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Application of innovation platforms to catalyse adoption of conservation agriculture practices in South Asia

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ABSTRACT

Conservation agriculture-based sustainable intensification (CASI) is a package of practices that could improve the sustainability of smallholder farm productivity and profitability. However, existing extension systems are unable to facilitate widespread adoption to have the impact necessary to meet food security and livelihood requirements. This paper examines the utility of ‘Innovation Platforms’ (IPs) as a tool to catalyse adoption of CASI for smallholder farmers in South Asia and generate opportunities for rural micro-entrepreneurship in areas with high rates of poverty, small farm sizes and complex labour markets. We established 37 village-level and five District-level IPs across the Eastern Gangetic Plains of Nepal, Bangladesh, and India. 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. Further work is needed to provide opportunities for high-level policy support to assist IPs to have a wider impact in supporting large-scale adoption of CASI.

KEYWORDS

Adoption; agricultural innovation; extension; multi-stakeholder platforms; partnerships; smallholder farmers; sustainable intensification

1. Introduction

Conservation agriculture-based sustainable Intensification (CASI) has been proposed as package of practices that could be used to improve the sustainability of smallholder farm productivity and profitability (Gathala et al., 2013; Gathala et al., 2021;

Islam et al., 2019; Jat et al., 2021; Keil et al., 2015). However, existing extension systems are not set up to support widespread adoption by using the innovation structures to have the impact necessary to solve food security and livelihood demands. Traditionally, adoption has often seen as a ‘top-down’ linear process (Rogers, 2003). Current linear models of technology

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transfer do not work (Sanyang et al., 2016): they fail to deliver programs to poor and marginal farmers. In Bangladesh and some parts of India, there is one government extension officer for 2000–3000 farmers, more often engaged in implementation of government schemes. There are simply not enough extension agents, even if the linear transfer of technology paradigm could work. Adoption is further complicated because CASI is a package of technologies, practices and knowledge, thus it is more difficult to achieve adoption (Andersson & D'Souza, 2014; Brown et al., 2018). New approaches are therefore needed.

The Eastern Gangetic Plains (EGP) of Bangladesh, India and Nepal, is home to over 300 million people, with the world's highest concentration of rural poverty and a strong dependence on agriculture for food security and livelihoods (Ericksen et al., 2011). The EGP has the potential to become a major contributor to South Asian regional food security, but rice and wheat productivity remain low and diversification is limited because of poorly developed markets, sparse agricultural knowledge and service networks, and inadequate development of available water resources and sustainable production practices (Gathala et al., 2021; Islam et al., 2019; Sugden et al., 2014). Most smallholder farmers have small areas of land (<1 ha) and labour shortages are becoming more acute as feminization of agriculture increases (Darbas et al., 2020), but this has not occurred equally across the region (Sen et al., 2019). Regional natural resource challenges include groundwater depletion, pollution, and inefficient use of water and energy, potentially further compounding the food-energy-water nexus (Gathala et al., 2020b; Kishore, 2019). Additionally, there are institutional and governance constraints such as limited public services and dominance of small, informal enterprises, poor coordination between agricultural research and development agencies, poor infrastructure and poor connectivity (Brown et al., 2020). These factors lead to smallholder vulnerability to climate shocks (Brown et al., 2019; Sugden et al., 2014;) and market risks that limit farmer and private sector investments in productivity-enhancing technologies. Access to quality inputs is also a major issue. However, there is variation across the EGP: in NW Bangladesh water policy and agricultural technologies have increased crop yields, although the sustainability of present rates of groundwater use is a concern.

A study was designed to explore the extent to which CASI could be applied in the EGP ('Sustainable

and Resilient Farming Systems Intensification', SRFSI). SRFSI focused on raising the productivity of the rice-, wheat- and maize-based farming systems characteristic of the EGP with Conservation Agriculture (CA) practices. Farm mechanization has been a strong focus, specifically the introduction of CA machinery which reduces inputs (labour, water, seed) while improving soil fertility by retaining and planting into crop residues (Gathala et al., 2020a; Gathala et al., 2020b; Islam et al., 2019; Sinha et al., 2019). This strategy is referred to as Sustainable Intensification (SI). These practices are largely proven and uncontroversial (Islam et al., 2019), although they need to be adapted to the local social-ecological systems within the EGP. Together, these are referred to as Conservation Agriculture based Sustainable Intensification (CASI) practices. This provided the basis for exploring pathways for catalysing adoption of CASI.

Innovation Platforms (IPs) and other multi-stakeholder forums have been identified and used to successfully overcome constraints in agricultural systems, particularly in developing countries in Africa (Adekunle & Fatunbi, 2012; Makini et al., 2013; see Section 2). IPs are a network of stakeholders established around a commodity or system of interest to identify 'bottom-up' solutions to problems (see Section 2 below and Schut et al., 2019 for overview). However, IPs have not been trialled extensively in South Asian situations, although there are limited examples in India for the supply of cotton (Andres et al., 2016) and milk production (Ravichandran et al., 2016). Furthermore, IPs have not been trialled in a systems perspective with key livelihood and food security cropping systems of rice-, wheat- and maize-dominated systems across the EGP. According to Kilelu et al. (2013), IPs need a degree of flexibility to be able to respond to specific situations and uncertainties, emergent outcomes, and provide windows of opportunity in innovation processes. Using the SRFSI project as case studies in the EGP across eight districts in three countries (Bihar and West Bengal in India, Eastern Nepal terai and Northwest Bangladesh), we examine the application of IPs in South Asia. This enabled an opportunity for evaluation of similarities and differences across the region. Over a 5-year period (2015–2019), we reviewed various approaches for implementing IPs and modified them for use in the EGP, conducted training with local partners ($n = 20$), assisted with implementation of 37 village IPs in eight districts, conducted ongoing monitoring and evaluation and finally reviewed overall progress and

learnings and suggest for the better governance and structural management changes as per local need and adaptability.

In this paper, we examine the utility of Innovation Platforms as a tool to catalyse adoption of CASI practices for smallholder farmers in South Asia and create rural business opportunities. Our evaluations are based on Sparrow and Traoré (2018) and Davies et al. (2018) to provide an overarching framework to help evaluate the IPs used in the SRFSI project. We recognize there are a wide range of differences in functionality, governance and structure among areas throughout the EGP and try to take this into account to explore the overall utility of IPs.

2. Review of innovation platforms

An important factor in explaining lower than expected use of new technology is the design of extension programs, largely implementing a 'linear process' (Pamuk et al., 2014). Conventional extension efforts, following classic 'diffusion' theory of Rogers (2003), have produced disappointing results and have generally failed to promote the adoption of agricultural innovations (Pamuk et al., 2014). There is large heterogeneity among smallholders (Williams et al., 2016), which means that blanket recommendations are unlikely to be relevant for many farming populations (Sanyang et al., 2016). This has been further exacerbated through insufficient public funding and perverse incentive effects. The linear model of technology transfer has therefore become obsolete, and as such there has been a move towards capacity building and farmer empowerment. Rather than lay the blame on 'extension' per se, this is a sign of broader system problems. One way to overcome these problems has been to use an agricultural innovation systems approach which includes dynamic networks of interactions and feedback loops involving institutional and policy settings to nudge the system to help stimulate technological change and innovation (Hall et al., 2016; Horton et al., 2017; Klerkx et al., 2010; World Bank, 2012). Innovation Platforms are considered part of this broader agricultural innovation systems approach (ISPC, 2015; Maru et al., 2018).

Innovation Platforms have been identified as a powerful tool for promoting agricultural development (Adekunle & Fatunbi, 2012; Dror et al., 2016; Hall et al., 2001; Hounkonnou et al., 2012; Jiggins et al., 2016; Kilelu et al., 2013; Sanyang et al., 2016; Schut et al.,

2016; Sparrow & Traoré, 2018). The ISPC (2015) note there are various definitions of IPs, and using the definition of Adekunle and Fatunbi (2012, p. 983), they define IPs as 'a physical, virtual, or physico-virtual network of stakeholders which has been set up around a commodity or system of mutual interest to foster collaboration, partnership and mutual focus to generate innovation on the commodity or system'. Stakeholders are brought together in so-called local 'innovation platforms' enabling bottom-up searches for solutions to local bottlenecks (Pamuk et al., 2014). Multi-stakeholder processes, including IPs in value chains and food systems, are used to diagnose constraints, explore opportunities, investigate solutions, and catalyse collaborative learning and collective action (Sanyang et al., 2016). An ideal and sustainable IP is based on local context and attracts stakeholders through a participatory and bottom-up process (Sanyang et al., 2016). Stakeholder analyses should be based on 'entry points' dictated by the constraints and/or opportunities for enhancing the productivity of the value chain (Sanyang et al., 2016). The IP serves as a vehicle for change in the interaction among research, farmers and farmer organizations, advisory services (public and private), agro-food processors, traders, input dealers, financial institutions (such as microfinance and banks), policy-makers, transporters, and the media (including rural radio) (Sanyang et al., 2016). Innovation priorities vary across IPs as each IP decides on its own priorities according to local preferences, opportunities and constraints. The success of IPs could be related to pre-existing levels of social capital (Sanyang et al., 2016) and the match between local conditions and innovations (Pamuk et al., 2014).

There are now a plethora of technical manuals, guides and experiences with using IPs, but these are largely based in Sub-Saharan Africa. The guides include Nederlof et al. (2011), Boogaard et al. (2013), Makini et al. (2013), plus a series of 12 IP Practice Briefs developed by CGIAR Humid Tropics research program (<https://cgspace.cgiar.org/handle/10568/33667>). These manuals were reviewed to determine the relevance of IPs for South Asia. We found many elements across each of these were relevant, but no single approach looked like it was sufficient. These guides formed the basis of some training provided to >20 partners across the four research regions. Further details are provided below about how the IPs were implemented in the SRFSI project.

3. Methods

3.1 Study sites

This paper builds on other work in the EGP through the SRFSI project (Brown et al., 2020; Gathala et al., 2020a; Gathala et al., 2020b; Gathala et al., 2021; Islam et al., 2019; Sinha et al., 2019). Districts were originally selected because they are considered as typical marginal areas with a range of constraints (Islam et al., 2019), but they were also matched in pairs across country borders to enable comparison of similar physical conditions (soil type, rainfall, ground water resources), but with different socio-economics and institutional settings (e.g., comparison of Rangpur, Northwest Bangladesh with Coochbehar, West Bengal, India) (Figure 1).

Participatory on-farm trials were conducted over several years across Rabi/winter crops and Kharif/summer crops. These were conducted on five communities ('nodes') in each district ($n = 8$) and involved 433 farming households (Islam et al., 2019). The climate was a typical monsoon dominated tropical climate, and there was some variability in soil types and hydrology (full details in Islam et al., 2019). There was a package of CASI practices trialled as part of the SRFSI project for rice-based, wheat, maize and lentils cropping systems compared to conventional cultivation technologies (see Islam et al., 2019 for details). Essentially, for rice, different technologies of traditional, conventionally tilled and puddled transplanted rice were compared to zero-tilled (ZT), unpuddled and dry seeded rice. Similarly, for wheat, maize and lentils, conventional tillage was compared to zero-tilled crops. Standardized fertilizer and herbicide recommendations were provided to farmers. The economics of these practices was also examined (see Brown et al., 2020 and Gathala et al., 2021 for details) to determine the benefits of CASI on labour resources, production costs and gross margins. CASI therefore involved a series of interlinked activities (technologies) and knowledge that the trial farmers needed to understand and adopt. These practices ranged from use of zero-till (ZT) machines to sow their crops, seeding rates, application of fertilizers, management of weeds, pests and diseases, and water (irrigation) management (see Islam et al., 2019 for details).

3.2 Development and implementation of IPs

Given the poor state of the extension system throughout the EGP, we were interested to explore whether

Innovation Platforms could be a useful way to enable the adoption of the CASI practices. We conducted a literature review of multi-stakeholder platforms and IPs to determine how they have been used in similar situations around the world. We wanted to know what they did, how they worked and who was involved etc. Ultimately, we wanted to know if an IP approach would be relevant for South Asia, and the EGP in particular. The literature review identified relevant materials developed principally in Sub-Saharan Africa (see Section 2). Whilst there are many similarities between Africa and South Asia, the situation in South Asia is highly complex, with numerous political, governance and institutional issues dominating the agricultural system. This is further exacerbated by the huge population pressure, poverty and problems with access to resources (land, water, energy, incentives etc.), as well as public food grain distribution systems (Banerjee et al., 2014), targeted support programs, minimum support price, and minimum employment guarantee (2005 National Rural Employment Guarantee Act, NREGA, Bauri, 2010; Sarkar et al., 2011). This meant that there could potentially be a large number of potential stakeholders involved in IPs, and many of which would have little 'power' or ability to change the system.

We developed a training package based on the identified literature and synthesized advantages and disadvantages of the different approaches to have a unified approach building components from several approaches. This was rolled out to researchers in the four jurisdictions of the SRFSI project. The emphasis of the training was as a tool to discuss the relevant issues for setting up, establishing and supporting the IPs as part of the SRFSI project in the EGP. A large part of the training was on how to facilitate the process of establishing an IP, and in particular, who should convene it, who should facilitate it, who should participate (which stakeholders) and how to make it relevant for the SRFSI project, along with the importance of utilizing participatory approaches. As part of this process we put together a framework to help understand the flow of logic, who to involve and how the IP develops and reflects through different iterations (following an Action Learning approach, Figure 2).

An analysis of key institutions and stakeholders in each of the SRFSI Districts around agricultural innovation was used to help identify key stakeholders and understand where potential constraints and



Figure 1. Approximate location of the eight Districts of the SRFSI project where the Innovation Platforms were evaluated. Dhanusha and Sunsari (blue triangles) were in the terai of Nepal, Madhubani and Purnea (orange squares) were in Bihar, India, Coochbehar and Malda (orange squares) were in West Bengal, India, and Rangpur and Rajshahi (green circles) were in Northwest Bangladesh. Base map from QGIS using Open Street Maps. Country borders are approximate only.

opportunities lay (Darbas et al., 2015). The analysis used the Agricultural Innovations Systems approach (Biggs, 1990; Hall et al., 2002; World Bank, 2012). There were 159 key informant interviews analysed across the eight Districts of the SRFSI project detailing the constraints and opportunities for scaling out the CASI technologies.

After the initial training, ongoing support was provided to SRFSI project partners implementing the IPs and the facilitators. We aimed to establish one IP for each 'Node' (village) where the project was being implemented. Several additional training events were held to provide ongoing support. One of the key support events was termed a 'structured

training workshop' in mid-2016 which included cross-visits from neighbouring jurisdictions (Nepali colleagues joined the workshop in Bihar, and the Bangladeshi colleagues joined with West Bengal). Additional site visits to each jurisdiction occurred through 2016 and 2017, along with presentation and discussion of progress being made at the annual SRFSI project planning workshops to review progress and consider learnings. There was also a strong emphasis on continuous cycles of learning and reflection throughout, which was built in from the beginning: what was working well, what was not working well, and consideration of options of improving the IPs.

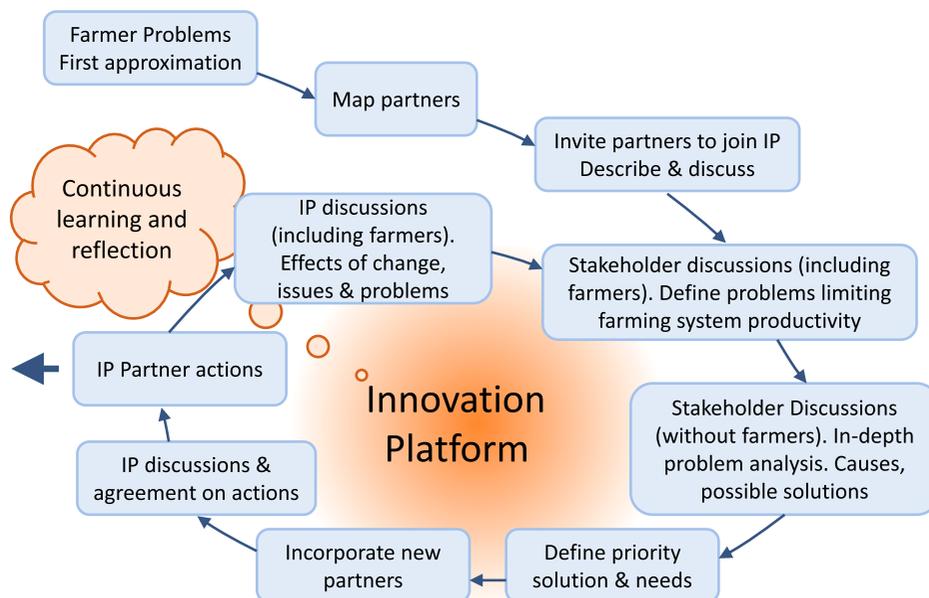


Figure 2. Steps involved in the IPs as initially used in the SRFSl project, essentially with continuous cycles to identify problems, map partners, discuss issues, review issues, take action and reflect.

3.3 Review, assessment, analysis and evaluation of IPs

There are several approaches for reviewing progress and the success of IPs, which have emerged recently (Boogaard et al., 2013; Davies et al., 2018; ISPC, 2015 Sparrow & Traoré, 2018; Watson et al., 2015;). The factors determining the success of IPs need to include institutional, technological and organizational factors (Pamuk et al., 2014). Given the number and complexity of the IPs that were established as part of the SRFSl project in the EGP, we used a range of approaches with selected in depth case studies, depending on opportunities for site visits for primary data collection via key informant interviews or using self-assessments (see Appendix A for details; essentially responses to a set of open questions with some requiring scores using a 5-point Likert scale). Our approach relied primarily on the conceptual framework of Sparrow and Traoré (2018) and Davies et al. (2018). The framework of Davies et al. (2018) was used to explain performance of IPs exploring context, structure, conduct, process, and performance and to consider the prospects of ongoing change and impact of the IPs with a focus on the detailed case studies in Bihar and West Bengal. We also offer some general comments from observations in Bangladesh and Nepal. Quotes in this paper are

identified using bracketed codes to maintain anonymity as required by our human research ethics approval. The IPs in Northwest Bangladesh were evaluated via the self-assessments and site visits and key informant interviews were held with representatives of IPs in Purnea in Bihar and Coochbehar in West Bengal (26 interviews conducted).

Unfortunately, towards the end of the SRFSl project, there was no on-going involvement with IPs in Madhubani in Bihar because of budgeting constraints. In addition, the constitutional and structural change in Nepal meant that there were no District representatives (District Agriculture Development Office of the Department of Agriculture were the implementers of the IPs, which operated at the District Level, but Districts functionaries no longer existed), so we were unable to evaluate the performance of the IPs in Dhanusha or Sunsari. However, we did review progress and evaluate learnings with several key staff through key informant interviews to reflect the experiences in Nepal.

Measurement of the adoption of CASI technologies, knowledge and practices in the context of this analysis was confounded by the way the project was implemented. The project had a strong focus of including smallholder farmers in the testing of CASI technologies, in comparison with conventional technologies. Farmers were encouraged to run trials,

with project support, on their own farms to explore the benefits of CASI on yields and water productivity (Islam et al., 2019), energy use and greenhouse emissions (Gathala et al., 2020b) and gross margins and labour-use efficiency (Gathala et al., 2021). As such, all trial farmers practiced a range of CASI technologies. The IPs were then built in the same villages (Nodes) and Districts within these farming communities. A comprehensive assessment of the adoption of CASI technologies would need to be independently conducted at some point in the future after the conclusion of the project and the support provided by the project has been withdrawn. This assessment would need to include core trial farmers, other farmers within their communities and farmers outside the sphere of influence of the project. We recognize that this is a limitation of the current analysis. Adoption is also compounded by the complex nature inherent in CASI: it is multi-faceted with technologies, knowledge and practices to be considered (Andersson & D'Souza, 2014; Brown et al., 2018). Forthcoming publications by project colleagues will consider broader adoption of CASI.

4. Results

4.1 Initial implementation of IPs

The IPs were initially established in 2015. By 2017, there were 37 'node' (village) IPs established (out of a possible 40 nodes) and five 'district' IPs established (out of a possible 8 districts) (Table 1). The primary issues being discussed in the IPs included: potential of CA, convergence of government programs, machinery hire, business models, sharing of market news, input supply issues, marketing issues, sharing of research results, technical knowledge and pest management (Table 1). Different modes of operation emerged in different districts, which are explored further below.

4.2 Bangladesh

RDRS Bangladesh (NGO) has been working in NW region since 1972. Since the beginning, agriculture development has been one of its prime activities. While initially, it focused on helping individual farmers, it has subsequently shifted its approach to working with farmer groups in the form of Union Federations. RDRS established Union Federations (UFs) as grassroots association of poor people to help them

attain greater collective strength, improved cooperation and unity and to evolve as a more productive agency for achieving broader objectives of sustainable production systems on behalf of their membership and community. Two out of five IPs supported by the SRFSI project in Rangpur have been established in Union Federations (Borodargha and Mohonpur) which performed better than other IPs, as self-assessed by RDRS. There was little evidence of more specialized livelihood strategies, nor improvements in how the markets work, changes in the capacity of R4D systems and associated institutions, nor changes in policy or formal institutions (see Appendix B).

The aim at the establishment of the IPs in Bangladesh was 'to provide various quality services and inputs at farmer level by creating a common platform of different stakeholders' (self-assessment). Furthermore, the vision was 'to identify problems and opportunities in relation to CASI technology'. In terms of implementation of IPs in NW Bangladesh, IPs played a role in providing technologies and practices and embed services for increasing crop production in a cost-effective manner to change the market system. The IP participants found that the CASI practices were good, but there was a need to improve the performance of the machines.

It was apparent that some IPs in NW Bangladesh were performing better than others (Table 2), as assessed by project partners. For example, in Rangpur, Borodargha and Mohonpur had higher self-assessed scores than for Durgapur, Kolkondo and Lakkhatari. The differences appeared to be related to level of participation, facilitation and negotiation and opportunity analysis (Table 2). Furthermore, most of the changes in outcomes and impacts from the IPs were realized through more accessible finance and changes in the capacity of local actors and socially embedded institutions (able to deal with emergent/unexpected capacity changes and changes in cultural/gendered institutions) (Appendix B).

4.3 Nepal

In 2015, the District Agriculture Development Office (DADO) in Nepal was tasked as the leading organization for initiating and establishing the IPs. DADO was responsible for agricultural extension and support at the District-level at the time. The Nepal Agricultural Research Council (NARC) also provided

Table 1. The status of innovation platforms as implemented in the SRFSI project in the Eastern Gangetic Plains (EGP) two years after implementation (as of 2017).

Jurisdiction & District	District IPs	Node IPs	IP mode of operation	Status	Issues being resolved
Northwest Bangladesh					
Rangpur		5	Union Federation Farmer School	Underway and active	Developing own service & business plans Farm advisory, quality input supply, aggregation of products, agro-clinics, mechanization & financial linkage Micro-credit
Rajshahi		5	Farmer School	Underway and active	Limited availability of quality seed Electricity supply in deep tube wells Pest management Micro-credit
Nepal terai					
Dhanusha	1	5	New entity (self-help farmer club)	Underway and partially active	Availability & timing of inputs Limited irrigation facilities Technical knowledge
Sunsari	1	5	New entity (self-help farmer club)	Partially active	Technical knowledge on CASI Agri-inputs & machinery service providers Access to agricultural subsidies
India, Bihar					
Purnea		5	Farmer producer company (e.g. Aranyak) Micro-entrepreneurs (DeHaat)	Underway and active	Problem identification Sharing market news (via mobiles) Moisture meter & weighing machines Awareness of agri producer company Input dealers & service providers
Madhubani	1	2	New entity (participation by a range of representatives e.g. farmers, input dealers, NGOs, Dept Ag, ICAR)	Partially active	Input supply issues Marketing issues
India, West Bengal					
Coochbehar	1	5	Farmer group (e.g. Dinhata) NGO-supported Service Provider (e.g. Satmile) Farmer producer organization supported service providers	Underway and active (3-4 meetings each)	Convergence of flagship government programmes & demonstrations Machine hire & availability of inputs (chemicals) New business models/ventures Establishment of Farmers Producers Organization (modalities, methods)
Malda	1	5	Farmers Club Farmers Producer Organization supported Service Provider (e.g. Bidyanandapur Sabuj Bahini Farmers Club)	Underway and active (3-4 meetings each)	Convergence of flagship government programmes & demonstrations Machine hire & availability of inputs (chemicals) New business models/ventures Establishment of Farmers Producers Organization (modalities, methods)
Total	5	37			

research support to the IP efforts. The IPs were established as a new entity (not through an existing group). For each IP, there were 15–25 people involved comprising a range of stakeholders, including farmers, tractor drivers, and service providers, to share problems and identify solutions (Table 1). Unfortunately, there happened to be a large turn-over of DADO staff during the early phase of the IPs, and there appeared to be a lack of coordination between DADO and NARC and a lack of a driving force, with no budget to support and so no momentum was achieved. The ongoing functioning of IPs was difficult partly due

to the constitutional crisis that engulfed Nepal during 2015 and 2016, which saw the abolishment of Districts including agricultural institutions such as DADO and the establishment of Provinces.

Despite the challenges in establishing and maintaining IPs in Nepal, some benefits of being involved in IPs were observed. The involvement of a range of different stakeholders were involved which opened-up new opportunities, and that farmers were able to access subsidy support. The performance of the IPs in terms of accessing agricultural inputs, subsidies and other services from the stakeholders, scaling out

Table 2. Self-assessment of performance of IPs from Northwest Bangladesh (Rajshahi and Rangpur Districts) scored on a 5-point Likert scale from 1 = very low degree to 5 = very high degree. Analysis based on Sparrow and Traoré (2018) (see Appendix A for details).

District	IP name	Overall function	Level of participation	Level of entry point	Research	Facilitation & negotiation	Opportunity analysis	Gender	Communication	Monitoring & evaluation
Rajshahi	Baduria	4	3	3	1	3	4	3	3	3
	Dharmipur	2	1	3	1	1	1	3	3	3
	Laxmipur	4	3	3	3	4	3	3	4	4
	Nabinagar	2	1	3	1	1	1	3	3	3
Rangpur	Premtoli	4	4	4	3	4	4	4	4	4
	Borodargha	4	4	4	1	4	4	4	4	4
	Dugapur	2	1	3	1	1	1	4	3	4
	Kolkodo	2	1	3	1	1	1	4	3	4
	Lakhatari	2	1	3	1	1	1	4	3	4
	Mohonpur	4	4	4	1	4	4	4	4	4

of CASI practices, marketing of agricultural products was excellent in some of the nodes (Bhokraha and Kaptangunj in Sunsari, and Sinurjoda in Dhanusha). These IPs had active IP members and had better linkages with the DADO, NARC and other stakeholders, particularly up until the abolishment of Districts; however, there were significant problems with resources. Some stakeholders found little meaning or benefits to be involved in the IPs. The Nepalese participants found there was no clear examples of functioning IPs to learn from and, thus, found it difficult if they were organizing something new (establishing IPs). With the restructuring of the country, local level governments, such as municipalities, now act as the key institution in providing various supports to the people. Hence, it will be crucial to have their participation or leadership in future IP facilitation/mobilization.

4.4 Bihar

Two case studies were explored in detail in Bihar: (1) Aranyak farmer producer company and (2) DeHaat micro-entrepreneur models.

Case Study 1: Aranyak farmer producer company model

The Aranyak farmer producer company is a model supported by Jeevika and Technoserve (<https://www.technoserve.org/>), an NGO with a strong focus on benefits to women. The Aranyak farmer producer company is 100% run by women with support from Jeevika. Aranyak started out as a women's self-help group (SHG), which grew into a Village Organization, then converted into a Producer Group (PG), and into a Farmer Producer Company. Inputs and marketing were considered big issues raised by the communities, so the Aranyak PG was set up to provide '360° support' to women farmers with profits split across all members. The Aranyak model has been highlighted as a successful approach for engaging with women and improving their livelihoods (Darbas et al., 2020). The original focus was on maize procurement to overcome problems including unfair payments. Aranyak improved grain quality, introduced electronic moisture meters, weighing machines, and established payments into bank accounts. Aranyak operated beyond SRFISI project communities (nodes). Aranyak is considered an IP because they bring in relevant stakeholder to solve a range of problems.

Mrs D (#11) pays 250 INR (~\$5 AUD) per year to be a member in Aranyak and has been involved over the past 4 years. She considers that Aranyak is an IP, which was built jointly by Jeevika and the SRFSI project. IP meetings were held about once per month at the Block level (local administrative unit), with up to 1,000 people attending (farmers, private sector companies and officials of Aranyak) along with the Aranyak Village Resource Person and Community Mobilizer (paid positions). Farmers discussed issues, purchased inputs and fertilizers, and sold produce. The initial focus was on maize procurement. There are several problems creeping into Aranyak, and Mrs D (#11) complained that Aranyak was not functioning as well as it had a few years ago. She directly blamed the President, Secretary and Treasurer of Aranyak for the current problems. ('Cream of the cake eaten by the President', Mrs D, #11). She said Aranyak were purchasing things for their community, but were then selling to other communities (implying malpractice). There was a loss in purchasing power because purchases occurred at the wrong time (purchasing maize at higher price in the beginning of the season and selling to the market at the end of the season during the glut period). This was not realized by Aranyak, and they lost money which led to mistrust among the members. It showed that Aranyak was inexperienced in marketing and so need to improve their marketing skills to rebuild the group. Previously, they purchased maize, then banana and paddy, but are not purchasing anything now. Aranyak originally worked directly with farmers and made payments into bank accounts. They are now working through a middleman and payments are made through brokers (receiving lower prices) and are delayed; essentially reverting to traditional practices. There is strong interest in continuing with Aranyak, but there needs to be significant change (Mrs D, #11).

Case Study 2: DeHaat micro-entrepreneur model

DeHaat is a micro-entrepreneur model based in villages to provide inputs, assist with marketing and crop advice, supported through 'agrevolution' (<https://agrevolution.in/home>). Local entrepreneurs are appointed in each village and receive training and guidance to support the local farming community. They market various inputs (seeds, pesticides, fertilizers, services, e.g. laser land levellers, sprinklers, small machines), assist with maize marketing, and have a mobile-based support service (mobile phone app or toll-free number) to assist farmers to make

agronomic decisions. They charge a small service fee. DeHaat was brought into various SRFSI project nodes (particularly in Purnea in Bihar). DeHaat has credibility in this sector and is growing its footprint, and is expected to be a sustainable model in the future.

DeHaat was considered an IP, although it is not a typical IP in that DeHaat modified its business approach to build business opportunities. The micro-entrepreneurs acted in a similar role to what partners do in an IP by talking to different stakeholders to identify problems, and talking to a different set of stakeholders to identify potential solutions. They were well-positioned to identify and access relevant stakeholders because of their established networks.

DeHaat also provided capital support for poor farmers, who returned credit after harvest. For example, the main problems faced by Mr K1 (#3) was the availability of agro-chemicals (rates, types), seed and market at harvest. Mr K1 (#3) normally solved his problems by himself, but if he contacted DeHaat for help if he could not solve a problem. Mr K2 (#4) said that DeHaat meetings were held each season to discuss new agro-chemicals and technologies. Furthermore, they were able to ask questions and all issues were solved during these meetings.

There were often 50–300 farmers attending meetings depending on the technology being discussed, the time and the season. Participation in DeHaat has resulted in changes in some farming practices. For example, Mr K3 (#5) previously used a traditional maize variety, but he now uses a hybrid variety, also growing vegetables and paddy because of increased awareness and support. Mr K3 (#5) is looking to purchase a subsidized zero-till machine through the Farmers Fair at District headquarters. He plans to use the machine himself, and to rent it out to others for a fee.

Mr K2 (#4) noted that many women came to meetings, also from other villages, who ask questions too. Mr K3's (#5) wife participates also in the meetings, and he feels she is now more empowered. Improved income was the main motivation for their family's participation in DeHaat.

Mr J (#6) used to go to the Krishi Vigyan Kendra (KVK), an extension system or farm science centre associated with agricultural universities in India, at the block office, but through DeHaat, now has support on his doorstep. Mr J (#6) stated that it is very important to have timely intervention of

activities. He has been well-supported through the SRFISI project but believes he can continue things himself with the support of DeHaat. He is part of a self-help group (SHG), and through the support of DeHaat, the SHG will purchase a zero-till machine.

4.5 West Bengal

Two case studies are explored in detail in West Bengal: (1) Satmile IP group, and (2) Dinahata farmer group IP.

Case Study 3: Satmile IP

Satmile Satish Club O Pathagar (SSCOP; abbreviated to 'Satmile' here) started as a youth club in 1974. The original focus was for cultural and sports programs (not farming) and was registered it as an NGO in 2001. They then shifted focus to farming through support from NABARD. In 2011 Satmile started to support and implement zero-till (ZT) wheat, and in 2013 with maize, with support (machinery) and guidance from Uttar Banga Krishi Viswavidyalya university (UBKV). Some initial technologies performed poorly (Mr K, #13). In 2013/14, UBKV initiated training on ZT machines and support services as a demonstration site, then the SRFISI project formally establish participatory trails. Satmile was set up as a 'service provider' in three project Nodes (villages), relying on SRFISI machines provided by UBKV. In 2014/15, Satmile purchased their first ZT machine. Satmile gradually moulded themselves as a 'trusted' provider of most major services (through Single Window Service provider model), which was then expanded to further farmers (10-20 farmers) looking for new business opportunities. Satmile has gone well beyond a farmer club: 'Farmers clubs are not always vibrant and dynamic, but Satmile is' (Mr D, #16).

As Satmile developed into a service provider, they started to see themselves as a broker to help overcome problems that farmers were experiencing. UBKV facilitated initial meetings with key stakeholders (farmer groups, progressive farmers, finance institutions) to provide the concept of an IP. Through technical advice and support from UBKV and DoA, Satmile formed strong networks with a range of other stakeholders (inclusive of other Farmers Clubs or Farmers Producers organizations), and essentially acted as an 'IP' (linking farmers, farmer clubs, input retailers and extension officials). Personal contact was critical to enable links to relevant market representatives and political leaders (local council) in the community (Mr D, #16). After initial establishment,

Satmile themselves took on facilitation and coordination responsibilities. There was, however, some confusion about who would then take the lead with the IPs and subsequent meetings (e.g. role of Secretary). Initial meetings were planned monthly, but the government officials declined to participate because the invitation came from a farmer group representative (thus, considered there was no power/influence). The government officials expected UBKV to send the invitation, which highlighted the problems with administration and hierarchies, particularly in India, which was not fruitful (Mr D, #16).

Once these early problems were resolved and stakeholders could see the benefits of being involved in the IPs, they expanded from three to seven nodes. Satmile IPs have improved farmer knowledge, especially the importance of quality seeds at sowing to achieve good yield at harvest, and knowledge of correct fertilizer doses (Mr R, #17). Mr R (#20) recognized the need for the IP for farmer development, especially through knowledge of technologies and diseases. Mr A (#23) said that there are always new technologies and pesticides coming, and he has been trying to solve a blast-like diseases problem in wheat; he would not have been aware of the problems without the IP. Mr R (#20) emphasized the importance of setting up meetings with seed and chemical companies (e.g. Monsanto), and knowledge about input use, e.g. people should know what, when and how to use inputs correctly. In the past, farmers relied on information given to them by input suppliers (fertilizer shop), which Mr R (#17) now knows was not always correct information, or herbicides were not available in the market (Mrs B, #21). Satmile IP holds regular seasonal meetings to discuss problems (with 50-100 farmers in attendance in groups, with 25-50% involvement of women; Mr R, #20, Mr A, #23). Farmers are very happy with this approach. More farmers participate in meetings if they know experts from UBKV or DoA will attend (Mr R, #17). Mr R (#20) has a smartphone to get technical support through the Satmile IP, or if Satmile can't help, then the request is forwarded on to someone else to help (showing importance of links and networks). He has also requested more harvesting machines.

The link with the SRFISI project has enabled linkage with the government and access government schemes (subsidy programs, support for women entrepreneurship, diversified ventures like fishery, duckery, lentil mill, etc.). High-level government support has been provided by The Chief Advisor (on agriculture) of

West Bengal Chief Minister. Mr K (#13) said that because of the success of the SRFSI project, the CASI machines and technologies are well known and accepted, and ZT is becoming very popular, thus a good agribusiness opportunity for Satmile. The overall Satmile model is working well (Mr K, #13) and they are considered a 'change agent' (Mr D, #16). More models like this are needed because demand is growing but needs time (Dr C, #15). Farmers are happy to invest their money from their own pockets, but they want to make sure it works (Mr K, #13). On the contrary, if they get things for free, they do not care very much.

The benefits for women are clear: women are now recognized as the 'farmer' (Mr R, #20). Mrs B (#19) attributes this to her exposure and continuous link with the Satmile IP. She contacts Satmile, UBKV or DoA for advice, and she can use a mobile phone in the group to send photos to identify diseases and obtain advice (strong sense of coming together). Additionally, Mrs B (#19) has adopted CASI, and can now undertake a range of other activities and earn additional income. She can do all the farm work, and her husband can take work outside (Mrs B, #19). In the past, she used to sit at home with no work and no money, but now has a mobile phone, TV, water pump for use in the kitchen, gas for cooking, and she can afford school fees, so her children are now educated.

Satmile became a large distributor for agricultural machines (zero tillage, rice transplanter, harvesters, threshers and dal mills, etc.) and seed and input supplier in West Bengal. Under Satmile, there are now >60 Farmers Groups being supported to facilitate the implementation of all agricultural-related government schemes. Satmile is also a hub for developing capacity building by accessing the Civil Society Money (e.g. Mahindra). Satmile received support from NABARD to establish a training facility.

Case Study 4: Dinhata farmer group IP

An IP was established through a farmer group in Dinhata through the support from UBKV and the SRFSI project. There was a contractual arrangement established between stakeholders (farmers, farmer club, input suppliers, etc.) for crop cultivation, initially for maize, but extended to other crops. The IP integrated a range of stakeholders whilst at the same time was a contractual business. Because the SRFSI trials were reasonably successful, many farmers believed the scientists, particularly the importance

of quality seeds, in successful crop cultivation. The driving force for the Dinhata IP was income earning (through payments) rather than mutual help, so more of a 'bottom-up' farmer group-driven IP. It was a separate entity to the Farmer Club, but there were connections with other villages, so others get to know about other schemes or activities that were around (Mr B, #24).

For many years, farmers used to discuss their problems amongst themselves, but could not find a solution (Mrs D, #25). They were introduced to the concept of IPs by UBKV, and the farmers were happy to try them (Mr B, #24). There was lots of interaction with markets, veterinarians, fertilizer agents, seed dealers (e.g. Monsanto) (Mr B, #24). There was also a strong link with the Coochbehar KVK about relevant schemes on offer (Mrs D, #25). The IP meetings were held twice per month initially where a range of representatives came along to discuss problems. The frequency of meetings has decreased but key stakeholders still interact through phone calls etc. (maintained connections) (Mr B, #24). Women felt it was important to be involved as members of the IP (Mr B, #24). Mrs D (#25) was worried when she was married (= 'sold'), but she now has economic power and independence. Mrs D (#25) stated that the IPs allowed many women to discuss a wide range of problems with other women, which is a form of informal information exchange, helping to solve some problems, and help alleviate depression and improve standards of living. Having experience with these benefits and success means that there are economic (improved distribution of income and purchasing power) and social gains; they believe they can do something for themselves or their family (self-empowerment; Mrs D, #25). Farming households now get more time for family and domestic work (Mrs D, #25). Mr B (#24) has the influence and confidence to help create new IPs in neighbouring areas as an integral unit in the confederation.

5. Discussion

It became evident that IPs established through the SRFSI project have had variable success in supporting adoption of CASI technologies and practices. Using the approach of Davies et al. (2018), we consider some of the important indicators for aspects of the IPs that worked well, and where they could be improved (Table 3):

Table 3. Factors indicated as important to explain performance of IPs, identified from thematic analysis. Category of variables from conceptual framework for IP effectiveness (adapted from Davies et al., 2018).

IP name	Context	Structure	Conduct	Process	Performance
Bangladesh					
General observations	Well recognized & respected NGO (RDRS) supported	Union Federations supported through NGO (RDRS)	Variable participation, facilitation and negotiation across IPs	Variable opportunity analysis Good communication	Improve inputs and services to farmers
Nepal General observations	Hampered by constitutional crisis Access subsidy support	New entity initially supported through DADO and NARC		Lack of driving force	Some improved access to agri-inputs, subsidies, CASI practices, marketing
Purnea, Bihar, India					
Aranyak	Evolved from women's self-help group to Farmer Producer Company Fair price for maize	Farmer Producer Company Profits split across members	Functioned well initially with good trust, but some problems emerged	Positions for Village Resource Person and Community Mobilizer Problems identified and resolved, particularly for maize procurement	Benefits to women Improved grain quality and grading Electronic payments into bank accounts
DeHaat	Local entrepreneurs provided with training support Input & output marketing Mobile-based support service	Micro-entrepreneurs Financial credit to farmers	High trust Market orientation	Brokering	Inclusion and empowerment of women Training Timely interventions
Coochbehar, West Bengal, India					
Satmile	Service provider model for implementation of project activities Links to government and schemes & subsidy programs	Registered NGO, linked with KVK & UBKV Strong networks	Service provider model expanded through Single Window Service provider model Vibrant and dynamic Business orientation	Brokering Change agent Capacity building	Increased access to inputs Improved knowledge Opportunities in new industries (poultry, ducks etc.)
Dinhata	Established by UBKV through SRFSI project Initial focus on maize, but extended to other crops Key driver is income earning (through payments)	Contract arrangement between stakeholders Well connected to Farmer Club & neighbouring villages, schemes & activities	Bottom-up farmer driven	Strong participation & involvement by women Economic and social gains	Informal information exchange, particularly with women

- Context: IPs had a clear need (income earning, access programs and subsidies) and clear prior relationships (involvement of respected NGOs).
- Structure: IPs were built on existing institutions/ organizations, with strong links and networks.
- Conduct: There was initial high trust, it was bottom-up farmer driven, there was strong market and business orientation, and IPs were considered vibrant and dynamic.
- Process: IPs were considered as a change agent, with a strong focus on brokering and capacity building, and had strong participation and involvement by women.
- Performance: IPs enabled timely interventions and improved inputs, knowledge and services (marketing, payments) to farmers.

Some of the factors that might affect the ongoing change and impact from the IPs established in the EGP include (Table 4):

- Context: Well-established networks, with a focus on solving problems, providing economic and social gains, and a focus on opportunities for women. In Nepal, context was hampered by the constitutional crisis.
- Structure: Well-supported through connections with NGOs, local authorities and government programs, with strong membership and vision, but well-functioning examples are required, especially to improve marketing skills (e.g. for Aranyak).
- Conduct: Strong sense of ownership with focus on benefits to women, modified business models including Single Window Service provider model, but there was a lack of change in the market in Bangladesh.
- Process: Strong incentive to solve problems, provided more accessible finances and improved capacity, but lacked specialised livelihood strategies and broader R4D system and policy change in Bangladesh and lacked coordination and budget to sustain in Nepal.
- Performance: Strong evidence of distribution of CASI machines (in some cases), improved capacity, empowerment and motivation of farmers, and benefits to women, but there was example of loss of purchasing power (e.g. Aranyak).

5.1 Emergent themes

There were several issues that emerged through our experiences with implementing the IPs as part of the SRFSI project in the EGP. We did not achieve success in all locations, but we were able to test out a range of approaches, which provide some opportunity for developing some broad principles for success.

There were several different 'modes' of IP implemented, four of which were shown through our case studies. (1) DeHaat business model which provided all inputs through a commercial service model, (2) Aranyak women's group for maize procurement, (3) Satmile Club as another service provider model which provided mechanical inputs for farmers, and (4) formalized IP farmer group (Dinhata), set-up through support of UBKV (Table 3). Each IP had strong support during the establishment phase from our SRFSI partners (BAU, UBKV, DoA). In the past, farmers struggled with solving problems and they were not aware of technologies. They mainly took advice from fertilizer sellers at the market or from other farmers. After the implementation of the IPs, many of the problems have been solved, but some problems still exist, and evidence that farmers were willing to use the IPs to try and solve them. Many farmers were also firmly convinced they are now more empowered to solve any new problems that might emerge.

Initial set-up of the IPs and the role of the facilitator

The initial set-up and establishment of the IP is critical for its success (Davies et al., 2015). Arenas of transition, such as multi-stakeholder IPs, must be facilitated to achieve concerted action and change, and success often depends on the relationships among multiple stakeholders and actors with different but complementary interests (Sanyang et al., 2016). Satmile and the Dinhata IPs showed the importance of early discussions with a range of potential stakeholders, but also with local government officials to gain support. Having project-related support early on (such as through the SRFSI project) gave the IPs some credibility. This was especially important when introducing complex technologies or practices like CASI. Because of the success of the field trials undertaken in trial plots in these villages (through SRFSI; Islam et al., 2019), farmers saw the benefits of CASI, and were also willing to be involved in the establishment of the IPs. Having clear lines of accountability for

Table 4. Prominent factors affecting prospects of ongoing change and impact from the IP by category of variables in the conceptual framework for IP effectiveness, showing factors expected to have positive impact (plain text) and factors expected to have negative impact (*italic text*). Adapted from Davies et al. (2018).

IP name	Context	Structure	Conduct	Process	Performance
Bangladesh					
General observations		Well supported through connections with NGO (RDRS)	<i>Lack of change in market</i>	More accessible finances Improved capacity <i>Poor specialized livelihood strategies</i> <i>Lack of change in R4D system</i> <i>Lack of change in policy & formal institutions</i>	<i>Need to improve access and performance of CASI machines</i>
Nepal					
General observations	<i>Hampered by constitutional crisis</i>	<i>Needs examples of functioning IPs to learn</i>		<i>Poor coordination and lack of driving force</i> <i>No budget to sustain</i>	
Purnea, Bihar, India					
Aranyak	Well-established networks with NGO support	Strong membership <i>Poor marketing skills</i>	Focus on benefits to women	<i>Reduced effectiveness of leadership</i>	<i>Loss of purchasing power</i>
DeHaat	Well established networks through 'agrevolution' Focus on solving problems	Fee for service	Modified business model to support broader farming community and build business opportunities	Strong incentive to be highly effective to solve problems (business model)	Improve capacity, empowerment and motivation of farmers
Coochbehar, West Bengal, India					
Satmile	Service provider model Mobile-based support service	Local authority support Maintain links with government programs, KVK & UBKV	Single Window Service provider model	'Coming together' Hub for capacity building	Benefits to women Distributor of agricultural machines (focus on zero-till)
Dinhata	Opportunities for women Economic and social gains	Clear vision and objectives	Bottom-up processes Strong sense of ownership	Strong farmer leadership supported by UBKV	Self-empowerment

who is involved in the IP and how they would be established and operated were important. The problems encountered with the IPs in Nepal also underlined this, because of confusion and high turn-over of staff. The role of the facilitator was critical, who needs to be an engaging personality willing to bring various stakeholders together. According to Sanyang et al. (2016), the main bottleneck in starting IPs was the weak facilitators, who are usually researchers with a natural science background, who had limited or no competence, skills, or experience in multi-stakeholder processes. To better facilitate IPs, facilitators and practitioners need to learn to observe, recreate, test, and perfect the IP process (Sanyang et al., 2016). Good facilitators can build mutual trust (ISPC, 2015).

Entry points and stakeholders

Initiating an IP should be based on clear and well-defined entry point(s) to allow systematic facilitation of interactions and relationships among social and economic operators with divergent interests but potentially common objectives (Sanyang et al., 2016). There were a range of entry points associated with the SRFSI IPs (Table 1). Organizing the interactions of stakeholders is the key enabler of innovation (ISPC, 2015). These interactions enable the two-way flows of information, enabling links to market opportunities, creating immediate benefits to keep participants engaged and willing to learn. Further, innovation systems thinking makes it clear that technological change rarely happens without institutional and policy change (Hall et al., 2003; Hounkonnou et al., 2012). Innovation brokers or intermediaries are key actors that required to facilitate the innovation process. IP members can utilize pre-existing networks to influence work areas (ISPC, 2015), but there also needs to be fluid membership, which depends on the innovations being pursued (Davies et al., 2015). It is important, though, to ensure that vulnerable stakeholders are not further disadvantaged through this process (Eidt et al., 2020).

Outside support

Having support from a project such as SRFSI gave the IPs some focus and helped to enable adoption of the CASI practices that were being tested. There were questions about the sustainability of the IPs after the SRFSI project ends. Some IPs (such as Satmile, DeHaat and Aranyak) were likely to continue

because they were also receiving support from other sources, and were likely to expand their businesses. Strong links with research and extension personnel enabled adoption of practices, for example, the role that UBKV and DoA play both in Satmile and Dinjata IPs in West Bengal. The problems encountered with of the IPs in Nepal were partly due to weak institutional support from DADO and NARC. Supportive institutional conditions can assist with integration with government interventions and access to schemes and programs, further assisting with scaling (Totin et al., 2020), but this needs to be balanced to ensure existing power relations are not further strengthened to serve their own interests, rather than for broader community benefits of minorities (Eidt et al., 2020).

Institutionalization and sustainability of IPs

Building on the previous point and to build sustainability after project support is withdrawn, IPs can often struggle with how to 'institutionalize' the approach more widely (ISPC, 2015). Often, what is missing is the institutional reforms to make those necessary changes happen (Struik et al., 2014). IPs are unlikely to be an effective way of achieving impact at scale unless their use is informed by wider systems thinking and conceptualization of change (ISPC, 2015). Our case studies have revealed that a range of approaches for the institutionalization of IPs could be achieved. Some IPs are small (12 participants) and others large (~100 participants) with a range of issues being discussed and resolved. It seemed appropriate for new forms of business to emerge to take the role of an IP to help farmers solve problems (e.g. DeHaat, Satmile). Similarly, existing farmer groups (e.g. Aranyak), or new farmer groups (e.g. Dinjata) could be established, some needing assistance with establishment. Entrepreneurship exists throughout the EGP, and various business opportunities should be built upon, as found in West and Central Africa (Davies et al., 2015). It is important, particularly in a highly complex location like the EGP, that there are different models available to achieve success. The degree of engagement with a range of actors and stakeholders beyond the farm can determine the sustainability of the IP (Davies et al., 2015). Lots of different stakeholders were involved early, but their involvement has waned. Some interviewees were not concerned by this because they had already established and built strong networks, and could maintain contact. It takes time for IPs to be

established, mature and deliver impacts (Pamuk et al., 2014). Older platforms (operational for 2 years) are more likely to show outcomes than younger ones (operational for 1 year), and this would be common for business models too. Platform maturity and social capital explain some of the variation in platform performance. Mutual interest(s) and benefit(s) are the key to success and sustainability of IPs. Successful IPs develop trust within the community and among stakeholders. The critical question on whether IPs should be formalized or to remain as an informal dynamic platform remains unanswered. IPs should remain informal in shape, but can become non-functional if it is not formalized (especially, in the question of convening meetings), however, some groups have credibility to call meetings (such as Satmile). It takes time; initially, it should be shouldered by a local institution (e.g. UBKV or DoA), but then by a credible private player.

Learning and reflection

Continuous learning is important. The objective of monitoring, evaluation and learning (MEL) in IPs is (Boogaard et al., 2013): (1) to generate research-based evidence for the effectiveness of IP across different contexts and (2) needed for joint learning among partners to help assess performance and to adapt the course of action accordingly. A functional IP will normally experience a series of iterative learning events, at the interface of which innovation is generated (Adekunle & Fatunbi, 2012). Through this project, we had several rounds of learning and reflection, as embodied in our original IP framework (Figure 2). Our thematic analysis here also constitutes a significant learning and reflection event for the project team. As such, we have redrawn the IP framework and nested it amongst a wider domain of the agricultural community and broader contexts (Figure 3). Providing business opportunities for the rural youth and women was also a significant learning.

Implications for gender

A key desire through the development of the IPs was to have strong benefits and outcomes for women, through direct engagement and empowerment. Rahma Adam and Maria Fay Rola-Rubzen et al. (personal communication) identified that membership in farmer and rural producer organizations could be a pathway to cultivate gender equality in both Africa and South Asia. We found that some strong benefits

for women emerged, in that they felt more empowered and they felt they were in a better economic position (due 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).

Moving beyond village level case studies for broad-scale adoption of CASI

Our project-related IPs enabled the adoption of CASI practices. Some IPs were operating beyond the original spatial scale of the project communities. DeHaat and Satmile worked across more communities benefiting many more farmers. CASI practices are now being adopted across the whole of West Bengal, because of connections established through the SRFSI project, a true example of enabling widespread adoption of CASI. A key reason for not adopting CASI is because of a lack of machines (Mr D, #16), but this is changing because of the creation of demand and through the IPs. However, the willingness for support by implementers, research and development leaders including policy makers is key for a functional and more vibrant IP that facilitates wider scale CASI adoption.

5.2 General discussion

IPs have enabled the adoption of CASI technologies and knowledge beyond the project-initiated activities (e.g. Aranyak, Satmile and DeHaat). This is in addition to general uptake of the CASI technologies because of the multiple benefits that have been demonstrated (Gathala et al., 2020a; Gathala et al., 2020b; Gathala et al., 2021; Islam et al., 2019; Sinha et al., 2019). Dixon et al. (2020) (citing Cummins 2018), showed that IP capacities and impacts varied across each region, but there were positive outcomes in terms of demonstrated changes in crop management, financing, crop input retail business services, adoption of CASI seeding systems, access to CASI machinery, knowledge, attitudes, skills, aspirations and social capital benefits. There were also broader business opportunities created because of demand for services and support (Dixon et al. 2020). These business opportunities include the DeHaat micro-entrepreneur model that has enabled participation of rural youth (opportunities for tractor drivers through to a service provider model), while Satmile has been

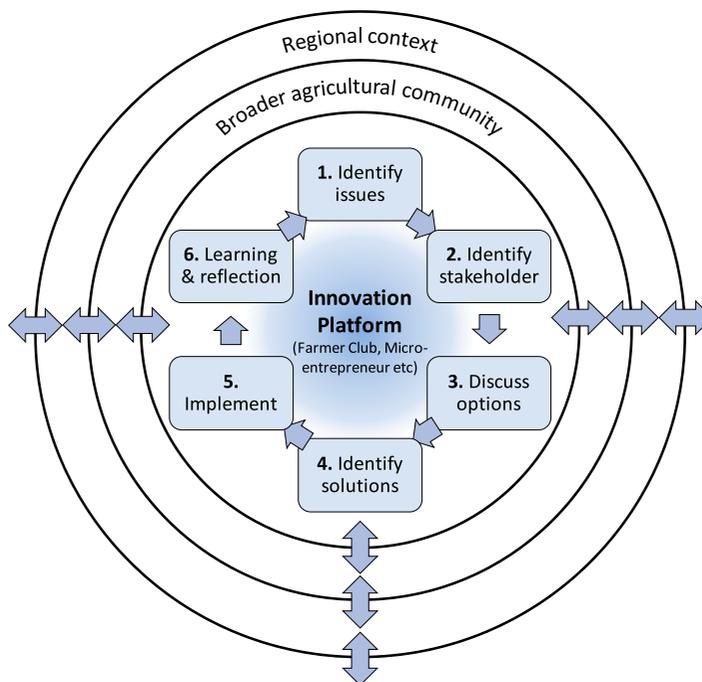


Figure 3. Simplified framework of Innovation Platforms as trialled through the SRFSI project in the Eastern Gangetic Plains. There are multiple links across scales and interactions with different components of the system. IPs could be created through existing or new farmer groups or community youth groups, and enable micro-entrepreneur business opportunities.

instrumental in the capture and convergence of development programs through ‘single-window’ businesses.

The IPs as described here in the EGP have added value over and above existing systems, particularly systems that are underperforming. There are many examples of farmer groups and service providers throughout the EGP. SRFSI has established a systems approach to enable these groups to go beyond project boundaries and to seek answers to a range of problems that ‘single-issue’ projects can provide whilst building trust amongst the community, youth, women and stakeholders. IPs enable stakeholders to seize opportunities quickly and to respond to a range of contextual dynamics (ISPC, 2015). We are not necessarily advocating that our approach can solve all problems, but there are some key principles that should nudge the system towards improved outcomes, which are outlined above. We strongly endorse the benefits that IPs can provide as described by Boogaard et al. (2013): support impact of research, strengthening interactions between multiple stakeholders to achieve a common objective, identifying and solving complex problems, provide an enabling

environment for innovation, and contribute to overcoming institutional barriers and creating institutional change.

6. Conclusion

Innovation Platforms can be a useful approach, particularly to enable the adoption of conservation agriculture-based sustainable intensification (CASI) practices. We identified that the IPs had a clear context (clear need, building on prior relationships), structure (built on existing links and networks), conduct (initial trust, bottom-up farmer-driven, strong market and business orientation), process (IPs as a change agent, brokering and capacity building and involvement by women), and performance (timely interventions, knowledge and services). A large amount of effort was required to train and support local partners to establish and initiate the IPs through our project communities. Not all IPs were successful, and this was largely the result of poor coordination, lack of budget, poor leadership, lack of CASI machines, or knowledge and skills in implementing CASI technologies. Where there was

good project-related support and guidance, IPs were successful at addressing a range of issues as identified by smallholder farmers (e.g. farm advisory, technical knowledge, quality inputs, mechanization, service providers, finance/credit, pest management, market news, new business models). Different models were trialled, from establishing IPs through existing farmer groups, to new farmer groups, through to support for businesses that played the role as a successful IP. It was apparent that there had to be immediate benefits for the IPs themselves and for their farmers, and it seems that creation of business opportunities has led to much of that success. These businesses also had the added incentive to make it profitable.

Our key learnings were: (1) the initial set-up and establishment of the IP was critical, as was the importance of finding a good facilitator, (2) importance of defining clear entry points to facilitate interactions to develop common objectives, (3) providing initial project support to help give focus and links with research and extension personnel, (4) look to institutionalize the IP to enable sustainability, which can occur through development of business models or building on existing networks (e.g. existing farmer groups), (5) build in continuous learning and reflection, as is good practice through iterative learning events, and (6) look for opportunities to build strong benefits for women to improve engagement and empowerment. Through this approach, it should be possible to move beyond case studies at the village level for broad-scale adoption of CASI to benefit many more farmers.

The Eastern Gangetic Plains is a highly complex area with a high rate of poverty, high population pressure, poor extension systems, but also a highly complex institutional environment. Therefore, commitment, dedication and dynamism are required among stakeholders involved to identify solutions. Agriculture in the EGP is not always profitable, so many are seeking wages in other locations (Darbas et al., 2020), further exacerbating the situation. The introduction of CASI, primarily through use of zero-till farming practices and improved timing of planting and harvesting of crops has enabled more profitable farming systems and reduced labour input (Gathala et al., 2021). The IPs have enabled this to occur through the identification of problems faced by smallholder farmers and interactions with a range of stakeholders in a facilitated approach to help to overcome these problems. The IPs are contributing to

overcoming institutional barriers and creating institutional change (Boogaard et al., 2013) and leading to broader adoption of CASI approaches.

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Appendices

Appendix A. Interview guide for key informant interviews and the 'self-assessment' questions used to evaluate utility of Innovation Platforms as used in the SRFSI project in the Eastern Gangetic Plains of South Asia.

Table A1. Interview guide to assist with guided discussion with key informant interviews to determine success of the IPs. Questions based on Davies et al. (2018) and Sparrow and Traoré (2018).

General background information

1. How were you involved in the SRFSI project
2. What were the main agricultural problems you faced?
3. How did you solve agricultural problems in the past? Where did you get advice?

Innovation platforms

4. How were you involved in the IP?
5. What problems were addressed in the IP?
6. Was any training provided?
7. What benefits were there for women to be involved in the IP?
8. What were the main benefits about being involved in the IP in terms of income, yield, time or livelihoods?

Future

9. What needs to be done in the future to improve your farming?
 10. What will you continue to do in the future (beyond the SRFSI project)?
 11. Opportunity for clarification questions
-

Table A2. Self-assessment of IPs as used in the SRFSI project. Questions based on Davies et al. (2018) and Sparrow and Traoré (2018).

Part A: What were the aims, establishment date and foci of IPs?

- Q1: IP name, climate zone, average rainfall and country?
 Q2: Production system?
 Q3: Focal value chain?
 Q4: Time when IP was established?
 Q5: What was the aim at the time of establishment?
 Q6: Activities conducted?
 Q7: Vision as at 2015/2016 (when first initiated)?

Part B: Self-assessment of IP

- Q8: Overall function: The IP is established and functional? (The IP has governance arrangements, including institutional relations and decision-making, and evidence of scheduled meetings over the past years)
 Q9: Level of participation: The IP has several major types of actors and the participation of these? (The IP goes beyond a meeting almost exclusively of producers and includes the active participation of representatives of the value chain and support services)
 Q10: Relevance of entry point: The IP has identified and is in the process of supporting entry points suited to innovation? (Appropriate innovations were developed by the project; they are being tested through project activities and thereby provide a stimulus for transformation)
 Q11: Research: The IP is incorporating new knowledge from research and through participation in research? (The research activities introduced or initiated by research participants or advisors have an impact on the evolution of the platform)
 Q12: Facilitation and negotiation: The IP has access to good facilitation and capacity in bargaining/brokerage? (Meetings of the innovation platform are organized by trained facilitators and there is evidence that there has been discussion and consensus around the actions of the platform)
 Q13: Opportunity analysis: The IP has prospective opportunities to achieve outcomes? (Additional financial support for the innovation platform will provide evidence attesting to the achievement of outcomes)
 Q14: Gender: The IP supports explicit effects on gender? (Innovations and the path to the impact will benefit women)
 Q15: Communication: The IP invests in communication and knowledge sharing? (Knowledge is captured and shared amongst members of the innovation platform and beyond through networks and media)
 Q16: Monitoring and evaluation: The IP is supported by a functional framework for monitoring and evaluation? (The monitoring and evaluation data collected support the desired effects and behavioural changes)

Part C: What were the domains of change in the agricultural system with outcomes and impacts from IP activities?

- Q17: New technologies adopted? (Yes/No, details)
 Q18: What were the changes in production system? (Number farmers with increased income (2018)? Income increase per farmer (2018)?)
 Q19: What were the changes in access to production inputs? (More accessible finance? More specialization, local livelihood strategies? Other mechanisms?)
 Q20: What were the changes in how the market works? (Yes/No, details)
 Q21: What were the changes in capacity of local actors and socially embedded institutions? (Emergent/unexpected capacity changes? Change in cultural/gendered institutions?)
 Q22: What were the changes in capacity of R4D systems and associated institutions (e.g. access to research and extension personnel and influence on research agendas and collaborations)?
 Q23: What were the changes in policy, formal institutions? (Details)
 Q24: Gender impacts? (Were there positive changes for women to improve livelihoods or food security?)
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Appendix B. Domains of change as applied to innovation platforms in Bangladesh.

Table B1. Domains of change in the agricultural system with outcomes and impacts from IP activities, from the SRFSI project in the EGP for Northwest Bangladesh (Rajshahi and Rangpur Districts) (following approach of Davies et al., 2018). Partner agencies conducted a 'self-assessment' of their own IPs. These data have not been independently verified. 'Y' = Yes, 'N' = No

IP name	New technologies adopted	1: Changes in production system		2: Changes in access to production inputs			3: Changes in how the market works	4: Changes in capacity of local actors & socially embedded institutions		5: Changes in capacity of R4D system & associated institutions	6: Changes in policy, formal institutions
		# farmers with increased income	Income increase per farmer (AUD)	More accessible finance	More specialised local livelihood strategies	Other mechanisms		Emergent/unexpected capacity changes	Change in cultural/gendered institutions		
Rajshahi											
Baduria	Y	25	225	Y	N	Y	N	Y	Y	N	N
Dharmpur	Y	15	225	Y	N	Y	N	Y	Y	N	N
Laxmipur	Y	12	225	Y	N	Y	N	Y	Y	N	N
Nabinagar	Y	15	225	Y	N	Y	N	Y	Y	N	N
Premtoli	Y	25	225	Y	N	Y	N	Y	Y	N	N
Rangpur											
Borodargha	Y	25	247	Y	N	Y	N	Y	Y	N	N
Dugapur	Y	25	247	Y	N	Y	N	Y	Y	N	N
Kolkodo	Y	15	247	Y	N	Y	N	Y	Y	N	N
Lakkhatari	Y	15	247	Y	N	Y	N	Y	Y	N	N
Mohonpur	Y	25	247	Y	N	Y	N	Y	Y	N	N