness has been rising over the previous period, though without a rise corresponding in use (**Figure 26**).

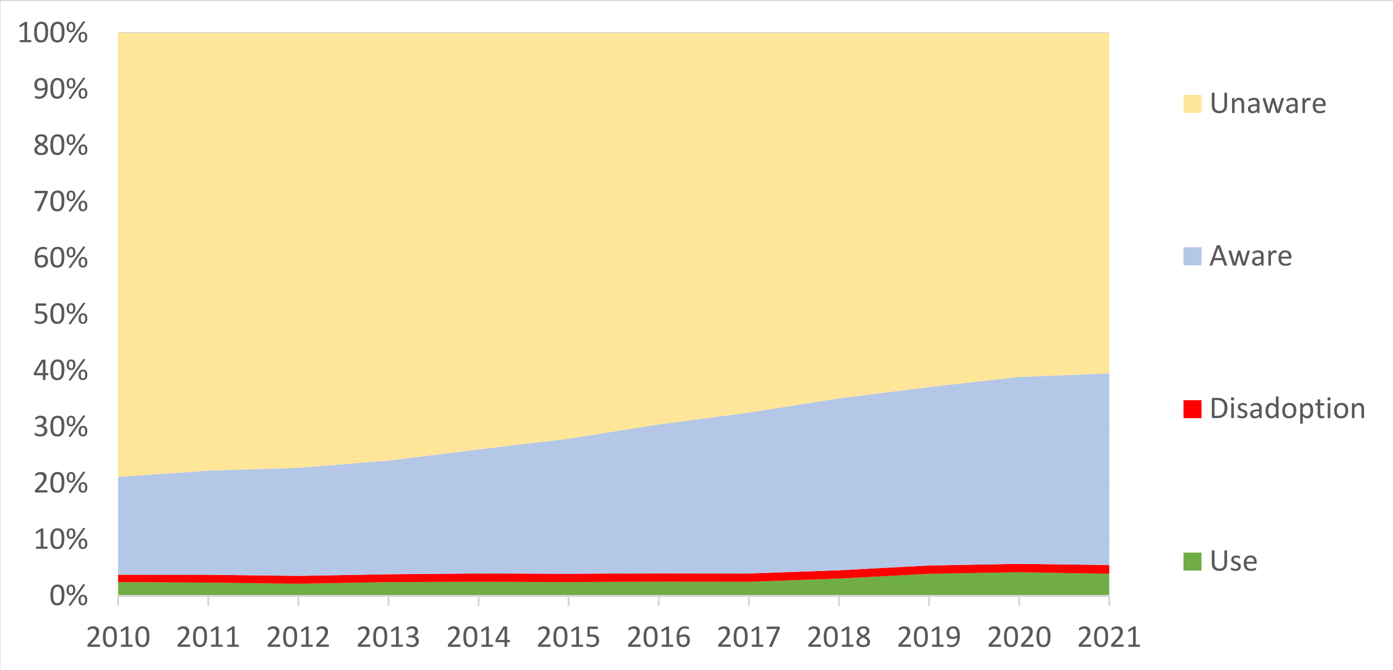


Figure 26: Proportional Analysis of the population in relation to Surface seeding in Malda.

7.3.3 What are the dominant types of use and non-use of CASI technologies across the region?

The SPM framework is applied to understand the proportional distribution of different use and non-use typologies across each of the 57 surveyed communities for each CASI planting practice. As can be seen, across each technology (Figure 27 for Zero tillage/ strip tillage; Figure 28 for the mechanical rice transplanter, Figure 29 for surface seeding in Malda), Unawareness remains the dominant typology across the region. However, we can see that in most 'original SRFSI locations' there is increased awareness and higher rates of both supported and unsupported use. In locations in Coochbehar and Malda, use is often supported so despite higher rates of use, there are also implications related to sustainability.

Using this approach, it can be seen how the SRFSI project has been responsible for nearly all CASI uptake, given that non-SRFSI (or 'control') communities tend to have more limited adoption and awareness rates. Counter to this, it also highlights there is still a need to work on wider convergence initiative to ensure that benefits are also experiences in non SRFSI communities.

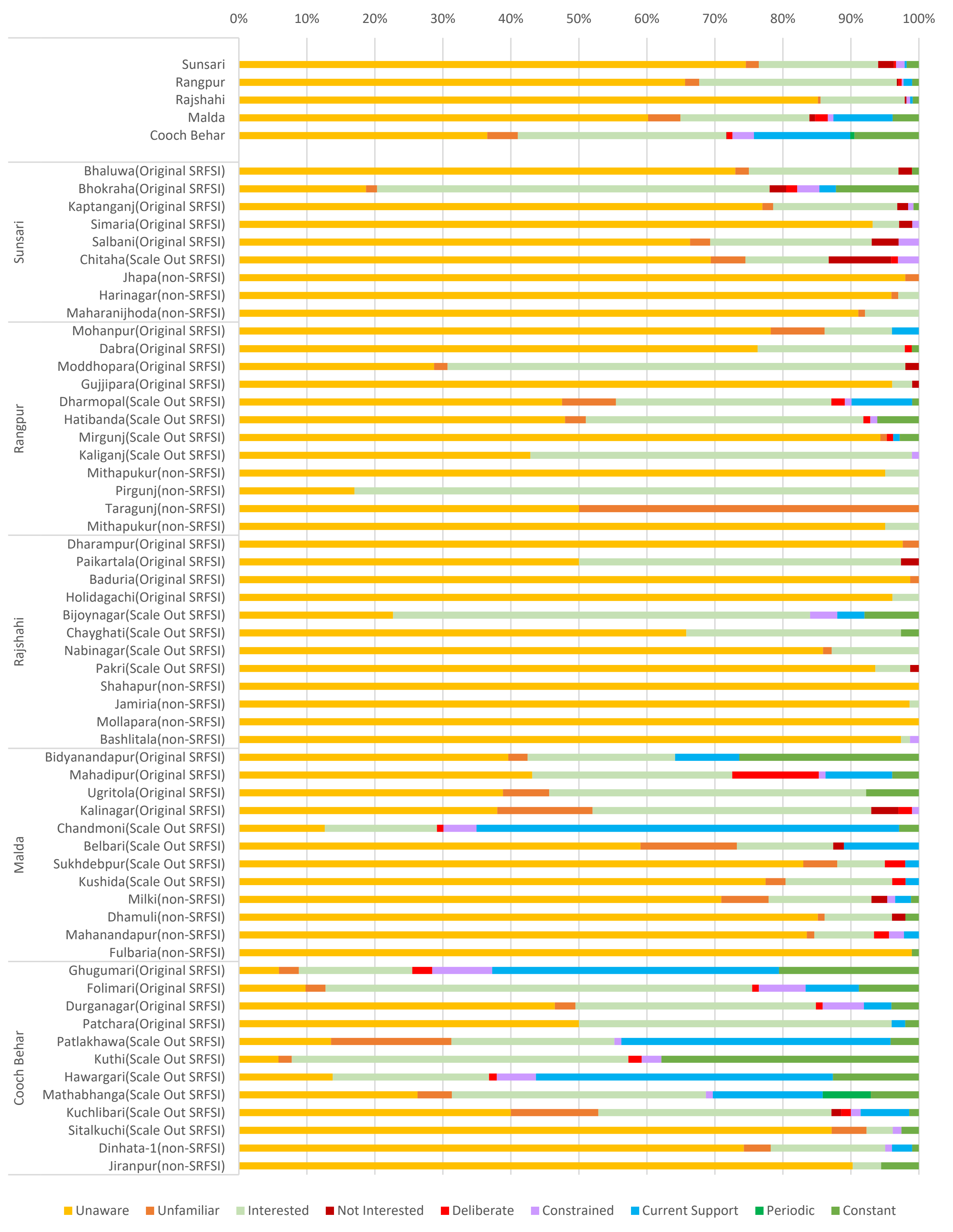


Figure 27: Proportional Typologies across all surveyed areas for the Zero Tillage / Strip Tillage drill in Rabi Season

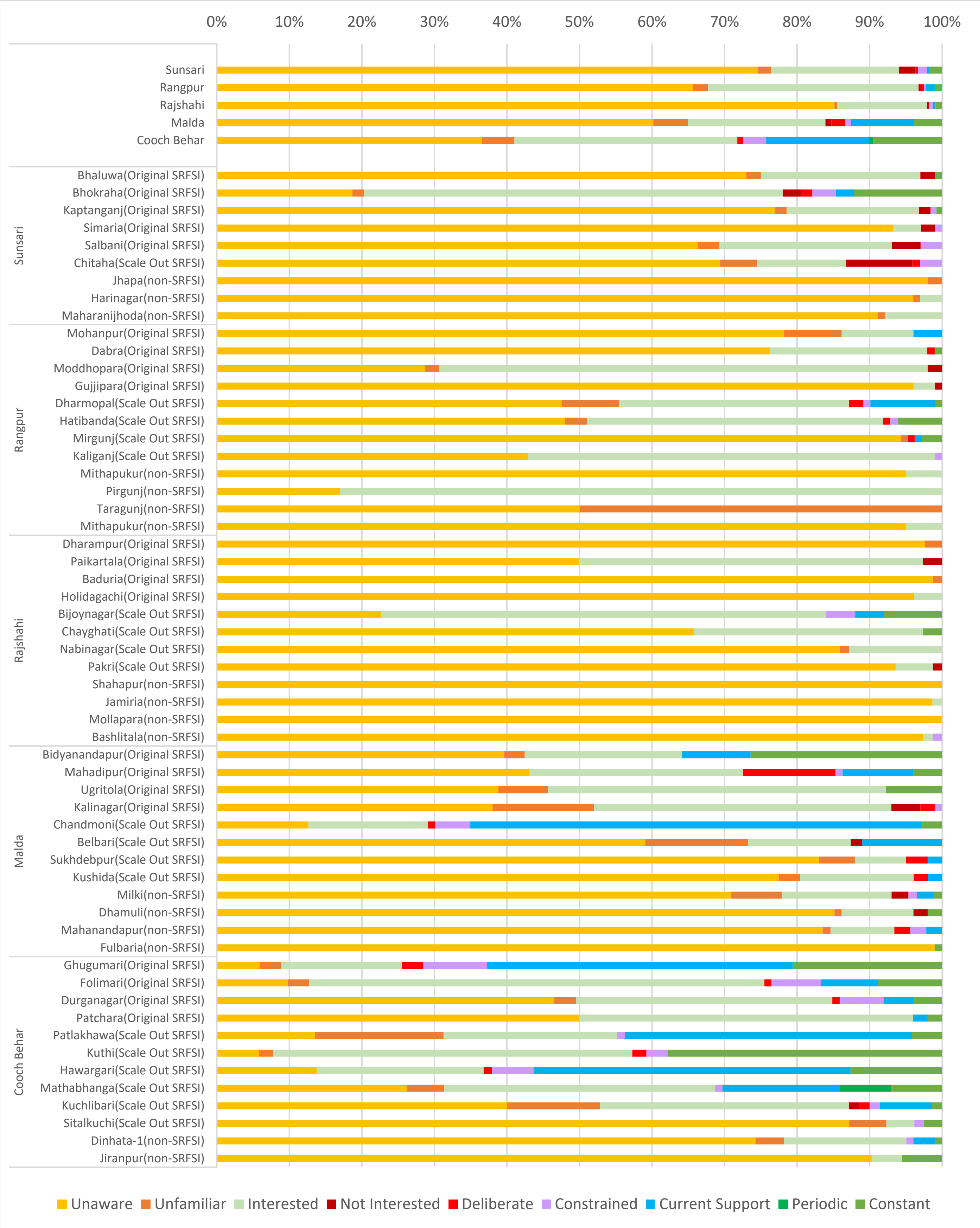


Figure 28: Proportional Typologies across all surveyed areas for the Mechanical Rice transplanter in Kharif Season

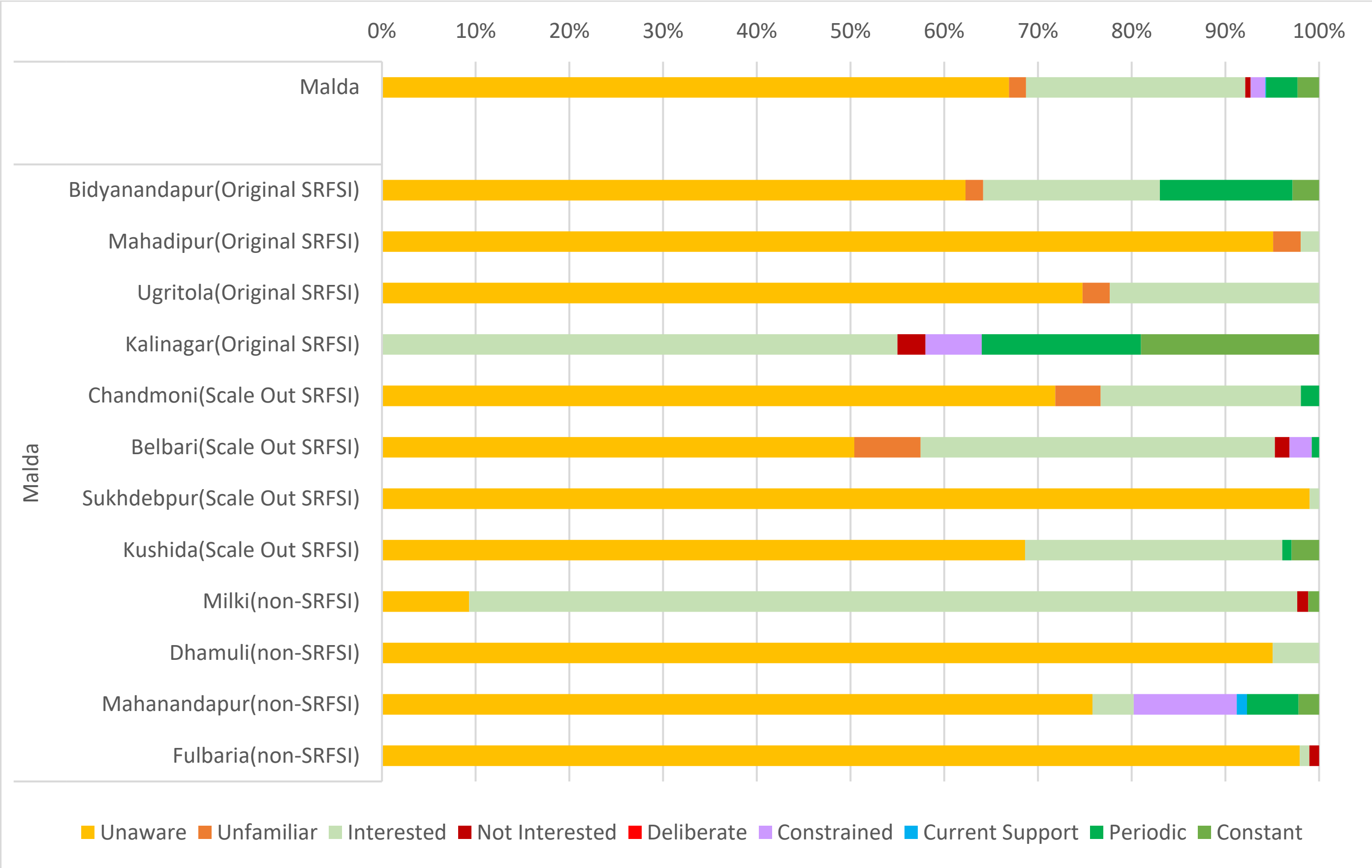


Figure 29: Proportional Typologies across all surveyed areas for Surface Seeding in Kharif Season

7.3.4 What are the pathways to use and non-use across the region?

A novel pathway analysis was developed to further understand how users and non-users reached their current typologies. These are available for each location in the Scaling reports. This approach is applied to create a deeper understanding of both current status as well as future sustainability and identify key constraints in the adoption process. These identified issues include:

- Informational constraints leading to overall low exposure rates for all CASI practices. ('Exposure Ratio')
- Limited progression to use once familiarity is obtained for all CASI practices ('Progression Ratio')
- High approval rates of non-users for all CASI practices ('Approval Ratio') paired with considerable rates of disadoption driven not by technological performance ('Inhibition rate'), meaning that there are issues in implementation of each CASI practice.
- Limited pathways to use that are without support via inputs for Zero tillage (yet not for Mechanical Rice transplanter) suggesting the need for invention to catalyse farmer uptake.
- High current support rates for zero tillage suggesting there may be future high disadoption rates.
- Limited graduation from support to constant unsupported use for the ZT drill, further suggesting implementation issues.

These are further elaborated on for zero tillage (Figure 30), Mechanical rice transplanter (Figure 31) and Surface seeding (Figure 32), though for comprehensive understanding the location specific results should eb viewed, available in the scaling reports. A note on the rice transplanter – our intention was to run a similar qualitative experiential assessment for kharif season but due to COVID-19 this was not possible. Hence our understanding for the mechanical rice transplanter and Direct Seeded Rice machinery is less certain.

Practice:	Zero Tillage Drill				Location:		Regional: EGP					**Figure 30**
*Sample size = **5,053** respondants (representative of communities investigated)*												
Ratios												
A	*Exposure*	***35%***	*C*	*Approval*	***97%***	*E*	*Intervention*	***60%***	*G*	*Supported Graduation*	***4%***	*Binary Adoption*
B	*Progression*	***33%***	*D*	*Inhibition*	***62%***	*F*	*Unsupported Graduation*	***76%***	*H*	*Adoption Status Ratio*	***33%***	***9%***

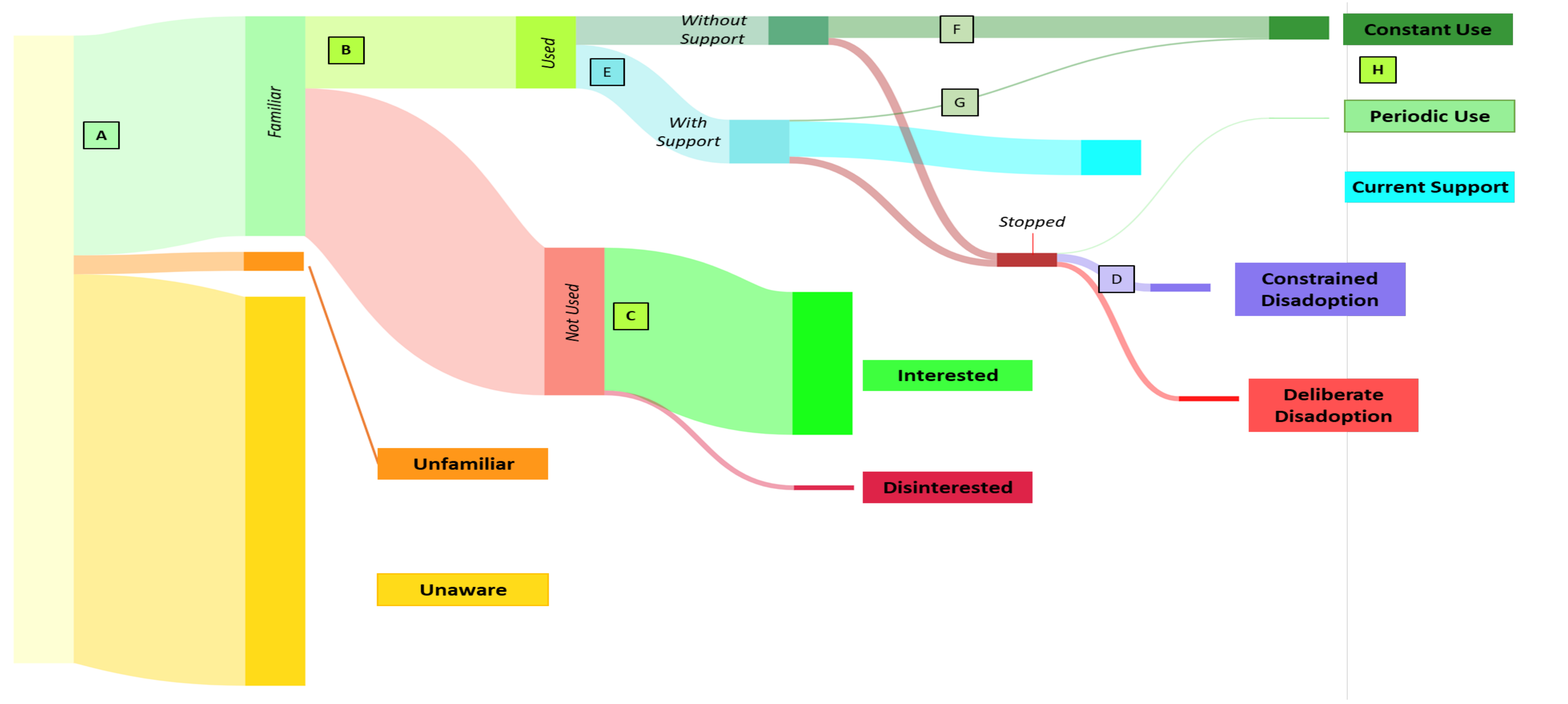


Figure 30: Pathway analysis for the Zero Tillage Drill (regional summary).

Practice:	Zero Tillage Drill	Location:	Regional: EGP
Ratio	Exposure		35%
Description	*Across the total population, compares the proportion of farmers aware of a practice to those who are not aware. Low exposure ratios are common in the early stages of scaling of a technology.*		
Result	Exposure is **limited** with only one third of respondents aware of zero tillage/ Strip tillage machinery.		
Explanation	Regionally, there remains key constraints with the exchange of information widely. This is likely further compounded though often insular information networks and limited access to information sources, yet preference for formal and in person extension systems. In some circumstances there may also be cultural boundaries (e.g. caste and other social structures) that limit information dissemination. In Nepal, the restructuring of government extension systems also contributes to limited exposure. *See scaling reports for detailed analysis of information systems sources and preferences for each location.*		
Implications	This suggests that improving information systems is a strong one consideration in the border scaling of the Zero Tillage Drill / Strip Tillage Drill.		
Ratio	Progression		33%
Description	*Within the **familiar** sub-population, compares the proportion of those who **have ever** used against those who have **not**. Low progression ratios are common in the early stages of scaling a technology or when implementation is difficult to achieve (see Disinterest ratio).*		
Result	Progression is **moderate**, with one third of respondents who are aware progressing to use.		
Explanation	*Limited progression is likely a result of constraints such as access to service providers, given that the approval rate is also substantial. This is further explored in section 7.3.9 and in detail in the scaling reports.*		
Implications	This suggests some but not overwhelming constraints to the use of the zero-tillage drill.		
Ratio	Approval		97%
Description	*Within the **non-user sub-population**, compares the proportion of the population who have **positively evaluated** the practice with those who have **negatively evaluated** the practice. A high approval ratio suggests that the population would like to use the technology but is constrained in ability to implement.*		
Result	The rate of approval is **very high,** with nearly all non-users finding the machinery desirable.		
Explanation	*The reasons for this are further explored in section 7.3.9 and in detail in the scaling reports.*		
Implications	Such a high approval rate suggests that considerable constraints exist in turning interest to implementation. A specific paper targeting this result is in drafting and summarised in section 7.3.9.		
Ratio	Inhibition		62%
Description	*Within the **disadopting sub-population**, compares the proportion of the population who are **positive about the practice but identify implementation constraints** with those who have chosen to Disadopt due to **poor technology or performance**.*		
Result	Inhibition is **high**, which coincides with the high approval rate.		
Explanation	*The reasons for this are further explored in section 7.3.9 and in detail in the scaling reports.*		
Implications	This suggests that the zero-tillage drill is perceived positively but not able to be used, meaning substantial problems with implementation, primarily in access to reliable service provider.		
Ratio	Intervention		60%
Description	*Within the user sub-population, compares the proportion of the population who have ever been directly supported with tangible inputs against those who have never obtained tangible inputs. Large projects in targeted areas are likely to have higher interaction ratios.*		
Result	Direct support remains **substantial**.		
Explanation	*A high rate of support for the zero tillage drill highlights bow farmers tend to rely on interventions to progress to use. This is reflective both relative novelty of the machinery as well as a cultural tendency to rely on support for practice change. This also reflects*		

	the resource poor contexts of most farmers in the region. Further analysis will be conducted on the characteristics of each pathway taken to correlate this theory.		
Implications	The majority of users have passed though usage of the Zero tillage drill with support from organisations. This highlights widespread efforts in promotion of the zero tillage drill in the surveyed locations.		
Ratio	Graduation	Supported	4%
		Unsupported	76%
Description	*Within the supported and unsupported user populations respectively, compares the proportion of the population who are currently constant users. This graduation to constant use is usually the objective of promotional efforts.*		
Result	For those who never received support, graduation remains high, suggesting that once use has begun it can be sustained. However, there are currently limited supported users who have graduated to constant (or periodic) use.		
Explanation	This result in particular requires further investigation. It implies that farmers who are supported tend to 'adopt' for perverse reasons other than the technology (e.g. status, recognition of technical partners, inputs etc) that when removed tend to lead to disadoption. This could relate to targeting strategies applied by interventions (e.g. helping women who without such inputs may not be able to continue) or reflect growing depend for service providers and a constrained service provision economy. Further work will be done to explore this results.		
Implications	This leads to question on if the 'supported' pathway is effectively leading to sustainable use of the zero tillage drill.		
Ratio	Adoption Status		33%
Description	*Within the current user sub-population, compares the proportion of the population who currently implement unsupported (i.e. constant and periodic use) with those who do not. Sustainable adoption is indicated by a high adoption ratio.*		
Result	Constant and periodic use remains moderate. It is important to note that 85% of supported users are still undertaking a trial and these are the dominant form of current usage.		
Explanation	This highlights that evaluations of the machinery is still ongoing and support is still present. SRFSI as a project had intended not to continue support in the final years of the project but this was in practice hard to implement with remaining partner budgets and COVID-19. Running this survey again in several years is likely to understand the outcomes of the current high rate of supported use.		
Implications	Future work should use a similar methodology to understand outcomes of current users, alongside our qualitative analyses. We also have future intention data to analyse to provide further clarity on this result.		

Practice:			Mechanical Rice Transplanter				Location:		Regional EGP			Figure 31
*Sample size = **5,053** respondants (representative of communities investigated)*												
Ratios												
A	*Exposure*	***31%***	*C*	*Approval*	***87%***	*E*	*Intervention*	***56%***	*G*	*Supported Graduation*	***87%***	*Binary Adoption*
B	*Progression*	***20%***	*D*	*Inhibition*	***61%***	*F*	*Unsupported Graduation*	***65%***	*H*	*Adoption Status Ratio*	***78%***	***5%***

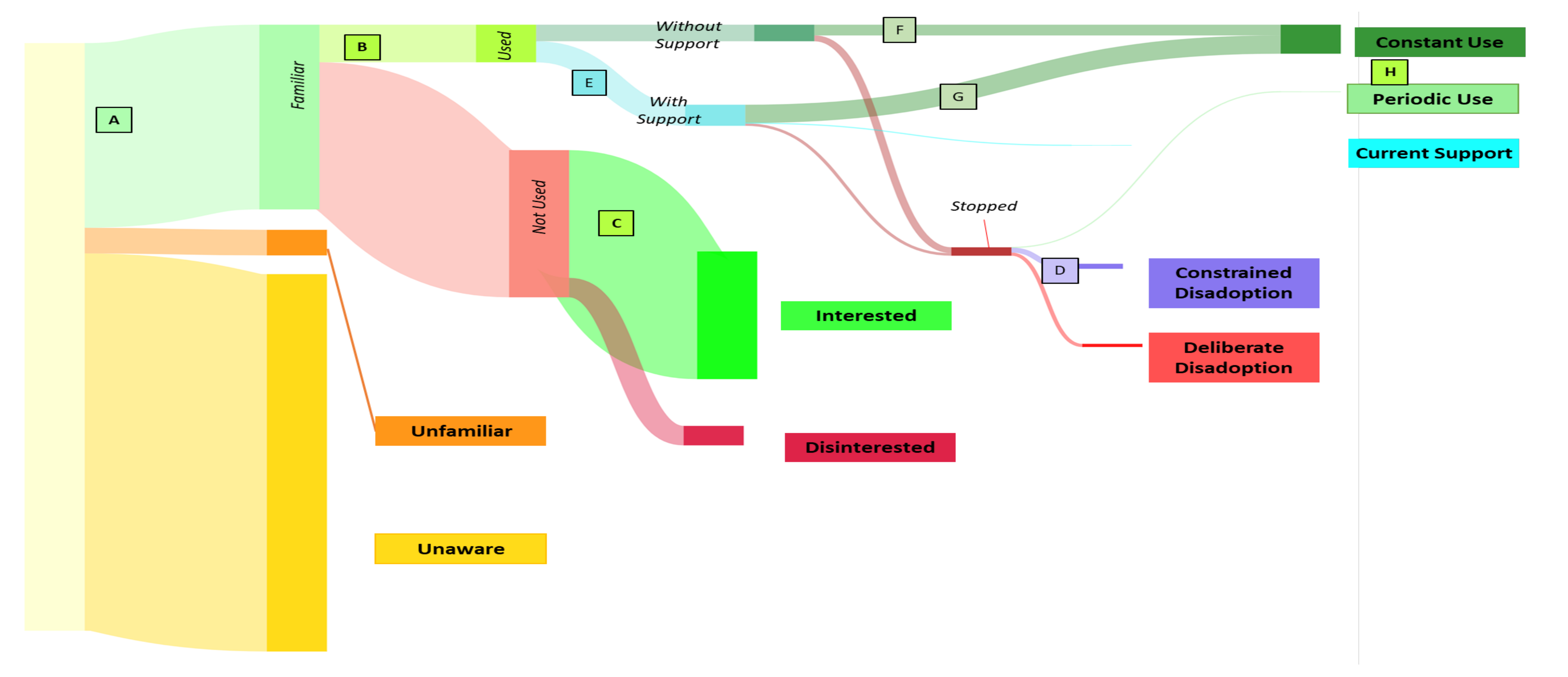


Figure 31: Pathway analysis for the Zero Tillage Drill (regional summary).

Practice:	Mechanical Rice Transplanter	Location:	Regional: EGP
Ratio	Exposure		31%
Description	*Across the total population, compares the proportion of farmers aware of a practice to those who are not aware. Low exposure ratios are common in the early stages of scaling of a technology.*		
Result	Exposure is **moderate**.		
Explanation	*The reasons are similar to the ZT drill machinery, and are further explored in the scaling reports.*		
Implications	This suggests that information is one consideration in the border scaling of the Zero Tillage Drill, but given the current usage rate is likely to happen more easily without external intervention.		
Ratio	Progression		20%
Description	*Within the **familiar** sub-population, compares the proportion of those who **have ever** used against those who have **not**. Low progression ratios are common in the early stages of scaling a technology or when implementation is difficult to achieve (see Disinterest ratio).*		
Result	Progress is **limited**.		
Explanation	This is likely a result of the relatively recent introduction of rice transplanters and low density office transplanters across the region, meaning access is limited. This is confirmed by the high approval rates.		
Implications	Increasing machinery access is likely to drive adoption.		
Ratio	Approval		87%
Description	*Within the **non-user sub-population**, compares the proportion of the population who have **positively evaluated** the practice with those who have **negatively evaluated** the practice. A high approval ratio suggests that the population would like to use the technology but is constrained in ability to implement.*		
Result	Approval is **very high.**		
Explanation (Qualitative)	This is likely a result of the relatively recent introduction of rice transplanters and low-density office transplanters across the region, meaning access is limited. This is confirmed by the low progression rates.		
Implications	Increasing machinery access is likely to drive adoption.		
Ratio	Inhibition		61%
Description	*Within the **disadopting sub-population**, compares the proportion of the population who are **positive about the practice but identify implementation constraints** with those who have chosen to Disadopt due to **poor technology or performance**.*		
Result	Deliberate disadoption is **low**. (though so is disadoption, a reflection of limited use)		
Explanation	Access is likely causing farmers to want to use this machinery yet not be able to. This is further explored in the scaling reports.		
Implications	Inventions should focus on machinery access.		
Ratio	Intervention		56%
Description	*Within the user sub-population, compares the proportion of the population who have ever been directly supported with tangible inputs against those who have never obtained tangible inputs. Large projects in targeted areas are likely to have higher interaction ratios.*		
Result	Direct support remains **moderate**.		
Explanation	There appears to be less support available to use the rice transplanter as opposed to the zero tillage drill. This is likely due to prioritisation of rabi season intensification by projects.		
Implications	Expanding support is likely to also drive exposure, so machinery access needs to be a priority.		
Ratio	Graduation	Supported	87%
		Unsupported	65%
Description	*Within the supported and unsupported user populations respectively, compares the proportion of the population who are currently constant users. This graduation to constant use is usually the objective of promotional efforts.*		
Result	Graduation across both supported and unsupported users is high.		
Explanation	This suggests that there are fewer complications in maintaining implementation of rice transplanters than the zero tillage machinery. The reasons of this should be explored to improve zero tillage graduation rates.		
Implications	Understanding and explaining these high graduation rates may have implications for the promotion of other machinery and practices.		
Ratio	Adoption Status		78%
Description	*Within the current user sub-population, compares the proportion of the population who currently implement unsupported (i.e. constant and periodic use) with those who do not. Sustainable adoption is indicated by a high adoption ratio.*		
Result	The dominant form of adoption is unassisted.		
Explanation	This implies that current support for this machinery is limited across the region.		
Implications	Increased support for machinery access is likely to improve the scaling of this machinery in the future.		

Practice:	Surface Seeding		Location:	Malda					Figure 32
*Sample size = **1218** respondants (representative of communities investigated)*									
Ratios									
A	*Exposure*	***31%***	*C*	*Approval*	***98%***	*E*	*Intervention*	***20%***	*G*
B	*Progression*	***23%***	*D*	*Inhibition*	***100%***	*F*	*Unsupported Graduation*	***35%***	*H*

G	*Supported Graduation*	***17%***	*Binary Adoption*
H	*Adoption Status Ratio*	***78%***	***6%***

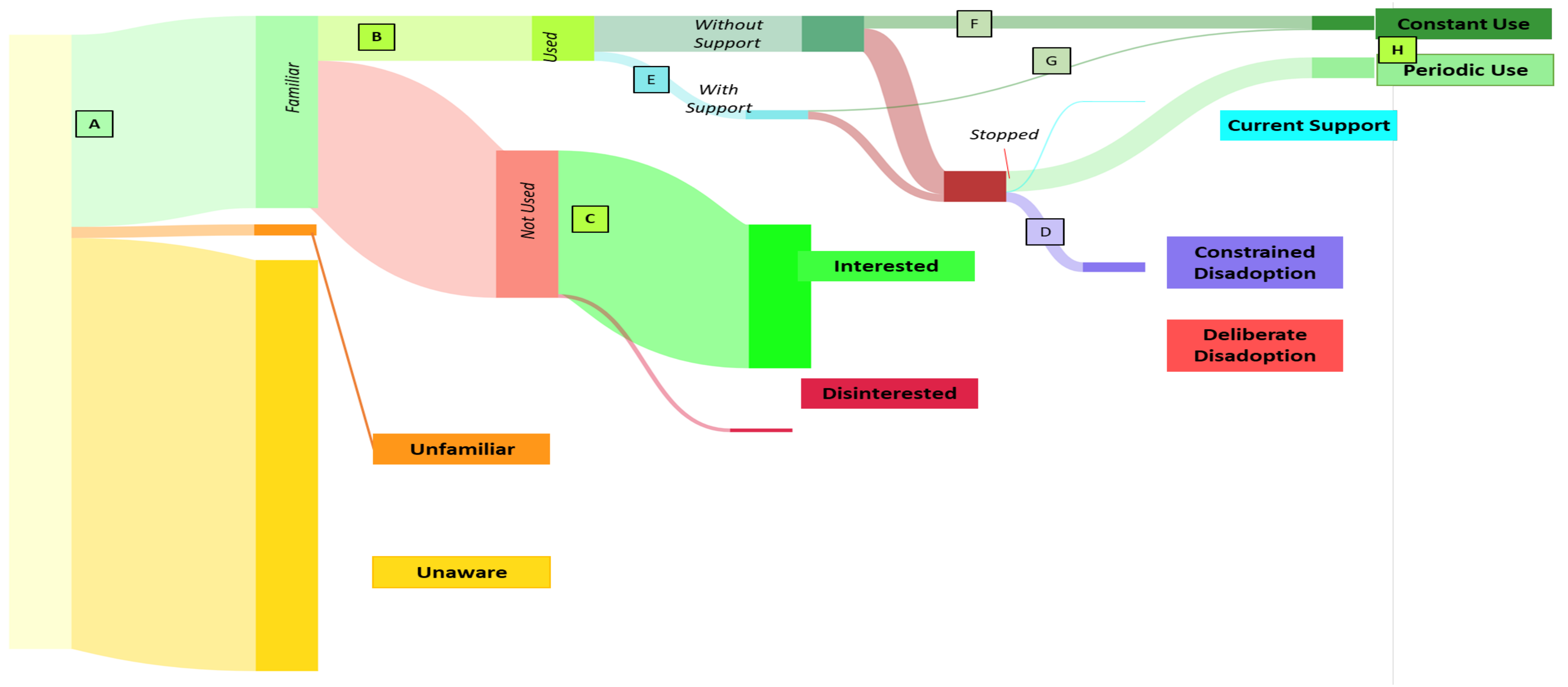


Figure 32: Pathway analysis for the Zero Tillage Drill (regional summary).

Practice:	Surface Seeding	Location:	Malda
Ratio	Exposure		31%
Description	*Across the total population, compares the proportion of farmers aware of a practice to those who are not aware. Low exposure ratios are common in the early stages of scaling of a technology.*		
Result	Exposure is **limited**.		
Explanation	Surface seeding has been practised in some nodes in Malda long before the Project started. The farmers were hence exposed to surface seeing in various forms, either before the project or after the project.		
Implications	This suggests that information is one consideration in the border scaling of surface seeding, but given the decades of presence of surface seeding, new methods may me required.		
Ratio	Progression		23%
Description	*Within the **familiar** sub-population, compares the proportion of those who **have ever** used against those who have **not**. Low progression ratios are common in the early stages of scaling a technology or when implementation is difficult to achieve (see Disinterest ratio).*		
Result	Progress is **low**.		
Explanation	Substantial issues appear to exist given this ratio, alongside very high approval and inhibition ratios. This is particularly peculiar given this practice does not require machinery and will be explored further in due course.		
Implications	Substantial issues exist in progressing interest to use for surface seeding which need to be diagnosed and addressed.		
Ratio	Approval		98%
Description	*Within the **non-user sub-population**, compares the proportion of the population who have **positively evaluated** the practice with those who have **negatively evaluated** the practice. A high approval ratio suggests that the population would like to use the technology but is constrained in ability to implement.*		
Result	Approval is **very high**		
Explanation (Qualitative)	This suggests again that substantial issues exist and technological performance is not the driver of limited use.		
Implications	Future research topic.		
Ratio	Inhibition		100%
Description	*Within the **disadopting sub-population**, compares the proportion of the population who are **positive about the practice but identify implementation constraints** with those who have chosen to Disadopt due to **poor technology or performance**.*		
Result	Inhibition is **very high**		
Explanation	As above.		
Implications	Future research topic.		
Ratio	Intervention		20%
Description	*Within the user sub-population, compares the proportion of the population who have ever been directly supported with tangible inputs against those who have never obtained tangible inputs. Large projects in targeted areas are likely to have higher interaction ratios.*		
Result	Direct support is **minimal**.		
Explanation	The intensification of surface seeding in some nodes was induced by the SRFSI project and officials at UBKV along with trainings on other CASI techniques, this resulted in an increased use and awareness. However, overall support for surface seeding appears minimal.		
Implications	Use is driven by farmers own resources which should increase the sustainability of adoption.		
Ratio	Graduation	Supported	17%
		Unsupported	35%
Description	*Within the supported and unsupported user populations respectively, compares the proportion of the population who are currently constant users. This graduation to constant use is usually the objective of promotional efforts.*		
Result	Graduation via both pathways is **limited**.		
Explanation	Farmers are often not really interested in surface seeding and merely utilise it as a means of continuing to cultivate crops on land that had been restricted. They would move to such machines whenever new techniques and technologies were available.		

	As a result, depending on the field location and weather circumstances, there was a potential of partial disadoption.	
Implications	Understanding farmer decision making is required to diagnose this.	
Ratio	Adoption Status	78%
Description	*Within the current user sub-population, compares the proportion of the population who currently implement unsupported (i.e. constant and periodic use) with those who do not. Sustainable adoption is indicated by a high adoption ratio.*	
Result	Constant and periodic use is high.	
Explanation	This is reflective of the low overall support provided for surface seeding alongside most farmers progressing in evaluation due to decades of presence in communities.	
Implications		

7.3.5 Was a sustainable supporting structure established for ongoing activity post project?

The 2021 SRFSI impact survey identified 82 organisations that have supported CASI machinery and practices (specifically use of the zero-tillage drill, mechanical rice transplanter or surface seeding in Malda) in the past. Of these, 63 have supported the ZT Drill, 67 have supported the mechanical Rice transplanter and 12 have supported surface seeding in Malda. 29% of identified actors are associated with SRFSI. Given that prior to the project there were few such promoting organisations, this highlights a large change in the supporting networks for scaling CASI. A full analysis of the support networks for CASI scaling is available in the scaling reports.

7.3.6 Did farmer training contribute to sustained post project momentum?

Due to COVID-19, we have not been able to assess the various recent methods of capacity development implemented, including the SRFSI visual training syllabus for CASI and the world's first CASI MOOC implemented by BAU and CIMMYT. The initial plan for the CASI visual syllabus was to film additional chapters for two-wheel machinery in Bangladesh and the mechanical rice transplanter, as well as on service provision as a business. However, this was not possible given COVID, which also did not enable a promotional campaign as intended. The below analyses only farmer level training.

For Zero Tillage

In total, 34 organisations were identified as having given training to respondents on the zero tillage drill, of which 32% had some SRFSI association. Of those, 16 were cooperatives (25% were SRFSI associated), 10 were government agencies (60% were SRFSI associated), 7 were businesses (14% were SRFSI associated) and 1 was an NGOs (not SRFSI associated).

Extent of Capacity Development in Community.

Overall, 8.4% of the surveyed respondents had taken training on the Zero Tillage Drill. This ranged from 15% for both locations in West Bengal, 6% in Rangpur and less than 1.5% in Sunsari and Rajshahi. The average number of days of training received varied strongly by location, with an average of 5 days in Sunsari, 2.7 days in Rangpur, 1.6 days in Malda, 1.2 days in Rajshahi and 0.9 days in Coochbehar. Only 13 respondents had taken more than five days of training.

Outcome mapping of Capacity Development

As can be expected, training can be linked to high rates of use of the zero tillage drill, with 51% of trained respondents having progressed to use of the zero tillage drill as compared to only 24% of non-trained respondents progressing to use. Receiving training is also linked to a reduction in interested respondents, who are transferred to user typologies. Interestingly, multiple respondents received support but did not receive training (i.e. Current support without taking training). Importantly, only 13% of those who took training were unsupported users which suggests complications in implementation (Figure 33)

N.B. statistical significance tests will be run to determine relationships between training and outcome, though time has not allowed in this report.

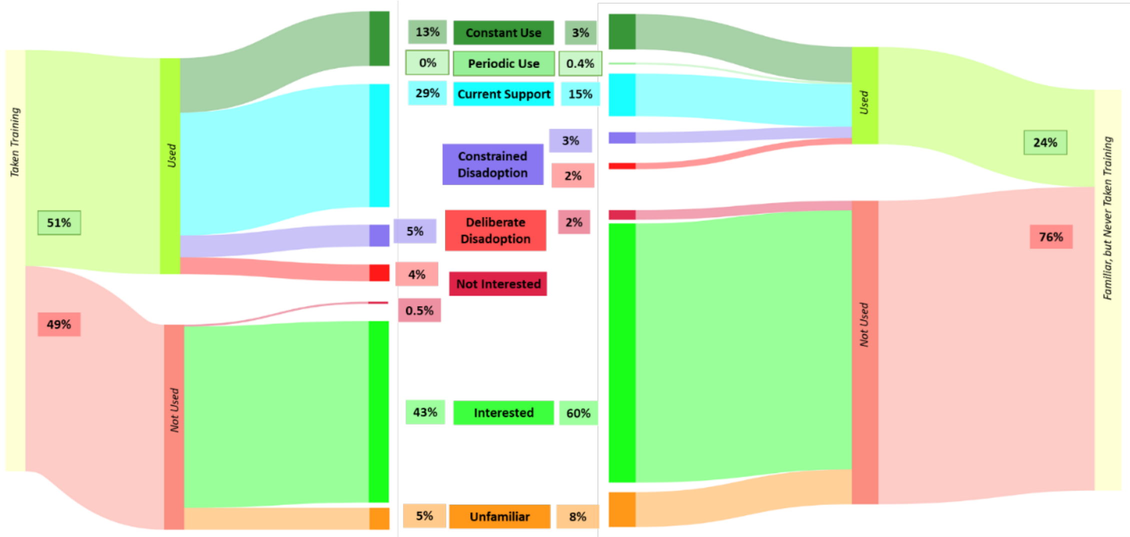


Figure 33: Typologies compared between those who have (left) and have not (right) taken training for the zero-tillage drill.

For Mechanical Rice Transplanter

In total, 35 organisations were identified as having given training to respondents on the mechanical rice transplanter, of which 31% had some SRFSI association. Of those, 14 were cooperatives (21% were SRFSI associated), 10 were government agencies (60% were SRFSI associated), 10 were businesses (none were SRFSI associated) and one was an NGOs (not SRFSI associated).

Extent of Capacity Development in Community.

Overall, 3.4% of the surveyed respondents had taken training on the Rice Transplanter. This ranged from 6.5% in Cooch Behar and 5.5% in Malda to 2% in Rangpur and less than 1% in Sunsari and Rajshahi. The average number of days of training received varied strongly by location, with an average of 5.5 days in Sunsari, 4.1 days in Rangpur, 3.4 days in Malda, 23 days in Rajshahi (with only 2 trained) and 1.2 days in Cooch Behar. Only 17 respondents had taken more than five days of training.

Outcome mapping of Capacity Development

As can be expected, training can be linked to high rates of use of the Rice transplanter with 44% of trained respondents having progressed to use as compared to only 5.1% of non-trained respondents progressing to use. Receiving training is also linked to a reduction in interested respondents, who are transferred to user typologies. Conversely to the Zero Tillage machinery, 35% of those who took training were unsupported users (**Figure 34**).

N.B. statistical significance tests will be run to determine relationships between training and outcome, though time has not allowed in this report.

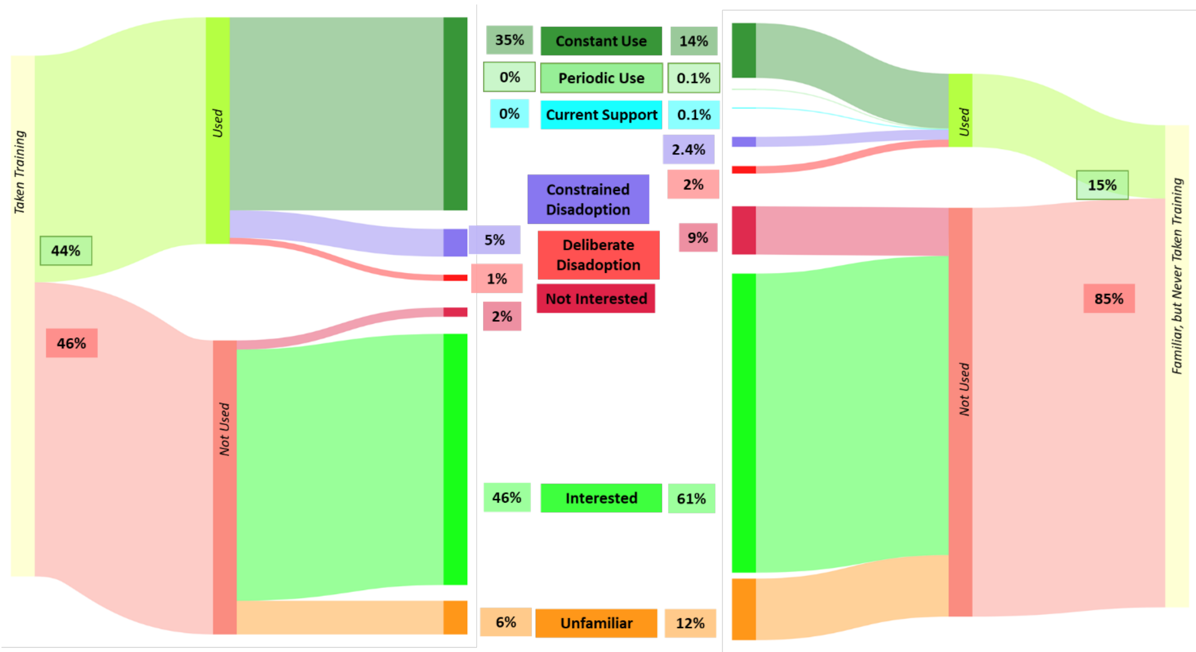


Figure 34: Typologies compared between those who have (left) and have not taken training (right) for the rice transplanter

7.3.7 Does the current policy environment enable ongoing activities post project?

Overall, the policy environment for CASI in the EGP remains mostly directly unsupportive and indirectly mixed. While all locations have highlighted agri-mechanisation in their policy platform, most locations do not have specific policies related to CASI and some have policies that are likely to limited CASI machinery uptake. This exception to this is West Bengal, where all new custom hire centres must have CASI machinery as part of their package. This will soon be supported by the recently commissioned Centre of Excellence for Conservation Agriculture which will provide state funded training on CASI to farmers, service providers and agricultural extension agents.

Nepal

Any specific CASI policies?

No

Any CASI policies that are counter to CASI adoption?

There is a broad desire within policy for agri-mechanisation, and subsidies are available on most machines and attachments but are largely aimed at large holders due to the minimum land requirement to purchase large machines such as 4WT, Laser Land Leveller etc. To meet the growing demand for mechanization, policies must be cognizant of the farmers capabilities and encourage service provision to allow for greater CASI uptake.

West Bengal

Any specific CASI policies?

Support for CASI is highly encouraging with the promotion of rural entrepreneurship such as providing financial incentives to establish custom hiring centers to ensure small and marginal farmers can access farm machinery without purchasing on an individual basis, which must have CASI machinery. This has been successful in increasing CASI uptake among farmers since it is mandatory to invest in CA technology to avail subsidy from the government.

Any CASI policies that are counter to CASI adoption?

No

Bihar

Any specific CASI policies?

There is a strong support for CASI within Climate Smart Agricultural initiatives under several national programmes that are largely supportive of CASI and is reflected in the inclusion of CASI machinery in subsidies and CASI principles in extension programmes. Within Bihar, programmes are aimed at increasing awareness through field demonstrations and providing financial incentives to farmers for CASI machinery. Several programmes are aimed at increasing awareness through training, demonstration of CASI technologies. Moreover, government programmes are aimed to bring both farmers and scientists together to engage in a dialogue and develop farmer driven training programmes.

Any CASI policies that are counter to CASI adoption?

Subsidies still exist that create an incentive for non-CASI machinery use.

Bangladesh

Any specific CASI policies?

Emphasis is placed on increasing awareness of CASI technology through training programs that will also promote the use of other CASI principles such as crop residue management.

Any CASI policies that are counter to CASI adoption?

The policy environment in Bangladesh is encouraging towards CASI adoption and focuses on easing credit access to users, producers and importers. There is also a push towards expanding local manufacturing and the policy outlines several financial incentives to encourage both local production and import of foreign machinery following an established set of guidelines and quality standards.

Cancelled Regional platform for Conservation Agriculture

SRFSI had the intention to create a regional platform for conservation agriculture with policy makers coming together to discuss integration of CASI programs into their various programs, and an integrated regional knowledge management service. This was intended to be hosted by the Nepal Agricultural Research council, though issues with ownership and COVID-19 meant this could not be further developed.

7.3.8 What is the future potential of CASI across the region?

SRFSI funded the further development '**ADOPT**: The **Adoption** & Diffusion Outcome Prediction Tool' (www.adopt.csiro.au) as part of its efforts to create a structured tool to formulate scaling discussions. While the intention was to implement ADOPT workshops for each CASI technology in each location, COVID-19 has not permitted this. Given the substantial investment made, it is hoped that this activity could still be run in the future, should conditions allow.

7.3.9 Diagnosis of particular elements of CASI decision making processes

The below analysis is based on summarised of various manuscripts in preparation build from the SRFSI qualitative experiential assessment.

Learnings about how to reduce negative evaluation

Based on the experiences recounted by farmers who evaluated CASI negatively, the findings show that four key constraints impacted farmers' decisions to utilise or discontinue using CASI in their fields. These constraints focus mostly on their beliefs and knowledge as well as the physical resources that the farmers perceived as a pre-requisite for practicing CASI. Despite the fact that most farmers agreed on the benefits of CASI in terms of cost savings from reduced tillage and labour needs, they did not continue to use it due to a variety of other constraints, demonstrating that numerous variables impact the decision to utilize ZT. Some farmers agreed that their production has decreased, which has negatively impacted their impression of CASI. Farmers believed that agriculture was not profitable, therefore they turned to other sources of income to make ends meet. As a result, small-scale landowners with limited financial resources struggled to pay for machinery rents. Farmers expressed uncertainty about yields and lack of confidence in the technology, as well as fear of loss, and future generations were not anticipated to employ the technology owing to these perceived shortcomings.

It was a common trend to hire labourers for various agriculture tasks however they mentioned labour shortage issue to be increasing but were reluctant to use CASI indicating that there is further need of exposure to increase their knowledge and understanding of CASI. Lack of communication with government agricultural offices and institutions might lead to a lack of understanding and a negative perception. Furthermore, increasing weed growth was expressed in a requirement for weed control expertise and technical assistance from local knowledge institutions, as well as a shortage of access to herbicides through markets in some locations. Farmers shared that they were unable to continue CASI usage mostly due to machine unavailability either due to high demand and less number of machines or defective machines with no repair and maintenance services. The other frequently mentioned issue was access to the fields because of lack of roads hindering the transportation of machine into the fields or inability to reach to a communal decision for using CASI because of different crop preferences of farmers. There were also multiple on farm and off farm livelihood options mentioned by the farmers, but this could be conflicting due to time allotted for each activity as opposed to time allotted for agriculture and the availability of household members participating in agriculture. Overall machine perception was negative for most locations due to the perceived constraints and experiences of negative evaluation by the farmers.

Manuscript reference: Chaudhary, A: Timsina, P; Suri, B; Karki, E; Sharma, A; Sharma, R; Brown, B (2022 - Pre-Submission) Farmer Logic for Negative Evaluation of Conservation Agriculture in South Asia

Learnings about how to progress potential users

Based on the observation and experiences of experimenting and interested non-user farmers, there are nine key themes that emerged that explain limiting factors hindering progression to use. Three themes include CASI specific technological constrains: inconsistent crop yields, weed incidence, and competing uses for crop residue. The other six key themes were diverse but non-CASI specific highlighting the lack of feasibility of implementation and limited enabling environments across agricultural systems. Specific themes include physical resource limitations, financial capacity, informational isolation, human resource limitations, institutional and community support. The findings of this paper highlight that many of the limitations reflect pertaining issues across small holder farmers agricultural systems, which then requires the need for an adequate catalyst to reimagine sustainable intensification across the EGP.

Manuscript reference: Karki, E; Sharma, A; Chaudhary, A: Timsina, P; Brown, B (2022 – Pre submission) Understanding why South Asian smallholder farmers do not progress from interest to use: A case study of Conservation Agriculture

Learnings from CASI users

The experiences from implementing farmers confirmed the agronomic benefits of practicing CASI and added to the list of indirect benefits they gained including implications and changes brought about by CASI in their lives. Farmers believed that their household's socioeconomic situation has improved, allowing them to utilize the profits in a variety of ways while also gaining more respect and standing out in the society as progressive farmers and information holders for CASI. Farmers also benefitted as they were able to increase their scope of supplementary sources for receiving agricultural information and exposure to different governmental and non-governmental organizations with significant influences from local farmers groups. Farmers added that CASI has allowed them to grow multiple crops in a year and choose to grow cash crops with better market prices thus helping them to make profits.

Other farmers in the community initially had negative opinions and were reluctant to adopt CASI technology; however, it changed once they observed the field and realized the CASI benefits enjoyed by the implementing farmers. While some constraints and challenges existed during CASI usage, the implementing farmers shared being able to identify and overcome majority of them. Some of the constraints identified were land constraints, stover management, technical problems, machine access and purchase. Changes in mindset and practice, manual replication of technology, attending trainings and learning from various sources for closing information gaps were a few of the unique approaches taken by the implementing farmers to ensure sustained use. Constant support from information networks and family members seems to be additional driving factors for scaling. Thus, enhancing information extension systems and channels, as well as proper project strategies, is critical for increasing awareness, reducing project reliance, and boosting technology scaling out.

Manuscript reference: Karki, E; Sharma, A; Chaudhary, A: Timsina, P; Brown, B (2021 - In preparation) What limits progression to use of CASI? Appendices [R]

Learnings about service provision

Zero Tillage Service provision

Smallholder farmers across the EGP broadly do not have the finances to personally invest in agricultural machinery. Fee for hire service provision facilities has therefore emerged as a way to create new economic opportunities for both farmers who can afford the machinery and for those who cannot. Zero Tillage service provision in the EGP has benefitted communities by helping both service providers and customer farmers achieve better crop yield and financial savings. Service providers benefited from zero tillage service provision through increased profits that led to positive lifestyle changes. Service provider households noted higher savings that helped them educate their children and invest in more land and housing. Service provider households also noted reduced drudgery that increased family time spent together leading to overall family satisfaction. With service providers having relatively better access to information as well along with knowledge of Zero tillage benefits, they were perceived as knowledge holders in their communities by other farmers.

However, service providers were faced with constraints for zero tillage service provision in the EGP that included technological issues and lack of after sales services for the machinery. The Zero tillage attachment across locations was found to have issues related to seed drop, and was considered heavy making it tiring for service providers to use the machine all day. In Malda, service providers noted rusting fertilizer boxes as well, and service providers all across felt that if these issues were resolved, the uptake of zero tillage in their communities would be higher. They also noted operator issues related to a lack of proper training resulting in careless drivers and operators that the service providers could not necessarily trust for meeting a standard of service to their customers. Further compounding this was the lack of after sales maintenance for their zero tillage attachments in their villages that delayed service provision as they had to travel out of the city for these services. As multiple service providers have alternative livelihood options to attend to, time management for them was also seen to be a constraining factor. Both the constraints and benefits of zero tillage service provision will further impact the success of zero tillage uptake among farming communities in the EGP.

Manuscript reference: Sharma, A; Karki, E; Chaudhary, A: Timsina, P; Brown, B (2021 - In preparation) Expanding Zero Tillage Service Provision: perspectives from machinery owners in the Eastern Gangetic Plains Appendices [S]

Direct seeded rice (DSR) Service provision

DSR service provision is limited across the region. A targeted study was undertaken to understand how supply and demand interact with DSR as a technology and service provision more generically, and the decision processes of zero tillage drill owners towards DSR service provision. A complex web of interactions both supply and demand as well as the complications of providing services to resource poor farmers were identified. This work was presented at the 8^{th} World congress of conservation Agriculture (**Figure 35).**

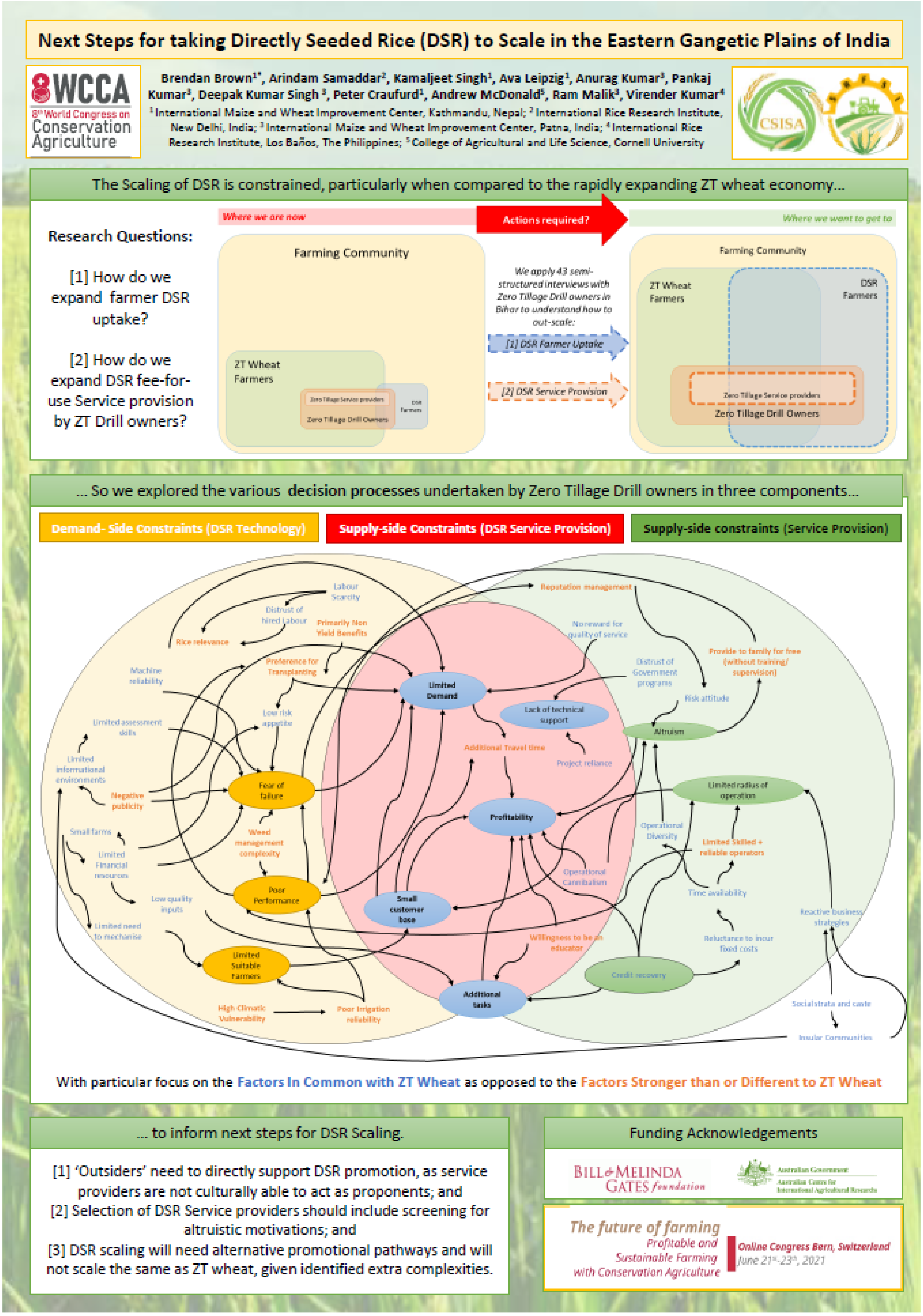


Figure 35: Poster on DSR service provision presented at the 8th WCCA.

Manuscript reference: Brown., B, Samaddar, A., Singh, K., Leipzig, A., Kumar, A., Kumar, P., Singh., D, Malik, R., Craufurd, P., Kumar, V., McDonald, A. (2021) Understanding decision processes in becoming a fee-for-hire service provider: a case study on direct seeded rice in Bihar, India. Rural Studies Volume 87, Pages 254-266, https://doi.org/10.1016/j.jrurstud.2021.09.025 Appendices [C]

Learnings about weed management as a constraint to CASI scaling

In the poverty-stricken, resource constrained Eastern Gangetic Plains (EGP) of South Asia, conservation agriculture (CA) has the potential to improve natural resource base, agricultural resilience to climate change, agricultural productivity and profitability alongside reducing farm drudgery and promoting women empowerment. The success of CA involves transitioning from the traditional ways of managing weeds to herbicide-based weed management. These changes in weed management also alter gendered labour arrangements potentially in favour of women who, traditionally, have looked after farm weeding. But there is a gap in the ideal and the real. Despite overall benefits offered by CA, changing weed management is a constraint for widespread uptake of CA in the EGP and largely undocumented in literature. This study attempts to fill this gap by answering two research questions- 1) What are farmer perceptions about herbicide-based weed management in the EGP? 2) What are the gender dynamics of herbicide use in the EGP?

The study involved participatory farmer research in six districts of the EGP- Cooch Behar, Malda in the state of West Bengal, India, Purnea in the state of Bihar, India, Rangpur and Rajshahi in Bangladesh and Sunsari in Nepal. In-depth interviews were conducted with users and non-users of zero-tillage (ZT) under CA to explore farmer knowledge and weed management practices. The objective was to capture their lived experiences, perceptions, gendered labour allocations and weed management responsibilities within households.

Results highlight that first, negative perceptions on herbicides were common among dis-users of CA and new-herbicide users who have relatively limited experience with CA, mostly concentrated in Bihar and Sunsari, compared to active users who reported time, cost and labor benefits, mostly in Cooch Behar, Malda and Bangladesh. Second, in households that use herbicides, weed management using sprays has become a male domain with women offering support services indicating reduced burden on women who were manually pulling out weeds traditionally. Thus, there is value in achieving a change of negative perceptions on herbicide-based weed management to positive that will ensure the success of ZT in EGP.

Towards this, the study suggests strengthening information channels through extensive extension services for dissemination of accurate information and knowledge around CA. It also suggests government-led incentives and support for resource constrained, smallholder farmers of EGP to ensure a wider uptake.

Manuscript reference: Suri, B; Timsina, P; Karki, E; Chaudhary, A; Sharma, A; Sharma, R, Gartaula, H and Brown, B (2021 – In preparation) Farmers' Experience of Weed Management under Conservation Agriculture: Insights from the Eastern Gangetic Plains of South Asia (for Technology in society). Appendices [T]

Learnings about Digital Agri-Advisory Services (DAAS)

SRFSI co-supported an ACIAR study on Digital Extension tools in the developing world, and in particularly supported the lead author to implement semi-structured overviews in SRFSI communities in Bihar. The below is the manuscript abstract.

Digital extension tools (DETs) include phone calls, WhatsApp groups and specialised smartphone applications used for agricultural knowledge brokering. We researched processes through which DETs have (and have not) been used by farmers and other extension actors in low- and middle-income countries. We interviewed 40 DET developers across 21 countries and 101 DET users in Bihar, India. We found DET use is commonly constrained by fifteen pitfalls (unawareness of DET, inaccessible device, inaccessible electricity, inaccessible mobile network, insensitive to digital illiteracy, insensitive to illiteracy, unfamiliar language, slow to access, hard to interpret, unengaging, insensitive to user's knowledge, insensitive to priorities, insensitive to socio-economic constraints, irrelevant to farm, distrust). These pitfalls partially explain why women, less educated and less wealthy farmers often use DETs less, as well as why user-driven DETs (e.g. phone calls and chat apps) are often used more than externally-driven DETs (e.g. specialised smartphone apps). Our second key finding was that users often made - not just found - DETs useful for themselves and others. This suggests the word 'appropriation' conceptualises DET use more accurately and helpfully than the word 'adoption'. Our final key finding was that developers and users advocated almost ubiquitously for involving desired users in DET provision. We synthesise these findings in a one-page framework to help funders and developers facilitate more useable, useful and positively impactful DETs. Overall, we conclude developers increase DET use by recognizing users as fellow developers – either through collaborative design or by designing adaptable DETs that create room for user innovation.

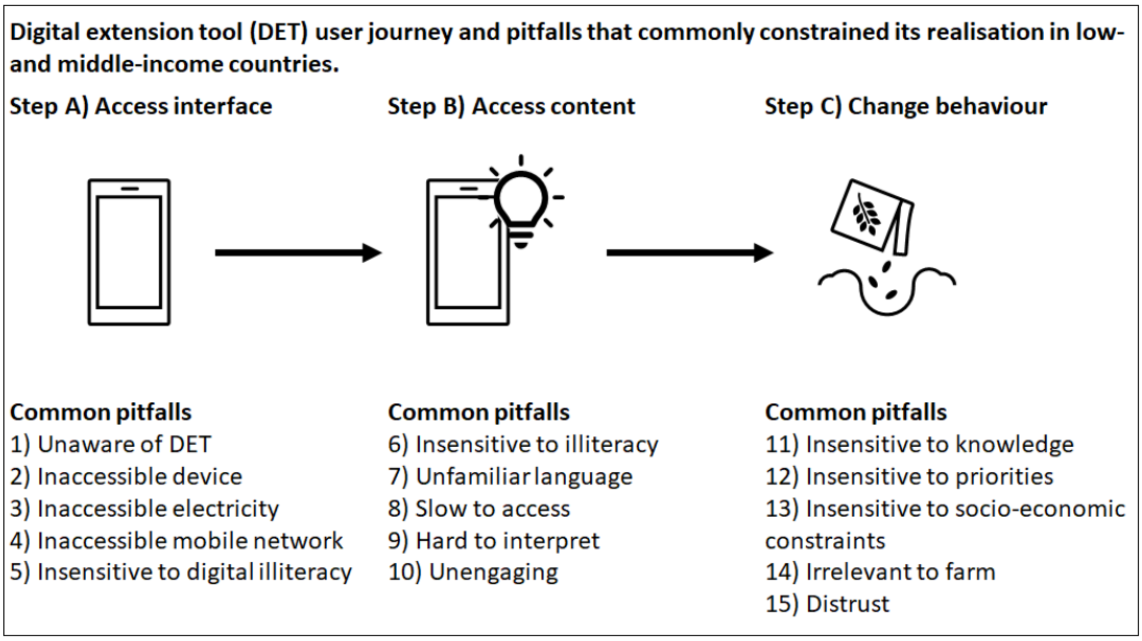


Figure 36: Visual Abstract for the DAAS manuscript

Manuscript reference: Coggins, S., McCampbell, M., Sharma, A., Sharma, R., Haefele, S., Karki, E., Hetherington, J., Smith, J., Brown., B (2021) How have smallholder farmers made digital extension tools useful? Practitioner and user voices across Sub-Saharan Africa, South Asia and Southeast Asia. Journal Global Food Security (Accepted for Publication – awaiting final publication details) Appendices [U]

8 Impacts

8.1 Scientific impacts – now and in 5 years

SRFSI will in years to come be remembered for the novel scientific approaches it employed to address its research questions, spanning both qualitative and quantitative explorations, and the catalytic scientific role it played in brining CASI to the regional agricultural agenda. It will also be known for its substantial publication record, which at the time of writing consisted of:

- 26 Published peer reviewed journal articles; and
- A further 10 journal publications currently under review, 7 in near submission and 30 in early and mid-stage drafting covering multiple aspects of CASI evaluation and scaling; and
- 16 International conference presentations; and
- Four book contributions.

A list of these publications is available in the publications list appendices [W]. While this publication record has not had time to move from output to impact, SRFSI does have many meaning impacts such as:

8.1.1 SRFSI is a catalyst and baseline for all CASI research and development in the EGP

As the first and largest collaboration contributing to the CASI agenda in the EGP, SRFSI should be considered seminal to the development of all current and future research and development agenda for CASI in the EGP. Prior to SRFSI there was no strong academic justification for the deployment of CASI in the region. Hence, any non-project current and future CASI activities in the region can be considered to stem from SRFSI.

8.1.2 The value of non-station agronomy trials

Prior to SRFSI (and SIMLESA, the sister project in Eastern and Southern Africa) it was extremely rare for large-scale farmer-managed agronomy trials to be implemented for academic purposes. The focus of similar programs was instead on demonstration of standardised experimental trials on research stations. It was considered too challenging to conduct rigorous, statistically valid on-farm trials to be worth the investment of time or other resources.

The SRFSI project has demonstrated not only the possibility of conducting large-scale on-farm participatory field trials, it has also illustrated the value of so doing. By conducting trials in a participatory manner which emphasised equal contributions by farmers and researchers, the project developed trust with farmers. This, plus the selection of field technicians from local communities, ensure that field trials were well-run and that most agronomic challenges were identified and overcome early (the exception to this was flooding at some sites in some seasons). This contributed to the high degree of rigour in field trial results.

About half (just over 400) of the field trials were conducted to test the project's core hypotheses around CASI crop management. The remainder of the over 800 total trials addressed questions that were of more immediate concern to farmers and revolved around how to optimise cropping systems, with a secondary focus on CASI management. This integration of farmer and researcher priorities also contributed to the high degree of rigour in the field trial results.

On-farm trials are one of the most effective ways of demonstrating an agronomic benefit, and of influencing additional farmers. These field trials, supported by farmer-to-farmer learning, farmer field days, demonstrations, exchange visits and the like which were facilitated by the project, enabled the project to disseminate knowledge within agricultural communities, informing over 100,000 farmers about the value of CASI and underpinning the successful out-scaling of CASI practice across the region.

The field trials and the innovation platforms established to support them enabled farmers to increase their awareness of the possibilities beyond the status quo. Farmers were informed and able to meaningfully engage with service providers and company representatives (e.g. from suppliers of agro-inputs), negotiate bank loans, empower women in their communities, and support local micro-entrepreneurs.

Further, on-farm trials underpinned a bottom-up engagement with local policy, governance and decision makers, ensuring the implementation of sound and appropriate policies to support farmers and communities in the adoption of CASI practices.

The robust field trial results, at both a local level and across the EGP, has resulted in local educational institutions incorporating CASI teaching into their curricula, and have been the basis for developing multidisciplinary research teams within institutions.

Lastly, the robust, large-scale field trials have underpinned high-impact scientific publications across a range of agricultural disciplines.

SRFSI has set the gold standard for farmer-led agronomy experimentation to achieve influence and impact outside of project trials, and particularly the value in respectfully and participatorily engaging with local communities to build trust and achieve researcher and farmer goals. Other research projects now have a model to base proof-of-concept experimentation blended with promotional activities.

8.1.3 Applying structured qualitative assessments

SRFSI implemented a huge qualitative survey to explore adoption dynamics, and with it proposed an amended and structured tool for qualitative research of farmer decision making. This dartboard approach to decision making is relevant for future studies of farmer decision making and has been integrated outside of the project (for example in the CSISA project in India). This highlights the applicability of large qualitative work structed around a centralised yet implementable framework for structuring design, analysis, and communication activities.

8.1.4 Applying pathway analysis for adoption studies

Like SRFSI's qualitative work, SRFSI also took a unique pathways approach to understanding the status of adoption. This work has also been integrated outside of the project, (e.g. in CSISA Nepal). This work has the potential to be seminal in furthering academic discourse beyond binary adoption and into a gated stepwise and dynamic process for monitoring, evaluation and learning.

8.1.5 Implementing successful Cross Project Collaboration

SRFSI has been unique in its cross-project collaborations, particularly with 'sister projects' and 'portfolio projects'. In term of sister projects, similar methods were employed in both SIMLESA and SRFSI to explore adoption dynamics, meaning that with some additional resources cross-regional learnings that could be facilitated (e.g. comparing CASI status, type, uptake, next steps between Africa and South Asia, or to collaborate on more global analyses). Likewise, SRFSI was paired regionally with the CSISA program and was able to implement conjoined studies between projects e.g. eastern and western locations in the CSISA mechanisations study in Nepal). Likewise, SRFSI has shared data with other SDIP projects (e.g. 3Is) and with other ACIAR projects (e.g. the behavioural economics projects) to maximise research impact. Such collaborations are not always how science is implemented, and highlight the strength and potential for in particular CGIAR led projects.

8.1.6 Highlighting benefits of multi-disciplinary collaboration

SRFSI blended research and development partners into a common theory of change to ensure that strong linkages would persist beyond the bounds of project influence. This is particularly strong in West Bengal where a development partner like SSCOP has become an academic and development hub for the region, because of the support of UBKV and West Bengal DoA. This approach has also integrated communications and strengthened collaboration between Government academia (UBKV), government Extension (DoA) and private enterprise (SSCOP) that is already impactful in improved outcomes for farmers.

This is seen also in the speed of change that is now possible in sanctioning policy changes, built though years of collaboration and trust building. For example, non-glyphosate protocols recently developed by UBKV and CIMMYT were quickly sanctioned by the DoA. This means that the partnerships established can have quick and direct implications on the roughly 70 million farmers in West Bengal.

8.1.7 Helping frame adoption processes and scaling discussions

Though SRFSI a new adapted online version of Smallholder ADOPT was developed. Tools such as this will increase the impactfulness of future interventions by enabling a structured evaluation of expected adoption outcomes and what can be done to increase outcomes. It is hoped this will play a role in future ACIAR projects within and outside the region, and has already been integrated in the CGIAR excellence in Agronomy program 2030.

Manuscript reference: Llewellyn, R., Brown, B. (2020) Predicting Adoption of Innovations by Farmers: What is Different in Smallholder Agriculture? Applied Economics Perspectives and Policy Vol 42 (1) pp 100 – 112 https://doi.org/10.1002/aepp.13012 **Appendices [V]**

8.1.8 Moving gender research beyond participation

Gender studies are not simply about percentage participation. There are multiple elements to practice change that impact on woman livelihoods, and SRFSI proposed methods of investigation to explore deeper elements of decision making, immediate and secondary implications of practice change. This process is likely to be emulated in future work where focus is placed not on immediate changes, but on how those changes affect livelihoods.

Manuscript reference: Brown, B; Karki, E; Sharma, A; Suri, B; Chaudhary, A (2021) Herbicides and Zero Tillage in South Asia: are we creating a gendered problem? Outlook on Agriculture (In Press) https://doi.org/10.1177/00307270211013823 Appendices [I]

Manuscript reference: Brown, B; Karki, E; Sharma, A; Suri, B; Chaudhary, A (2021 – In review) Beyond agronomy and economics to self-sufficiency, fulfilment and new economic opportunities: what South Asian farmers do with additional time and money achieved through zero tillage. Journal of Development Practice Appendices [J]

Manuscript reference: Karki, E; Sharma, A; Suri, B; Chaudhary, A, Timsina, P.; Brown, B (2021- In Preparation) How does gender influence the evaluation of Conservation Agriculture in South Asia? Appendices [N]

Manuscript reference: Timsina, P.; Sharma, A; Chaudhary, A.; Karki, E; Sharma, A; Suri, B; Chaudhary, A.; Brown, B (2021 – In preparation) Necessity as a driver of bending agricultural gender norms in the Eastern Gangetic Plains of South Asia Appendices [O]

8.1.9 APSIM as a scientific tool

The SRFSI field trials generated data which allowed the APSIM modelling team to learn how to simulate CA vs CT cropping systems in the rice-based cropping systems of the Eastern Gangetic Plains. The APSIM model performance was evaluated against observed data and acceptable model performance was demonstrated. This was a new achievement which positioned the model well to assist with other research questions (Gaydon et al., 2018). The model was subsequently used to examine CA vs CT practices across the SRFSI regions across a much longer time-frame and in different climatic scenarios from those which the SRFSI field trials allowed, thereby assessing relative risk levels between the practices. The model was also used to evaluate CA vs CT under projected future climates and from the perspective of greenhouse gas (GHG) emissions (Gaydon et al., 2020). Under most scenarios examined, distinct advantages to CA were revealed, however not everywhere (Chaki et al., 2021a, 2021b). The APSIM work has demonstrated that there are important environmental benefits of CASI, especially through improved soil characteristics, increased soil biotic activity, improved water use efficiency, and energy-use efficiency. Greenhouse gas and climate change impacts have also been investigated. Published reports and papers include:

8.1.10 International recognitions

In July 2021, SRFSI was recognised global for its solid scientific contribution to CASI academia. Eight SRFSI related presentations were accepted for presentation at the 8th World Congress on conservation Agriculture (**Table X**). Additionally, three of those were recognised as best presentations in their fields. This highlights that SRFSI science is likely to be well regarded into the future. All presentations are online at https://srfsi.cimmyt.org/8wcca/.

Table 1: Presentations from SRFSI at the 8th World Congress on Conservation Agriculture

Type	Lead Presenter	Title	Theme	Award
Oral	Brendan Brown (CIMMYT)	Catalysing Conservation Agriculture Uptake in the Eastern Gangetic Plains of South Asia	Sub-theme 1-Successful experiences and learnings from Conservation Agriculture worldwide	Best oral Presentation [Theme 1]
Poster	Apurba Chowdhury (UBKV)	Successful scaling approaches leading to autonomous adoption of Conservation Agriculture in West Bengal	Sub-theme 3: Mainstreaming of CA with national policy and institutional support and for global governance to support national and international needs and commitments	Best poster presentation [Theme 1]
Poster	Emma Karki (CIMMYT)	"Is Conservation Agriculture 'female friendly': Learnings from the Eastern Gangetic Plains of South Asia"	Sub-theme 1: Successful experiences and learnings from Conservation Agriculture worldwide	Best poster presentation [Theme 2]
Oral	Ram Datt (Bihar Agricultural University)	Learnings from the first Conservation Agriculture focused MOOC	Sub-theme 4-Promoting CA-based knowledge and innovation systems and information sharing and communication	
Oral	Ml Jat (CIMMYT)	Conservation agriculture impacts in cereal-based cropping systems of South Asia: A meta-analysis	Sub-theme 1: Successful experiences and learnings from Conservation Agriculture worldwide	
Oral	Mahesh Gathala (CIMMYT)	Conservation agriculture-based intensification sustainably improves the food, energy and water nexus for smallholder farmers in South Asia	Sub-theme 2: Farm and ecosystem level benefits of CA systems to farmers, society and environment	
Poster	Dipendra Pokharel (Nepal DoA)	Conservation Agriculture Technologies Increase Production and Productivity of Cereal Based Farming System In Eastern Plains of Nepal	Sub-theme 1: Successful experiences and learnings from Conservation Agriculture worldwide	
Poster	Brendan Brown (CIMMYT)	"Next steps for taking Directly Seeded Rice to Scale in the Eastern Gangetic Plains of South Asia"	Sub-theme 1: Successful experiences and learnings from Conservation Agriculture worldwide	

8.2 Capacity impacts – now and in 5 years

Capacity development was a particular focus of phase two of the project. More than 60,000 individuals received SRFSI training, the impact of which is part covered in section 7.2 and 7.3.6. The impacts of this will continue to be felt for an extended period to come. Beyond this, further capacity impacts include:

8.2.1 Infrastructure of CECA at UBKV, Coochbehar

The Centre of Excellence for Conservation Agriculture (CECA) has been approved by both ICAR and the West Bengal DoA to become the premier hub for conservation agriculture across West Bengal and the broader EGP. This Centre will establish the infrastructure to further promote CASI beyond the scope of SRFSI and beyond the life of the project, a great development for CASI training infrastructure for long term capacity impact. The West Bengal government is also providing the operating funds for this center to ensure sustainability outside of SRFSI.

8.2.2 Degree and non-degree training

The impacts of higher degree training will not be truly known until those newly trained individuals have time to move into new positions and create their impact. However, more than 20 emerging researchers obtained higher degree research degrees as part of the SRFSI project, with multiple through Australian higher research institutions.

Beyond formal higher degree research training, CIMMYT, CSIRO and UWA have provided multiple courses and fostered strong relationships with local researchers that will increase the quality of science for years into the future. This is wide ranging from implementation of agronomic trials (e.g. CIMMYT and CSIRO), conducting economic analyses (e.g. CIMMYT and UWA), implementing qualitative impact assessments (e.g. CIMMYT) and writing academic articles for publications (e.g. CSIRO). These are all likely to have longer term impacts for both emerging researchers and farmer livelihoods.

8.2.3 Hand over of equipment

SRFSI purchased on behalf of partners some of the first CAIS machinery in the region, and continued to develop machinery stocks across the region. Remaining equipment will now be handed over to partners for them to continue conducting research and development activities as part of their own programs at the completion of SRFSI.

8.2.4 Innovation platforms

For innovation platforms, other researchers are becoming aware of our work in the application of using Innovation Platforms through SRFSI. The publication of the innovation platforms paper is hoped to stimulate broader debate about usefulness of Innovation Platforms in the region. IPs are being used by other researchers and practitioners in the region, and we hope our experiences will help guide them to improved outcomes and impacts and ultimately benefit farmers and the farming communities.

8.2.5 Capacity for future MEL and scientific activities with non-scientific organisations

At the inception of SRFSI, many collaborating organisations has limited interaction with international organisations. Because of this, their capacity for prudent financial and technical reporting was limited. SRFSI as a project collectively grew these local organisations capacities to create a vision, articulate that for funding, implement and report, both technically and financially, to donor organisations. This can be seen now in organisations ability to secure alternative funds from donor organisations for their work (e.g. SSCOP and NARBIND and the Australian high commission).

8.3 Community impacts – now and in 5 years

Estimating the impact of interventions is a tricky game. SRFSI has taken a pragmatic approach to matching agronomic, economic and environmental impact of the project. This matches estimated acreage under various CASI principles with their corresponding scientifically confirmed benefits in comparison to conventional practices, as variously published. These calculations are shared in Appendix [X].

8.3.1 Economic impacts

The total direct economic benefit to farmers from the SRFSI project is more than AUD$40,000,000 AUD, not including any indirect, institutional and broader benefits from the project. This represents a return (to farmers) on investment of approximately 4. If current adoption is maintained (and not increased as expected), a annual benefit of nearly AUD$11 million is directly accrued to farmers through CASI practices.

For individual results please see the results section 7.1. In summary, CASI practices reduce the cost of production alongside creating additional marketable resources. It also opens opportunities for intensification (both through Pre-Kharif season opportunities and through diversification opportunities. Importantly, saved time can also be moved towards new economic opportunities and empowerment, including livestock and farm-aligned (e.g. service provision) and off farm opportunities

8.3.2 Social impacts

74% of CASI users in the Impact survey stated that they are now more likely to try new agricultural technologies due to their experience with CASI. This suggests that longer term social impacts may arise through SRFSI enabled CASI usage. Like many social impacts however, these are likely to accrue into the future.

Women's agency and empowerment

SRFSI made specific efforts to ensure that women were not left behind in the development pathways of SRFSI. For instance, more than 22% direct involvement on CASI and other allied sectors is by women in West Bengal. More so, partners have linked SRFSI to increased confidence of women in daily processes. For example, SSCOP reports "women have become extremely vocal and interact with important people confidently. A large number of women are now able to take independent decisions on farming and hence are devoting full time in agriculture".

Youth

SRFSI project has proven that agricultural service provision is an alternative to out migration, particularly in West Bengal. This could have longer term societal implications.

Spending capacity and prioritises

Research suggests that extra fund from CASI are being prioritised for transport, communication and educational expenses. In particular there may potentially be longer term benefits to educational outcomes given extra time and money is being prioritised for these purposes.

Innovation Platforms

Existing extension systems are unable to facilitate widespread adoption of CASI to have the impact necessary to meet food security and livelihood requirements. "Innovation Platforms" (IPs) were proposed as a tool to catalyse adoption of CASI for smallholder farmers across the EGP to generate opportunities for rural micro-entrepreneurship in areas with high rates of poverty, small farm sizes and complex labour markets. IPs allowed widespread uptake of CASI with benefits to smallholder farmers, input and output suppliers, and enabled extension systems to be more efficient. There was variability across locations with different modes of IPs established, building on existing farmer or community youth groups, and enabling micro-entrepreneur business opportunities. IPs were effective in developing trust in communities, among stakeholders, empowering rural youth and women through direct engagement. Ensuring strong ownership was key.

There was some evidence of improved profitability through being involved in Innovation Platforms, and in particular with the adoption of CASI. However, some of the interviews revealed that having experience with IPs and having benefits and success means that not only are there economic gains (improved distribution of income and purchasing power) but also social gains. Furthermore, some strong benefits for women emerged, in that they felt more empowered and they were in a better economic position (due both to the SRFSI project and the IPs). As highlighted in the case studies for Satmile and Dinhata, the benefits for women included more economic power, more independence and social gain; they believed they can now do something for themselves (self-empowerment). This reflects the common assertion of project partners that the focus on training of females (goal at 30% of total training) was a game changer that has helped to refocus other programs on the need to do this.

SRFSI had the ambition to run a study in Coochbihar that looked at the spin off economic opportunities that have eventuated from saved labour of females – specifically in relation to activities such as paddy mat seedling production, mushroom and vegetable production. With COVID-19, this study seems unlikely to be implemented.

8.3.3 Environmental impacts

The theoretical implications of CASI on environmental outcomes have been proven though SRFSI, as well as considerable environmental impacts. These include more than 16.5 million litres of water saved, more than 9 million tons carbon dioxide equivalents mitigated and more than 77 million MJ of energy saved. On an annual basis if current levels are to be maintained (and not as expected, increased), there will be an ongoing minimum annual benefit of 4 million litres of saved water, 2.4 million CO2 equivalents mitigated and 2.4 million megajoules of energy saved. Beyond this, efforts have already become fruitful in the no glyphosate CASI protocols that have been adapted in West Bengal which may reduce the risk of future environmental hazards.

8.4 Communication and dissemination activities

8.4.1 A focus on publications

The mandate of SRFSI was to conclusively explore whether CASI could be beneficial for the EGP, and then learn about scaling processes to improve CASI uptake across the region. To do this, a focus must be placed on academic publication.

This was comprehensively achieved with SRFSI. As of the time of writing, SRFSI had produced:

- 26 Peer reviewed Journal publications in press
- A further 10 journal publications currently under review
- 16 International conference presentations
- Four book contributions
- 7 advanced draft academic publications for submission before the end of project
- 30 early and mid stage publications identified for eventual submission to academic journals over the medium term.

A list of these publications is available in the publications list appendices [W].

Non-academic communication

Specific efforts have also been placed on communicating to non-scientific audiences with the establishment of the SRFSI online repository (SRFSi.cimmyt.org). This repository was not developed as a project website, but as a ‘one-stop-shop- for information about CASI on the EGP. It includes a repository of extension materials each targeted to different user types and available in 4 languages.

8.4.2 Visual Syllabus

A particular novel approach was the Visual syllabus (https://srfsi.cimmyt.org/intro-casi-visual-syllabus/) which was filmed with community actors and scripted with partner organisations. COVID-19 meant the plants for multiple chapters had to be scrapped and so the Rice transplanter, surface seeding, 2-wheel machinery and running a business chapters were scrapped. Additionally, a promotional program planned with BAU and UBKV networks and community cinemas was also not possible.

8.4.3 MOOC

The first massive open online course on Conservation Agriculture based Sustainable Intensification provided by Bihar Agriculture University (BAU) at agMOOCs portal with the support of Sustainable and Resilient Farming Systems Intensification (SRFSI) project provided an opportunity for learners to enhance knowledge on CASI based farming. To explain the basics of CASI and the advantages for smallholder farmers, BAU started a six-week online course from 12 February till 31 March 2020.

With 7417 virtual participants from 50+ countries, this course focused on portfolios of CASI, machinery, agronomic management, challenges, advantages, and business models to implement CASI service provision business, with the aim of providing a thorough overview of CASI systems to a wide audience ranging from students, agri-professionals, farmers to extension officers, entrepreneurs, and policymakers.

Ultimately 2,578 of the participants completed the entire course and were awarded a completion certificate from the Centre for Continuing Education Indian Institute of Technology, Kanpur, Commonwealth of Learning, Canada, and Bihar Agricultural University, Sabour. Please see https://www.agmoocs.in/course/conservation-agriculture-based-sustainable-intensification-casi for MOOC details.

8.4.4 Business accelerator program

Through iDE, SRFSI commissioned a business accelerator program to help emerging businesses, farmer producer organisation and service providers evaluate CASI and develop business plans. This was intended to be scaling out during the last year of the project but was not possible due to COVID-19. However, workbooks and course content has been finalised.

8.4.5 Establishing virtual service provider support networks

In the situation of COVID-19, several regional virtual service provider networks were established. These provide an opportunity for CASI service providers to share experiences and learn from each other.

8.5 Policy Impacts

A more conductive policy environment for CASI has been one of the major impacts of the project, and likely to sustain CASI impact well into the future. In West Bengal in particular, the State Government of West Bengal have adopted CASI in their policy document – Schemes & Guidelines. Convergence with different government schemes (BGREI, NFSM, NMOOP, CHC, ATMA etc) of DOA and policy changes of DOA on adoption of new variety, agronomic package, CHC to farmers groups, incorporation of CA machineries in the compulsory list of CHC are all present. Further, Adoption of CASI technology in state plan and revised course curricula in university degrees subjected to ICAR Education division.

9 Conclusions and recommendations

9.1 Conclusions

Fact 1: CASI is now a proven practice for and belongs in the EGP

Though multiple research methods and development activities, SRFSI has comprehensively proven that CASI should be integrated into programming of partner organisations and beyond. The depth and breadth of benefits have been repeatedly confirmed and in many cases peer reviewed, with some remaining publications left to also be added to the academic literature. These benefits have also been communicated at policy levels with various key stakeholders.

Fact 2: An informal network of trained CASI actors exists across the EGP

Sheer volume of trained individuals through SRFSI has set a sound scaling base for future CASI initiatives. Empowered with that learned in Fact 1, that CASI works in their locations, this has already and will continue to forward the CASI agenda across the region.

Fact 3: Varying levels of momentum have been built for CASI Scaling across the EGP

We can see that over the course of SRFSI there has been huge increases in both awareness of and (to a lesser extent) usage of CASI practices. West Bengal has shown sizable leaps in usage enabled though CASI enabling policies in turn led by SRFSI champions. Bihar has also seen the invitation of huge government programs focused on CASI. Momentum in Nepal and Bangladesh is led evident, though huge potential exists.

Fact 4: SRFSI has been a wise investment

SRFSI was proposed on the premise that an unproven set of practices could be proven and promoted in a limited time period. Given the number of farmers who have adopted and the extent of evidence to support the scaling of CASI in the region, this can be seen as successful, Economically, the direct return on investment of at least 4 also supports the proposal that SRFSI was a wise investment. Into the future with various SRFSI enabled interventions, the project is likely to further increase its impact and return.

Fact 5: The job is not done (for CASI scaling)

COVID-19 came at a difficult time during the scaling and closure phase of the project. Particularly in Bangladesh and Nepal where critical mass was not reached, it has a large effect. The basis for CASI scaling is present but there is still much to be done to ensure long-term success (*see recommendations*).

9.2 Recommendations

At the closure of SRFSI, the project team has four recommendations.

[1] Consider the role of CASI as a pathway to crop, livestock and livelihood diversification, in the context of future support and initiatives

Given ACIAR's ambition to focus on broader food system change and crop diversification in follow on work in the region, the results of SRFSI suggest that CASI mechanisation is an entry point to achieve this. CASI was shown to have potential benefits for all of crop, livestock and livelihood diversification. Given that momentum has already begun in many locations, CASI should be considered as the building block for further food system research initiatives. This will also allow ongoing technical support to partners for scaling CASI. The current framing of the new ACIAR food systems project commissioned with the University of Adelaide appears to limit any potential activity on CASI as a catalyst for diversification, and this would appear a missed opportunity. The role of CASI as a catalyst to food system change warrants further exploration and we recommend that CASI remains a strong focus within future diversification initiatives such as the new ACIAR initiative (WAC/ 2020/148).

[2] Consider prioritisation of service provision research to ensure sustainable mechanisation pathways

Each country in the EGP has stated objective towards achieving agri-mechanisation. However, it is likely that pathways to achieve this may be unsustainable and based around tillage intensification and associated avoidable negative environmental outcomes. At this crucial and timely juncture, efforts are required to understand and encourage CASI service provision models, such that CASI can become the incumbent mechanisation pathway supported by an active and inclusive service provision economy. More work is required on the characteristics of sustainable small business and entrepreneurship models, to ensure economic opportunities for both farmers and small businesses are possible. Importantly, this requires branching away from more farmer led research and initiatives and more into business model / value chain research and promotion.

[3] Provide additional resources to deeply explore scaling processes

Given the in-depth information on what has worked where and why across 57 communities in six regions, an opportunity exists if time and resources can be made available to undertake a comprehensive assessment via social history explorations on how success is achieved. This would include a series of in-depth explorations that analyse processes for farmer, extension, support network and policy actor change that could inform all regional interventions on how change occurs. This could also include in depth qualitative analyses that correlate to the ADOPT model for final verification. While the Food System project (WAC/2020/148) will explore some of the learnings that came from SRFSI, time limitations and an emphasis on learning from a variety of different ACIAR investments means that learnings are likely to be limited, and there are currently no resources available to cement the learnings of SRFSI and what this means for future interventions, meaning a missed opportunity for learnings of how to create and sustain change processes. Dedicated resources would enable stronger learnings and sustained impacts from SRFSI.

[4] Provide resources for a final push for publication and communication activities

In COVID-19 times, the quantitative survey was delayed and because of reporting timelines only a superficial analysis has been completed. There is much more to learn if time and financial support could be provided. This includes more than 20 publications where data has been collected and analysis is often nearing completion, yet no time or financial resources are available to complete this analysis. Given ACIARs priority to ensure the impact survey was implemented despite COVID challenges, there has been little further support to enable learnings from the dataset, which is potentially wasteful in both financial and human resources. Dedicated funding to complete these analysis and publication would enable much stronger learnings from the dataset which may otherwise be lost as other funding and priorities dictate workplans.

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10.2 List of publications produced by project

See appended publications list for full details

Journal Articles Published

1	Das et al. (2016) Characterization of research nodes: An integrative approach through indexing. Int. J. of Bio-resource & Stress management
2	Gathala et al. (2016) Energy-efficient, sustainable crop production practices benefit smallholder farmers and the environment across three countries in the Eastern Gangetic Plains, South Asia . Journal of Cleaner Production Volume 246, 10 February 2020, 118982 https://doi.org/10.1016/j.jclepro.2019.118982
3	Apurba et al. (2017) Effect of conservation agriculture based rice- wheat systems on sheath blight and spot blotch diseases in eastern India . Journal of Mycopathol. Rese 54(4): 543-545
4	Adhikari et al. (2018) Technical efficiency of hybrid maize production in eastern terai of Nepal: A stochastic frontier approach. Journal of Agriculture and Natural Resources (2018) 1(1): 189-196
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7	Agrawal et al. (2019) Growth and yield enhancement of rabi maize through identification of best timing for herbicide application. International Journal of Chemical Studies Vol. 7, Issue 4 (2019)
8	Gathala et al. (2019) Enabling smallholder farmers to sustainably improve their food, energy and water nexus while achieving environmental and economic benefits. Renewable and Sustainable Energy Reviews Volume 120, March 2020, 109645
9	Islam et al. (2019) Conservation agriculture based sustainable intensification: Increasing yields and water productivity for smallholders of the Eastern Gangetic Plains.. Field Crops Research, 238: 1-17
10	Sinha et al. (2019) Trends in key soil parameters under conservation agriculture-based sustainable intensification farming practices in the Eastern Ganga Alluvial Plains.. Soil Research 57(8) 883-893
11	Dutta et al. (2020) Improved water management practices improve cropping system profitability and smallholder farmers' incomes. Agricultural Water Management
12	Jat et al. (2020) Conservation agriculture for sustainable intensification in South Asia. Nature Sustainability, 3(4), 336–343.
13	Kumari et al. (2020) Effect of Tillage, Sowing Time and Irrigation Levels on Nutrient Uptake and Yield of Maize (Zea mays L.). International Journal of Current Microbiology and Applied Sciences 9(3):296-303
14	Llewellyn and Brown (2020) Predicting Adoption of Innovations by Farmers: What is Different in Smallholder Agriculture? . Journal: Applied Economic Perspectives and Policy 42: 100-112.
15	Mitra et al. (2020) Zero Tillage Technology in Jute Cultivation: A Successful Venture in West Bengal. International Journal of Current Microbiology and Applied Sciences Volume 9 Number 5
16	Rola-Rubzen et al. (2020) Improving Gender Participation in Agricultural Technology Adoption in Asia: From Rhetoric to Practical Action. Applied Economics Perspectives and Policy 42(1)
17	Sankar et al. (2020) Effect of seed rate and N application rate in wheat blast resistant genotype BHU 35 under zero till condition. Journal of Cereal Research,12(3):338-341
18	Thingbaizam et al. (2020) Differential pattern in labour use on male vs female managed farms and its economic consequences : a case study from Manipur, India. Agricultural Economics Research Review, 2019, vol. 32, issue 1
19	Brown, B et al. (2021) Herbicides and Zero Tillage in South Asia: Are we creating a gendered problem?. Outlook on Agriculture
20	Brown, B et al. (2021) Visualizing adoption processes through a stepwise framework: A case study of mechanization on the Nepal Terai. Agricultural Systems
21	Brown, P et al. (2021). Application of Innovation Platforms to catalyse adoption of conservation agriculture practices in South Asia. International Journal of Agricultural Sustainability,

22	Chaki et al. (2021) Conservation agriculture enhances the rice-wheat system of the Eastern Gangetic Plains in some environments, but not in others.. Field Crops Research
23	Chaki et al. (2021) Puddled and zero-till unpuddled transplanted rice are each best suited to different environments–An example from two diverse locations in the Eastern Gangetic Plains of Bangladesh. Field Crops Research
24	Chakraborty et al. (2021) Plant disease dynamics vis-a vis conservation agriculture. J.Mycol.Pathol.Res. 58(4):221-227
25	Gathala et al. (2021) Improved smallholder farmers' gross margins and labor-use efficiency across a range of cropping systems in the Eastern Gangetic Plains. World Development
26	Brown, B et al. (2021) Understanding decision processes in becoming a fee-for-hire service provider: a case study on direct seeded rice in Bihar, India. Rural Studies Volume 87, Pages 254-266,
27	Coggins et al. (2021) How have smallholder farmers made digital extension tools useful? Developer and user voices across Sub-Saharan Africa, South Asia and Southeast Asia. Journal Global Food Security (Accepted for publication August 2021)
28	Karki et al. (2021) Farm Mechanization in Nepal: Policy Context, Drivers and Options. Journal of International Development (Accepted for publication November 2021)
29	Chaurasiya et al., (2022) Layering smart management practices to sustainably maintain rice yields and improve water use efficiency in eastern India. Field Crops Research vol. 275

Journal Articles In review

1	Adam et al. (World Development) Can membership in farmers and rural producers organizations be a pathway to cultivate gender equality?. Under Review
2	Brown, B et al. (2021) From farm benefit to livelihood implications - a photovoice exploration of the wider implications of cereal intensification in South Asia. Journal of Development Studies (Submitted June 2021)
3	Chaudhary, A: et al. (2021) How to make Conservation Agriculture a success: Experience from smallholder farmers in the Eastern Gangetic Plains – Frontiers Special Edition on Conservation Agriculture (Submitted September 2021)
4	Paz et al. (Australian Journal of Agricultural and Resource Economics) Does Conservation Agriculture-based Sustainable Intensification Improve Farming Efficiency: The case of Bangladesh . Under Review
5	Rakesh et al. () Short-term effect of tillage and cropping system on soil organic carbon and its fractions in alluvial soils of subtropical eastern India. Under Review
6	Rola-Rubzen et al. (Journal of Environmental Management)) Explaining adoption of conservation agriculture-based sustainable intensification technologies in the Eastern Gangetic Plains: A comparative analysis of adoption models . Under Review
7	Rola-Rubzen et al. (Agriculture, Ecosystems and Environment) Impacts of Conservation Agriculture for Sustainable Intensification (CASI) Technologies among Men and Women Farmers in the Eastern Gangetic Plains. Under Review
8	Rola-Rubzen et al. (Land Use Policy) Why Do Farmers Disadopt Conservation Agriculture-based Sustainable Intensification Technologies after Field Trials: Lessons from South Asian Experience. Under Review
9	Rola-Rubzen et al. (World Development) Mainstreaming Gender to Raise Farm-Households Out of Poverty in the Eastern Gangetic Plains. Under Review
10	Timsina et al (2021) Necessity as a driver of bending agricultural gender norms in the Eastern Gangetic Plains of South Asia – Asian Development Bank Special Edition. (Submitted September 2021)
11	Rakesh et al. (2021) Short-term effect of tillage and cropping system on soil organic carbon and its fractions in alluvial soils of subtropical eastern India. Plant and Soils
12	Boa-Alvarado, M., Woltering, L., Stahl, J., Van Loon, J., Hernández, E., Brown, B., Gathala, M., Thierfelder, C. (2021) Capacity development for scaling conservation agriculture in smallholder farming systems: exposing the hidden levels – World Development (Submitted September 2021)

Journal Articles In Preparation

1	Akbar et al. (2021 - In preparation) Tillage and wheat genotypes interactions in Bangladesh
2	Akbar et al. (2021 - In preparation) Weed management strategies for direct seeded/unpuddled transplanted rice in Bangladesh
3	Anwar, M.M. et al. (2021 - In preparation) Participation and Technical Efficiency of Women Farmers using Conservation Agriculture Technologies under Wheat and Maize farming System in Bangladesh
4	Aun, M. et al. (2021 - In preparation) Access to Agricultural Credit and Productive Efficiency in Nepal: Is there a Nexus?
8	Brown et al. (2021 - In preparation) Adoption dynamics of agricultural practices on the Eastern Gangetic Plains
9	Brown et al. (2021 - In preparation) How CASI impacts households: farmers perceived impacts from adoption
10	Brown et al. (2021 - In preparation) What is CASI in the Eastern gangetic Plains: is it just Zero Tillage?
11	Brown, P. et al. (2021 - In preparation) Farm-household's perceptions on the Benefits, Advantages, and Disadvantages of CASI technologies
12	Chaudhary et al. (2021 - In preparation) Farmer Logic for Negative Evaluation of Conservation Agriculture in South Asia
13	Das, K.K. et al. (2021 - In preparation) Identifying Determinants in Popularizing Conservation Agriculture-based Sustainable Intensification: A Study in Cooch Behar, West Bengal, India
14	Dutta et al. (2021 - In preparation) Production sustainability, profitability and nutrition of diverse cropping systems under conservation agriculture – A long term study in the Eastern Gangetic Plains
15	Dutta et al. (2021 - In preparation) Simulating lodging in monsoon rice crops
16	Gathala et al. (2021 - In preparation) synthesis of CASI practices in the Eastern Gangetic Plains
17	Karki et al. (2021 - In preparation) Does Gender Influence the evaluation of Conservation Agriculture in South Asia?
18	Karki et al. (2021 - In preparation) What limits progression to use of CASI?
19	Laing et al. (2021 - In preparation) Sustainable agronomic management also benefits human health in South Asia
20	Laing et al. (2021 - In preparation) Widespread benefits for women and rural households of intercropping dry season maize in the Eastern Gangetic Plains, South Asia
21	Maharjan, S. et al. (2021 - In preparation) Farming Systems Zones Characterization: Implications for Targeting CASI technologies in the EGP
23	Masood et al. (2021 - In preparation) Validating the ADOPT tool in South Asia
24	Mitra et al. (2021 - In preparation) Efficacy of pre- and post-emergence herbicide combinations on weed control in no-till mechanically transplanted rice
25	Murray-Prior, R. et al. (2021 - In preparation) Models of service provision for CASI in the EGP: Opportunities and Challenges
26	Murray-Prior, R. et al. (2021 - In preparation) To Adopt or not Adopt? Key Decision Processes Used by South Asian Farm Households on the Adoption of CASI Technologies
27	Phan, N. et al. (2021 - In preparation) Conservation agriculture adoption and production efficiency of wheat farmers in Bangladesh: A stochastic frontier analysis
29	Rola-Rubzen, M.F. et al. (2021 - In preparation) Does Conservation Agriculture improve farming efficiency: Evidence from South Asia
30	Rola-Rubzen, M.F. et al. (2021 - In preparation) Farmer perception of Conservation Agriculture-based Sustainable Intensification Technologies, Risk attitude and Innovativeness: Do they matter in CASI adoption? A Structural Equations Modelling Approach
31	Rola-Rubzen, M.F. et al. (2021 - In preparation) Mainstreaming Gender to Raise Farm-Households Out of Poverty in the Eastern Gangetic Plains
32	Rola-Rubzen, M.F. et al. (2021 - In preparation) Towards poverty reduction – Can CA lift rural people out of poverty?
33	Sharma et al. (2021 - In preparation) Characteristics of CASI service provision in the Eastern gangetic Plains
34	Sharma et al. (2021 - In preparation) Expanding Zero Tillage Service Provision: perspectives from machinery owners in the Eastern Gangetic Plains

35	Sharma et al. (2021 - In preparation) Wealth, risk and Access: drivers of CASI uptake on the Eastern gangetic plains
36	Suri et al. (2021 - In preparation) Farmers' Experience of Weed Management under Conservation Agriculture: Insights from the Eastern Gangetic Plains of South Asia

Conference presentations

1	Das et al. (2019) Critical Factors Influencing Conservation Agriculture for Sustainable Intensification – A Case Study of Coochbehar District, West Bengal, India, AARES Conference, 6-9 February, Melbourne..
2	Rola-Rubzen, et al. (2020) Abandonment of Conservation Agriculture Technology after Field Trial: Lessons from the Eastern Gangetic Plains Experience, Paper presented during the Australasian Agricultural & Resource Economics Society Annual Conference in Perth, Western Australia. 10-14 February 2020..
3	Rola-Rubzen, et al. (2020) Explaining adoption of CASI technology in the Eastern Gangetic Plains: lessons learned, Paper presented during the Australasian Agricultural & Resource Economics Society Annual Conference in Perth, Western Australia. 10-14 February 2020..
4	Rola-Rubzen, et al. (2020) Impact of Conservation Agriculture-based Sustainable Intensification Technologies among Men and Women Farmers in the Eastern Gangetic Plains, Paper presented during the Australasian Agricultural & Resource Economics Society Annual Conference in Perth, Western Australia. 10-14 February 2020..
5	Das et al. (2020) Entrepreneurial potential of service providing model — a study in North Bengal economy. Invited Lecture in the South Asian Conference on "Social Enterprise – value and processes" organised by Tata Institute of Social Science at Mumbai, India. 8-10 January 8-10 2020..
6	Maharajan et al. () Is ZT-multi crop planter services profitable for service providers? A Case study from Coochbehar, West Bengal, India.
7	Rola-Rubzen, et al. () impact of Conservation Agriculture and Sustainable Intensification (CASI) Technologies in the Eastern Gangetic Plains, South Asia,.
8	Anwar et al. () Participation and Technical Efficiency of Women Farmers using Conservation Agriculture Technologies in Wheat and Maize Production in Bangladesh,.
9	Rola-Rubzen, et al. () Women and Conservation Agriculture Tools: Case Studies from SRFSI,.
10	Datt et al. () Learnings from the first Conservation Agriculture focused MOOC.
11	Gathala et al. () Conservation agriculture-based intensification sustainably improves the food, energy and water nexus for smallholder farmers in South Asia.
12	Brown, B et al. () Catalysing Conservation Agriculture Uptake in the Eastern Gangetic Plains of South Asia.
13	Jat et al. () Conservation agriculture impacts in cereal-based cropping systems of South Asia: A meta-analysis.
14	Chowdhury et al. () Successful scaling approaches leading to autonomous adoption of Conservation Agriculture in West Bengal.
15	Brown, B et al. () Next steps for taking Directly Seeded Rice to Scale in the Eastern Gangetic Plains of South Asia.
16	Karki et al. () Is Conservation Agriculture 'female friendly': Learnings from the Eastern Gangetic Plains of South Asia.

Book Contributions

1	Dabras et al. (2020) The feminization of agriculture on the Eastern Gangetic Plains: Implications for rural development. In 'Bihar: Crossing Boundaries.' (Eds Lall, S., Kumar, N., and Sinha-Kerkhoff, K.). pp. 97-126. (Primus Books: New Delhi)
2	Dixon et al. (2020) Socioeconomic Impacts of Conservation Agriculture based Sustainable Intensification (CASI) with particular reference to South Asia, in Dang Y.P., Dalal R.C., Menzies N.W. (eds), No-till Farming Systems for Sustainable Agriculture, pp377-394, Springer, Cham. https://doi.org/10.1007/978-3-030-46409-7_22 (ISBN: 978-3-030-46408-0 (print); 978-3-030-46409-7 (online).

3	Rola-Rubzen et al. (2021) Voices of Women: Case Studies of the Impact of CASI on Farm-Households in the EGP of South Asia, (For submission to Springer - under revision)..
4	Gathala et al. (2021) Conservation agriculture-based sustainable intensification to achieve food, water and energy security while reducing farmers' environmental footprint in the Eastern Gangetic Plains of South Asia.

10.3 Final Review program and Recording Links

All sessions have been uploaded at https://srfsi.cimmyt.org/srfsi-final-review-meeting/

SRFSI - Final Review Meeting 2021

16th to 18th August 2021

Day 1	16th August 2021

Topic		Presenter	Youtube Link
Session 1: **Opening Session**			https://youtu.be/2tG7Nl52aV4
Opening Remarks		Dr. Brendan Brown (CIMMYT)	https://youtu.be/6Y209rZSirM
		Dr. Eric Huttner (ACIAR)	https://youtu.be/6Y209rZSirM
		Dr. Timothy Krupnik (CIMMYT)	https://youtu.be/6Y209rZSirM
		Dr. Manohara Khadka (For Reviewers)	https://youtu.be/6Y209rZSirM
Introduction of Participants		All, Facilitated by Dr. Brendan Brown (CIMMYT)	https://youtu.be/Ch8izd41_qQ
Setting the Scene	The Why and How of SRFSI?	Dr. Brendan Brown (CIMMYT)	https://youtu.be/nRYjPN0qelY
	The Initial Proof of Concept Phase'	Dr. Mahesh Gathala (CIMMYT) and Alison Laing (CSIRO)	https://youtu.be/VXMPe489KJo
	'The Capacity Development Phase'	Dr. TP Tiwari (CIMMYT)	https://youtu.be/_ba71d_Sips
	'The Scaling Phase'	Dr. Brendan Brown (CIMMYT)	https://youtu.be/AbAQzh2u-6o
Open Discussion	Clarifications on SRFSI Purpose, Justification and Approach	Moderated by Dr. Brendan Brown (CIMMYT)	https://youtu.be/xQWT9i33HAU
Virtual Group Photo		All, Facilitated by Manisha Shrestha (CIMMYT)	
Session 2: A celebration of SRFSI Partnerships			https://youtu.be/aLR5AvI3iH0
Session Overview		Dr. Brendan Brown (CIMMYT)	https://youtu.be/iCcCg3ySTLw
Each SRFSI partner is asked to reflect on how partnership	*Uttar Banga Krishi Viswavidyalaya*	Dr. Arunava Ghosh (UBKV)	https://youtu.be/k22o_06HJtI
	West Bengal Department of Agriculture	Dr. Rajat Chaterjee (WB DOA)	https://youtu.be/VQlbqZUvFEc

enabled their success with SRFSI	*Satmile Satish Club*	Tapan Chowdhury (SSCOP)	https://youtu.be/4qehXWCqERQ
	Rangpur Dinajpur Rural Services	Mamun Rashid (RDRS)	https://youtu.be/IOV2NlbiuOA
	Bangladesh Agricultural research Institute	Dr. Shakhawat Hussain (BARI)	https://youtu.be/MsdBhum1VWg
	Bihar Agricultural University	Dr. Sanjay Kumar (BAU)	https://youtu.be/KKnVN0Tr01k
	Nepal Department of Agriculture	Dr. Ram Khrishna Shrestha (Nepal DoA)	https://youtu.be/rDdAaycz_Rc
	Nepal Agricultural Research Council	Shukra Raj Shrestha (NARC)	https://youtu.be/rh4NewtHxMs
	Roadmaps for sustainable Mechanisation Project	Anjana Chaudhary (CIMMYT)	https://youtu.be/Dr183kb6-5s
	Commonwealth Scientific and Industrial Research organisation	Dr. Peter Brown (CSRIO)	https://youtu.be/BboX3JHhevA
	The University of Western Australia / Curtin University	Dr. Fay Rola-Rubzen (UWA)	https://youtu.be/uGj8rWbSE4U
	Other SRFSI Partners	Dr. Brendan Brown (CIMMYT)	https://youtu.be/kZYy6Du7gJg
Open Discussion	SRFSI achievements and partnerships	Moderated by Dr. Kuhu Chaterjee (ACIAR SDIP)	https://youtu.be/PV0xRvFpf0o

Day 2		17th August 2021	https://youtu.be/QUBaoynbltw

Topic		Presenter	
Session 3: A celebration of SRFSI **Capacity Development**			https://youtu.be/QUBaoynbltw
Various Capacity development efforts are highlighted			
Session Overview		Dr. Brendan Brown (CIMMYT)	https://youtu.be/FETPwDW7kiA
The Early years (including L1,L2, L3 achievements)		Dr. Mahesh Gathala (CIMMYT) and Alison Laing (CSIRO)	https://youtu.be/18jXyexlK_s
International Capacity Development initiatives		Dr. Peter Brown (CSIRO)	https://youtu.be/0vBTZReSB6s
International Capacity Development initiatives		Dr. Fay Rola-Rubzen (UWA)	https://youtu.be/DdnU2Ctbpy8
Nepal Agricultural Machinery Training and Testing Centre (NARC)		Anjana Chaudhary (CIMMYT)	https://youtu.be/i2Py6aZTYEU
CASI Visual Syllabus		Emma Karki (CIMMYT)	https://youtu.be/GSYI263Mob8
CASI Business Accelerator program		Deepak Dhoj Khadka (iDE)	https://youtu.be/xjgC7-apFy4
CASI Massive Online Open Course (MOOC)		Dr. Ram Datt Mishra (BAU)	https://youtu.be/ItkB8xjr6dk
ADOPT for South Asia		Dr. Rick Llewellyn (CSIRO)	https://youtu.be/FzZcxdVmPM8
Regional Conservation Agriculture Centre of Excellence		Prof. Apurba Kumar Chowdhury	https://youtu.be/XokFNUQVOME
SRFSI Web repository		Manisha Shrestha (CIMMYT)	https://youtu.be/r1xU-4AEbH0
Open Discussion	SRFSI Capacity Development	Moderated by Dr. Tamara Jackson (ACIAR SDIP)	https://youtu.be/B5wHJsS5qHo
Tea Break			
Session 4: A celebration of SRFSI Publications			https://youtu.be/Xj7iH1TXlUk

3 Minute video abstracts of some key SRFSI publications			
Session Overview		Dr. Brendan Brown (CIMMYT)	https://youtu.be/GK-tFSXtDXs
Introducing SRFSI's Proof of Concept Publications		Dr. Brendan Brown (CIMMYT)	https://youtu.be/GK-tFSXtDXs
Conservation agriculture based sustainable intensification: Increasing yields and water productivity for smallholders of the Eastern Gangetic Plains	Islam et al., 2021 - **Field Crops Research**	Mahesh Gathala	https://youtu.be/I8jOULySFkU
Enabling smallholder farmers to sustainably improve their food, energy and water nexus while achieving environmental and economic benefits	Gathala et al., 2020 - **Renewable and Sustainable Energy Reviews**	Alison Laing	https://youtu.be/V4JyZlNybbE
Improved water management practices improve cropping system profitability and smallholder farmers' incomes	Dutta et al., 2020 - **Agricultural Water Management**	Swaraj Kumar Dutta (BAU)	https://youtu.be/sLwETvLHX4I
Energy-efficient, sustainable crop production practices benefit smallholder farmers and the environment across three countries in the Eastern Gangetic Plains, South Asia	Gathala et al., 2020 - **Journal of Cleaner Production**	Mahesh Gathala	https://youtu.be/Vclw92UhSW8
Layering smart management practices to sustainably maintain rice yields and improve water use efficiency in eastern India	Chaurasiya et al., In Review - **Field Crops Research**	Swaraj Kumar Dutta (BAU)	https://youtu.be/6-g6C9kBuXg
Improving smallholder farmers' gross margins and labour-use efficiency across a range of cropping systems in the Eastern Gangetic Plains	Gathala et al., 2021 - **World Development**	Alison Laing	https://youtu.be/ysKNSnzB3EM
SRFSI Scientific Exploration: West Bengal	Several Publications including PhD / MSc thesis	Dr. Biplab Mitra	https://youtu.be/zRAw3RQupDk
When cereal intensification isn't just about cereals: Secondary implications of agricultural transition in South Asia	Brown et al., Under Review - **Journal of Development Studies**	Dr. Brendan Brown (CIMMYT)	https://youtu.be/B3pA4gkywE0
Introducing SRFSI's Adoption Processes publications		Dr. Brendan Brown (CIMMYT)	

Visualising adoption processes through a stepwise framework: A case study of mechanisation on the Nepal Terai	Brown et al 2021, **Agricultural Systems**	Dr. Brendan Brown (CIMMYT)	https://youtu.be/Gfc-8PMd_sc
Application of Innovation Platforms to catalyse adoption of conservation agriculture practices in South Asia	Brown et al 2021, **International Journal of Agricultural Sustainability**	Dr. Peter Brown (CSIRO)	https://youtu.be/bnxqUoZoBvQ
How have smallholder farmers used digital extension tools? Practitioner and user voices from Sub-Saharan Africa, South Asia and Southeast Asia	Coggins et al., In review - **Global Food Security**	Sam Coggins (ACIAR/ ANU)	https://youtu.be/zHBr6dM1wPw
Farm Mechanization in Nepal: Policy Context, Drivers and Options	Karki et al., Under Review - **Journal of International Development**	Emma Karki (CIMMYT)	https://youtu.be/h_MO49QcZt8
Expanding Zero Tillage Service Provision: perspectives from machinery owners in the Eastern Gangetic Plains	Sharma et al., 2021 - Pre submission	Akriti Sharma (CIMMYT)	https://youtu.be/txnFtip0FME
Understanding decision processes in becoming a fee-for-hire service provider: a case study on direct seeded rice in Bihar, India	Brown et al., Under Review in **Rural Studies**	Brendan Brown (CIMMYT)	https://youtu.be/wwYzsqiYM8k
understanding typology outcomes: From (non-) interest to implementation and disadoption	Various Pre-submission Publications	Emma Karki (CIMMYT) and Anjana Chaudhary (CIMMYT)	https://youtu.be/240WlSJvhvg
Farmers' Experience of Weed Management under Conservation Agriculture: Insights from the Eastern Gangetic Plains of South Asia	Suri et al., Presubmission	Bhavya Suri (CIMMYT)	https://youtu.be/g9pnClFgyxI
Introducing SRFSI's gender based publications		Dr. Brendan Brown (CIMMYT)	
Herbicides and Zero Tillage in South Asia: Are we creating a gendered problem? https://youtu.be/OyJa8HaL5LU	Brown et al., 2021 - **Outlook on Agriculture**	Dr. Brendan Brown (CIMMYT)	https://youtu.be/OyJa8HaL5LU
How does gender influence the evaluation of Conservation Agriculture in South Asia?	Karki et al., Presubmission	Emma Karki (CIMMYT)	https://youtu.be/luYJtA5rwko

https://youtu.be/luYJtA5rwko			
Necessity as a driver of bending agricultural gender norms in the Eastern Gangetic Plains of South Asia	Timsina et al., Presubmission	Pragya Timsina (CIMMYT)	https://youtu.be/3dedSaExraE
Open Forum	SRFSI Science and Publications	Moderated by Dr. Pratihba Singh (ACIAR)	https://youtu.be/X7tdg-nvHjw

Day 3		18th August 2021	
Topic		**Presenter**	
Session 5: A celebration of SRFSI Convergence and Impact			https://youtu.be/4uLbbiPxdLY
Session Overview		Dr. Brendan Brown (CIMMYT)	https://youtu.be/826w8emJ4dc
Initial Results of the SRFSI Impact Assessment		Dr. Brendan Brown (CIMMYT)	https://youtu.be/4iLw_UEDA8o
Convergence and Sustainability	West Bengal	Dr. Prateek Bhattacharya (UBKV)	https://youtu.be/LualQaq8OOM
	Bangladesh (Rangpur)	Mamun Rashid (RDRS)	https://youtu.be/PSVZXfd3CUU
	Bangladesh (Rajshahi)	Dr. Shakhawat Hussain (BARI)	https://youtu.be/60X-4eDnR1c
	Bihar	Dr. Ram Datt Mishra (BAU)	https://youtu.be/uth-nbojBtg
	Nepal	Dr. Ram Khrishna Shrestha	https://youtu.be/sZ2jSovVTHo
Top 10 SRFSI Achievements		Dr. Brendan Brown (CIMMYT)	https://youtu.be/yqCM4_HdB7E
Open Forum	CASI Convergence and Impacts	Moderated by Dr. Robyn Johnston (ACIAR)	https://youtu.be/Jn-d0IxJ1_c
Session 6: SRFSI **Reviewer Q and A** and **Open Discussion**			https://youtu.be/9fFc5V0IYDY
SRFSI Closure:	Conclusions and Next Steps	Dr. Brendan Brown (CIMMYT)	https://youtu.be/9XxU3SqnUlg
Reviewer Q and A		Dr. Manohara Khadka (IWMI)	https://youtu.be/4Wuf5NnSLCg
		Dr. Abdul Hamid Mianh	https://youtu.be/vHdx-H3iad4
		Dr. Ranjitha Puskur (IRRI)	https://youtu.be/ZD12rJ-mOxM
Open Forum	All topics	Moderated by Dr. Eric Huttner (ACIAR)	https://youtu.be/9osUNdD18T0
Closing Remarks		Dr. Ranjith Puskur (For Reviewers)	https://youtu.be/3R9Fc2vJJlU
		Dr. Eric Huttner (ACIAR)	https://youtu.be/3R9Fc2vJJlU
		Dr. Brendan Brown (CIMMYT)	https://youtu.be/3R9Fc2vJJlU

11 Appendixes

Supplementary information has been added to the SRFSI website at: https://srfsi.cimmyt.org/repository/ (excluding Academic literature in preparation or under review).

10.3.1 Non log frame

- [A] Islam et al (2019) Field Crops Reserach
- [B] Brown et al (2021) Mechanisation Status of the Nepal Terai (AGSY)
- [C] Brown et al (2021) DSR decision processes Bihar (RURAL)
- [D] SRFSI 2021 Impact Survey - Decision Maker Form- Kobo Language
- [E] SRFSI 2021 Impact Survey - Spouse Form - Kobo Language
- [F] SRFSI Household head Qualitaitve Question Schedule
- [G] SRFSI Spouse Qualitative Question Schedule
- [H] SRFSI summary and links for deliverables
- [I] Brown et al (2021) Is ZT creating a gendered problem - EGP South Asia (OAG)
- [J] Brown et al (2021) Extra TimeMoney (JDS) - Submission
- [K] Gathala et al (2018) SRFSI Research synthesis report 2018
- [L] Jaskson et al (2018) SDIP Synthesis & SE report
- [M] Brown P et al (2020) ACIAR Tehcnical report - Socioeconomic summary SRFSI
- [N] Karki Et al (2021) Gendered anlaysis of Househodl heads decision making on CASI
- [O] Timsina et al (2021) Nessesaity as a driver of chanigng gender norms.
- [Q] Karki et al (2021) how to progress farmers towards CASi usage
- [R] Chowdary et al (2021) Leasons for CASi users
- [S] Sharma et al (2021) Understanding Zero tilalge service provision economy
- [T] Suri et al (2021) Understanding weed dynamics in CASI systems
- [U] Coggins et al (2021) Digital Advisory Services (GFS)
- [V] Llewellyn et al (2020) Predicting Adoption of Smallholders - ADOPT (AEPP)
- [W] SRFSI Publications List 2020 CSE-2011-077
- [X] SRFSi Impact Calculations

- [Y] Interim Final Technical Review Report 26Mar18
- [Z] CapDev4CA_manuscript_revised draft 11 MB

10.3.2 Log frame

[1] Characterisation of SRFSI nodes (CIMMYT - 2015)
[2] Incentives, constraints and innovation pathways in the EGP (CSIRO - 2014)
[3] Socioeconomic Report_ A Synthesis (CIMMYT-2015)
[4] Socioeconomic Access to water Resources (IWMI - 2016)
[5] Groundwater Irrigation Use in the EGP (IFPRI - 2015)
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