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# Final report

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# Contents

# 1 Acknowledgments

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# 2 Executive summary

Across the Eastern Gangetic Plains (EGP), including Bangladesh, farm sizes are very small (average land size of 0.6 ha) and plots are usually fragmented. There is a predominance of small and localized private businesses that provide agricultural inputs, machinery services, and sometimes aggregate and market produce. In this context an understanding of which methods are best suited for the scaling of certain agricultural technologies to large numbers of small-scale farmers is critical. Finding ways to foster linkages between research providers, extension officers, these types of private businesses and farmers to enable scale-out of improved agricultural technologies is an ongoing challenge. Research and extension providers are increasingly trying to partner with diverse organisations in the innovation system to help encourage the adoption of new practices and technology. At the same time the inclusiveness of different approaches needs to be understood to ensure equitable access to agricultural technology and benefits that are shared across farming communities.

In this project we focused on one initiative designed to help deliver new services to small-holder farmers and their communities. Farmers' Hubs were developed by the Syngenta Foundation for Sustainable Agriculture (SFSA) and are designed to provide multiple services such as the purchase of inputs including seed and seedlings, selling farm produce, and access to machinery as a commercial business. Our objective was to document how hubs are being used to improve the adoption and scaling of new agricultural technologies to small-holder farmers and identify opportunities for them to be used more effectively. This project sits within a broader program of research and development work being undertaken in the EGP (the ACIAR Sustainable Development Investment Portfolio (SDIP) program), but our study was focussed on Bangladesh.

There are a total of 286 hubs (as of December 2020) listed as operating in Bangladesh so we developed a process to select six sample hubs that would be the focus of this study. We excluded hubs that had been established recently, and then randomly selected two hubs from Rangpur division and three hubs from Rajshahi division. There are hubs that are run by small ethnic community groups in Bangladesh, and we deliberately included one of these in our study (in the Rangpur division). We conducted a quantitative survey of farmers who engaged with the selected hubs (participants), and non-participant farmers are those who live in the villages nearby the selected hubs. A total of 323 samples were collected. In addition to the quantitative survey, participant observation, key informant interviews, and expert consultation were performed to capture the diverse perspectives.

The most common service provided by the six sample hubs in our study was the selling of vegetable seedlings. This involved the development and use of the coco-peat media in seedling trays and the use of crop types and varieties that had been trialled by the SFSA research team and were optimized for local conditions. This seedling technology and practice information provides farmers with a much lower mortality rate for seedlings, earlier harvest for some crops and can lead to a price advantage at the time of sale. However, not all farmers purchase seedlings through the hub alone as the price of these is high relative to other sources or the use of farmer-saved seeds, as the seedlings are grown under controlled environment and production cost is relatively higher in the hubs. Hub owners and network managers act as aggregators of produce from many farmers, and this does enable access to distant markets at a better price. According to our survey, 42% of the respondents said they used this service. According to SFSA Bangladesh, direct buying and selling of farm output was one of the major sources of income by the hubs (about 19% of the profit received in the first six months of 2020). However, not all farmers are getting benefit from this service. For example, in our survey only one sample hub bought a significant amount of farm produce (vegetables) and about 27.5% of vegetable output of participant farmers were sold back to that hub. Hub participants also accessed some machinery services from the hub, such as power sprayers, mechanical weeders, and seedling transplanters. For hub participants some information across all information types was provided by the hub, but the choice of which variety to use, the crop type choice, pesticide use advice and fertilizer

use advice were the most identified by hub participants. In the non-participant group sellers and traders and extension agents provided information about pesticides and fertilizer use.

All survey respondents were able to slightly increase their productivity over the short time scale we assessed (2018 to 2021). A greater proportion of hub participants said their productivity had greatly increased, whereas non-participants said their productivity had moderately increased. For hub participants this change was attributed to a shift from the use of seeds to the use of high-quality seedlings and the fact that they had adopted a new crop or variety. The shift to seedlings does incur greater production costs but the price at sale for their vegetables was also higher. Given the relatively young age of the farmers who are participants of the hub this is big change to their farming systems and demonstrates one of the harder to measure aspects of participation in hubs (or other collective groups), that is the de-risking of practice change through support and knowledge.

The hubs have not been successful in engaging women entrepreneurs to lead hub activities and we had few women respondents included in our quantitative survey (both hub participants and non-participants). This limits the conclusions we can draw. However, during the scoping trips and field visits it was observed that female labour was involved in seedlings preparation and other hub related activities. The hubs have been successful at attracting young entrepreneurs and developing their capacity to lead a farming business.

SFSA has introduced a digital tool called e-FarmersHub which helps hub owners keep track of daily transactions, get automated business analysis, inventory, customer, and marketplace information, while enabling SFSA to monitor progress in real time. There were large numbers of respondents to our survey who did not use digital tools at all and were unsure about how they could use them to their advantage in the future to improve their agricultural practices. However, the survey respondents did say that in the future they would like to use apps relevant to agriculture more. There was a desire to access smart phones more in the future and to use computers to access digital tools, however this may be many years away for most farmers.

The hubs play a broader role in the rural communities in which they are based, and our survey respondents identified several social-service roles the hubs could play in the future. Suggestions included a club or training centre for farmers, education and library facilities for children and farmers, and health facilities. A financial support role was mentioned but this was not limited to loans to support farm businesses, but also resources and funds to help poor members of the community.

This was a short and limited study that only focused on six sample hubs in two regions. Therefore, the conclusions we draw, and the recommendations we make, may not be appropriate for all the hubs across Bangladesh. A future study involving a larger sample of hubs may provide additional insights, especially in relation to services not commonly provided at the six sample hubs in this study. We also focussed on information provided by hub participants and could conduct more in-depth research with hub owners. We recommend that hubs have a greater emphasis on de-risking the adoption process for farmers for a diversity of services they provide (i.e. not just seedlings), and there may be some benefits to expanding this to machinery services. To assist in this process there should be more connection and collaboration between the hubs and The Bangladesh Department of Agricultural Extension (DAE). Currently there are informal interactions but there may be benefits to making this relationship more formal (through institutional linkages). Further research on vegetable value chain development in the Northwest of Bangladesh may provide insights into how higher-value agri-food systems can be implemented from aggregated products. The intersection between the use of digital tools to facilitate product aggregation and sale at a price high enough to provide equitable outcomes for all stakeholders is a one area that requires further research.

Whilst the differences we observed between participants and non-participants of the hubs were subtle, there was some evidence that the hubs are supporting younger farmers to trial, adopt and see the benefits of more challenging farming practices. There are flow-on benefits to farming communities through greater capacity and confidence of farmers that is hard to value. The trialling and optimizing of practices in the local context before they are scaled-out to farmers is a critical step

in the adoption process that if missed, can lead to dis-adoption of practices. This study contributes to our understanding of how the public and private systems and institutions interact in Bangladesh to assist in the scale-out of agricultural technology. The work to date on scaling in the Northwest region of Bangladesh (and further into the EGP) has focussed on the adoption process related to Conservation Agriculture Sustainable Intensification (CASI). Some of the practices and machinery used in CASI will not be relevant into the small vegetable producers (as they are direct seeders for field crops) that were common in the study hubs we examined. However, the process of adoption and dis-adoption and the frameworks established for CASI could be usefully applied here.

# 3 Background

The traditional view of innovation in agricultural systems involves linear information dissemination, usually from a research provider, through a publicly funded extension system to support the adoption of new practices by farmers. However, this approach under-estimates the farmers role as innovators (Bellotti & Rochecouste 2014) and ignores the powerful influence of private sector stakeholders in providing services, tools, and information to farmers. If we assume that there are many pathways by which farmers receive information and advice, we can start to assess which pathways may be the most influential for each technology. By understanding the innovation system as it applies in different contexts today, we may be able to speed up the adoption of new practices by farmers.

Across the Eastern Gangetic Plains (EGP), including Bangladesh, farm sizes are very small (average land size of 0.6 ha) and plots are usually fragmented. It is one of the most densely populated places in the world, with approximately 300 million people living, working, and relying in some way on agricultural production. The farming systems are dominated by rice production with wheat, maize, pulses, and other minor crops included in the rotation. The small plot-size has restricted the utility of four-wheeled tractors, however mechanization of tillage using two-wheel tractors has spread across Bangladesh since the 1990s (Miah et al. 2019). Growth in agricultural productivity over the last 20 years has been modest (0.03%) in many regions of Bangladesh, and there have been declining levels of technical efficiency (Bagchi et al. 2019, Alam et al. 2011). Whilst researchers have been investigating options to increase productivity and have identified several profitable cropping options to intensify production (e.g. Gathala et al. 2021), the scale at which new practices must be adopted for meaningful impact creates new challenges.

Effective methods for scaling agricultural innovations requires a well-connected innovation system that links researchers, extension staff, private agri-businesses, service providers, input suppliers, farmer organizations and collectives, and individual farmers. To achieve this there have been significant changes to the public sector extension system (Chowdhury et al. 2013) in Bangladesh towards solving specific problems, supporting group-based learning opportunities, and rapid adoption of Information and Communication Technologies (ICTs). There is a diversity of organizations involved in the R&D system, with Rahman et al. (2017) identifying 50 agricultural and training organizations operating in Bangladesh. More recently the disruptions to agricultural input supply and agricultural service supply (including labour and machinery services) because of the COVID-19 pandemic have demonstrated the vulnerability of the food production system in Bangladesh (Amjath-Babu et al. 2020, Mottaleb et al. 2020).

In the EGP there is a predominance of small and localized private businesses that provide agricultural inputs, machinery services, and sometimes aggregate and market produce. Finding ways to foster linkages between research providers, extension officers, these types of private businesses and farmers to enable scale-out of improved agricultural technologies is an ongoing challenge. Innovation Platforms (IPs) or multi-stakeholder platforms (Sartas et al. 2018) are one way to bring all the stakeholders together to coordinate action to address a complex problem. The Sustainable and Resilient Farming Systems Intensification (SRSFI) project established IPs focussed on the adoption of conservation agriculture practices (Brown et al. 2020, Brown et al. 2021). In Bangladesh this has led to the establishment of new business models that provide equipment hire. The Sustainable and resilient farming systems intensification in the Eastern Gangetic Plains project (SRSFI) enabled the successful establishment of village-based IPs but district-level IPs had much less engagement (Brown et al. 2020). Beyond innovation platforms there are a diversity of other mechanisms for scaling innovations (Table 1) and methods by which the private and public components of the agricultural innovation system could potentially interact.

In general, there is a lack of up-to-date and accessible information for farmers to help with decision-making and at the other end of the innovation pathway researchers face challenges with getting their findings to their next users. Digital tools can be used to enhance communication and dissemination of information. In many countries there is evidence that small-holder farmers and associated agri-businesses are eager to harness new technology, including the use of digitally enabled agricultural services (DEAS) (Porciello et al. 2021, Rashid et al. 2016). Mobile phones and other digital tools can be used to access information about farming practices, financial services, market information, and to connect with suppliers and buyers. In Bangladesh we know that extension officers in the Department of Agricultural Extension (DAE) regularly seek out information to improve their own technical knowledge and thereby provide better advice to farmers, however this is not usually through accessing resources available on the internet (Hossain et al. 2018). The development of training videos delivered through television broadcasts is a proven way to communicate change of practice to farmers. If provided in a DVD form or shared through social media some people can watch the content as needed (Bentley et al. 2016). The deployment of training videos through the internet (via YouTube and Massive Open Online courses e.g. MOOC on conservation agriculture sustainable intensification) may also be used more in the future. However, we need to make sure that potential users can access this information in terms of having the appropriate hardware and access to the internet for this purpose.

In this context an understanding of which methods are best suited for the scaling of certain technologies to large numbers of small-scale farmers is critical. The methods for scaling a new pest management practice may be different to those needed for scaling new irrigation practices, and pilot projects rarely provide the information needed to assess performance of interventions at scale (Woltering et al. 2019). Research providers are increasingly trying to partner with diverse organisations in the innovation system (Table 1) to help encourage the adoption of new practices based on the knowledge and technology they develop. At the same time the inclusiveness of different approaches needs to be understood to ensure equitable access to agricultural technology and benefits that are shared across farming communities. For example, Quisumbing & Kumar (2011) found that women's assets increased more relative to men's when technologies were scaled through women's groups.

In this project we focus on one initiative designed to help deliver new services to small-holder farmers in Bangladesh to understand how information is moving through this system and what the broader impacts are on farm communities. Farmers' Hubs were developed by the Syngenta Foundation for Sustainable Agriculture (SFSA) and are designed to provide multiple services to small-holder farming communities. According to information obtained from the SFSA website and expert meetings with SFSA Bangladesh personnel, the SFSA (created in 2001) is an independent non-profit organization established by the agribusiness Syngenta, which has its own strategy and activities to improve the livelihoods of smallholders in developing countries. SFSA has been working in Bangladesh since 2011 and focuses on creating value for resource-poor small farmers through innovation in sustainable agriculture and the activation of value chains. The Farmers' Hubs initiative is one of its key activities. The hubs are operated locally by rural entrepreneurs, agribusiness suppliers or farmers' cooperatives. Each hub is run by an individual as a commercial business, but they are operated as a network of businesses in a franchise system and have links to extension services (Table 1). They are similar in some ways to Innovation platforms and multi-stakeholder platforms in terms of the networks they create, but they also compete commercially with other traders and input suppliers in a region. Therefore, they are an ideal model to use to get some understanding of mechanisms for successful scale-out of agricultural technologies in Bangladesh.

**Table 1** Different types of scaling mechanisms to provide access to new agricultural technology (this includes information and services).

| Types of organization | Types of outputs provided to farmers | Examples and links to other mechanisms, focus on Bangladesh |
|---|---|---|
| Private businesses selling services/products* | Machinery, seeds, pesticides, information about markets, commercial relationships with farmers. | National Agricultural Mechanization Policy 2020- encourage to introduce and use of modern agricultural machinery/methods for proper application of chemical fertilizer, insecticide and pesticide, and irrigation water (NAMP, 2020). |
| Innovation platforms (IP), multi-stakeholder platforms* | Access and information about markets, machinery services, network with others. Multi-stakeholder problem analysis. | Described as Union Federation Farmer schools (5), and farmers schools (5) established in Northwest Bangladesh (Brown et al. 2021). Analyse the gender sensitivity of rural advisory services in Bangladesh (Rahman et al. 2017). |
| Private extension services* | Information, advice, direct towards where to buy services/products. Part of a commercial transaction. | Often directly related to private businesses selling inputs. “Zero Cost” Extension and Advisory Service (EAS) is a model developed by BIID under the e-Krishok service basket (BIID, 2021). |
| Public extension services* | Information, advice, access to government support. | Synthesis extension, gender and nutrition programs of public, private and development organizations in Bangladesh (Rahman et al. 2017). “Should ensure agricultural extension services to all farmers. Meanwhile, tenant farmers, young, women and land less families should give especial priority in providing extension services” (New Agriculture Extension Policy, 2015). |
| Peer-to-peer, friends, and family | Any outputs. | Development of Peer-to-Peer Business Networks in “Southern Delta” project under the Agricultural Value Chain (AVC) program (BIID, 2021). |
| Government subsidies | Encourage the use of certain practices or inputs | Lower interest rate (4%) for growing crops (Agricultural and rural credit policy and program 2020-21). |
| Government policies and regulation | Stop or phase out certain practices or encourage uptake of practices through regulation changes. | National Agricultural Mechanization Policy 2020 emphasis on popularization and extension of agricultural Machineries through credit and price subsidy (NAMP 2020). |
| NGOs and development organisations* | Subsidise or provide access for certain people to technology, training, and networks | Often involved in the development of IPs and link to government policies and subsidies; e.g. The Agriculture and Nutrition and Extension Project (ANEP), INGENAES. |
| Farmer organizations (FO) and women’s groups | Delivery of training and inputs | 198114 FOs of various types were identified. 81% formed with support from government agencies, 14% from national NGOs, 5% from international NGOs, and less than 0.01% were formed autonomously. Just over 2% of FOs are federated at any level. (FAO 2014). |

*SFSA Farmers’ Hubs fall across these organisations.

# 4 Objectives

The Syngenta Foundation for Sustainable Agriculture (SFSA) is a non-profit organization developed by Syngenta with a focus on supporting small-holder farmers. Farmers' Hubs were developed by SFSA in collaboration with local organisations and are designed to provide multiple services to small-holder farming communities such as the purchase of inputs including seed and seedlings, selling farm produce, and access to machinery. The Farmers' Hub also provides agri-extension messages (how to grow, what to grow, where to sell) as embedded services. Hubs are initiated to develop a self-sustaining profitable business that also act as a social enterprise, so they are an example of a scaling mechanism that merges both public and private mechanisms (Table 1). They started in Bangladesh but have also been developed in Indonesia, Kenya, Senegal, Mali, and recently in Cambodia. They are not a one-size-fits-all solution but a method for determining what is missing in terms of services in a local community and developing a business model for how this gap could be filled.

Our study documents how Farmers' Hubs are being used to improve the adoption and scaling of new agricultural technologies to small-holder farmers and identify opportunities for them to be used more effectively. Our objective was to evaluate how and in which contexts Farmers' Hubs facilitate the dissemination of new products, practices, and services to small-holder farmers and the broader farming community as commercial service providers. This project sits within a broader program of research and development work being undertaken in the EGP. The ACIAR Sustainable Development Investment Portfolio (SDIP) program goal is to maximise agriculture's contribution to sustainable food systems in the EGP, for improved food, energy, and water security; and as such, opportunities for understanding scaling are a critical part of the program.

There are five research questions we have addressed in this study:

**RQ1 How do Farmers' Hubs operate in the innovation system in relation to research, extension, and public/private service provision to small-holder farmers?** A description of how Farmers' Hubs operate in the broader agricultural R&D system, how they interact with public organisations and private businesses, and commonalities and differences between hubs.

**RQ2 How do agricultural researchers contribute to and interact with Farmers' Hubs (and vice versa)?** These Hubs may provide an additional opportunity for researchers to communicate information on change of practice. Understanding when and why this interaction has provided positive outcomes in terms of wide-spread dissemination of new practices is critical.

**RQ3 What is the impact of hubs at the community-level (disaggregated for women, men and young community members)?** Whilst the Hubs approach has the potential to benefit an individual entrepreneur, we want to understand if there are benefits at a community-level as well (e.g. access to services that would not otherwise be present). As part of this research question we have addressed if and how Farmers' Hubs are inclusive for different types of farmers, e.g. women and men farmers and youth.

**RQ4 What other roles could hubs serve in terms of community service provision?** This is an exploratory question to ask what other services could be provided and are there capacity-building opportunities for farmers that have been missed.

**RQ5 What are the digital tools Hub owners currently use, and what digital tools would they like to use in the future?** Given the Hub model is about aggregation and service provision, understanding information delivery and management using digital tools is important.

# 5 Methodology

## 5.1 Hub selection

There are a total of 286 hubs currently listed as operating in Bangladesh so we developed a process to select the hubs that would be the focus of this project. A list of all the hubs in Bangladesh was provided by SFSA which contained location details, network assignment, and the time since establishment. We excluded hubs established in 2020 (80 in total) as these have not had enough time to develop fully. There are 40 hubs in the 2013-17 establishment year group and 166 hubs in the 2018-19 establishment year group. The financial performance of the hubs (as judged by SFSA) was not considered in the selection process. Only one of the hubs is listed as being owned by a female, however many hubs are family-owned and will have women involved in decision-making in some way. The remaining hubs belonged to four networks that sit in two divisions. We randomly selected two hubs from Rangpur division and three hubs from Rajshahi division. Within this list were hubs that were run by small ethnic community groups in Bangladesh, and we deliberately included one of these in our study. These ethnic groups are not isolated, or vulnerable communities and they interact regularly with Bengali people in their region as part of their business practices. This ethnic hub falls under Rangpur division. This gave a total of six hubs that formed the focus of our survey work (Fig. 1).

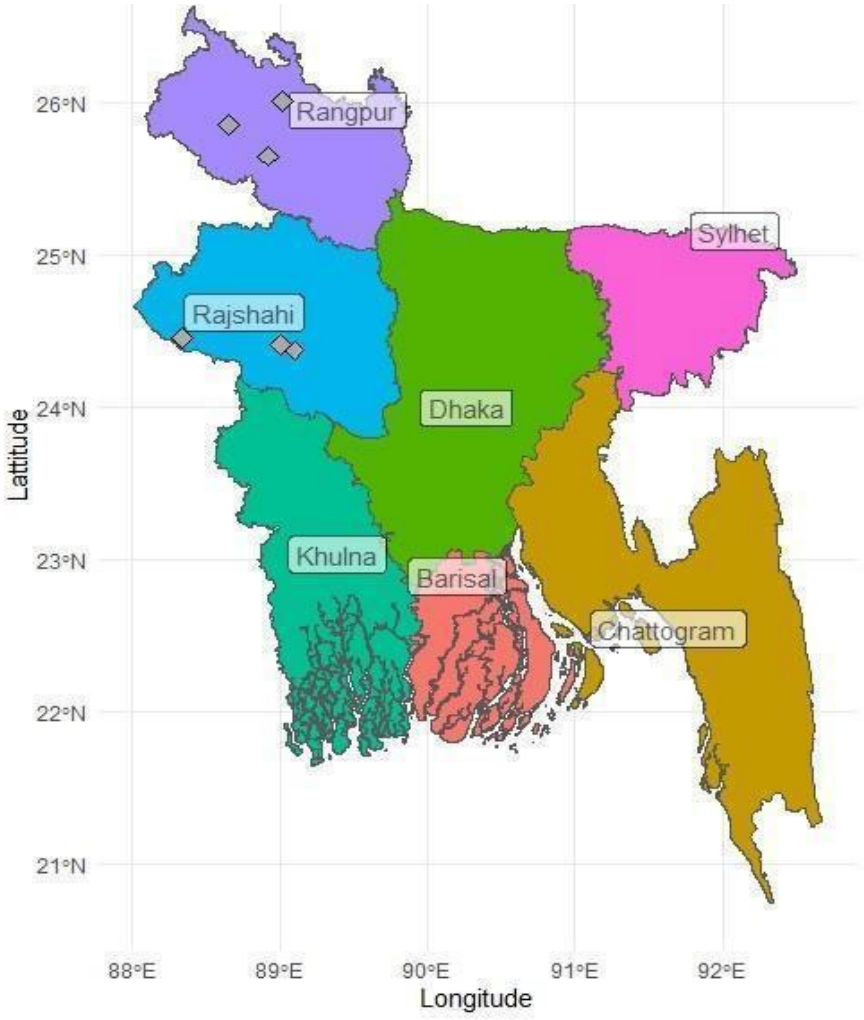



**Figure 1.** Map showing the towns nearest the study hubs in Bangladesh chosen for inclusion in this study (grey diamonds).

## 5.2 Quantitative survey

After selecting the above-mentioned hubs, a list of the participant farmers was collected from the SFSA. The target population of this study are those farm households who engaged with the selected hubs. In contrast, non-participants farmers are those who live nearby villages of the selected hubs but did not receive any support and services from the hubs. A list of non-participant farmers was collected from the respective Sub-assistant Agricultural Officer (SAAO) who is responsible for work in the study villages. From each selected hub, around 50 farmers were interviewed randomly from the list provided by the SAAO and SFSA. In addition, 3-5 more samples were collected from each location to keep the total sample size at least 300. A total of 323 samples were collected across hubs. Table 2 shows the sample distribution across hubs and regions. Among the respondent's 52% are participants and 48% non-participants, respectively. Again, the respondents are distributed as 49% in Rangpur division and 51% percent in Rajshahi division, respectively.

**Table 2** Distribution of the samples across division and participant category in our quantitative survey.

| Hub name | | | Region | | | All |
|---|---|---|---|---|---|---|
| | Non- participant | Participant | Name | Non- participant | Participant | |
| Hub A | 25(41) | 36(59.0) | Rangpur | 78(49.1) | 81(50.9) | 159(49.23) |
| Hub B | 25(49.0) | 26(51.0) | | | | |
| Hub C | 27(51.9) | 25(48.9) | | | | |
| Hub D | 26(50.0) | 26(50.0) | Rajshahi | 77(47.0) | 87(53.0) | 164(50.77) |
| Hub E | 25(47.2) | 28(52.8) | | | | |
| Hub F | 27(50.0) | 27(50.0) | | | | |
| All | 155(48.0) | 168(52.0) | | 155 | 168 | 323(100) |

Note: Figures in parentheses indicate the percentage. We have removed the hub names and given them a code name to de-identify the respondents.

### 5.2.1 Socio-demographic profile of the sample households

The age, education and experience are important attributes of an individual to decide participating in productive activities. The age structure of the sample respondents was classified into three age groups such as less than 35, 35-45, and more than 45 years (Table 3). Interestingly, all three categories are estimated around one-third. However, a relatively higher percentage of young respondents belong to participant households.

It is well documented in literature that education has an influence on increasing the enterprise output (Asadullah & Rahman, 2009; Eric et al. 2014). The education level of the respondents has been grouped into six categories: (1) no formal education, (2) below class five, (3) class 6 to 10, (4) class 11-12, (5) Class 13-16, and (6) above 16 years. More than 13% of respondents do not have any formal education (Table 3). Of the educated respondents, 35% respondents had 6-10 years of education followed by 31% with 1-5 years. It was observed that most of the respondents belong to the below primary level of education (<10 years of education) (Table 3). Crop production was listed as the primary business of 95% of the respondents, with a commercial business listed as their secondary occupation (22%) (Table 4). Other common secondary occupations included livestock and poultry production (18%) and general labourer jobs that were paid on a daily wage (16%).

**Table 3.** Socio-demographic profile of the sample respondents to our quantitative survey

| | Region | | All average |
|---|---|---|---|
| | Non-participant | Participant | |
| ***Age*** | | | |
| 18-35 years | 28.39 | 38.46 | 33.64 |
| 35-45 years | 34.84 | 34.91 | 34.88 |
| More than 45 years | 36.77 | 26.63 | 31.48 |
| ***Education*** | | | |
| No formal education | 12.34 | 14.55 | 13.48 |
| 1-5 years | 31.17 | 30.30 | 30.72 |
| 6-10 years | 34.42 | 36.36 | 35.42 |
| 11-12 years | 11.69 | 14.55 | 13.17 |
| 13-16 years | 9.09 | 3.03 | 5.96 |
| More than 16 years | 1.30 | 1.21 | 1.25 |
| ***Gender*** | | | |
| Female | 0 | 3.55 | 1.85 |
| Male | 100 | 96.45 | 98.15 |

Note: Figures shown as a percentage of total respondents

**Table 4**. Occupations of the respondents to our quantitative survey

| | Primary occupation | | | Secondary Occupation | | |
|---|---|---|---|---|---|---|
| | Non-participant | Participant | All | Non-participant | Participant | All |
| Business | 1.29 | 0.59 | 0.93 | 20.55 | 23.9 | 22.3 |
| Crop farming | 96.13 | 94.67 | 95.37 | 4.11 | 5.66 | 4.92 |
| Housewife | 0.00 | 1.18 | 0.62 | 0 | 1.26 | 0.66 |
| Shop keeper | 0.65 | 0.59 | 0.62 | 6.85 | 4.4 | 5.57 |
| Student | 0.00 | 1.18 | 0.62 | 2.74 | 3.14 | 2.95 |
| Wage labourer | 1.29 | 0.00 | 0.62 | 12.33 | 19.5 | 16.07 |
| Rickshaw/van pulling | 0.00 | 0.00 | 0.00 | 4.11 | 7.55 | 5.9 |
| Livestock and poultry | 0.00 | 0.00 | 0.00 | 21.92 | 14.47 | 18.03 |
| Other | 0.65 | 1.78 | 1.23 | 5.48 | 6.92 | 6.23 |
| No secondary occupation | - | - | - | 21.92 | 13.21 | 17.38 |
| Total | 100.00 | 100.00 | 100.00 | 100.00 | 100.00 | 100.00 |

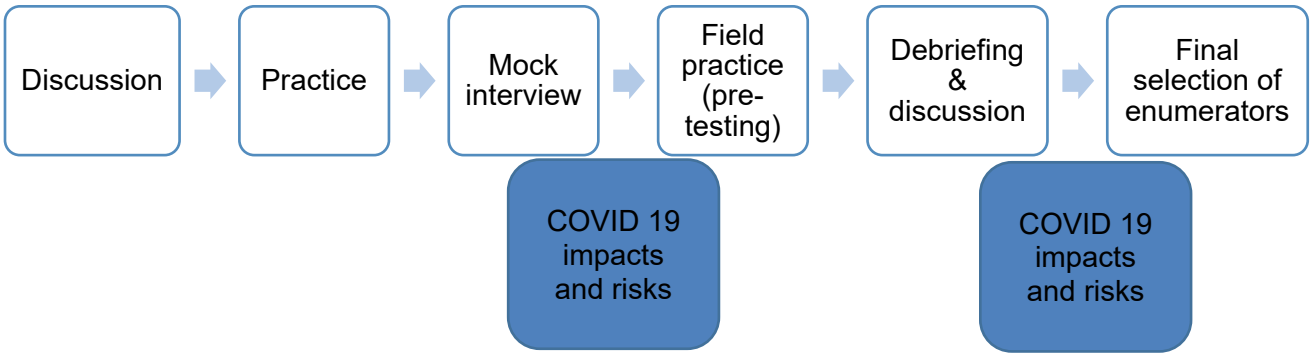
Note: Figures shown as a percentage of total respondents

### 5.2.2 Quantitative data collection procedure

To collect the required data, an interview schedule was prepared in accordance with the objectives set for the study. Major questions are related to socio-demographic, agricultural inputs and farm machinery services, extension advisory services, farm productivity, and level of satisfaction of existing services. The interview schedule was transferred into ONA software for digital data collection. The prepared interview schedule was then pre-tested in the field before final data collection (Fig. 2).

A total of eight post-graduate students of Bangladesh Agricultural University were recruited as data enumerators. A comprehensive two days (28-29 March 2021) training workshop on “Data Collection Procedure” were performed physically and virtually. Attempts were made to ensure a uniform pattern in administering the survey. The training plan puts more emphasis on skill training on the real situation rather than classroom training.

The following training strategy was maintained:




The enumerators collected data through face-to-face interviews under direct supervision of the research team (virtual). There was a regular virtual meeting conducted with the enumerators (mostly in the evening) to resolve any survey related concern that arises in the field. Data was collected during 1st April to 3rd June 2021, then data collection was postponed due to the impacts of the COVID-19 pandemic (Fig. 2). The team had to pause data collection due to travel restrictions thus we required a longer time to complete all the surveys.

**Figure 2**. The enumerators conducting interviews in the field.

### 5.2.3 Data management and analysis

Data were collected using a digital tablet and uploaded into the paid ONA server. Stored data were downloaded and arranged as per analytical requirements. In case of inaccuracy, inconsistency and incompleteness identified of any data, communication (through mobile phone) was made with the respondent to resolve the problem. Data were analysed by using SPSS and SATA software. Simple descriptive statistics were used to estimate perception about the product and services received by the sample respondents and presented as averages, percentages, ratio, frequency, etc. after generating descriptive tables, a consultation meeting was carried out with the enumerators and SFSA personnel to listen their different perspectives on various issues.

## 5.3 Qualitative data gathering

Besides the quantitative survey, participants observation, key informant interview, and expert consultation were performed to capture the diverse perspectives on farm input services and delivery mechanisms.

The research team visited the study sites as a scoping trip prior to the quantitative survey design. Through this scoping trip, the team visited several hubs and met with hub owners, extension personnel, network manager, and SFSA local staff. All discussions were recorded (audio) then transcribed accordingly. Furthermore, in connection to the research question two, the research team organized two expert consultation meetings- i) one with the extension personnel and researcher; and ii) another with the SFSA personnel both local and national level.

The team had planned to carry out participant observation in two different hubs but this could not happen due to the COVID-19 pandemic impacts. However, a local graduate student was recruited to collect daily notes from the selected hub (as this person resided in the area). The observer collected regular/daily notes on how the hub operated and the interaction between hub owner and the service recipients. The field notes were translated into English then synthesized based on the research questions (particularly the research question number two).

## 5.4 Achievements against activities and outputs/milestones

| No. | Activity | Outputs/ Milestones | Completion date | Comments |
|---|---|---|---|---|
| 1.1 | Project commencement | Development of contract with ACIAR and BAU complete, establish project communication plan, data management plan. We will try to get this complete as soon as possible. | 1/12/2020 | Completed as planned. |
| 1.2 | Planning and engagement | Plan the survey and key informant interviews and small group discussions.<br>Locations and types of questions.<br>Consult with SFSA and others. | 1/02/2021 | Completed as planned. We also completed a CSIRO human ethics approval. |
| | | Train enumerators and plan logistics for the survey | 1/02/2021 | This was completed, but later than planned due to COVID-19 impacts. Training took place on the 28/29 March. |
| | | Map the other stakeholders that are involved in the study hubs, review other literature. | 1/02/2021 | This was completed as planned. We also used the scoping trip in Feb. to add details. |
| 1.3 | Quantitative survey | Conduct the field work with hub owners and community. | 30/03/2021 | The quantitative survey was conducted from 1/04/2021 until 3/06/2021 with a break due to COVID travel restrictions. |
| | Data analysis | Analyse the data. Synthesize the results. Start writing the report. | 30/04/2021 | Delayed until after data gathering was completed. |
| | Qualitative data | Expert Interviews<br>Participant observation | 30/03/201 | Delayed due to COVID but we conducted these throughout July. |
| 1.4 | Communication activities | Workshop/online meeting to communicate findings. TBC | 30/04/2021 | Still being planned for later in 2021. We have contributed to the SDIP review meetings but see our communication plan for more details. |
| 1.5 | Final report | Final report ready to be delivered to SDIP/ACIAR | 15/06/2021 | Delayed, but still being delivered. |

# 6 Key results and discussion

## 6.1 RQ1 How do Farmers' Hubs operate in the innovation system?

Farmers' Hub is one-stop commercial service platform creating small-holders' access to various agricultural inputs and services like seedlings, farm machinery, market linkages, and knowledge about cultivation. The SFSA Farmers' Hub initiative has been running since 2013, when it started in collaboration with the GBK Enterprise, an offshoot of the Gram Bikash Kendra (GBK) NGO, which was working on developing commercial agri-entrepreneurs in the North-Western region of Bangladesh (SFSA, 2020; scoping trip). We have learnt about the origin and the basic mechanism of its functions from a published report (LightCastle Partners, 2017), a document obtained from SFSA (SFSA, 2020), and the scoping trip of the research team. The SFSA Farmers' Hub has been commercially running under an arrangement of Franchise Business System where the master franchisee or the network manager manages the farmers' hubs, ensure the branding and quality of services (following standard operating procedures) and maintains the commercial relationship with member hubs through supplying input material and purchasing aggregated output. SFSA Bangladesh plays a role of 'Franchisor' of this farmers' hub franchising system as concept and Intellectual Property (IP) rights holder and ensuring proper support and mentoring to the network managers and its member hubs. The GBK Enterprise was the first network manager, and later evolved to add three other network managers and expanded services in the North-Western and South-Western regions of Bangladesh.

At the community or village level, a local entrepreneur is selected in collaboration between the SFSA and the network manager, who has some business experience and entrepreneurial mindset to operate the hub. They directly serve the farmers in the community by selling seedlings, buying, and aggregating farm outputs, and renting out farm machinery. According to the SFSA personnel and previous reports (SFSA, 2020; LightCastle Partners, 2017), the farmers are believed to benefitting from this system by getting access to quality seedlings and farm machinery that enable them to grow profitable high value crops (mainly vegetables), enjoying competitive market advantages by reducing post-harvest losses, cost and time in transportation and marketing, and avoiding unseen weight cuts, and getting better market access by selling to the hubs or gaining linkages to sell to distant buyers.

To understand how the sample hubs in our study operated or what role they play in the agricultural innovation system we conducted scoping visits and spoke to several managers and participants in hubs. SFSA has classified the services they provide into five domains: agri-input selling, farm machinery rental, post-harvest handling, buying-selling, and agri-advisory. However, not all these aspects are the focus of the six study hubs included in our survey.

During our scoping trips and participant observation, it was observed that one of the most visible functions the farmers' hubs perform is producing vegetable seedlings in soilless coco-peat based medium (see Box 1). The seedlings are prepared under a controlled environment in a polythene or net house. The media is usually prepared by the network managers and is made of coconut dust, which is bought from southern districts of Bangladesh through middlemen or traders. At first, raw coco-dust is neutralized then appropriate chemicals are mixed within it. After that, organic matters are mixed into it and the coco-peat based medium is prepared. We have been told during the scoping trip that some experienced hub owners are also capable of preparing the medium. The network managers use this medium to grow seedlings themselves and sell it to the farmers' hubs. The hubs may buy the medium and grow seedlings in a net poly house on a plastic tray. All the hubs we visited during the scoping trip perform this function. Some of the hubs use sprinkler irrigation to the seedbeds and seed trays.

Another noticeable aspect of the hubs is the availability of farm machinery. The GBK-Enterprise and other network managers as well as the farmers' hubs visited during the scoping trips contained at least some type of farm machinery like, power tiller, potato planter, sprayers, weeder etc., which are

rented to the farmers. Buying of farm output directly from farmers was also seen at some hubs, although it was learnt that not all hubs engage in the act of buying products from farmers.

We included some questions in the quantitative survey to clarify what services and information were being provided by the six study hubs and outline those results below.

### 6.1.1 Agri-input selling services

The most common service provided by the six study hubs in our survey was the selling of seedlings. With 97% of the hub participants using this service in some way (Table 5). This involved the development and use of the seedling coco-peat media in seedling trays and the use of seedling crop types and varieties that had been trialled by the SFSA research team and were optimized for local conditions. Overall respondents were very satisfied (58%) or satisfied (41%) with this service and the results they achieved. Through participant observation it was revealed that there is no compensation mechanism in the hub business if the purchased seedling dies. Similarly, sometimes a proportion of the seeds bought from GBK do not germinate. Seeds which do not germinate, can neither be returned to GBK Enterprise nor do they provide compensation. However, this is a common/usual practice for any seedling business in Bangladesh. There is also concern about the quality of coco-peat (wet) and the trays (where seedlings grow). It was reported that the cost of seedlings are comparatively higher than farmers producing seedlings from their saved seeds (as the seedlings in the hubs are produced under controlled environment), but the quality of hub seedlings are much better.

Hub participants also sourced seeds and seedlings from retailers in the local market (32%, compared to 51% of non-participants), and produced them independently (18%, compared to 34% of non-participants) (Table 5). Retailers in distant markets also provided a small number of seeds or seedling inputs (6% for non-participants, 3% for participants).

**Table 5** Information from respondents to our quantitative survey about the source of seeds or seedlings they use.

| | Non-Participant | Participant | All Farmers | Significant difference |
|---|---|---|---|---|
| Self-produced or owned | 34.47 | 18.47 | 26.12 | *** |
| Retailers in local market | 51.18 | 31.63 | 40.98 | *** |
| Retailers in distant market | 5.68 | 2.53 | 4.04 | * |
| Farmers' hub | 0.00 | 44.14 | 23.02 | *** |
| Company representatives | 2.74 | 0.96 | 1.81 | * |
| Government sources | 3.05 | 1.05 | 2.01 | * |
| Other/peer farmers | 2.82 | 1.15 | 1.95 | ** |
| Other sources | 0.06 | 0.06 | 0.06 | ns |
| Total | 100.00 | 100.00 | 100.00 | |

Note: The percentage of respondents who participate in the hubs and those who do not (non-participant) are shown. The statistically significant difference is based on t-tests. *** Significant at 1% level of significance, ** Significant at 5% level of significance, * Significant at 10% level of significance, ns = not significant.

### 6.1.2 Farm machinery rental services

There were several machinery services provided by the six study hubs. These include access to two-wheel tractors, combine harvesters and seedling transplanters (rented out to the farmers or service providers). Of the hub participants 12% accessed some machinery services from the hub, and this was most commonly power sprayers (48%), mechanical weeders (17%) and seedling transplanters (10%, Table 6). The level of satisfaction with this service offering was relatively high, greater than 90% of the respondents being either satisfied or very satisfied (Table 7). Respondents also used machinery services provided by local retailers (41% of non-participants, 31% of participants), and owned some machinery themselves (37% of non-participants, 42% of participants). A relatively high number of respondents sourced machinery services from other farmers (22% of non-participants, 15% of participants) (Table 8).

**Table 6** Information from respondents to our quantitative survey about what they knew about the range of machinery services the Farmers' Hub is offering, and which of them they were currently using.

| | Participants who know | Participants who use |
|---|---|---|
| Combined harvester | 2.98 | 0.60 |
| Potato planter | 3.57 | 0.60 |
| Harvester and grader | 2.38 | 0.60 |
| Powered sprayer | 63.10 | 47.62 |
| Seedling trans-planter | 18.45 | 10.12 |
| Weeder | 30.95 | 17.26 |
| Two-wheel tractor | 1.19 | 1.19 |

Note: Shown as a percentage of respondents who participate in the hubs.

**Table 7** Information from respondents to our quantitative survey about their level of satisfaction when using different agro technologies from hub.

| | Powered sprayer | Seedling trans-planter | Weeder |
|---|---|---|---|
| Very Satisfied | 33.75 | 41.18 | 31.03 |
| Satisfied | 65.00 | 52.94 | 65.52 |
| Neutral | 1.25 | 5.88 | 3.45 |
| Dissatisfied | 0.00 | 0.00 | 0.00 |
| Very Dissatisfied | 0.00 | 0.00 | 0.00 |
| Number of Users | 80 | 17 | 29 |

Note: Shown as a percentage of respondents who participate in the hubs.

**Table 8** Information from respondents to our quantitative survey about access to farm machinery. The percentage of respondents who participate in the hubs and those who do not (non-participant) are shown.

| | Non-Participant | Participant | All Farmers | Significant difference |
|---|---|---|---|---|
| Self-produced/owned | 36.46 | 41.51 | 39.10 | * |
| Retailers in local market | 40.50 | 30.95 | 35.52 | *** |
| Retailers in distant market | 0.10 | 0.24 | 0.17 | ns |
| Farmers' hub | 0.00 | 12.40 | 6.47 | *** |
| Company representatives | 0.03 | 0.00 | 0.02 | ns |
| Government sources | 0.39 | 0.00 | 0.19 | ns |
| Other/peer farmers | 21.74 | 14.91 | 18.18 | ** |
| Other sources | 0.77 | 0.00 | 0.37 | ns |
| Total | 100.00 | 100.00 | 100.00 | |

Note: The percentage of respondents who participate in the hubs and those who do not (non-participant) are shown. The statistically significant difference is based on t-tests. *** Significant at 1% level of significance, ** Significant at 5% level of significance, * Significant at 10% level of significance, ns = not significant

### 6.1.3 Post-harvest handling services

The six study hubs provide support for a range of post-harvest handling services for horticulture vegetables such as potato, tomato, chill, brinjal etc. This includes the use of plastic crates (borrowed from the hubs unless sent to distant markets) (26% of participants), the use of vans to transport the produce (11% of participants) and access to weighing machines (10% of participants) (Table 9). The level of satisfaction with these three services was relatively high, greater than 80% of the respondents being either satisfied or very satisfied (Table 10).

**Table 9** Information from respondents to our quantitative survey about what they knew about the range of post-harvest handling services the Farmers' Hub is offering, and which of them they were currently using.

| | Participants who know | Participants who use |
|---|---|---|
| Plastic crates | 30.95 | 25.60 |
| Three-wheeler vans for transportation | 20.24 | 10.71 |
| Washing/grading/sorting facilities | 7.14 | 2.98 |
| Preserving/packaging facilities | 5.36 | 4.17 |
| Weighing machine | 14.29 | 10.12 |

Note: Shown as a percentage of respondents who participate in the hubs.

**Table 10** Information from respondents to our quantitative survey about their level of satisfaction when using different post-harvest handling services.

| | Plastic crates | Three-wheeler vans | Weighing machine |
|---|---|---|---|
| Very Satisfied | 44.19 | 27.78 | 47.06 |
| Satisfied | 53.49 | 55.56 | 41.18 |
| Neutral | 2.33 | 11.11 | 11.76 |
| Dissatisfied | 0.00 | 5.56 | 0.00 |
| Very Dissatisfied | 0.00 | 0.00 | 0.00 |
| Number of Users | 43 | 18 | 17 |

Note: Shown as a percentage of respondents who participate in the hubs.

### 6.1.4 Buying and selling services

One of the key roles of the hubs is to facilitate the development of networks that link small-holder farmers to new or different markets to sell their produce at a competitive price. However, for the six study hubs in our survey 51% of hub participants reported knowing about this service and 42% said they used this service to get access to better forward linkages. Of those who did use this service (70 respondents), they were either satisfied (77%) or very satisfied (23%) with this offering.

Also, direct buying of farm output is one of the major functions of the hubs. According to data provided by SFSA Bangladesh, buying, and selling services earned about 19% of all profit generated by hubs during the first six months of 2020. However, it was observed during the scoping trips and the survey that all hubs do not engage in this practice equally.

To understand the impact of buying selling services of hubs on the local community, we asked the respondents in our survey about where their vegetable produce is consumed or sold. As mentioned earlier, not all hubs participate in this function equally and in our survey only one of the sample hubs (Hub A) did it at a significant scale. In case of that hub, the majority of the output is sold at local markets either directly or via middlemen (57% of produce for non-participants, 32% of produce for participants), and some goes to distant markets via a middleman (11% of produce for non-participants, 19% of produce for participants). Some is consumed or used in the household and was similar across the participants and non-participants of the hub (16-17% of produce), (Table 11).

A similar result was found during the 2016 impact assessment survey (LightCastle Partners 2017), which found that a minority of respondents (18%) used hubs to access markets and sell produce at a competitive price. However, it was observed during the scoping trips and through the survey question about market linkages that in some hubs the hub owners and network managers act as a connector to distant markets through the relationships they have with others, but our survey did not explicitly show the quantities sold through this process.

**Table 11** Information from respondents to our quantitative survey about what proportion of their produce they consume at home or sell to customers.

| | Non-Participant | Participant | All Farmers | Significant difference |
|---|---|---|---|---|
| Self-consumption | 16.92 | 15.53 | 16.10 | ns |
| Local consumer/market | 24.16 | 20.64 | 22.08 | ns |
| Middlemen/retailer who sell in local market | 33.56 | 10.55 | 19.98 | ** |
| Middlemen/retailer who sell in distant market | 11.04 | 19.02 | 15.75 | ns |
| Other farmers | 0.00 | 0. 77 | 0.46 | ns |
| Farmers' Hub | 0.00 | 27.5 | 16.23 | *** |
| Other buyers | 6.32 | 5.97 | 6.11 | ns |

Note: The percentage of respondents who participate in the hubs and those who do not (non-participant) are shown. The significant difference is based on t-tests. *** Significant at 1% level of significance, ** Significant at 5% level of significance, * Significant at 10% level of significance, ns = not significant

### 6.1.5 Agri-advisory services

In addition to the access to important services related to farm production, access to information about farm practices, techniques, pest issues and weather are also important for improving productivity. We know that small-holder farmers use a diversity of information sources in their daily lives but wanted to know specifically which types of information came from each source. For those participants in the hubs (Fig. 3 bottom graph) some information across all information types was provided by the hub, but the choice of which variety to use (77%), the crop type choice (68%), pesticide use advice (61%) and fertilizer use advice (59%) were the most identified by hub participants. In the non-participant group (Fig. 3 top graph) sellers and traders provided information about pesticides (83%) and fertilizer use (80%) to more of our survey respondents. The extension agents also provided relatively more information to non-participants in several key areas (pesticide use 51%, disease and pest control 50%, choice of crop variety 48%). For all respondent's family and friends and other farmers and peers were used for a diversity of information types. Weather was perhaps the only information type where media content (newspaper this includes newspapers, televisions, YouTube channels that usually re-broadcast the news, and social media. Radio plays less of a role in this context) played a large role.

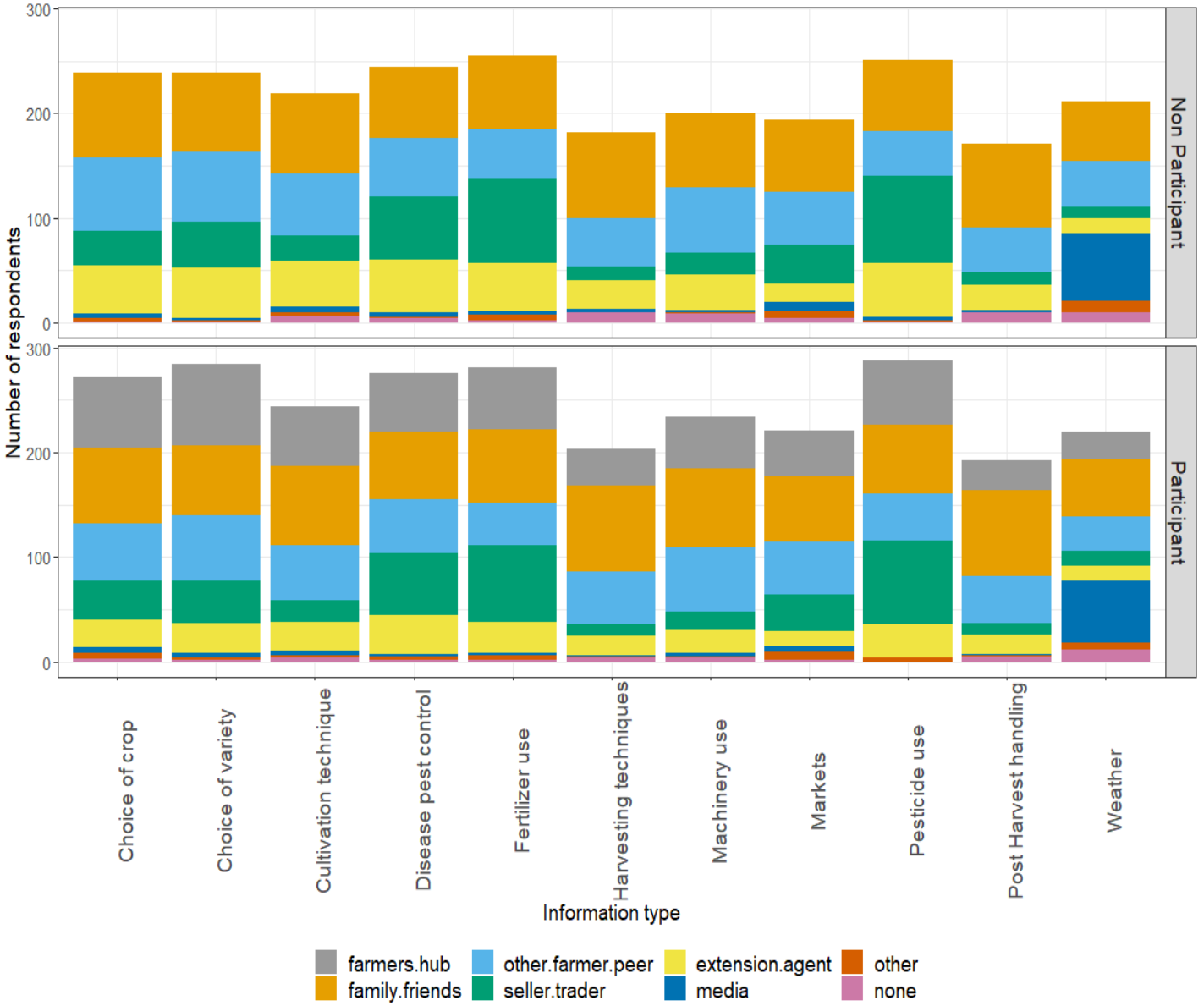



**Figure 3** Information from respondents to our quantitative survey about sources of different types of information. The number of respondents who identified sources of information in relation to each information type are shown. Percentage data in tables can be found in Appendix 2.

### 6.1.6 Crop insurance

The Farmers hubs do offer a type of crop insurance that is index-based insurance that depends on rainfall. This service was not commonly used by the respondents to our survey from the six study hubs. Of the hub participants 23% knew about this service and only 11% were using the service. Most users were satisfied (67%) or very satisfied (22%) with the service, and 11% were neutral (neither satisfied nor dissatisfied). The crop insurance industry has been present in Bangladesh for some time but it is not yet widely adopted by farmers in Bangladesh. However, the government is considering providing support for more farmers to access this type of insurance in the future.

**BOX 1: HOW A HUB OPERATES: AN EXAMPLE**

Participant observation was carried out at one hub. An enumerator from the local area stayed nearby and gathered information on daily basis to provide a more detailed picture of how the hub operates and the challenges faced by stakeholders.

**The seedling production procedure at hub**

- The mulch medium made of coco-peat is added to the cells of a tray, a light hole is made, and one seed is planted in each hole. The hole is lightly filled with coco-peat. The seeds germinate in one or two days.
- After sowing the seeds, the trays are heaped. The heap is made by keeping 10 trays together on a mattress. In the summer, the trays are covered with black polythene and placed under shade, and in winter the trays are covered with black polythene and placed under sun.
- In summer, seedlings are irrigated twice per day. In winter, once a day or once every alternative day. If the irrigated water is excessive, water leaks out from the bottom of the tray.
- The nutrients diminish in coco-peat 15 days after sowing. The seedlings must be given extra nutrients via liquid fertilizers sold by GBK (GBK enterprise, is an offshoot of the Gram Bikash Kendra (GBK) non-government organisation). These fertilizers must be sprayed according to the characteristics of the seedlings. Pesticides and fungicides are bought from the market. Pesticides are sprayed once per month and fungicides sprayed once per week.
- The seedlings of beans, cucumber, pumpkin, bitter gourd etc. are sold within 10 to 15 days. The seedlings of cauliflower, cabbage, tomato, chilli and brinjal are sold within 25 or 30 days. Brinjal, chilli and papaya seedlings are transferred from one tray to another tray when the seedlings are 15 days old. It takes almost 60 days to sell papaya seedlings.

**The services provided by hub**

- Hubs sell good quality seedlings to farmers and provide information.
- Farmers are gathered by SFSA and provided training on different crop varieties. SFSA disseminates information on seedlings and cultivation through leaflets, video footage, and a microphone (amplifier).
- Hub owners go to farmers' fields and give suggestions to the farmers about how to plant seedlings and which fertilizers are more effective. If a hub owner does not know what to advise they communicate with GBK and SFSA. Some farmers received information from hub owners but may choose to not adopt the advice given.

## 6.2 RQ2 How do agricultural researchers contribute to and interact with Farmers' Hubs?

The following diagram (Fig. 4) shows how the SFSA farmers' hubs connect farmers with research, extension, and market agents. This figure has been designed based on our learning and experience during the scoping trip, participant observation and expert interviews. During the scoping trip, we learnt that the farmers' hubs buy coco-peat media, plastic trays, and farm machinery from the network managers. They buy seeds from different sources, based on the recommendation of the SFSA R&D (Research and Development Centre), passed on through the network managers. Some of the hubs buy output from the farmers and sell to distant buyers, and some of them help farmers make linkages with distant buyers.

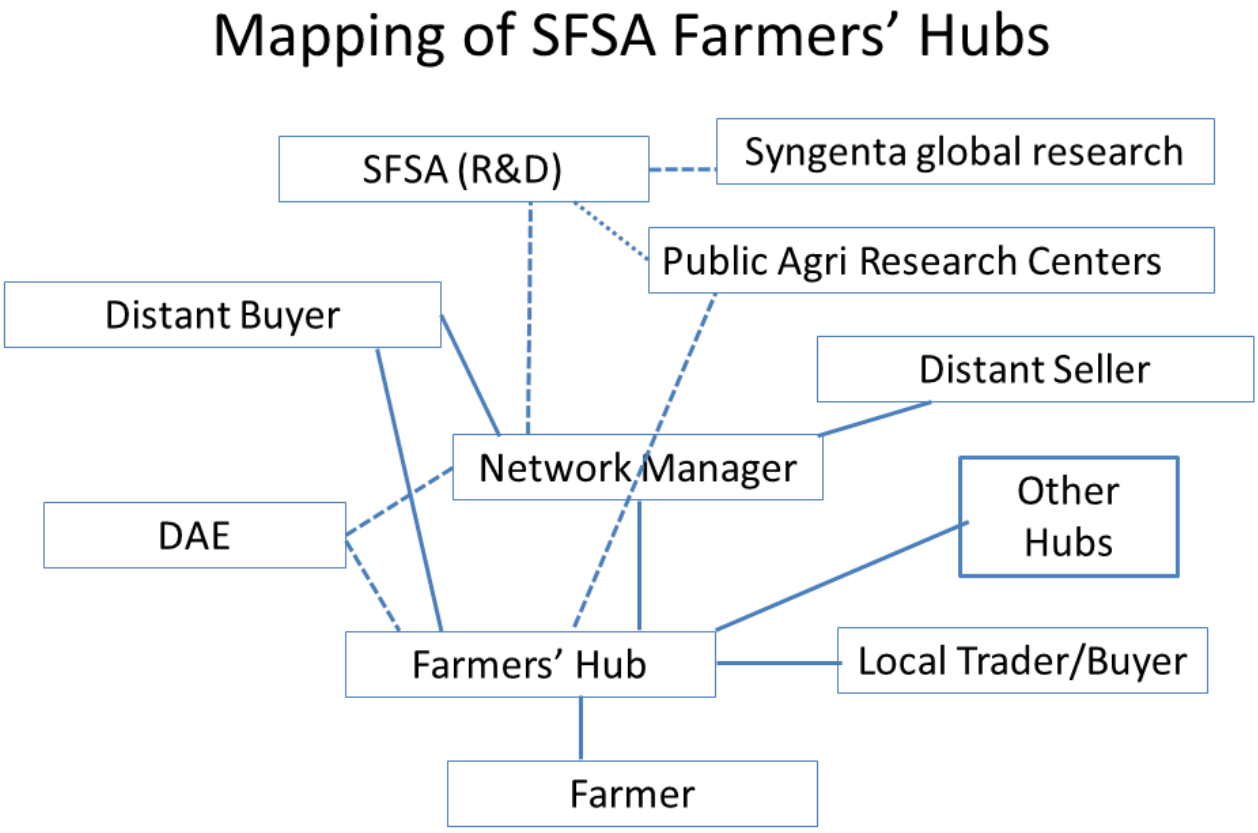



**Figure 4.** Illustration of how the Syngenta Foundation for Sustainable Agriculture (SFSA) Farmers' Hubs connect farmers with research, extension, and market agents in Bangladesh. Flows of information and advice are represented by the dashed lines and flows or access to services and information is represented by the solid lines.

The Farmers' Hubs work as intermediaries between farmers and agricultural researchers. One of the crucial instruments of this link is the SFSA R&D, in Rangpur district. During the scoping trip, we observed that two full time scientists are employed to conduct field trials of different alternative technologies (mostly different varieties of crops). The varieties tested and verified here are from different seed companies and are commonly available in the market. Other technologies like different farm machineries and different cultivation techniques are also tested in this facility.

Based on the results of the trials, the Farmers' Hubs and networks are instructed on which varieties of seeds are to be used for their seedlings production. The SFSA personnel, during both the scoping trip and the expert interview, claimed that they always provide unbiased suggestions based on the trial results, and no preference is given to seeds from the Syngenta Company. Guidelines about the use of different farm machinery and cultivation techniques are passed on through the channel of farmers' hubs. Thus, it has been observed that the SFSA farmers' hubs are a mechanism where the use of suitable agricultural technologies can be scaled out through the network of hubs. The SFSA personnel, both during the scoping trip and during the expert interview, have claimed that one of the major successes they have achieved through this research and extension network of the farmers hubs is the introduction and spread of the coco-peat based seedlings. They claim that they are the first in Bangladesh to have commercially introduced such a technology, and they have managed to spread this to their hubs. Other private companies are also interested in adopting this technology.

Another aspect of the work the R&D does (that we have learnt during the scoping trip) is providing solutions to the problem's farmers face in the field. Since the hubs are a source of information to the farmers, they can ask about any problems they face in cultivation. If the hub owners are not able to meet their query, they can pass on the network managers, who can either directly contact the local DAE officials or government research stations or pass on this problem to the scientists at SFSA R&D. The R&D personnel may either provide solutions if known or investigate the problem further using their own research resources. They may also pass this problem on to the SFSA global research platform if they are unable to address it. Thus, the SFSA hubs have developed mechanisms through which farmers are connected to agricultural researchers at the R&D, public research stations within Bangladesh, and researchers from other countries through the SFSA global research platform (Fig. 4).

However, the SFSA R&D centre does not have the capacity or mandate to develop new varieties or produce new technologies, since they do not have the laboratories to conduct such research activities. Their role is to localize and optimize the existing technologies and crop varieties through trials for the benefit of the farmers' hub participants.

Through our expert interviews we found out more about the current relationship between DAE, other researchers, and the hubs. It was reported that DAE has strong relationships with other stakeholders of the agricultural production and marketing system like farmers, NGOs and private companies. However, there is currently no formal relationship between the hub and the Regional Agricultural Research Station (RARS), but there is a link between RARS and the SFSA R&D department. If SFSA R&D staff come to RARS with farmers, then RARS staff will show them their agricultural technology and have discussions. Sometimes RARS staff may collect/observe technology from SFSA R&D. DAE officials sometimes join in large-group training activities run by SFSA and DAE has a direct connection with a small number of hubs. The people at our interviews suggested that there should be more connection and collaboration between the hubs and DAE in the future. They suggested staff sitting together to plan to grow crops that have higher market demand and price for the farmer. SFSA and DAE could organize seminars and workshops together. As a result, DAE will know and understand the hub activities and can inform other farmers and stakeholders. The hub affiliated farmers could be given opportunities to make field visits directly to DAE research field trials and relevant stations. DAE and the hubs should have more regular communications so that DAE can assist with solving problems the farmers face.

## 6.3 RQ3 What is the impact of hubs at the community-level?

We have broken the results down into sections on the impact on women and young community members, as well as impacts on production, farm income and the environment. Our quantitative survey results are supplemented with information from the expert interviews.

### 6.3.1 Gender impact

The involvement of women farmers or hub owners in our quantitative survey was very low (no females in the non-participant group and only 4% of participant respondents (Table 3). The few female participants we interviewed were part of the ethnic minority hub in the Rangpur division. This does not mean women farmers are not involved in agricultural operations and decisions in the household, but rather the people we spoke to during the survey were often the head of the household and therefore the first point of contact for our enumerators. Furthermore, some of the details we were asking were relating to tasks that are the responsibility of male household members.

From the expert interviews with the SFSA staff we learnt that they originally had a target of 9% engagement by women in the hub initiative, but this has not been achieved for various reasons, although there are some women listed as being part of the hubs. In Bangladesh, the number of female agricultural entrepreneurs (from which to attract potential new hub owners) is very low. But the contribution of women in some aspects (post-harvest operation, coco-peat based seed sowing and management) of farming is high. SFSA adopted a household approach to train both husband and wife together so that female farmers would benefit along with male farmers. In the hubs 80-90% processing tasks related to seedling production are done by female laborers. Thus the hubs create employment opportunities for women agricultural workers. The SFSA staff reported that women farmers don't commonly visit the hub to obtain services because that is not part of their role in the household.

### 6.3.2 Impact on youth

The hub aims to increase youth engagement in agriculture or to support youth entrepreneurship and to thereby support the continued development of advanced farming practices in rural Bangladesh. The emphasis is on long-term support for young entrepreneurs to build capacity and knowledge across time. During the expert interviews we learnt that SFSA does target younger people for inclusion in their activities and for entrepreneur diversification. At the time of this interview younger farmers get training. In the study hubs 15-20% members are more than 40 years old and other members are below 40 years old (Table 3). The age of hub participants was significantly lower than that of non-participants to the hub (participants mean = 39.31, SD = 12.61, non-participants mean = 43.03, SD = 13.91, p=0.0126).

### 6.3.3 Impact on farm productivity

There is a growing trend of vegetable production in Bangladesh. Around 26.7 million tons of vegetables were produced across Bangladesh in 2018-19 fiscal year (BBS, 2020). This has happened due to the introduction of modern technologies and high yielding varieties of vegetables without significant increase of acreage. According to the Agriculture Information Services (AIS), some 156 varieties of traditional and non-traditional vegetables are being cultivated in the country, among which 35 are considered as principal vegetables. Farmers cultivate vegetables in both the Rabi (winter) and Kharif-1 (rainy season) seasons. Farmers who are engaged in the production of vegetables often earn higher incomes than those engaged in the production of cereal crops alone (Weinberger and Lumpkin, 2005). Vegetables like brinjal, radish, cabbage, cauliflower, and pumpkin gave returns at least three times higher than rice (Ateng, 1998). Table 12 presents the yield of different crops mostly the vegetables. The average highest yield was obtained for cabbage (33.75 MT/ha) while the lowest yield estimated for jute (3.17 MT/ha). Cauliflower gave high yields (28.84 MT/ha) followed by tomato (19.63 MT/ha), snake gourd (18.96 MT/ha), cucumber (17.86 MT/ha), okra (17.40 MT/ha). The farmers in our survey obtained higher yields from vegetables rather than cereals (like rice and corn) and fibers (jute) (also found by Ateng, 1998).

On average the yield obtained by the farmers in the study hub regions is higher than the national average. For example, the national cabbage yield is estimated at 17.33 MT/ha (BBS, 2020), while 33.75 MT/ha was recorded by the farmers in our survey. Similarly, national average yield of tomato is 13.73 MT/ha (BBS, 2020) but our surveyed farmers obtained 19.64 MT/ha. We observed some yield variation between participants and non-participants of the hubs, where in most of the cases the participant farmers obtained relatively higher yields than that of non-participant farmers but the differences were mostly statistically insignificant (Table 12).

**Table 12** Information from respondents to our quantitative survey about the average yield (kg/ha) of the selected crops.

| Crops | Average yield kg/ha | | | | National Average kg/ha |
|---|---|---|---|---|---|
| | Non-participant | Participant | Significant difference | All average | |
| Cabbage | 34615 | 32824 | n.s | 33755 | 17339 |
| Cauliflower | 28429 | 29299 | n.s | 28846 | 14081 |
| Tomato | 19020 | 20095 | n.s | 19637 | 13738 |
| Snake gourd | 21494 | 17193 | n.s | 18964 | - |
| Cucumber | 28825 | 11324 | ** | 17850 | 9297 |
| Okra | 24093 | 10937 | ** | 17404 | 4900 |
| Potato | 16848 | 17992 | n.s | 17362 | 22077 |
| Brinjal | 16763 | 16428 | n.s | 16541 | 10740 |
| Bitter gourd | 13892 | 15910 | n.s | 15268 | 5076 |
| Bottle gourd | 15818 | 14452 | n.s | 14921 | - |
| Kakral | 12672 | 13700 | n.s | 13579 | 5728 |
| Country bean | 14712 | 10657 | n.s | 12820 | 9369 |
| Radish | 11768 | 11092 | n.s | 11450 | 11821 |
| Chili | 9516 | 10084 | n.s | 9839 | 2440 |
| Pumpkin | 9382 | 10101 | ** | 9736 | 11327 |
| Corn/maize | 8824 | 9084 | n.s | 8979 | 8015 |
| Ridge gourd | 3180 | 9237 | * | 8371 | 5115 |
| Garlic | 6914 | 9012 | n.s | 8161 | 6499 |
| Amaranth | 7607 | 7527 | n.s | 7568 | 4100 |
| Rice | 5161 | 5891 | n.s | 5511 | 1613 |
| Jute | 3228 | 3144 | n.s | 3172 | 1144 |

*The level of statistically significant difference is based on t-tests. *** Significant at 1% level of significance, ** Significant at 5% level of significance, * Significant at 10% level of significance, ns = not significant.* Note: Shows the average across respondents who participate in the hubs and those who do not (non-participant), as well as the national average.

When we asked survey respondents how their productivity and farm income had changed across time (from 2018 until 2021) most people identified that it had increased. We found that a greater proportion of hub participants said their productivity had greatly increased, whereas a greater proportion of non-participants said their productivity had moderately increased (Table 13). For hub participants this change was attributed to a shift from the use of seeds to the use of seedlings and the fact that they had adopted a new crop or variety (Table 14). For non-participant farmers they have altered their cultivation techniques.

**Table 13** Information from respondents to our quantitative survey about the direction of change in productivity between December 2018 and 2021.

| Direction of Change | Non-participant | Participant | Total |
|---|---|---|---|
| Greatly increased | 15.48 | 27.98 | 21.98 |
| Moderately increased | 78.71 | 67.86 | 73.07 |
| Remained same | 1.94 | 2.98 | 2.48 |
| Moderately decreased | 3.23 | 1.19 | 2.17 |
| Largely decreased | 0.65 | 0 | 0.31 |

Note: Shows the number of respondents who participate in the hubs and those who do not (non-participant).

**Table 14** Information from respondents to our quantitative survey about the reasons behind the change in productivity they observed between December 2018 and 2021.

| | Non-participant | Participant | Total |
|---|---|---|---|
| Adopted new crop and/or variety | 89.68 | 93.45 | 91.64 |
| Change in yield due to change(s) in: | | | |
| Seed/seedling quality | 93.87 | 94.05 | 89.16 |
| Shift from seed to seedlings | 18.06 | 30.95 | 24.77 |
| Fertilizer use | 69.68 | 68.45 | 69.04 |
| Pesticides use | 69.68 | 67.26 | 68.42 |
| Mechanization | 46.45 | 46.43 | 46.44 |
| Cultivation techniques | 65.81 | 55.36 | 60.37 |
| Disease management | 45.81 | 41.07 | 43.34 |

Note: Shows the percentage of respondents who participate in the hubs and those who do not (non-participant).

### 6.3.4 Impact on farm income

The estimated change of farm income per decimal of land between 2018 and 2021 for participants of the hubs was slightly lower, but not significantly different from those of non-participants (participants mean = 372, SD = 784, non-participants mean = 534, SD = 1208, p=0.157). From our survey respondents there were a slightly higher proportion of hub participants in the lowest income bracket/cohort, and the two highest income brackets in 2018. By 2021 a larger proportion of the hub participants had moved to the second income bracket, whilst there had been no shift in the distribution across incomes of the non-participants (Table 15). We attribute the slightly lower incomes of participant farmers to a range of factors, the engagement of younger and therefore more inexperienced farmers in the hubs, and the use of improved inputs such as seedlings which are more costly. However, the return on each crop type was higher for participant farmers, we think because of their ability to sell earlier and therefore garner higher prices (Table 16). Here, Table 16 provides the key cost items in respect to seedling, transaction cost and the price of produces but it does not present a comprehensive cost and return estimation. The transaction cost is estimated by adding transportation cost, labour cost and the fees. Although transaction cost and seedling cost seems higher for participant farmers but the return is estimated higher amount due to higher selling price (Table 16).

**Table 15** Information from respondents to our quantitative survey about their annual farm income in the two time periods (2018 and 2021).

| | Non-participant | Participant | All farmers |
|---|---|---|---|
| **2018** | | | |
| Up to 100,000 | 22.58 | 36.31 | 29.72 |
| 100,001-200,000 | 50.32 | 29.76 | 39.63 |
| 200,001-300,000 | 15.48 | 13.69 | 14.55 |
| 300,001-400,000 | 3.87 | 7.14 | 5.57 |
| 400,000+ | 7.74 | 13.1 | 10.53 |
| Total | 100.00 | 100.00 | 100.00 |
| **2021** | | | |
| Up to 100,000 | 11.61 | 22.02 | 17.03 |
| 100,001-200,000 | 42.58 | 30.95 | 36.53 |
| 200,001-300,000 | 24.52 | 20.24 | 22.29 |
| 300,001-400,000 | 8.39 | 10.71 | 9.6 |
| 400,000+ | 12.9 | 16.07 | 14.55 |
| Total | 100.00 | 100.00 | 100.00 |

Note: Shows the percentage of respondents who participate in the hubs and those who do not (non-participant). Income expressed in Bangladesh Taka (1US$ = 85.12BDT).

**Table 16** Information about per hectare cost and return on major crops included in our survey.

| | Non-participant | Participant | Average |
|---|---|---|---|
| **Tomato** | | | |
| Seeds/seedling cost | 19981 | 31103 | 25689 |
| Transaction cost for the seedling | 373 | 1018 | 696 |
| Product selling cost | 44089 | 54358 | 50293 |
| Price per Kg | 15.86 | 22.29 | 19.74 |
| Return ha | 281680 | 488494 | 406630 |
| **Chilli** | | | |
| Seeds/seedling cost | 21267 | 27288 | 25740 |
| Transaction cost for the seedling | - | 2231 | 2231 |
| Product selling cost | 27995 | 29443 | 28814 |
| Price per Kg | 43 | 41 | 41 |
| Return | 305202 | 388974 | 352620 |
| **Brinjal** | | | |
| Seeds/seedling cost | 24853 | 31667 | 30228 |
| Transaction cost for the seedling | 1868 | 1618 | 1743 |
| Product selling cost | 45866 | 23637 | 30306 |
| Price per Kg | 23 | 29 | 27 |
| Return | 429691 | 412326 | 417535 |
| **Country bean** | | | |
| Seeds/seedling cost | 9025 | 11162 | 10361 |
| Transaction cost for the seedling | 906 | 993 | 950 |
| Product selling cost | 43007 | 42859 | 42949 |
| Price per Kg | 23.45 | 27.33 | 25.0603 |
| Return | 351737 | 439611 | 388098 |
| **Cauliflower** | | | |
| Seeds/seedling cost | 14013 | 21569 | 17521 |
| Transaction cost for the seedling | 828 | 1067 | 948 |
| Product selling cost | 12 | 17 | 14 |
| Price per Kg | 100927.7 | 104857 | 102528 |
| Return | 351297 | 412361 | 377467 |
| **Cucumber** | | | |
| Seeds/seedling cost | 15280 | 18727 | 17086 |
| Transaction cost for the seedling | 1150 | 1248 | 1199 |
| Product selling cost | 20841 | 15983 | 16590 |
| Price per Kg | 7 | 9 | 8 |
| Return | 217132 | 233392 | 225649 |

Note: Shows information from respondents who participate in the hubs and those who do not (non-participant). Income expressed in Bangladesh Taka (1US$ = 85.12BDT).

### 6.3.5 Impact on the environment

The SFSA has a goal for all its projects to use environmentally friendly practices and support a climate smart resilience strategy. We discovered during the expert interviews that during 2013-14 they provided 84,00 soil testing cards or soil health cards to farmers to assist the adoption or trialling of balanced fertilizer applications. There are 81 vermicompost plants (waste recycling using worms) from where compost is produced and utilized by farmers. They ensure judicious use of fertilizer and pesticides. Above all SFSA promotes precision agriculture and tries to avoid any environmentally unfriendly technologies as reported by the SFSA participants. In our quantitative survey we asked both the hub participants and non-participants which “environmentally friendly” practices they had or hadn’t adopted in 2018 and then in 2021. Our definition of adoption was broken down into three

simple categories: complete use of the practices on their farm (adoption), partial use in some way (partial adoption), or no use at all (non-adoption). Not all the 12 practices we asked about have a clear and well documented link with environmental performance (Table 17), and some practices may have limited applicability to certain farming systems. For example, minimal or no pesticide application may not be good practice if you need to till the soil many times to control weeds.

**Table 17** Description of the environmental practices we asked the respondents to our quantitative survey about.

| Name | Description of practice |
|---|---|
| advanced.machinery | The use modern or newer machinery that has improved performance such as power tiller, tractor, combined harvester, and sprayer. |
| balanced.fertilizer | The use of tools and knowledge to apply balanced fertilizer inputs. |
| bird.perching | The establishment of bird roosting areas in or near crop fields. This is for pest management. |
| crop.rotation | The use of crop rotation to improve weed management and soil fertility. Improved crop diversity through rotation across time. |
| min.pesticide | The use of optimal or minimal pesticide applications to control invertebrate pests, weeds and diseases. This involves careful consideration of whether an application is needed (i.e. if significant losses are likely to occur if the pest population is not controlled). |
| mulching | The use of mulching the crop to improve soil fertility. |
| net.house | The building of a net house or shadehouse to control pest issues and minimize the use of pesticides. Not all crops can/should be grown in a net house. |
| pheromone.trap | The use of pheromone traps to attract and kill pest species. Also can be used as an early warning system. |
| residue.retention | Retaining crop residues on the soil surface to maintain soil cover, improve conservation of water in the soil, reduce erosion risk and improve soil health. The reduction in residue burning also improves air quality. |
| waste.disposal | The use of systematic waste disposal systems to avoid contamination of nearby waterways. |
| water.savings | The use of water saving technologies such as pot irrigation, ridge bed system |
| zero.till | The use of minimal or zero-till practices to maintain soil health, improved resilience to climate change impacts, and reductions in greenhouse gas emissions from agriculture. |

The use of advanced machinery had the lowest level of adoption in both 2018 (73% non-adoption by participants, 78% non-adoption by non-participants) and 2021 (69% non-adoption by participants, 76% non-adoption by non-participants), with slightly more non-participants not using this practice at all. The practices that were adopted completely by the most people were the use of balanced fertilizer (2018, 40% participants, 48% non-participants, 2021, 60% participants, 63% non-participants) and minimal pesticide inputs (2018, 41% participants, 49% non-participants, 2021, 58% participants, 59% non-participants) (Fig. 5 and 6). For the minimal pesticide applications there was a difference between the participants and non-participants in terms of the people non-adopting. About 11% more hub participants did not use this practice at all suggesting they might have higher awareness and/or access to pesticides through their hub activities. Many respondents only partially used zero tillage practices (2018, 74% participants, 75% non-participants, 2021, 74% participants, 74% non-participants), and this may reflect that some farming systems are not suited to this practice (Fig. 5 and 6).

Overall, there were not large differences in participants versus non-participants in terms of the type of practices they adopted across this time. To assess the rate of adoption across time, calculated by taking the difference for complete adoption for each group between 2020 and 2018 (Fig. 7, more detailed graphs in Appendix 3), a negative value indicating a reduction in the people's complete adoption, and a positive value indicating an increase. Hub participants showed a greater rate of complete adoption between 2018 and 2021 for minimum pesticide use, advanced machinery,

balanced fertilizer use, and water saving technologies (Fig. 7). Crop rotations and residue retention were also completely adopted by slightly more hub participants. For non-participants the rate of complete adoption across time was greater for the use of net houses, pheromone traps, crop mulching and systematic waste disposal (but see the numbers of people in each category in Appendix 3). Very few respondents identified complete or partial adoption of advanced machinery regardless of whether they were a hub participant.

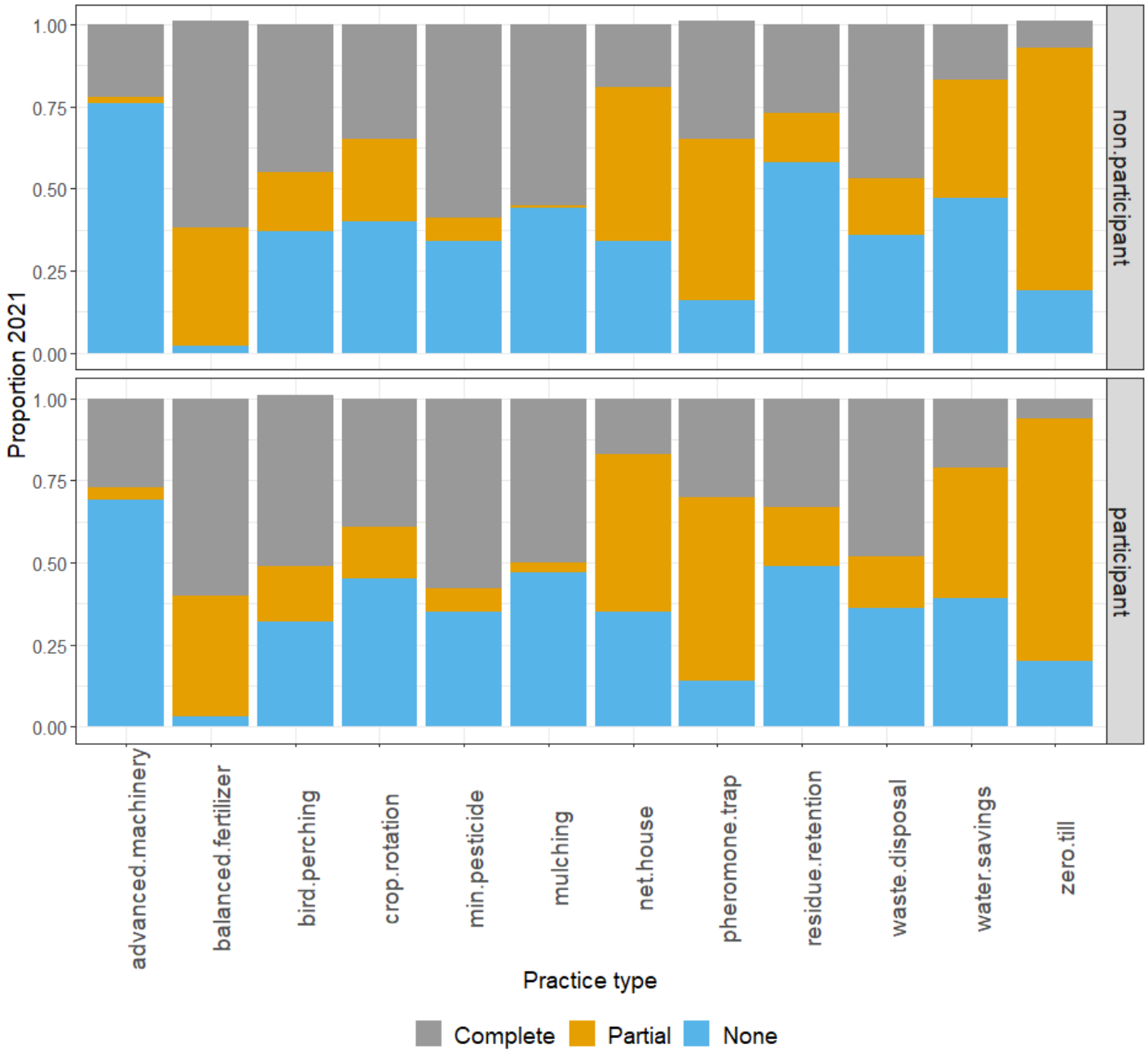



**Figure 5** Information from respondents to our quantitative survey about environmental practices they were using in 2021. They were asked to identify if they completely used this practice, partially used this practice or didn't use the practice at all (non-adoption). Participants of the study hubs are shown on the bottom and non-participants on the top.

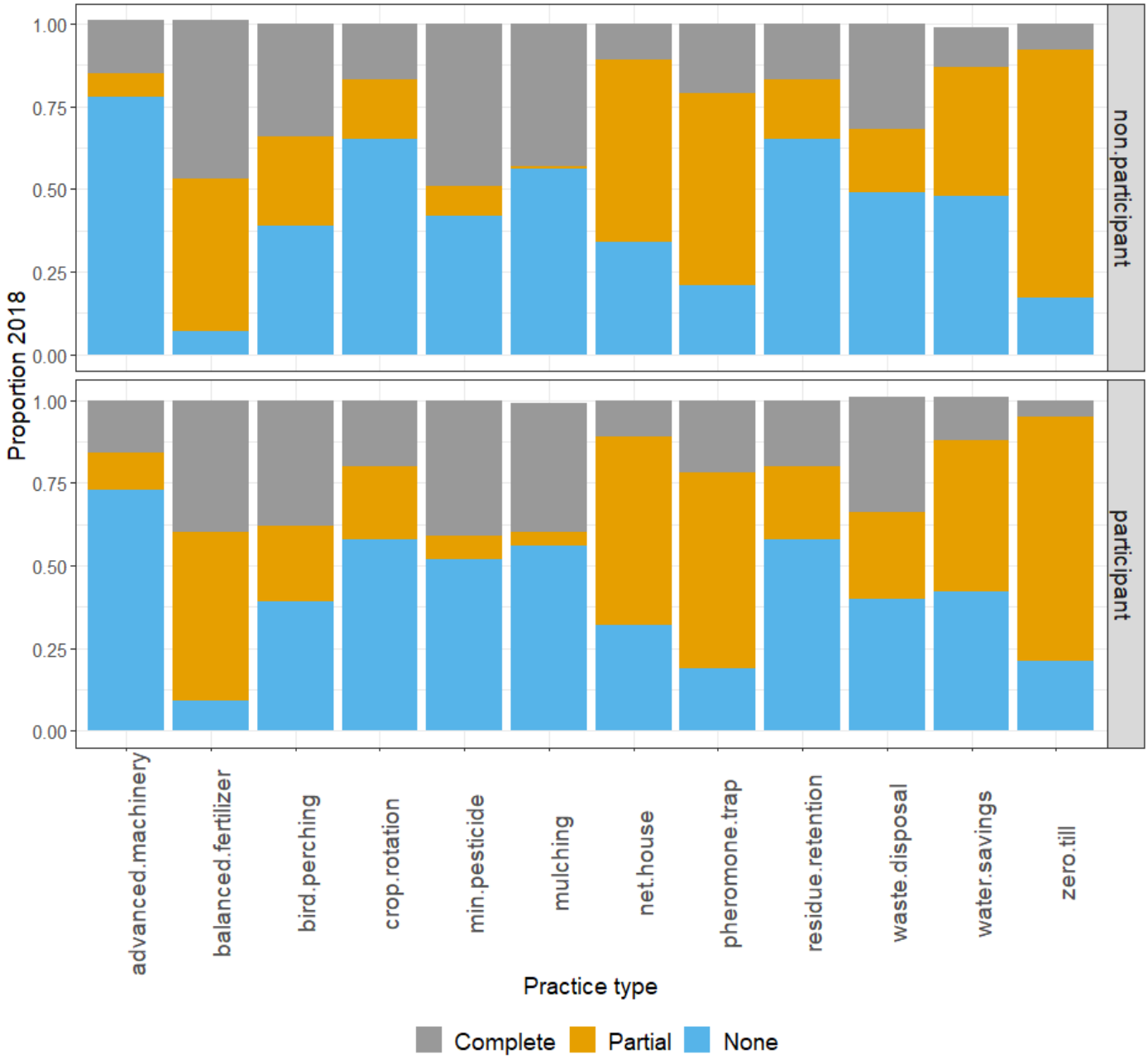



**Figure 6** Information from respondents to our quantitative survey about environmental practices they were using in 2018. They were asked to identify if they completely used this practice, partially used this practice or didn't use the practice at all (None). Participants of the study hubs are shown on the bottom and non-participants on the top.

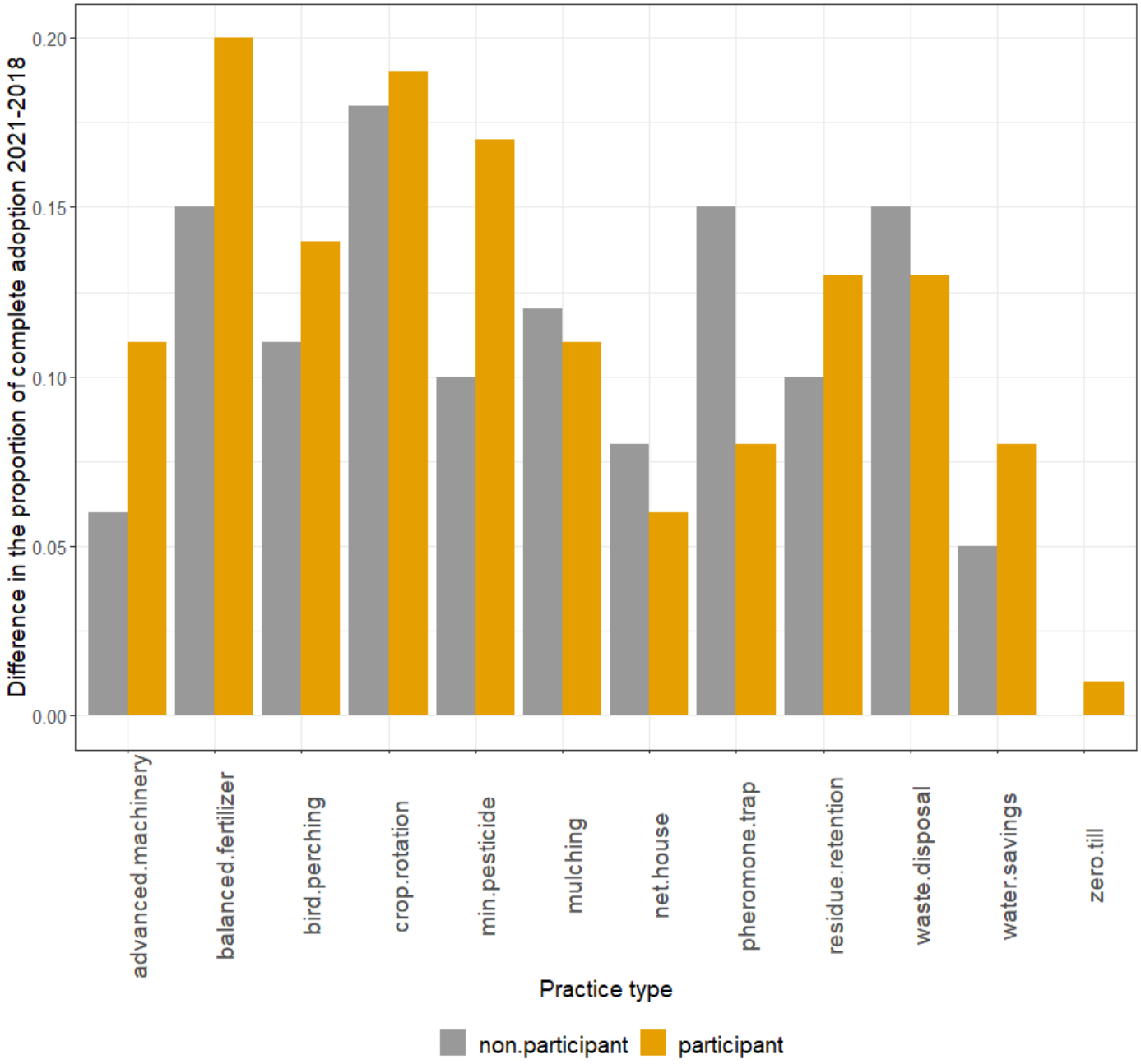



**Figure 7** Information from respondents to our quantitative survey about environmental practices they were using in 2018 versus 2021. Bars show the differences in change across time of those practices that were completely adopted. A positive value indicates that complete adoption increased since 2018, and a negative value indicates a decrease in complete adoption (but no negative values in this data set). Participants of the study hubs are shown in orange and non-participants in grey.

## 6.4 RQ4 What other roles could hubs serve in terms of community service provision?

We asked the respondents to our survey what other roles the Farmers hubs could serve in the future. This was a very broad and open question, and we received a diversity of responses. Therefore, the individual responses have been grouped into broad themes (Table 18). There were some respondents who suggested they could act as a club or training centre for farmers (23%), provide education and library facilities (14%) for children and farmers, and health facilities (14%) such as a community clinic and vaccination centre. A financial support role was mentioned (9%) but this was not limited to loans to support farm businesses, but also resources and funds to help poor members of the community.

During our expert interviews we asked SFSA staff about areas they see for future growth to assist small-holder farmers. They identified that high value crops should be produced at a large scale, concentrated in one area so that crops can be collected in bulk quantities. Quality could be standardised and maintained, and exporting may be possible. Then processing companies could then purchase crops at the large scale they require.

They identified a need for the private sector to become more involved in developing processing facilities in partnership with farmers. They noted that farmers do not get a fair price when bulk handled commodity crops are produced at a large scale. We infer this means a price that is low from their perspective, but still may be a positive return in an economic sense. Therefore, food processing and value addition practices should be started to increase the demand for these raw crops and hopefully improve the price paid to farmers. An online marketing platform may be useful for connecting food processors with farmers at scale. The hubs involved in our study would like to expand their seedling business but feel this needs to be supported by DAE, research organizations and government to achieve this. They also see the need for greater introduction of modern production technologies (e.g. poly-houses or green houses) at the local level to further develop new food sectors.

**Table 18** Information from respondents to our quantitative survey about what other community services the hubs could provide.

| Suggestion | Non-participant | Participant | All farmers |
|---|---|---|---|
| Farmers' club or training | 25.00 | 20.00 | 22.55 |
| Educational facilities | 16.67 | 11.30 | 14.04 |
| Health facilities | 13.33 | 13.91 | 13.62 |
| Financial support | 5.00 | 13.91 | 9.36 |
| Social awareness activities | 8.33 | 10.43 | 9.36 |
| Employment opportunities | 7.50 | 7.83 | 7.66 |
| Flood shelter and other infrastructure | 5.83 | 7.83 | 6.81 |
| Sports & recreation | 3.33 | 3.48 | 3.40 |
| Religious purpose | 2.50 | 3.48 | 2.98 |
| Information center | 2.50 | 0.87 | 1.70 |
| Drinking water source | 0.83 | 1.74 | 1.28 |
| Youth organization | 2.50 | 0.00 | 1.28 |
| Community center | 0.83 | 0.87 | 0.85 |
| Agro processing industry | 0.00 | 0.87 | 0.43 |
| Education for old | 0.83 | 0.00 | 0.43 |
| Machine repairing workshop | 0.83 | 0.00 | 0.43 |
| A marketplace | 0.00 | 0.87 | 0.43 |
| Marriage help | 0.83 | 0.00 | 0.43 |
| Newspaper facilities | 0.00 | 0.87 | 0.43 |
| Organic farm | 0.00 | 0.87 | 0.43 |
| School van | 0.83 | 0.00 | 0.43 |
| Social dispute resolution | 0.83 | 0.00 | 0.43 |
| Solar pump | 0.83 | 0.00 | 0.43 |
| Training center for women entrepreneur | 0.00 | 0.87 | 0.43 |
| Women handicrafts training | 0.83 | 0.00 | 0.43 |
| Percent of respondents | 100.00 | 100.00 | 100.00 |
| Number of respondents | 120 | 115 | 235 |

## 6.5 RQ5 What are the digital tools Hub owners currently use, and what digital tools would they like to use in the future?

SFSA has introduced a digital tool called e-FarmersHub which is a mobile, digital platform, designed to help entrepreneurs keep track of daily transactions while enabling the SFSA to monitor progress in real time (SFSA 2021). It helps to keep their business transaction record and get automated business analytics, inventory, customer, and credit management options. It was observed during the scoping trips that some hub owners also use online platforms like WhatsApp to communicate and carry out transactions among themselves.

In the survey we investigated the role of digital tools for farmers. We used a very broad definition of digital tools in this survey. The term “digital” is well known in Bangladesh as a slogan term. We explained to the survey participants that the definition of “digital tools” we were using for this activity included any sort of electrical device that is not farm machinery (e.g. phones, computers). However, there is still some uncertainty around access to hardware (phones, computers) versus access to software tools like apps or websites relevant to agriculture. When asking about whether respondents had a mobile phone, this could either be a feature phone (with little or no access to internet, but still access to texts, calls, call centres etc.) or a smart phone with potential to access the internet (with android or other operating system).

During the expert interviews we discussed that SFSA provides information through mobile message (SMS) services in Bengali so farmers can get agricultural information, even those who are using a feature phone. They provide an OBD service (voice information service) to farmers which builds the capacity of farmers and provides weather related information. SFSA provides information from their own e-FarmersHub app to other agribusiness companies for use as a decision-making tool. The rationale is that the companies will understand the small-holder farmers' needs better and make useful and affordable products (for which there is already a high demand). The SFSA staff explained that in the future they would like to use digital technology more to provide training to many farmers at a lower cost.

We asked DAE staff and researchers questions about digital tools as part of our expert interviews. They noted that some farmers (the richer ones) do currently access DAE services and information using smartphones and they could use video interactions more. They suggested that the price of digital devices should be reduced so they are more accessible to many farmers. They suggested that greater and better access to appropriate weather information was needed by farmers to protect crops and minimize risk. They suggested that social media platforms like a Facebook group could be used more by the hub to raise awareness of their services and activities. The hubs could also use local cable channels and YouTube to highlight successful farmer stories. This may increase demand from local people to use the hub and enable the hub to digitally connect with new stakeholders.

Many respondents to our quantitative survey used a feature phone in some way (77% of non-participants and 79% of participants, Table 19). The feature phones are used commonly to assist or plan farming activities (71% of both non-participants and participants, Table 20). This could involve calling other farmers for advice, contacting input suppliers, managing machinery hire and service, and talking to experts for advice. There was some access to farmer-relevant call centres that was slightly higher for the hub participants (1% of non-participants and 3% participants, Table 20). The use of mobile phone apps (probably via a smartphone) was low (3% of both non-participants and participants, Table 20), however the respondents did say that in the future they would like to use apps relevant to agriculture more (12% of non-participants and 13% participants, Table 21). In the future some respondents identified a desire to access smart phones more (38% of non-participants and 35% participants, Table 21) and greater use of computers to access digital tools (9% of non-participants and 10% participants, Table 21). There are still relatively large numbers of respondents who did not use digital tools at all (21% of non-participants and 20% participants, Table 20), and where unsure about how they could use them to their advantage in the future (31% of non-participants and 29% participants, Table 21). However, this result is not unusual in the context of Bangladesh.

**Table 19** Information from respondents to our quantitative survey about the type of mobile phone the respondents use.

| | Non-Participant | Participant | All Farmers |
|---|---|---|---|
| Feature phone | 76.77 | 79.17 | 78.02 |
| Smart phone | 23.23 | 20.83 | 21.98 |
| Total | 100.00 | 100.00 | 100.00 |

Note: The percentage of respondents who participate in the hubs and those who do not (non-participant) are shown.

**Table 20** Information from respondents to our quantitative survey about what digital tools the respondent currently uses in farming. The percentage of respondents who participate in the hubs and those who do not (non-participant) are shown.

| | Non-Participant | Participant | All Farmers |
|---|---|---|---|
| Mobile phone | 70.97 | 70.84 | 70.90 |
| Mobile apps | 2.58 | 2.98 | 2.79 |
| Call centers | 1.29 | 2.98 | 2.17 |
| Multiple responses* | 1.94 | 2.39 | 2.17 |
| Social media | 0.65 | 0.60 | 0.62 |
| None | 22.58 | 20.24 | 21.36 |
| Total | 100.00 | 100.00 | 100.00 |

Note: The percentage of respondents who participate in the hubs and those who do not (non-participant) are shown. *The multiple responses included mobile phones, mobile apps, social media, call centers, etc.

**Table 21** Information from respondents to our quantitative survey about what digital tools the respondent would like to use in the future.

| | Non-Participant | Participant | All Farmers |
|---|---|---|---|
| Smart phone | 38.07 | 35.13 | 36.54 |
| Apps useful for agriculture | 12.26 | 13.10 | 12.69 |
| Computer | 9.04 | 10.12 | 9.60 |
| Mobile phone | 5.81 | 8.93 | 7.43 |
| Internet facilities | 2.58 | 1.79 | 2.17 |
| Cell centers | 0.00 | 0.60 | 0.31 |
| Digital agricultural tools | 1.29 | 1.20 | 1.24 |
| None/don't know | 30.97 | 29.17 | 30.03 |

Note: The percentage of respondents who participate in the hubs and those who do not (non-participant) are shown.

# 7 Impacts

## 7.1 Scientific impacts – now and in 5 years

There is a gap in knowledge in the scientific literature around the optimization of scaling out of agricultural technology and practice change in the context of Bangladesh small-holder farmers. Whilst there are many NGOs, development organisations extension staff focussed on the roll-out of certain practices, comprehensive analyses of what is the best strategy to achieve the desired outcomes in lacking. Our research partially fills this gap by focussing on one initiative, SFSA farmers hubs. Whilst the qualitative and quantitative data we have collected was limited by restrictions placed on us due to the COVID-19 pandemic we still think we have the foundation of a useful scientific paper. Our goal is to see this published as soon as possible.

## 7.2 Capacity impacts – now and in 5 years

Throughout the course of this project, we have been building capacity in local researchers to contribute to the data gathering process. We trained a group of eight enumerators of which seven were used in the data gathering exercises. This has built capacity at BAU to do similar social science studies in the future, and hopefully inspired some of the enumerators to consider a career in scientific research. For the CSIRO Agroecology team, we now have access to socio-economic expertise that despite being based in Bangladesh, may still prove useful for our Australian projects in the future. We have established a good working relationship between BAU and CSIRO that we intend to build on in the future if opportunities for future projects arise. As we see the lessening of travel restrictions in the next few years this may involve short visits or opportunities for PhD or postdoctoral students to take up opportunities at each organisation.

The activities on this project have strengthened the relationship between SFSA, DAE and the BAU staff. Hopefully this will provide opportunities to conduct more research projects in the future.

## 7.3 Community impacts – now and in 5 years

### 7.3.1 Economic impacts

The shift from low input farming practices, that are simplified, to practices that require purchasing of inputs and considerable knowledge, tools, and services to implement successfully is challenging for many farmers. We saw that the shift from the use of seeds to seedlings and greater emphasis on crop type and variety increased productivity of farmers, but also came with some risks. However, given the low returns provided by more traditional rice/wheat systems in the EGP, there is a greater push towards more high value crops, such as vegetable seedlings. Whilst the production side of this problem is well established the aggregation and selling of large amounts of high-quality vegetables has not yet been achieved. The full economic benefits of this shift will not be realized until other parts of the value chain are developed in Bangladesh (e.g. we heard about the development of processing facilities from the people we spoke with).

### 7.3.2 Social impacts

We explored how the hubs could be used more in the future to deliver services to small-holder farming communities. The survey respondents identified several activities that could be implemented in the short-term, but we did not explore who would pay to support these activities (given these are commercial businesses run by an entrepreneur). We did observe that the farmers hubs engaged younger farmers and supported them to trial and adopt new practices. Capacity building of younger farmers and agri-business owners can have several flow-on benefits to local communities and help to retain a skilled workforce in rural areas. Given the recent migration back to rural areas (because of COVID-19 pandemic impacts) maintaining and building new employment opportunities in rural areas is critical for wellbeing and household food security.

### 7.3.3 Environmental impacts

Our quantitative survey provided some information about the type and rate of adoption of practices that have some (usually positive) environmental impacts. There may be a greater recognition of the importance of these practices at larger geographic scales, and potentially adoption by non-hub participants at similar rates. If this diffusion of practice-change does occur the resulting environmental benefits could be large.

## 7.4 Communication and dissemination activities

We have not yet completed all the communication activities we would like. We participated in the SDIP final review meeting and provided a presentation as part of that meeting. We are planning to convene an online meeting to inform SFSA about our findings and recommendations in late 2021. We would also like to invite the DAE staff who might be able to access the online meeting format.

We plan to develop a one-page summary document that can be translated into Bengali and disseminated via email. This might also be useful for the hub owners who participated in the study. We would like to work with local students/journalists to see if we can get an article published in a local paper that may be read by the people in each region.

Currently we are not planning a face-to-face workshop (as we had anticipated at the start of the project) due to the COVID-19 risks and travel restrictions, but we are hopeful we can still communicate our findings through these other mechanisms.

# 8 Conclusions and recommendations

## 8.1 Conclusions

The hub initiative, as it has been established by SFSA in Bangladesh, does offer some advantages to network managers, hub owners and participating farmers. The hubs play an important role in innovation and local adaption of agricultural technology and practice change information. The most common service provided by the six study hubs in our study was the selling of vegetable seedlings. This involved the development and use of the coco-peat media in seedling trays and the use of crop types and varieties that had been trailed by the SFSA research team and were optimized for local conditions. This seedling technology and practice information provides farmers with a much earlier harvest for some crops and can lead to a price advantage at the time of sale. However, not all farmers purchase seedlings through the hub alone as the price of these is high relative to other sources or the use of farmer-saved seeds. In addition to the access to important inputs related to farm production, access to information about farm practices is also important for improving productivity. For hub participants some information across all information types was provided by the hub, but the choice of which variety to use, the crop type choice, pesticide use advice and fertilizer use advice were the most identified by hub participants.

Hub owners and network managers act as aggregators of produce from many farmers, and this does enable access to distant markets at a good price (the price may be less through the services of a middleman). Buying selling was reported by SFSA as one of the major sources of income by the hubs. However, not every participant farmer gets benefit from this service. For example, in our survey only one sample hub deals with buying of farm produce at a significant amount and 27.5% of vegetable output of participant farmers were sold through that hub. Selling through the hub offers potential advantages through reduced transportation cost, lower perishability, and handling. Marketing costs and post-harvesting costs are lower, and crops are accurately weighted at the hub, therefore profit margins should be higher for the same sale price.

All respondents to our survey were able to increase their productivity over the short time frame we examined (2018-2021). A greater proportion of hub participants said their productivity had greatly increased, whereas non-participants said their productivity had moderately increased. For hub participants this change was attributed to a shift from the use of seeds to the use of seedlings and the fact that they had adopted a new crop or variety. The shift to seedlings does incur greater production costs and so carries some risks, however some farmers received higher prices for their vegetables because they could sell them earlier. Given the relatively young age of the farmers who are participants of the hub this is a big change to their farming systems and demonstrates one of the harder to measure aspects of participation in hubs (or other collective groups), that is the de-risking of practice change through support and knowledge. In this context the hub acts as an enabler for practice change for some farmers who may struggle to make such a change of their own volition through conducting their own trials and research.

Hub participants showed a greater rate of complete and partial adoption of many practices that may be beneficial for the environment relative to non-participants. Between 2018 and 2021 they showed a greater rate of complete adoption of minimum pesticide use, advanced machinery, balanced fertilizer use, water saving technologies, crop rotations and residue retention.

The hubs have not been successful in engaging women entrepreneurs to lead hub activities and we had few women respondents included in our quantitative survey (both hub participants and non-participants). This limits the conclusions we can draw. The hubs have been successful at attracting young entrepreneurs and developing their capacity to lead a farm business, and there are employment opportunities created for women labourers as part of the coco-peat processing activities of the hub.

The hubs have developed mechanisms through which farmers are connected to agricultural researchers at the R&D, public research stations within Bangladesh, and researchers from other countries through the SFSA global research platform. However, the SFSA R&D centre does not have the capacity or mandate to develop new varieties or produce new technologies, since they do not have the laboratories to conduct such research activities. Their role is to optimize the existing technologies and assess crop varieties for the local environment (through the trials) for the benefit of the hub participants.

There were large numbers of respondents to our survey who did not use digital tools at all and were unsure about how they could use them to their advantage in the future to improve their agricultural practices. This result is not unusual in the context of farmers in Bangladesh. Many people currently use a feature phone in some way to assist or plan farming activities. This could involve calling other farmers for advice, contacting input suppliers, managing machinery hire and service, and talking to experts for advice. The use of mobile phone apps (via a smartphone) is currently low; however, the respondents did say that in the future they would like to use apps relevant to agriculture more. There was a desire to access smart phones more in the future and to use computers to access digital tools, however this may be many years away for most farmers.

## 8.2 Recommendations

Given the limited nature of this study we have grouped our recommendations into those for SFSA, those for SDIP, and those for ACIAR in terms of identifying areas where further research is required.

**Recommendations for SFSA**

This was a short and limited study, that only focused on six hubs in two regions. Therefore, the conclusions we draw, and the recommendations we make, may not be appropriate for all the hubs across Bangladesh. A future study involving a larger sample of hubs may provide additional insights, especially in relation to services not commonly provided at the six sample hubs in this study. Furthermore, the hub model is being used in other countries and our quantitative approach could be replicated to compare what is happening across countries.

We identified that the hubs already play an important role in the trialling of crop varieties so they are optimized for the local environment. This serves to reduce the risk of adoption of seedlings by farmers who are trialling this practice change, as they are costly to buy, and failure may lead to dis-adoption. This is a critical step in the innovation system that is not always present for all practice change or technology. The hubs could have a greater emphasis on this process for a diversity of services they provide (i.e., not just seedlings), and there may be some benefits to expanding this to machinery services.

To assist in this process there should be more connection and collaboration between the hubs and DAE in the future. Currently there are informal interactions but there may be benefits to making this relationship more formal (through institutional linkages). The people we interviewed suggested staff sitting together to plan to grow crops that have higher market demand and price for the farmer. SFSA and DAE could organize seminars and workshops together. As a result, DAE staff will understand the hub activities and can inform other farmers and stakeholders. The hub farmers could be given opportunities to make field visits directly to DAE research field trials and relevant stations so that DAE staff can also be called upon to assist with solving problems the farmers face.

The hubs involved in our study would like to expand their seedling business but feel this needs to be supported by DAE, research organizations and government to achieve this. They also see the need for greater introduction of modern production technologies (e.g., poly-houses or green houses) at the local level to further develop new food sectors. The economic sustainability of hubs across time (especially after initial project investment is reduced) was not a part of our current study. However, the broader question of what economic sustainability for private businesses means in the context of smallholder farming communities in Bangladesh is of interest to this team. Given the diversity of links between different mechanisms for scaling identified in Table 1, and the degree of change across time seen in this space this question has great practical relevance.

There was some discussion about the aggregation of production and selling of high value crops through the hubs. In theory, high value crops should be produced at a large scale, concentrated in one geographic area, so that crops can be collected in bulk quantities. Quality could be standardised and maintained, and therefore exporting may be possible. This may encourage the engagement by processing companies who require large volumes of standardised crops. The people we spoke to identify a need for the private sector to become more involved in developing processing facilities in partnership with farmers. They noted that farmers currently do not get a fair price when bulk handled commodity crops are produced at a large scale. Therefore, food processing and value addition practices should be started to increase the demand for these raw crops and hopefully improve the price paid to farmers. As a first step towards this longer-term goal the hubs could focus on further promoting the aggregation of production and purchase of the crops by the hubs to be sold. There is a need to examine the costs and benefits of this approach to different stakeholders at a pilot scale as it may be risky for hub owners.

There was a desire to increase the machinery services provided by the hubs. Hub participants accessed some machinery services from the hub, such as power sprayers, mechanical weeders, and seedling transplanters, but they also used machinery provided by local traders and other farmers and own some machinery themselves. When asked about the adoption of advanced machinery in relation to environmental impacts a large proportion of respondents (~75%) had not adopted any. Research to determine what are the most appropriate machinery items for tasks associated with vegetable production, and how these can be integrated into local farming systems with benefits for men and women farmers is warranted. An assessment of government initiatives to encourage the adoption of farm machinery (via subsidies) may also identify areas of likely benefit.

**Recommendations for SDIP**

The work to date on scaling in the Northwest region of Bangladesh (and further into the EGP) has focussed on the adoption process related to Conservation Agriculture Sustainable Intensification (CASI). Some of the practices and machinery used in CASI will not be relevant into the small vegetable producers that were common in the study hubs we examined. However, the process of adoption and dis-adoption and the frameworks established for CASI can be usefully applied here. We would like to synthesize the learnings from the Innovation Platforms established in Bangladesh as part of SRSFI (Brown et al. 2020, 2021) and see how they relate to our study.

**Recommendations for ACIAR (future research)**

Given the low number of respondents to our survey that were women farmers, and the low engagement by women as hub owners we can't make clear recommendations in this area. The SFSA could support further research to find out more about the desire by the women labourers for training and career development, but they should not ignore practical suggestions such as increases in their hourly or daily wage (to match the wages offered by non-farm industries). In terms of understanding more about the barriers to entry for women entrepreneurs as hub owners, engagement with a group specializing in women's empowerment in agriculture might prove useful. Diversifying hub activities to include those farming tasks that are the responsibility of women in the households would be one way to engage women, but not the only way. For example, the Nutrient Management for diversified cropping in Bangladesh project had a small activity on training women farmers to conduct soil testing services. Asking the broader question about how hubs or other activities can create alternative livelihood options that have strong uptake and involvement by women farmers may be one way to address this knowledge gap.

Further research on vegetable value chain development in the Northwest of Bangladesh may provide insights into how higher-value agri-food systems can be implemented from aggregated products. Consistency in quality and quantity of product has already been identified as a barrier, but the hub owners and network managers expressed ideas about how this could be addressed. No doubt there are many barriers to processing and value chain development that need to be overcome, but what would be some of the ways to engage multiple stakeholders (including people

who aggregate products) in this process? The intersection between the use of digital tools to facilitate product aggregation and sale at a price high enough to provide equitable outcomes for all stakeholders is a one area that requires further research.

Our research work identified a desire by farmers, hub owners and network managers to use digital tools more for agricultural practice change in the future, but clear directions for this work are not obvious. We know that there are many training courses, information portals and field guides already digitally available (e.g. the DAE website). The barrier is not around content development but more in the accessibility and use of these tools in daily decision-making. Therefore, research into ways to optimise information sharing via hubs should be explored. Additional collaboration between DAE and the NARS that links digitally through to the hubs is one option to consider. Research to pilot how this might be implemented and who would access the information is required. Linking this information access to the future development of insurance products may be one way to test this with certain farmers in the near term.

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# 10 Appendixes

## Appendix 1: Copy of the quantitative survey questionnaire

**FARMERS' HUBS AS A VEHICLE TO DELIVER SOLUTIONS AND SERVICES TO FARMING COMMUNITIES**

**Survey Questionnaire**

Sample No.

a. Name of Field Enumerator: b. Date

c. Study Hub: Som Tudu Farmers' Hub/Joshai More Farmers' Hub/Dighir Par Farmers' Hub/Hub A/Hub B/Hub C/Other (specify)

d. Village:

e. Farmer Type:

| ☐Participant | ☐Non-participant |
|---|---|

**Demographics and Socio-economic Profile**

1. Farmer's Name: 2. Age

3. Farmer's Mobile Number: 4. Sex:

5. Highest educational qualification (year):

6. Occupation: a. Primary b. Other/secondary

7. Number of family members: Total Male: Female Earning:

Family members involved with farming: Total: Male: Female:

Youth family members involved with farming:

8. a) Cultivable land size

| Land Type | Decimal | | Decimal | | Decimal |
|---|---|---|---|---|---|
| a. Self-Owned | | b. Rented/leased out | | c. Rented/leased in | |

b) How many plots (pieces of land) have you cultivated during the last year?:

Crop cultivation data from all plots of the farmer:

| Plot | Area (decimals) | Name of Crop per Season* | | |
|---|---|---|---|---|
| | | Rabi | Kharif 1 | Kharif 2 |

| | | | | |
|---|---|---|---|---|
| 1 | | | | |
| 2 | | | | |
| 3 | | | | |
| 4 | | | | |
| 5 | | | | |

*Crop names: Cauliflower, Cabbage, Country Bean, Tomato, Bottle Gourd, Sweet Gourd, Ash Gourd, Bitter Gourd, Ridge Gourd, Pointed Gourd, Snack Gourd, Cucumber, Chilli, Brinjal, Okra, Potato, Papaya, Guava, Mango, Rice, Wheat, Corn, Other (specify), Fallow.

9. What is your estimated annual household income (in BDT)?

| Income Source | At present | At December 2018 |
|---|---|---|
| Staple Crops (specify) | | |
| | | |
| | | |
| Vegetables or Fruits (specify) | | |
| | | |
| | | |
| | | |
| | | |
| Livestock and/or poultry | | |
| Fisheries | | |
| Other farming (specify) | | |
| Total Farm | | |
| Salary | | |
| Wages | | |
| Agricultural commodity trading | | |

| | | |
|---|---|---|
| Agricultural input trading | | |
| Farm machineries rental | | |
| Other business | | |
| Remittances | | |
| Total Non-farm | | |
| Total | | |

10. What is your current annual household expenditure (in BDT)?

| |
|---|
| |

11. How much was the expenditure in last one year (in BDT) for the following categories and what has been the level of changes compared to 2018?

| Item | At present | Change compared to 2018 |
|---|---|---|
| Food | | |
| Education | | |
| Healthcare services | | |
| Housing | | |
| Durable assets | | |
| Others | | |

Code: Greatly increased = 5; Moderately increased = 3; Remained same = 3; Moderately decreased = 2; Largely decreased = 1.

12. What is/are the reason(s) for your change in farm productivity and profitability (if any) between December 2018 and now?

| | Productivity | Profitability |
|---|---|---|
| Direction of change* | | |
| Reasons | | - |

| | | | | |
|---|---|---|---|---|
| | Adopted new crop and/or variety | | | - |
| | Change in yield due to change in: | | | - |
| | | Type of crop | | - |
| | | Seed/seedling quality | | - |
| | | Shift from seed to seedlings | | - |
| | | Fertilizer use | | - |
| | | Pesticides use | | - |
| | | Mechanization | | - |
| | | Cultivation techniques | | - |
| | | Disease management | | - |
| | Change in parameter due to change in access to information regarding: | | | |
| | | Weather | | - |
| | | Cropping practices | | - |
| | | Disease management | | - |
| | Change in value/price due to change in | | | |
| | | Input prices | - | |
| | | Output prices | - | |
| | | Transportation | - | |
| | | Storage | - | |
| | | Market access | - | |
| | | Market information | - | |

| | | | | |
|---|---|---|---|---|
| | | Post-harvest handling (washing/packaging/grading etc.) | - | |
| | | Contracts | - | |
| | Covid-19 | | | |

*Indicate: Greatly increased = 5; Moderately increased = 3; Remained same = 3; Moderately decreased = 2; Largely decreased = 1

13. From which source(s) did you receive information or advice on the following aspects?

| Information about | Family and friends | Other /peer farmers | Seller/ Trader | Extension agent | Farmers hub | Media | Other sources (specify) | None |
|---|---|---|---|---|---|---|---|---|
| Weather | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | | ☐ |
| Choice of crop | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | | ☐ |
| Choice of variety | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | | ☐ |
| Cultivation technique | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | | ☐ |
| Fertilizer use | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | | ☐ |
| Pesticide use | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | | ☐ |
| Disease/pest control | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | | ☐ |
| Machinery use | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | | ☐ |
| Harvesting techniques | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | | ☐ |
| Post-Harvest handling techniques | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | | ☐ |
| Market prices, demand and supply of product | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | | ☐ |

14. Sources of inputs and services and levels of satisfaction from each source.

| | Seeds or seedlings | | Farm machineries | |
|---|---|---|---|---|
| Seller/Provider | % of Input | Satisfaction | % of Input | Satisfaction |
| Self-produced/owned | | | | |
| From retailers/rental in local market | | | | |

| | | | | |
|---|---|---|---|---|
| From retailers/rental in distant market | | | | |
| Through farmers' hub | | | | |
| From company representatives | | | | |
| From government sources | | | | |
| From other/peer farmers | | | | |
| Other sources | | | | |

*Satisfaction code: 1 = Very Satisfied, 2= Satisfied, 3= Neutral/Don't know/use, 4 = Dissatisfied, 5= Very Dissatisfied

15. What proportion do you consume or to whom do you sell your outputs/produces? Mention the % of sales and level of satisfaction.

| Buyer | Major crops/cereals | | Vegetables | | Fruits | |
|---|---|---|---|---|---|---|
| | % of output | Satisfaction | % of output | Satisfaction | % of output | Satisfaction |
| Self-consumption | | | | | | |
| Local consumer/market | | | | | | |
| Middlemen/retailer who sell in local market | | | | | | |
| Middlemen/retailer who sell in distant market | | | | | | |
| Other farmers | | | | | | |
| Farmers' Hub | | | | | | |
| Other buyers | | | | | | |

*Satisfaction code: 1 = Very Satisfied, 2= Satisfied, 3= Neutral/Don't know/use, 4 = Dissatisfied, 5= Very Dissatisfied

16. How many years have you been associated with the Farmers' Hub?: ☐

17. What is the distance of your household to the nearest Farmers' Hub in km?: ☐

18. Question for participant farmer: Do you know what services the Farmers' Hub is offering, which one of them are you currently using and what is your level of satisfaction?

| Services | Do you know? | Do you use? | Satisfaction |
|---|---|---|---|

| | | | | |
|---|---|---|---|---|
| Access to improved seeds/seedlings | | ☐ | ☐ | |
| Access to improved agro technologies | | | | |
| | Combine Harvester | ☐ | ☐ | |
| | Potato planter | ☐ | ☐ | |
| | Harvester and grader | ☐ | ☐ | |
| | Powered sprayer | ☐ | ☐ | |
| | Seedling trans-planter | ☐ | ☐ | |
| | Weeder | ☐ | ☐ | |
| | Two wheel tractor | ☐ | ☐ | |
| | Other (specify) | ☐ | ☐ | |
| Access to agro support services | | | | |
| | Plastic crates | ☐ | ☐ | |
| | Three wheeler vans for transportation | ☐ | ☐ | |
| | Washing/grading/sorting facilities | ☐ | ☐ | |
| | Preserving/packaging facilities | ☐ | ☐ | |
| | Weighing machine | ☐ | ☐ | |
| Access to better and convenient backward and forward linkages/marketplace (multiple traders of inputs and outputs) | | ☐ | ☐ | |
| Training on selling and marketing techniques | | ☐ | ☐ | |
| Crop insurance | | ☐ | ☐ | |
| Others (specify) | | ☐ | ☐ | |
| | | ☐ | ☐ | |

*Satisfaction code: 1 = Very Satisfied, 2= Satisfied, 3= Neutral/Don’t know/use, 4 = Dissatisfied, 5= Very Dissatisfied

To what extent are you satisfied with the professionalism of the hub owner?: [Satisfaction code]

19. Question for non-participant farmer: How much are you satisfied with the services provided by the service providers in the market?

| Services | | Type of provider | Satisfaction |
|---|---|---|---|
| Access to improved agro technologies | | | |
| | Combine Harvester | | |
| | Potato planter | | |
| | Harvester and grader | | |
| | Powered sprayer | | |
| | Seedling trans-planter | | |
| | Weeder | | |
| | Two wheel tractor | | |
| | Other (specify) | | |
| Access to agro support services | | | |
| | Plastic crates | | |
| | Three wheeler vans for transportation | | |
| | Washing/grading/sorting facilities | | |
| | Preserving/packaging facilities | | |
| | Weighing machine | | |
| Access to better and convenient backward and forward linkages/marketplace (multiple traders of inputs and outputs) | | | |
| Access to agro based information | | | |
| | Weather | | |
| | Choice of crop | | |
| | Choice of variety | | |
| | Cultivation technique | | |
| | Fertilizer use | | |
| | Pesticide use | | |

| | | | |
|---|---|---|---|
| | Disease/pest control | | |
| | Machinery use | | |
| | Harvesting techniques | | |
| | Post-Harvest handling techniques | | |
| | Market prices, demand and supply of product | | |
| Training on selling and marketing techniques | | | |
| Others (specify) | | | |
| | | | |

*Satisfaction code: 1 = Very Satisfied, 2= Satisfied, 3= Neutral/Don't know/use, 4 = Dissatisfied, 5= Very Dissatisfied

**Type code: 1 = DAE, 2= Input dealer, 3=Retail shop, 4=Family and friends, 5= Other farmers, 6= Media, 7= Others (pls specify), 9= None.

20. Cost of transactions during the last year for two main vegetables/ crops (BDT)

First Vegetable/Crop name:

| | Unit | Price | Transaction Cost | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | | | Farm-gate | Farmers' Hub | | | Other (specify) | | |
| | | | | Trans | Lab | Fees | Trans | Lab | Fees |
| Buying/renting | | | | | | | | | |
| Seeds or seedlings | | | | | | | | | |
| Farm machinery (specify) | | | | | | | | | |
| | | | | | | | | | |
| Selling | | | | | | | | | |

Second Vegetable/Crop name

| | Unit | Price | Transaction Cost | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | | | Farm-gate | Farmers' Hub | | | Other (specify) | | |
| | | | | Trans | Lab | Fees | Trans | Lab | Fees |
| Buying/renting | | | | | | | | | |

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| Seeds or seedlings | | | | | | | | | |
| Farm machinery (specify) | | | | | | | | | |
| | | | | | | | | | |
| Selling | | | | | | | | | |

21. Have you attended any capacity building events (training/discussion/meeting/farm visit/demonstration plot) organized by the Farmers' Hub in the last three years?

| | |
|---|---|
| ☐Yes | ☐No |

22. If answer to the previous question is yes, then how much are you satisfied with those events?

| Name of the event | Level of satisfaction* |
|---|---|
| Training | |
| Discussion/Meeting | |
| Farm Visit | |
| Demonstration Plot | |
| Other (specify) | |

*1 = Very Satisfied, 2= Satisfied, 3= Neutral/Don't know/use, 4 = Dissatisfied, 5= Very Dissatisfied

23. Do you require capacity building activities on anything else other than the above mentioned ones? Please tell us only one thing that you think you need to be trained on.

| |
|---|
| |

24. What digital tools (mobile phones, call centers, social media, apps) do you currently use in farming?

| |
|---|
| |

What type of phone do you use?: ☐ Smart phone ☐ Feature phone

25. What digital tools would you like to use in the future?

| |
|---|
| |

26. Changes in farming practices that affect the environment

| Name of Practice | At December 2018 | At present |
|---|---|---|
| Balanced fertilizer application | | |
| Minimum/optimum pesticide application | | |
| Bird perching | | |
| Advanced machinery use | | |
| Minimum or zero tillage | | |
| Water saving technologies | | |
| Systematic waste disposal | | |
| Residual retention | | |
| Crop rotation | | |
| Mulching | | |
| Net house | | |
| Pheromone trap | | |

Code: Partially practice =1; Completely practice=2; Don’t practice =0

27. Changes in social standing (affiliations with different organizations)

| | | At present | At December 2018 |
|---|---|---|---|
| Leadership in | | | |
| | Local government | ☐ | ☐ |
| | Political body | ☐ | ☐ |
| | Religious body | ☐ | ☐ |

| | | | |
|---|---|---|---|
| | Cooperatives/Collectives or savings groups | ☐ | ☐ |
| | Other organization (specify) | ☐ | ☐ |
| Membership in | | | |
| | Political body | ☐ | ☐ |
| | Religious body | ☐ | ☐ |
| | Cooperatives/Collectives or savings groups | ☐ | ☐ |
| | Other organization (specify) | ☐ | ☐ |

Thank you for your valuable time.

# Appendix 2: Sources of agricultural information accessed by respondents to our quantitative survey

Percentage of All Farmers

| information about | none | family and friends | other /peer farmers | seller/ trader | extension agent | farmers hub | media | other sources |
|---|---|---|---|---|---|---|---|---|
| Weather | 10.84 | 55.42 | 38.39 | 12.69 | 13.93 | 13.93 | 61.61 | 8.98 |
| Choice of crop | 2.17 | 76.16 | 62.85 | 34.98 | 35.29 | 35.91 | 5.26 | 4.02 |
| Choice of variety | 1.24 | 71.21 | 64.40 | 42.41 | 37.46 | 40.25 | 3.41 | 1.86 |
| Cultivation technique | 5.26 | 75.85 | 56.04 | 22.29 | 35.60 | 29.41 | 4.33 | 2.79 |
| Fertilizer use | 2.17 | 70.28 | 43.65 | 76.47 | 37.46 | 30.65 | 2.79 | 4.64 |
| Pesticide use | 0.62 | 66.56 | 43.96 | 81.42 | 40.87 | 31.89 | 1.86 | 2.48 |
| Disease/pest control | 2.48 | 65.94 | 53.56 | 59.75 | 43.34 | 29.10 | 3.72 | 2.48 |
| Machinery use | 6.50 | 73.07 | 61.61 | 19.50 | 27.86 | 25.70 | 2.48 | 0.93 |
| Harvesting techniques | 6.50 | 82.04 | 47.99 | 12.38 | 22.29 | 18.58 | 2.17 | 0.93 |
| Post-Harvest handling techniques | 7.74 | 81.11 | 44.27 | 10.84 | 21.36 | 14.86 | 1.55 | 0.31 |
| Market prices, demand and supply of product | 2.48 | 65.63 | 50.77 | 36.53 | 15.48 | 22.91 | 6.81 | 7.74 |

Percentage of non-participant Farmers

| Information about | none | family and friends | other /peer farmers | seller/ trader | extension agent | farmers hub | media | other sources |
|---|---|---|---|---|---|---|---|---|
| Weather | 9.68 | 56.77 | 43.87 | 11.61 | 13.55 | 0 | 64.52 | 11.61 |
| Choice of crop | 1.29 | 80.65 | 70.97 | 32.90 | 45.16 | 0 | 4.52 | 3.23 |
| Choice of variety | 1.29 | 75.48 | 67.10 | 43.87 | 47.74 | 0 | 1.94 | 1.29 |
| Cultivation technique | 6.45 | 76.13 | 59.35 | 24.52 | 43.87 | 0 | 5.16 | 3.23 |
| Fertilizer use | 2.58 | 70.32 | 47.10 | 80.00 | 46.45 | 0 | 3.23 | 5.16 |
| Pesticide use | 1.29 | 67.74 | 43.23 | 83.23 | 50.97 | 0 | 3.23 | 1.29 |
| Disease/pest control | 3.87 | 67.74 | 55.48 | 60.65 | 49.68 | 0 | 5.16 | 1.29 |
| Machinery use | 9.03 | 70.97 | 61.94 | 21.29 | 33.55 | 0 | 2.58 | 0.65 |
| Harvesting techniques | 9.68 | 81.94 | 45.81 | 13.55 | 27.10 | 0 | 2.58 | 0.65 |
| Post-Harvest handling techniques | 10.32 | 80.65 | 42.58 | 11.61 | 23.87 | 0 | 1.94 | 0 |
| Market prices, demand and supply of product | 3.87 | 69.03 | 50.97 | 37.42 | 17.42 | 0 | 8.39 | 7.10 |

## Percentage of hub participant farmers

| Information about | none | family and friends | other /peer farmers | seller/ trader | extension agent | farmers hub | media | other sources |
|---|---|---|---|---|---|---|---|---|
| Weather | 11.90 | 54.17 | 33.33 | 13.69 | 14.29 | 26.79 | 58.93 | 6.55 |
| Choice of crop | 2.98 | 72.02 | 55.36 | 36.90 | 26.19 | 68.45 | 5.95 | 4.76 |
| Choice of variety | 1.19 | 67.26 | 61.90 | 41.07 | 27.98 | 77.38 | 4.76 | 2.38 |
| Cultivation technique | 4.17 | 75.60 | 52.98 | 20.24 | 27.98 | 56.55 | 3.57 | 2.38 |
| Fertilizer use | 1.79 | 70.24 | 40.48 | 73.21 | 29.17 | 58.93 | 2.38 | 4.17 |
| Pesticide use | 0 | 65.48 | 44.64 | 79.76 | 31.55 | 61.31 | 0.60 | 3.57 |
| Disease/pest control | 1.19 | 64.29 | 51.79 | 58.93 | 37.50 | 55.95 | 2.38 | 3.57 |
| Machinery use | 4.17 | 75 | 61.31 | 17.86 | 22.62 | 49.40 | 2.38 | 1.19 |
| Harvesting techniques | 3.57 | 82.14 | 50.00 | 11.31 | 17.86 | 35.71 | 1.79 | 1.19 |
| Post-Harvest handling techniques | 5.36 | 81.55 | 45.83 | 10.12 | 19.05 | 28.57 | 1.19 | 0.60 |
| Market prices, demand and supply of product | 1.19 | 62.5 | 50.60 | 35.71 | 13.69 | 43.45 | 5.36 | 8.33 |

# Appendix 3: Additional graphs relating to the change in complete, partial and no adoption of certain environmental practices between 2018 and 2021.

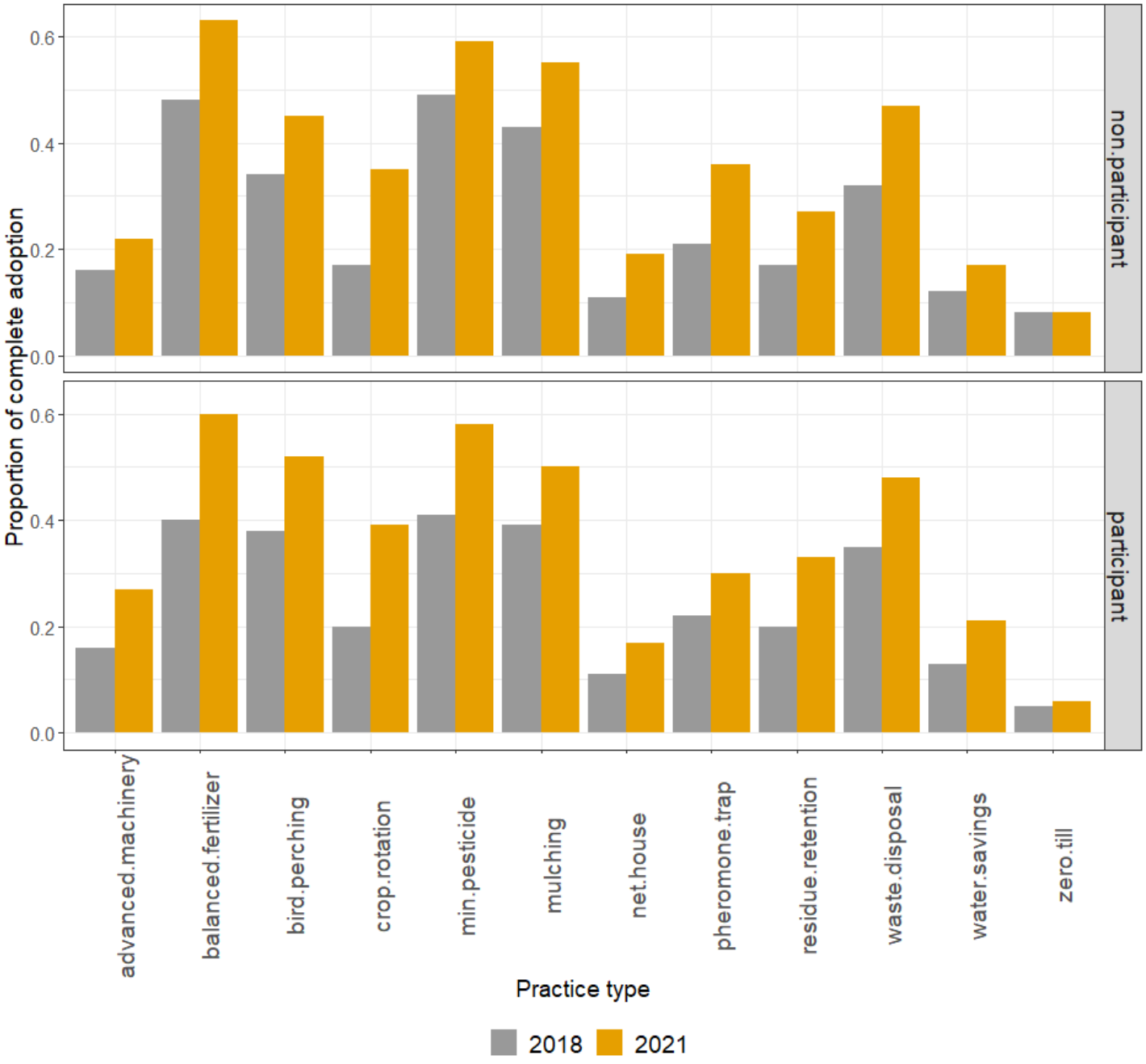


**Figure A3.1** Information from respondents to our quantitative survey about environmental practices they were using in 2018 and 2021. Showing change across time of those practices that were completely adopted. Participants of the study hubs are shown on the bottom and non-participants on the top.

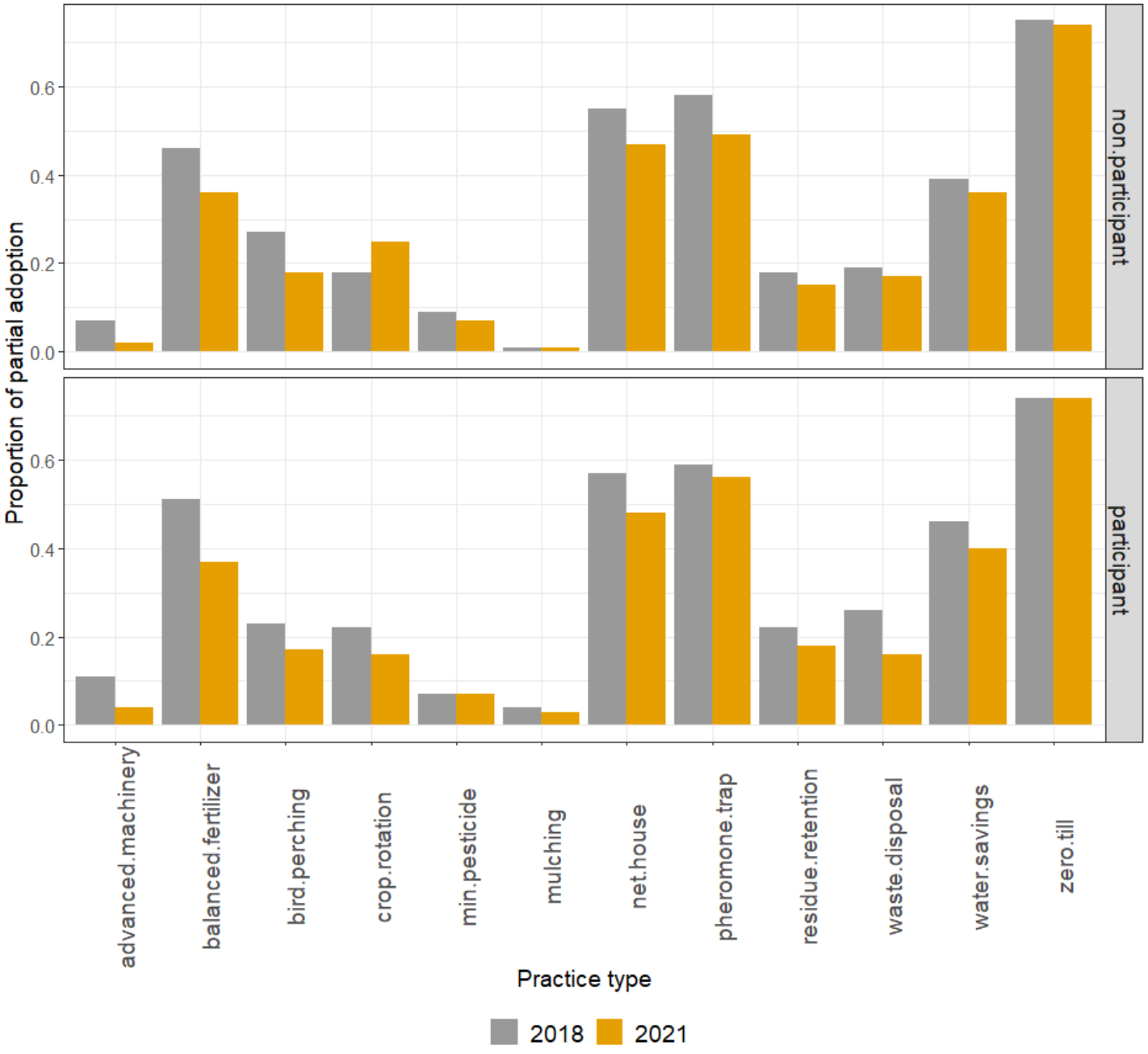


**Figure A3.2** Information from respondents to our quantitative survey about environmental practices they were using in 2018 and 2021. Showing change across time of those practices that were partially adopted. Participants of the study hubs are shown on the bottom and non-participants on the top.

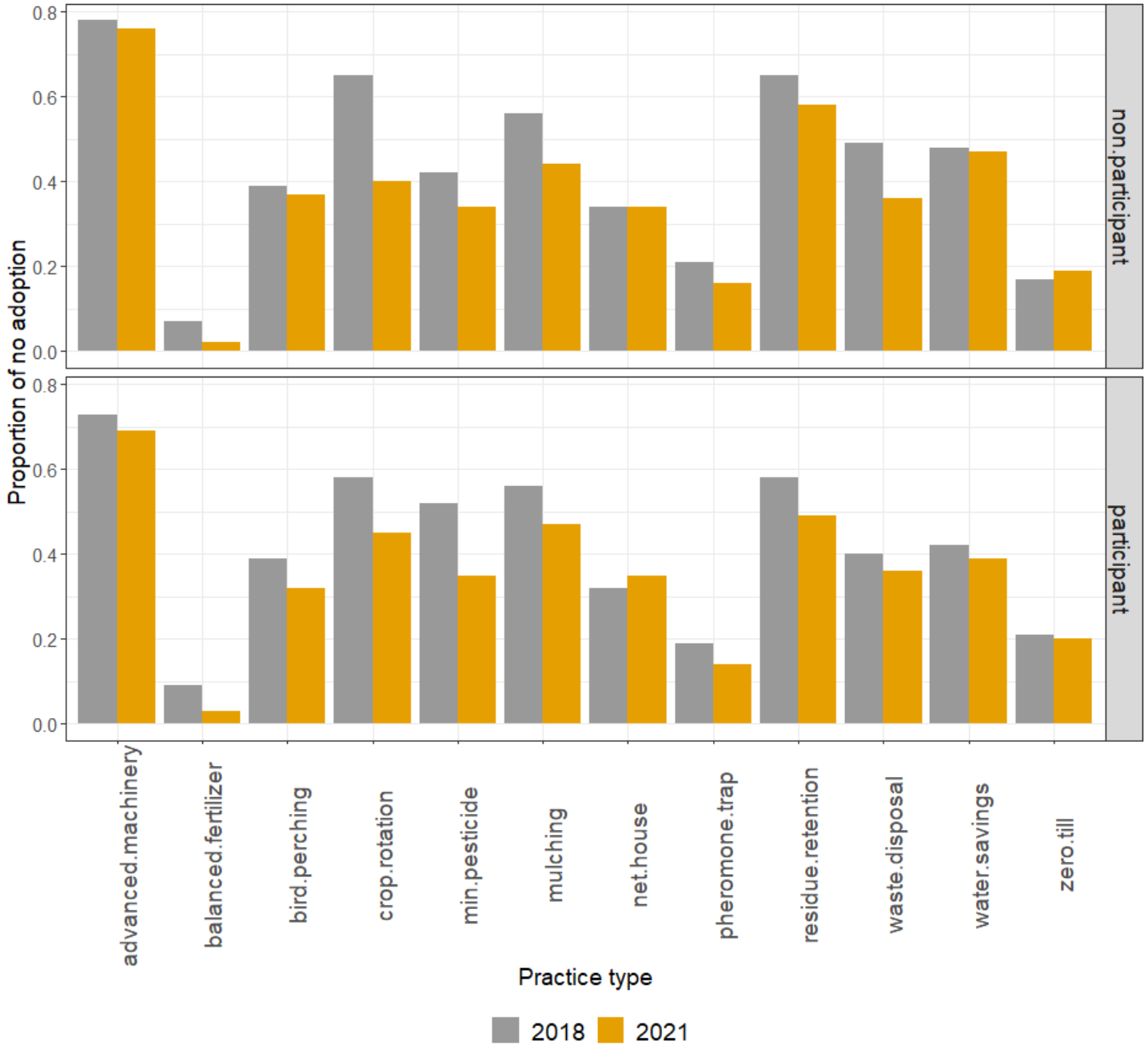


**Figure A3.3** Information from respondents to our quantitative survey about environmental practices they were not using in 2018 and 2021. Showing change across time of those practices that were not adopted. Participants of the study hubs are shown on the bottom and non-participants on the top.