FEED THE FUTURE
The U.S. Government's Global Hunger & Food Security Initiative

Cereal Systems Initiative for South Asia

Annual Report

October 2021- September 2022




CSISA

Funded by

USAID FROM THE AMERICAN PEOPLE

BILL & MELINDA GATES foundation

CSISA Partners

CIMMYT International Maize and Wheat Improvement Center

IFPRI

IRRI

IWMI International Water Management Institute

Alligned with

CGIAR Transforming Agrifood Systems in South Asia

CSISA Covid Resilience Activity Partners

ATM

iDE

Table of Contents

List of Acronyms and Abbreviations

2WT	two-wheel tractor
4WT	four-wheel tractor
AAS	Agricultural Advisory Society
ACCL	Auto Crop Care Limited
ACDI-VOCA	Agricultural Cooperative Development International and Volunteers in Overseas Cooperative Assistance
ACIAR	Australian Center for International Agricultural Research
AIRN	Agriculture Inputs Retailers' Network
AIS	Agricultural Information Services
AKC	Agriculture Knowledge Center
AMMI	Additive Main Effect and Multiplicative Interaction
APSIM	Agricultural Production Systems Simulator
ATT	average treatment effect on treated
ATU	average treatment on untreated
BADC	Bangladesh Agriculture Development Corporation
BARC	Bangladesh Agricultural Research Council
BARI	Bangladesh Agricultural Research Institute
BMD	Bangladesh Meteorological Department
BpLB	*Bipolaris* leaf blight
BRRI	Bangladesh Rice Research Institute
BWMRI	Bangladesh Wheat and Maize Research Institute
CBF	community business facilitator
CBO	Community-based organization
CCAFS	Climate Change, Agriculture and Food Security
CEs	choice experiments
CHC	custom hiring center
CGIAR	*formerly the* Consultative Group for International Agricultural Research
CIMMYT	International Maize and Wheat Improvement Center
CSA	climate-smart agriculture
CSISA	Cereal Systems Initiative for South Asia
CSISA-MI	CSISA-Mechanization and Irrigation
CSRD	Climate Services for Resilient Development
DAE	Department of Agricultural Extension
DSR	direct-seeded rice
Embrapa	Brazilian Agricultural Research Corporation
EWS	early warning system
FAW	Fall Armyworm
FtF	Feed the Future

FtF–ZOI	Feed the Future Zone of Influence
GON	Government of Nepal
GWRDB	Groundwater Resources Development Board
HRS	Healthy rice seedlings
HSD	Honestly significant difference (test)
IAL	Ispahani Agro Limited
IARI	Indian Agricultural Research Institute
ICIMOD	International Centre for Integrated Mountain Development
iDE	International Development Enterprises
IFPRI	International Food Policy Research Institute
IGP	Indo-Gangetic Plains
ILSSI	Innovation Lab for Small-Scale Innovation
INGO	international non-governmental organization
IPM	integrated pest management
IRRI	International Rice Research Institute
IVR	interactive voice response
IWM	integrated weed management
JRIP	Joint Rice Implementation Program
KISAN	Knowledge-Based Integrated Sustainable Agriculture in Nepal
NAMEA	Nepal Agricultural Machinery Entrepreneurs' Association
NARC	Nepal Agricultural Research Council
NARES	National Agricultural Research and Extension Systems
NSAE	Nepalese Society of Agricultural Engineers
ODK	Open Data Kit
OFRD	On-farm Research Division
NPR	Nepali rupee
NSAF	Nepal Seed and Fertilizer project
PCFE	per capita food expenditure
PMAMP	Prime Minister Agriculture Modernization Project
PQR	premium quality rice
PSA	public service announcement
pSIM	Parallel System for Integrating Impact Models and Sectors
RDC	Rice and Diversified Crops Activity
SAAO	Sub-Assistant Agricultural Officer
SI	sustainable intensification
SIIL	Sustainable Intensification Innovation Lab
SP	Service provider
SRFSI	Sustainable and Resilient Farming Systems Intensification in the Eastern Gangetic Plains
TAFSSA	Transforming Agrifood Systems in South Asia
TOT	Training of Trainers

TSP	Triple superphosphate
USAID	United States Agency for International Development
WMRI	Wheat and Maize Research Institute
WRF	Weather Research and Forecasting
ZOI	Zone of Influence

Executive Summary

With the support of the United States Agency for International Development (USAID) and the Bill & Melinda Gates Foundation, the Cereal Systems Initiative for South Asia (CSISA) was established in 2009 with the goal of increasing the productivity and resilience of millions of farmers by the end of 2020. CSISA is led by the International Maize and Wheat Improvement Center (CIMMYT) and is implemented jointly with the International Food Policy Research Institute (IFPRI), the International Water Management Institute (IWMI) and the International Rice Research Institute (IRRI), in addition to numerous public and private sector partners. CSISA is about bridging the divide between research and impact. In rural Bangladesh, India and Nepal, CSISA:

- works to increase the adoption of resource-conserving and climate-resilient agricultural technologies, and to improve farmers' access to market information and enterprise development
- supports women farmers by improving their access and exposure to modern and improved technological innovations, knowledge and entrepreneurial skills
- collaborates with numerous strategic public, civil society and private-sector partners, aligning them in synergy with regional and national efforts.

USAID supports CSISA's activities in Nepal and Bangladesh, while the Bill & Melinda Gates Foundation supports work ongoing in India through the fourth phase of CSISA. These efforts are made possible through the cooperation of a multidisciplinary team including agronomists, systems analysts, data scientists, behavioral economists, livestock specialists, agricultural engineers, sociologists, and pest and natural resources management experts, among others. Over time, CSISA's work in Bangladesh and Nepal has developed into a more comprehensive applied research-for-development program, with additional and synergistic investments and buy-ins by USAID/Washington, the USAID Missions in Nepal and Bangladesh, and the CGIAR Research Program on Climate Change, Agriculture and Food Security (CCAFS), in addition to Michigan State University's Borlaug Higher Education for Agricultural Research and Development (BHEARD) program, to deepen the scope and impact of CSISA's work. As such, CSISA has evolved well beyond its origins as a primarily agronomic research initiative to embrace interdisciplinarity as prerequisite for understanding and efficiently responding to the challenges faced in South Asia's cereal-based farming systems.

This report focuses on the current third phase (2015–23, CSISA III) of the 'base' or 'original' set of CSISA investments.[2] The phase focuses on USAID's support to activities in Nepal and Bangladesh, where CSISA supports partners in the public and private sectors to better contribute to sustained change by addressing systemic weaknesses. By addressing these areas and fostering new connections and collaborative efforts across the innovation system, CSISA is seeking to mainstream elements of its approach and ensuring a successful exit of some aspects of programming. At the same time, the Activity is in discussion with USAID about an anticipated extension into 2023 end.

Bangladesh highlights

Key highlights from CSISA's work in Bangladesh during the October 2021–September 2022 reporting period include:

[2] CSISA III is primarily referred to as 'the Activity' throughout this report. CSISA III in Bangladesh and Nepal has been extended through to the end of 2023, after which it is envisioned that most of CSISA's ongoing regional work will be continued through the One CGIAR Regional Integrated Initiative Transforming Agrifood Systems in South Asia (TAFSSA), which builds directly on the foundation laid by CSISA. Working across South Asia, this Initiative aims to deliver a coordinated program of research and engagement across the food production–to–consumption continuum to support equitable access to sustainable healthy diets, improve farmer livelihoods and resilience, and conserve land, air and groundwater resources.

- To increase farmers' profitability in rice production, CSISA has been working to expand the cultivation of premium quality rice (PQR) since Phase III of the Activity was initiated in 2016, starting in south-west Bangladesh (the Khulna region), and in 2019 in the northern region (Rangpur and Dinajpur). To facilitate the expansion of PQR production at the farm level, the Activity has been working with DAE, local seed companies, NGOs and farmer groups. To kick-start this, CSISA provided a sub-grant to local seed companies, and PQR seeds to farmers free of cost. As a result, significant numbers of auto rice mills began milling BRRI dhan 50 and BRRI dhan 63 and marketing them throughout Bangladesh under the brand names Bangla Bashmoti and Banglamoti, and in Dhaka as Jashore Bashmoti. CSISA's efforts have resulted in Jashore becoming positively associated with the Bashmoti brand, with demand for this variety increasing daily. By switching from non-PQR to PQR rice varieties, farmers throughout CSISA's two working areas are now realizing 10%–20% higher profits. Where CSISA has a presence in south-west Bangladesh, around 30%–40% of farmers' fields are occupied by PQR *boro* varieties and 10%–20% by PQR *aman* varieties.
- Wheat blast is a devastating fungal disease that appeared in Bangladesh in 2016 and affected 15,000 hectares of wheat areas, resulting in about 25%–30% crop losses and reducing wheat production of up to 85 million tons, equivalent to USD13 million. Since then, Bangladesh has remained on alert given the risk of subsequent outbreaks. To fulfill farmers' seed demand, during this reporting period the Activity established 25 demonstration plots utilizing 25 farmers' fields covering three hectares of land in the Dinajpur region, in collaboration with BWMRI and DAE, and facilitated training for participating farmers and a number of dealers in wheat quality seed production and preservation. CSISA also provided technical support to local seed companies, of which seven produced a total of 81.48 tons of the new variety wheat seeds: BARI Gom 33 (33 tons), BARI Gom 32 (38.7 tons), BARI Gom 30 (8.2 tons) and WMARI 3 (1.3 tons).
- Also focused on wheat blast disease, CSISA has facilitated an ongoing wheat blast surveillance program and extension agent training to assure that the wheat blast early warning system (www.beattheblastews.net), developed in partnership with Universidad de Passo Fundo and EMBRAPA in Brazil and through its synergies with the now completed Climate Services for Resilient Development (CSRD) in its South Asia project, also supported by USAID, is fully functional in the event of an outbreak. To date, CSISA has trained and enrolled over 6,500 extension agents in Bangladesh in the system.
- Mung bean is a highly profitable legume crop, widely cultivated in the southern central coastal region of Bangladesh, especially Patuakhali, Barguna and Barishal districts. However, every year during the peak of the harvesting period, heavy rain and storm events from April to May cause large yield losses (and thus income loss) to mung bean farmers. In response, CSISA has contributed to building and interactive voice response (IVR) system for mung bean farmers in some coastal areas of Bangladesh (Patuakhali and Barguna districts). This IVR system provides real-time weather alerts, warning farmers to harvest their mung bean ahead of forecasted heavy rainfall events which could damage their crop. This automated IVR system issued a total of 2444,478 IVR calls to 10,446 mung bean farmers (668 women, 9,778 men) in 17 selected unions between 5 April– 22 May 2022, during the peak of the mung bean harvesting season. The CSISA research team analyzed the IVR call data and found that of the 310,269 location-specific advisory IVR calls automatically generated by the system, 99,086 (41%) were successfully received and listened to by farmers, with many of them acting to save their crop from damage that could have been incurred due to heavy rainfall events before harvest. CSISA is now working to secure a private sector partner willing to take on long-term operation and financing of the IVR system. At the time of writing, nine companies have responded to an expression of interest and are being vetted by CSISA for their business proposals to sustain

the IVR system's operation.

- From April 2022 to August 2022, CSISA collaborated with the Bangladesh Rice Research Institute (BRRI) to conduct an on-farm directly sown rice (DSR) trial on the performance evaluation of rice varieties under different seeding rates and establishment methods in dry direct-seeded systems in Jhenaidah, Bangladesh. The objective of the trial was to identify the optimum seed rate of spring season *aus* inbred and hybrid varieties in dry direct-seeded systems. Field trial results of the study show that rice grain yield was not affected by the establishment methods; it was however affected by the variety, seed rate and these factors' interaction. In summary, the hybrid seed variety produced a higher yield than the inbred variety: for the hybrid variety, a 30 kg ha^{-1} seed rate was found to be optimum, whereas with the inbred variety a 45–60 kg ha^{-1} seed rate is needed to achieve optimal yield. For line sown DSR, the seed rate can be reduced to 30 kg/ha; for broadcast DSR, a 60 kg ha^{-1} seed rate gave the best yield.
- Agvisely is an agrometeorological services tool/application initiated by the CSRD project and scaled by CSISA that offers timely, localized and reliable climate information and crop advisories for the entire country at 495 sub-district levels of Bangladesh. It was endorsed by the Government agricultural research and extension departments in 2019, and is now available in the Google Play Store and linked to the Bangladesh Department of Agricultural Extension (DAE), Bangladesh Agro-Meteorological Information System (BAMIS) portal and BWMRI websites. Currently, nine major crops including three rice crops and corresponding spring, summer, and winter seasons (*aus*, *aman* and *boro*), wheat, maize, potato, lentil, mung bean and mustard are available on the app. Agvisely reached a new milestone in Bangladesh during the reporting period, with a record number of 7,078 registered and active extension agents within DAE using it. A subsequent study by CSISA suggests that during the reporting period, a total of 587,474 farmers were reached with information derived from Agvisely. Almost 99% reported receiving information from Agvisely and the majority (98%) received the information from SAAOs; 25% obtained information from neighboring farmers, followed by the Internet (13%), a mobile app (8%) and farm input dealers (5%).
- The Cereal Systems Initiative for South Asia – Mechanization and Extension Activity (CSISA-MEA) is supported by USAID/Bangladesh and part of the constellation of CSISA project efforts in South Asia. The Activity works to support the growth and expansion of agricultural mechanization in Bangladesh so that smallholder farmers can affordably access cost and resource-saving sowing, irrigation, harvesting, and other types of machinery. CSISA-MEA supports market actors along the entire value chain including machinery manufacturers, ag machinery importers and retailers, dealers, mechanics, spare parts vendors, and machinery "local service providers" who provide services directly to farmers. At the time of reporting, CSISA–MEA has supported 194 agriculture-based light engineering (ABLE) small and medium-scale enterprises (SMEs) to develop and expand their business through the provision of training for staff, technical advice, and access to finance. During the reporting period the Activity facilitated lead firms [The Metal Private Limited (TML), ACI Motors, Abedin Equipment, Alim Industries, Janata Engineering and RK Metal] to implement a program of demand creation events. These resulted in the sale of 145 combined harvesters (USD 2,303,267), one mini combine harvester (USD 5293), two Power Tiller-Operated Seeders (PTOSs) (USD 1873), 26 reapers (USD 22,102), 16 rice transplanters (USD 23,262) and 26 fodder choppers (USD 8535). The total value of private sector sales in Bangladesh's in the year 2021–22 was USD 2,365,017.

Nepal highlights

Key highlights from CSISA's work in Nepal during the October 2021–September 2022 reporting period for include those listed below.

- In the CSISA Response and Resilience Activity in Nepal, CSISA supported 13,434 individuals (44% of whom were women) to purchase new and/or improved mechanized cost-saving farm services for irrigation, harvesting and post-harvest activities. The activity also assisted 361 MSMEs to obtain business loans by mobilizing 106 banks and farmers' cooperatives. Through collaboration with commercial banks, CSISA facilitated the provision of 299 Kisan Credit Cards to farmers who can now use them to avail point-of-sale credit for agricultural machinery services and agricultural inputs. Along with a product discount model, CSISA worked through private sector intermediaries to provide technical advice to 690 farmers from marginalized ethnicities to promote mechanized harvesting. Finally, CSISA provided 207 agricultural equipment mechanics with tool kits and technical repair training, and facilitated the establishment of farm machinery businesses for 61 return migrant entrepreneurs who were forced back to Nepal during the pandemic. Additional for the CSISA Response and Resilience investment by the USAID/Nepal Mission can be found later in this document in a dedicated report section found here.
- During the reporting period, CSISA provided technical support to government partners (mainly PMAMP, AKCs, and local governments and palikas) to facilitate the organization of 23 training sessions on agricultural machinery. These involved a total of 615 participants (109 women, 506 men), and resulted in 258 machinery services providers receiving basic operation and basic repair training, 18 mechanics receiving detailed machinery repair training, 42 Green Volunteers (local agriculture resource persons recruited and developed by Lumbini Province) receiving basic machinery operation and maintenance training, and 297 farmers receiving training on agricultural machinery whose usage reduce cost of production of field crops and vegetables.
- Mung bean is a short-duration (70 to 90 days maturity) leguminous crop that easily fits into the rice-wheat cropping system of Nepal. The inclusion of mung bean in the rice-wheat system plays a crucial role in sustainable profitability by enhancing soil fertility, thus increasing the system's productivity. In Nepal, the land remains fallow for 80 to 90 days after wheat harvesting, and this fallow land can be utilized for growing mung bean. However, the land remains fallow due to a need for more awareness and knowledge about mung bean cultivation. CSISA has been conducting research and facilitating market linkages between mung bean farmers and industry as part of Phase III activities. As a partial result of CSISA's market facilitation efforts, Panchshakti seed company in Kailali sold about 2.2 m tons of mung bean seed, and GATE Nepal seed company sold 2.5 m tons of mung bean seed during the reporting period.
- CSISA conducted a social experiment in Dang district, Lumbini province to explore the effectiveness of phone-based extension approaches in building farmers' knowledge on the diagnosis and management of Fall Armyworm (FAW). This included efforts to quantify the ways in which extension messaging influences the adoption of Integrated Pest Management (IPM) approaches appropriate for FAW. Phone-based extension approaches included auto-recorded voice calls, and phone calls from trained personnel with information on FAW management. Both treatment groups received the same set of information, followed by four weekly SMS reminders on the same topics. The experiment reached more than 2,300 farmers from 134 villages across four municipalities in Dang using phone surveys. Around 70% of the participants were women agriculture decision-makers. During the reporting period, CSISA focused on analysis of data from this experiment. The analysis reveals that those belonging to socially privileged caste communities were more likely to know about FAW compared to less privileged caste groups. Female

respondents were less likely to know about FAW than males; older respondents were more likely to have heard of FAW at the time of the baseline survey. Respondents from households with farming income were more likely to score higher across all treatment and control groups compared to those with no household farming income. It is however encouraging to note that the knowledge scores for respondents from households with a female agriculture decisionmaker were higher than those with male decisionmakers. Nonetheless, female respondents across all groups were likely to have lower knowledge scores on average, compared to male respondents. Factors such as remittance income or households with migrant members, caste and gender of household head did not demonstrate statistically significant impact on knowledge scores.

- Farmers in Nepal remain very vulnerable to climate shocks and extremes. The delayed 2022 monsoon was a case in point; reportedly, more than 60% of farmers transplanted their rice paddy late – with consequences for rice production and following crops that will likely be planted late due to a late rice harvest. In response, CSISA, the Government of Nepal (GoN), and other development partners are facilitating smallholder resilience through inclusive irrigation development. To ensure its sustainability, CSISA has piloted a digital groundwater management system (pilot product: www.gw-nepal.com) and presented a framework for inclusive and sustainable irrigation development to the Ministry of Energy, Water Resources, and Irrigation in a workshop in Kathmandu in March 2022. The Ministry has endorsed these outputs and CSISA is now focusing on coordinating with the GoN and developing partners for implementing and scaling these approaches in Nepal's Feed the Future Zone.

CSISA's policy research highlights

Key highlights of CSISA's policy research conducted during the reporting period includes the following:

- CSISA in collaboration with CSISA–MEA is conducting research to improve policy makers' understanding of the factors determining smallholder farmers' ownership and use of agricultural machinery in Bangladesh, and service provision for these machines. Preliminary results suggest that among machines used for land preparation and planting, use of both the power tiller and rotavator was high; however, ownership was quite low. Among irrigation machinery, use and ownership was highest for groundwater diesel centrifugal pumps and lowest for groundwater grid-connected electric pumps. Use and ownership was lower for grid electric pumps than diesel centrifugal pumps. Ownership of machinery used in harvest and post-harvest activities was the lowest among all types of machines. Among machine owners, just three main types of machines were being used intensively for service provision: the power tiller (attached to a two wheel tractor), the groundwater diesel centrifugal pump, and the surface water diesel centrifugal pump. Among these, the highest proportion of farmers were providing services for the groundwater diesel centrifugal pump. Factors such as age, education, inclination to take risks, and livestock ownership were found to be mostly positively associated with owning, service provision and hiring decisions for most machines. However, findings around factors such as farm size, off-farm income, household members contributing to farming, wealth score and communication scores were not very conclusive and need further investigation.
- A major methodological finding from CSISA's FAW phone surveys conducted to understand the gendered impact of the COVID–19 pandemic among farmers in Nepal (a subset of the sample for the FAW experiment was interviewed for this study) was the widespread use of speakerphone by female respondents. CSISA researchers found that this precluded the administration of sensitive questions in the survey, and also affected responses to other seemingly innocuous questions on intra-household decision-making. These findings have been published as an IFPRI discussion paper,

and have important implications for the design and analysis of phone survey data.

Documenting CSISA's scientific and extension contributions:

In addition to the above research into real-world development outcomes and impact, CSISA worked during the reporting period to scientifically document its efforts and to publish a range of technical and extension materials. Between 2021-2022, scientists and development professionals working in CSISA have published 12 peer-reviewed papers, 1 research report and policy briefs, 3 extension manuals, and four educational videos. Details of publications can be found in Annex I.

Context, Approach and Theory of Change

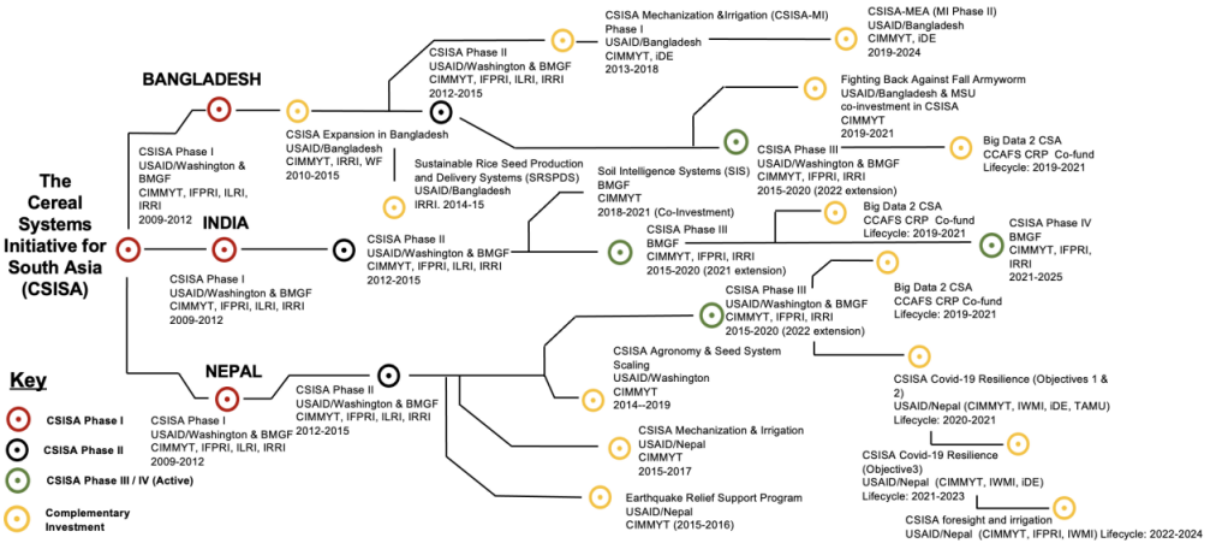
Ever since the food price crisis, agricultural research and development in the developing world has received renewed public sector, private sector and donor investment. In South Asia, attention has shifted to focus on the impoverished areas of the Eastern Indo-Gangetic Plains – particularly Nepal and Bangladesh – where cereals feed well over half a billion people. As time has gone on, interests of governments and international donors have also shifted to embrace more complex agri-food systems issues in an integrated, systems-oriented context. Nevertheless, investments in agriculture have been less adept at supporting transformative change than many development planners had hoped. While progress has been made in addressing some of the systemic weaknesses which contribute to low rates of rural development, many key problems continue to persist:

- Many national **research organizations** construe their mandates narrowly and are only partially oriented towards farmers and the private sector as clients of research outputs. Research tends to be still commodity-specific, and focused mainly on production, with less emphasis on other disciplines that can assist in providing insights crucial for overcoming agricultural development challenges.
- **Resilient** farm practices, nutrition, and rural livelihood strategies are insufficiently considered in comparison to technical interventions that focus mainly on yield improvements for singular commodities.
- **Agricultural extension** primarily focuses on single technologies or generalized 'packages of practices', which are not always underpinned by rigorous or participatory field evaluations, and that often lack strategic targeting efforts.
- **Livelihood** initiatives do a commendable job of reaching underserved communities, including women farmers, but rarely have the technical competence to extend their reach or to interact comprehensively with farmers as managers of diverse production enterprises.
- The **private sector** – although learning quickly – lacks strategic experience in the emerging markets in the region along with the types of locational intelligence that can steer engagement and support smallholder farmers' access to new technologies.
- **Rural and small entrepreneurs** generally lack access to support services, both for business development and technical improvements, in their attempts to serve clients and generate revenue.
- Progressive **policies** ostensibly support farmers, but often impede private investment.
- **Cooperation is still not optimized** in the agricultural research-for-development space. This limits opportunities to leverage skills and harness synergies for development impact.
- Activities at addressing **social equity and gender inclusiveness** are unfortunately more transactional and may lack depth. Initiatives to address social equity and justice in agriculture require integrated sets of action, adequate planning, and adaptive management.

Agricultural research and development efforts are complicated by the risks inherent in cropping in areas where weather patterns are erratic, water resources are poorly developed or irrigation is costly, heat stress is a binding constraint, and timely field operations are frequently compromised by rapidly declining diminishing supply and increasing costs for rural labor, due in large part by the out-migration of men to urban areas or abroad as they seek more remunerative employment. Despite these challenges, there is considerable promise that the many individual strengths within the innovation system[3] in South Asia can

[3] Innovation systems can be understood as networks of business, organizations and people – including farmers, researchers, extension agents, policy makers and entrepreneurs – which, through the sum of their actions, bring new technologies,

be marshaled and coordinated to spur and sustain transformative change. With support from the Bill & Melinda Gates Foundation and the U.S. Agency for International Development (USAID), the Cereal Systems Initiative for South Asia (CSISA) has worked as an eco-regional initiative to support agricultural development in South Asia since 2009. The Activity has developed into a program of investments in Bangladesh, India and Nepal, with a number of synergistic side-investments provided mainly by USAID's Missions in Bangladesh and Nepal.



Above: evolution of USAID and Bill & Melinda Gates Foundation (BMGF) investments in the overall CSISA program in Nepal, Bangladesh and India since 2009, indicating core CGIAR and INGO partners including new investments in the CSISA–MEA activity in Bangladesh and buy-ins by the USAID/Nepal Mission.

CSISA works with technologies and management practices which fall under the rubric of 'sustainable intensification' in order to enhance the productivity of cereal-based cropping systems, increase farm incomes and reduce agriculture's environmental footprint.[4] As a science-driven and research impact-oriented initiative, the Activity is positioned at the intersection of a diverse set of partners in the public and private sectors, occupying the crucial middle ground where research meets development. As such, while most CSISA team members are scientists, each is committed to developing and ensuring pathways by which research products and technologies can be pushed into real-world use and impact by farmers. The Activity generates data and evidence on improving crop production and identifying more sustainable means of growing crops, and then scales these out to partners in the public and private sectors, to raise the awareness of farmers and other stakeholders of these options. By engaging with a network of partners as an agricultural innovation systems broker, CSISA is built on the premise that transformative development typically requires not one single change but the orchestration of several changes.

With USAID's focused support, CSISA Phase III pursues four **inter-linked primary outcomes**:

innovations, products processes or policies into use. Efforts to coordinate these groups and actors can accelerate the rate of uptake of technological innovation which can improve the impact of development interventions. CSISA plays a coordinating and facilitating role in South Asia as an agricultural innovation system broker.

[4] Pretty and Bahrucha (2014) define sustainable intensification as '…. a process or system where agricultural yields are increased without adverse environmental impact and without the conversion of additional non-agricultural land. The concept does not articulate or privilege any particular vision or method of agricultural production. Rather, it emphasizes ends rather than means…. The combination of the terms 'sustainable' and 'intensification' is an attempt to indicate that desirable outcomes around both more food and improved environmental goods and services could be achieved by a variety of means.' (Pretty, J. and Bharucha, Z.P. (2014). Sustainable intensification in agricultural systems. Annals of Botany 114: 1571–1596).

1. The **widespread adoption of climate adapted, sustainable intensification technologies and management practices** in South Asian cereal systems.
2. **Mainstreaming innovation processes** into the programming of national, state and district level government institutions in order to improve the impacts achieved with current and future investments in agricultural research for development (R4D).
3. **Generating critical knowledge and research-based products** that will support technology scaling-out (among farmers and service providers) and also scaling-up (institutional systems change that sustains technology generation and availability) for durable development impacts.
4. **Improving the policy environment to support sustainable intensification** in CSISA's target geographies by (1) prioritizing scaling efforts, and (2) working through national partners to address policy constraints to increase the productivity and resilience of smallholder farming systems.

The Activity thus carries out research and shares results on the constraints and benefits of technologies. It also works with partners to extend evidence-based options to farmers and stakeholders on a targeted and strategic basis.

This report focuses exclusively on the constipation of USAID investments in CSISA. In addition to CSISA III activities detailed in this report, ongoing buy-ins from the USAID/Nepal Mission and a complementary independent project that is directly aligned with CSISA and supported by USAID/Bangladesh. Active during the reporting period, these buy-in and strategically aligned projects include the following:

- **CSISA Mechanization and Extension Activity (2019-2024):** This USAID/Bangladesh investment is synergistically aligned with CSISA. It builds on the CSISA team's strengths and utilizes a similar research in development, governance, and public-private partnership approach to market systems enhancement in the agricultural machinery sector in Bangladesh. The Activity operates in the Feed the Future Zone of Influence (ZOI) in south-west Bangladesh and the Feed the Future Zone of Resilience (ZOR) in the Rohingya refugee crisis-impacted Cox's Bazar region in south-east Bangladesh. The Activity aims to support the mechanization of agriculture in Bangladesh by developing the capacity of the private sector to develop, manufacture and market innovative, climate-smart technologies, which will enable the country's farmers to mechanize their agricultural production and increase their resilience to climate change. Through this it will achieve the core objective of enhancing agricultural resilience through the development of agriculture-based light engineering (ABLE) small and medium enterprises (SMEs) and develop a youth and gender-inclusive workforce with a special emphasis on crisis affected areas of Bangladesh. This core objective is achieved through three intermediate results including (I) the competitiveness and efficiency of domestic and private sector-led agricultural machinery manufacturing boosted, (II) institutional capacity for agricultural mechanization through the development of a skilled and youth workforce enhanced, and (III) access for farmers to agricultural machinery, production and marketing services improved.

- **The CSISA Response and Resilience Activity** (2020-2023): This Activity was initiated by the USAID/Nepal Mission to develop mechanisms to support longer-term resilience among smallholder farmers and the private sector – emphasizing empowering youth and overcoming challenges faced by women-headed farm households that resulted from the economic shock caused by the COVID-19 crisis. Over time, the activity has evolved as a resilience building effort aimed at strengthening Nepal's agricultural economy to overcome other economic shocks that could undermine improved productivity, food and economic security for smallholder farmers. The Activity has three objectives, including (I) Enable rapid, targeted, and effective agricultural COVID-19 crisis response through scale-appropriate farm mechanization and rural services provision, (II) Break the bottleneck to sustainable and inclusive irrigation development in Nepal's

Feed the Future Zone, and (III) Supporting rapid response and resilience-building from Nepal's second and third COVID-19 waves.

- **CSISA Ukraine Crisis Response (2022-2024):** In 2022, CSISA was awarded $2.2 m by USAID/Nepal in Ukraine supplemental funding as a buy-in to provide data analysis for USAID to implement an evidence-based response to shocks and to scale up sustainable irrigation. This Activity has two major development objectives (I) USAID/Nepal and development partners' ability to respond to agrifood systems crises improved through data-driven insights and strategic guidance: The outputs of this Objective will provide USAID and policymakers with a solid evidence-base assessing potential agricultural productivity at a seasonal time-step, economic, and national food security consequences of the Russian-Ukrainian conflict and ongoing price volatility on Nepal's agricultural economy on smallholder farmers and poor consumers. (II) Smallholder farmers' resilience to economic shocks and climate change improved through sustainable and inclusive irrigation development. Irrigation is a cornerstone for efforts to increase yields and build farmers' resilience to climate variability and economic shocks such as those associated with the Russia-Ukraine conflict. Building on support provided by USAID/Nepal to foster irrigation development and enhance farmers' resilience in the face of the COVID-19 crisis, this activity will continue to support the public and private sector in sustainable and inclusive irrigation development including the scaling out of a previously piloted digital groundwater monitoring system for Nepal. Activities in Objective II will develop locally-targeted irrigation scaling strategies, management advisories, and gender-equitable business models, including access to finance for irrigation pumps (with a focus on but not limited to solar irrigation).

- **Fighting Back Against Fall Armyworm in Bangladesh (2019-2022):** This USAID/Bangladesh and Borlaug Higher Education for Agricultural Research and Development (BHEARD) supported Activity responded to the incursion of Fall Armyworm (FAW), an invasive pest species in Bangladesh. This Activity has five inter-related objectives: (I) develop educational materials to aid in reaching audiences with information to improve understanding and management of fall armyworm, (II) assist the Department of Agricultural Extension in deploying awareness raising and training campaigns, (III) prepare the private sector for appropriate fall armyworm response (IV) standing FAW task force supported, (V) generate data and evidence to guide integrated fall armyworm management. The Fighting Back Against Fall Armyworm in Bangladesh project is aligned with Michigan State University BHEARD program and which supports the long-term training of agricultural researchers in USAID's Feed the Future priority countries. To achieve synergies and scale, the project will also be supported in part by in-kind staff time and activities, through linkages to the third phase of the USAID-supported Cereal Systems Initiative for South Asia (CSISA), led by the International Maize and Wheat Improvement Centre (CIMMYT). CSISA and CIMMYT staff work very closely with Bangladesh's Department of Agricultural Extension and the Bangladesh Maize and Wheat Research Institute (BWMRI) in addition to other partners under the Ministry of Agriculture.

- **Big data analytics for climate-smart agricultural practices in South Asia (Big Data^2 CSA; 2018-2021):** In partnership with national research systems and the private sector in Bangladesh, India and Nepal, Big Data^2 CSA partnered with CSISA to develop is developing digital data collection systems to crowdsource, data-mine and interpret a wide variety of primary agronomic management and socioeconomic data from tens of thousands of smallholder rice and wheat farmers. The project team analyzes these data by stacking them with spatially-explicit secondary environmental, climatic and remotely sensed data products, after which data mining

and machine learning techniques are used to identify key factors contributing to patterns in yield, profitability, greenhouse gas emissions intensity and resilience. The project, supported by the CGIAR Research Program on Climate Change, Agriculture and Food Security (CCAFS) Flagship 2 on Climate-Smart Technologies and Practices, is closely aligned with CSISA and has five objectives including (I) develop ICT tools enabling digital collection of crop management data and a cloud-based database that can be managed by next-users, (II) support advanced degree-level students to engage in field and data science research, (III) create a digital data collection platform enabling crowd sourcing of crop management information to evaluate contributions to CSA, (IV) create interactive and customizable web-based dashboards presenting post-season research results and providing CSA management recommendations (V) Organize CSA and big data policy briefings on mainstreaming processes and policy workshops.

- **Transforming Agrifood Systems in South Asia (TAFSSA):** Starting from January 2022, CSISA's work has also been strategically aligned with the One CGIAR Regional Integrated initiative Transforming Agrifood Systems in South Asia (TAFSSA). TAFSSA is One CGIAR regional integrated initiative to support actions that improve equitable access to sustainable healthy diets, improve farmers' livelihoods and resilience, and conserve land, air, and water resources in South Asia. TAFSSA is a consortium that includes CIMMYT, IFPRI, IRRI, IWMI, the International Potato Center (CIP), the Alliance Bioversity International – CIAT, and WorldFish.

Key highlights from these complementary and buy-in investments are also detailed in this report where appropriate.

1. Bangladesh – Achievements

A. INNOVATION TOWARD IMPACT

A1. Reducing risk to facilitate uptake of sustainable intensification practices

A1.1 Direct-seeded rice to address labor and energy constraints to precision rice establishment

In South Asia, researchers have long encouraged a shift from the most dominant agronomic method of rice production crop establishment – widely referred to as puddled transplanted rice – to dry direct-seeded rice (DSR). DSR can dramatically reduce production costs, and improve and reduce the environmental impact of rice production. However, for farmers who transition from transplanted rice to DSR, significant changes in management practices and agricultural machinery are often needed. DSR is established without standing water in the field, and through machine-aided sowing rather than transplanting. In combination, this saves labor, water and cultivation costs, and can lower greenhouse gas emissions. However, while DSR has benefits, farmers tend to emphasize that it also has risks, which limit its adoption in South Asia, including Bangladesh. Examples of these concerns include poor and uneven crop establishment, weed management challenges, and a lack of suitable cultivars for DSR. In addition, soils need to be of the right texture, and farmers need to manage irrigation and floodwater depths much more carefully. Rice is also sensitive to cold, particularly early in the winter season. Because of cold injury risks to seedlings during the winter '*boro*' rice season and uncontrollable flooding in the summer '*aman*' season, the research conducted by CSISA on DSR has focused mainly on the pre-monsoon '*aus*' season (usually sown in April–May and harvested in July–August – also known as *kharif*-1). Efforts have also targeted selected parts of the southwest of the country where soil and hydrological conditions are likely to be better suited to cropping.

CSISA works on DSR in close partnership with BRRI, the Department of Agricultural Extension (DAE), non-governmental organizations (NGOs) and private sector entrepreneurs (especially mechanized seed drill owners) in the spring *aus* rice season. The primary research activity streams relate to efforts to quantify the impact of DSR on yield profitability, compared to farmers' predominant practices of wet tillage (puddling) and manual transplanting. As the only rice varieties available are developed for puddled transplanted systems and not specifically bred for DSR conditions, CSISA works closely with BRRI to identify the most suitable rice varieties to adapt to DSR conditions for use in the monsoon *aus* season. The Activity also arranges public field visit days to on-farm trials to raise awareness of DSR among farmers and other stakeholders. CSISA has made use of field visits from policymakers within the Ministry of Agriculture to boost their understanding of DSR as an option when the season, location and rice variety are right.

CSISA and its partner BRRI jointly conducted three consecutive years of agronomic research trials from 2019 to 2021 on performance evaluation of DSR in comparison to farmers' predominance method of rice establishment methods in the *aus* season. In this study, DSR (mechanized line sown and manually broadcast) was compared for agronomic and economic performance with farmers' current practice of puddled transplanted rice under different landscapes (lowland, medium-land and upland) to identify the most suitable landscape positions for DSR cropping. The major findings of the last three years have already been presented in previous reports. Based on these three-year data, a scientific manuscript for a refereed journal is under development. CSISA plans to organize a national-level workshop in BRRI by

February 2023 to present the last three years' results to stakeholders and discuss with them how DSR technology can be deployed on a large scale in Bangladesh.

During the DSR trials, BRRI realized that the seed rate used for manual broadcasting seemed higher and, with the assistance of CSISA, conducted a DSR trial in the *aus* 2022 season focusing on the seed rate of inbred and hybrid varieties. BRRI has already included the DSR trial reports in its annual reports and plans a number of DSR demonstrations in the hill tracts of Bangladesh from the next *aus* season. CSISA's activities with DSR in the October 2021–September 2022 reporting period are detailed below.

Direct-seeded rice activities: on-farm trials on establishment methods, varieties and seed rate

From April 2022 to August 2022, CSISA collaborated with Bangladesh Rice Research Institute (BRRI) to conduct an on-farm DSR trial on the performance evaluation of rice varieties (V) under different seeding rates and establishment methods in dry direct-seeded systems in Jhenaidah. The objective of the trial was to identify the optimum seed rate of *aus* inbred and hybrid varieties in dry direct-seeded systems.

The seed rate (SR) is an important factor in DSR crop establishment which determines the adequate plant population for optimum yield. In the DSR system, low plant population and high gaps encourage the growth of weeds. Conversely, high plant density produces less productive tillers, creates a favorable condition for insect pest and disease infestation because of poor aeration, increases crop lodging, and required higher nitrogen application. High SR is encouraged in DSR systems to compensate for poor crop establishment and to suppress weeds, the chance of bird and rodent damage, and seed rotting due to too much rain shortly after sowing, or seedling death due to submergence. No (or limited) studies have been conducted on optimizing the seed rate for DSR in the *aus* season. Previous studies in Bangladesh were conducted during the T. *Aman* season and results showed that a seed rate of 30–40 kg ha^{-1} was optimum for line-sown DSR, for inbred cultivars under weed-free conditions and a no-risk scenario. However, under partially weedy conditions and where there is a higher risk of field inundation due to heavy rain during the early emergence/establishment stage, a seed rate of 60–80 kg ha^{-1} performed well.

Hybrid seed is costlier and a higher SR therefore increases farmers' production costs. In addition, for broadcast DSR, comparatively higher seed rates are recommended to maintain optimum and uniform plant population. For the *aus* season, the risk of early inundation during crop emergence/establishment is low compared to the T. *Aman* season; it is therefore important to identify the optimum seed rate for line sown and broadcast DSR systems.

The experiment had the following treatments: Factor 1 – establishment method (line sown DSR and broadcast DSR, and Factor 2 – variety recommended for the *aus* season (inbred variety BRRI Dhan 98 and hybrid variety BRRI hybrid dhan 7) and seed rate (30, 45, and 60 kg ha^{-1}). The trial was conducted in three farmers' fields with each field considered an experimental replication.

Results of the study show that rice grain yield was not affected by the establishment methods; it was however affected by the variety, seed rate and these factors' interaction of EM × V and V × SR (see table below). Overall, BRRI hybrid dhan 7 produced an 18% higher yield than the inbred variety BRRI dhan 98, irrespective of DSR establishment method and seed rate. Across DSR establishment methods, the yield obtained with BRRI hybrid dhan 7 was similar for all seed rates ranging from 30 to 60 kg ha^{-1} whereas for the inbred variety BRRI dhan 98, a higher yield was recorded with a seed rate of 45 and 60 kg ha^{-1} than with 30 kg ha^{-1}. This suggests that a lower seed rate can be employed with a hybrid variety than with an inbred variety of seed (see table, below). Across varieties, line seeding produced similar yields for all three seed rates; however, with the broadcast method, the highest yield was recorded with

a seed rate of 60 kg ha^{-1} and the lowest with 30 kg ha^{-1}. The yield of broadcast DSR at a rate of 45 kg ha^{-1} did not differ from that obtained from a 60 kg ha^{-1} rate.

In summary, the hybrid seed variety produced a higher yield than the inbred variety: for the hybrid variety, a 30 kg ha^{-1} seed rate was found to be optimum, whereas with the inbred variety a 45–60 kg ha^{-1} seed rate is needed to achieve optimal yield. For line sown DSR, the seed rate can be reduced to 30 kg/ha; for broadcast DSR, a 60 kg ha^{-1} seed rate gave the best yield.

Effect of different establishment methods, varieties and seed rates of DSR on rice grain yield, in *aus* 2022.

Variables	Treatments	Yield (t ha^{-1})
Establishment methods (EM)	line seeding	4.66
	broadcasting	4.53
Varieties (V)	BRRI dhan 98	4.22 b
	BRRI hybrid dhan 7	4.98 a
Seed rate (SR) (kg ha^{-1})	30	4.40 b
	45	4.78 a
	60	4.61 ab
F-values		
EM		NS
V		53.24***
SR		4.46*
EM × V		NS
EM × SR		11.82**
V × SR		12.46**
EM × V × SR		NS

NS indicates not statistically significant. ** and ** indicate significance at P<0.01and P<0.001, respectively. Data not sharing the same letters within a column are significantly different according to Tukey's HSD test at alpha = 0.05.

Effects of variety and seed rate, and establishment method and seed rate on rice grain yield in *aus* 2022

Variety	Seed rate (kg ha^{-1})	Yield (t ha^{-1})	Establishment methods	Seed rate (kg ha^{-1})	Yield (t ha^{-1})
BRRI dhan 98	30	3.69 b	Broadcast seeding	30	4.02 b
	45	4.43 a		45	4.74 ab
	60	4.53 a		60	4.84 a
BRRI hybrid dhan 7	30	5.11	Machine-aided line seeding	30	4.79
	45	5.14		45	4.83
	60	4.68		60	4.37

Above: a DSR trial plot around crop maturity stage at farmer's field in aus 2022 in Vatoi, Shailkupa, Jhenaidah. The yellowish crop is BRRI hybrid dhan 7; the green crop is BRRI dhan 98. (Photo credit: Md. Salim Billah)

A1.2 Agronomic and variety recommendations to reduce the threat of wheat blast

Wheat blast is a devastating fungal disease that appeared in Bangladesh in 2016 and affected 15,000 hectares of wheat areas, resulting in about 25%–30% crop losses and reducing wheat production of up to 85 million tons, equivalent to USD13 million. In response, CSISA initiated various agronomic and varietal development programs with BWMRI to reduce the threat and risk of wheat blast diseases. BWMRI released the blast-resistant variety BARI Gom 33 in collaboration with CSISA, demand for which is increasing at the farmer level. To fulfill farmers' seed demand, during this reporting period the Activity established 25 demonstration plots utilizing 25 farmers' fields covering three hectares of land in the Dinajpur region, in collaboration with BWMRI and DAE, and facilitated training for participating farmers and a number of dealers in wheat quality seed production and preservation. CSISA also provided technical support to local seed companies, of which seven produced a total of 81.48 tons of the new variety wheat seeds: BARI Gom 33 (33 tons), BARI Gom 32 (38.7 tons), BARI Gom 30 (8.2 tons) and WMARI 3 (1.3 tons).

Since 2016, CSISA has conducted a wheat blast surveillance program to evaluate the wheat blast early warning system (www.beattheblastews.net), developed in partnership with Universidad de Passo Fundo and EMBRAPA in Brazil and through its synergies with the now completed Climate Services for Resilient Development (CSRD) in its South Asia project, also supported by USAID. This season the surveillance program was also conducted across seven districts of Bangladesh, of which the most infection was observed in Meherpur district (where about 22% of surveyed fields were infected) followed by Bhola district (about 11% of the surveyed fields were infected). A much smaller incidence of disease was found

in Pabna, Rajshahi, Faridpur and Jashore districts (only 2%–8% of surveyed fields were infected) and Dinajpur region was completely disease-free. Although last season was not the blast pandemic season, the early warning system was fully functional and prepared to deliver the five-day disease forecast alert system for the 6,500 extension agents registered in the EWS system.

Above: training farmers in newly released wheat varieties at the Bangladesh Wheat and Maize Research Institute (BWMRI) in Dinajpur, Bangladesh. Photo credit: Alanuzzaman Kurishi

Above: Farmer Field Day on early wheat sowing in Dinajpur, Bangladesh. Photo credit: Alanuzzaman Kurishi

A2. Adding value to extension and agricultural advisory systems

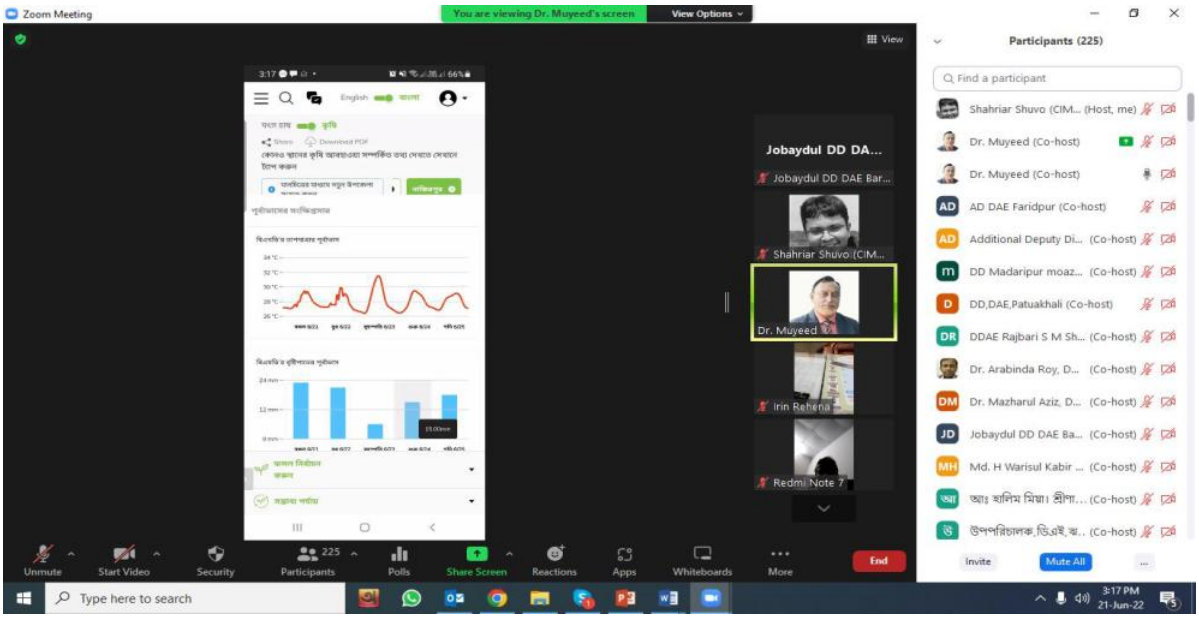
A.2.1 Strengthening the foundations of agro-advisory through knowledge organization and data integration

Building farmers' resilience using actionable climate services: national partnerships result in large-scale use of the Agvisely decision support tool

Agvisely is an agrometeorological services tool/application that offers timely, localized and reliable climate information and crop advisories for the entire country at 495 sub-district levels of Bangladesh. It was endorsed by the Government agricultural research and extension departments in 2019, and is now available in the Google Play Store and linked to the DAE, Bangladesh Agro-Meteorological Information System (BAMIS) portal and BWMRI websites. Currently, nine major crops including three rice seasons (*aus*, *aman* and *boro*), wheat, maize, potato, lentil, mung bean and mustard are available on the app.

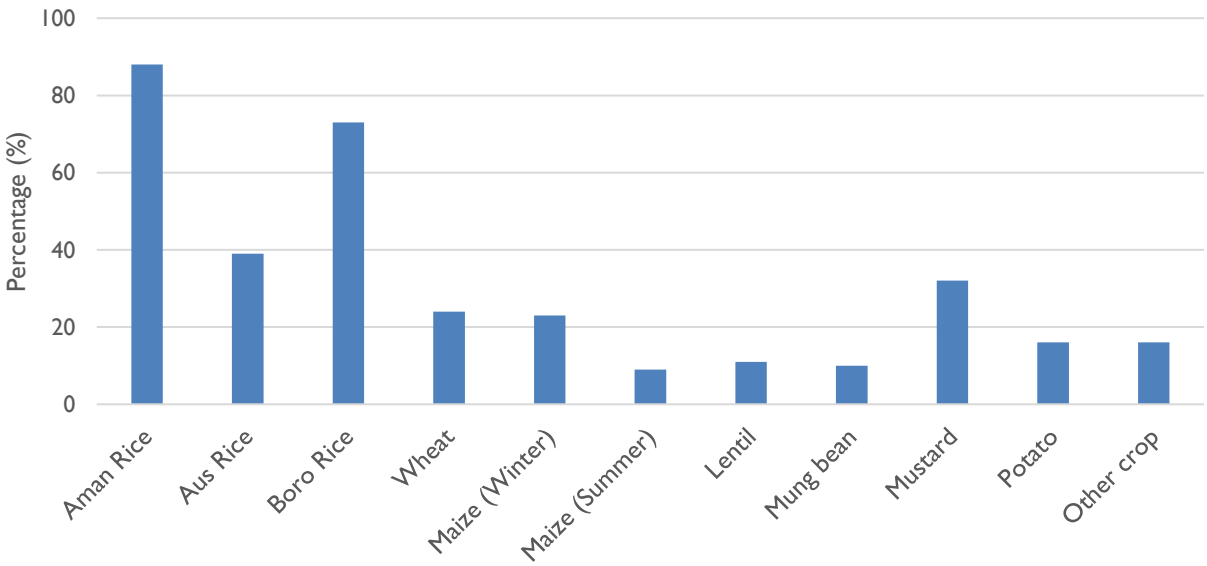
Each crop has a threshold point at its different phenological stages. Using temperature and precipitation forecast for the following five-day period at the upazila level, the likely thresholds for the phenological stage of each crop are compared to the forecast values. If the forecast is above or below the threshold, the anticipated impact on the crop is damaging and an advisory for mitigating its impact is automatically triggered. To popularize the application, CSISA organized a series of virtual meetings with all the DAE cadre officers and sub-assistant agricultural officers (SAAOs) during the 2021–22 reporting period. In most of the sessions, either the DAE Director General attended as chief guest or the respective Additional Director of the region as special guest. These virtual sessions witnessed very active

participation from DAE field officials, with most of the 1,029 SAAOs who attended registering themselves successfully during the training session. Currently, Agvisely has 7,078 registered users.



Above: CSISA conducted Zoom trainings on Agvisely, addressing the installation process, uses and how to popularize the app among DAE grassroot level officials, during the reporting period.

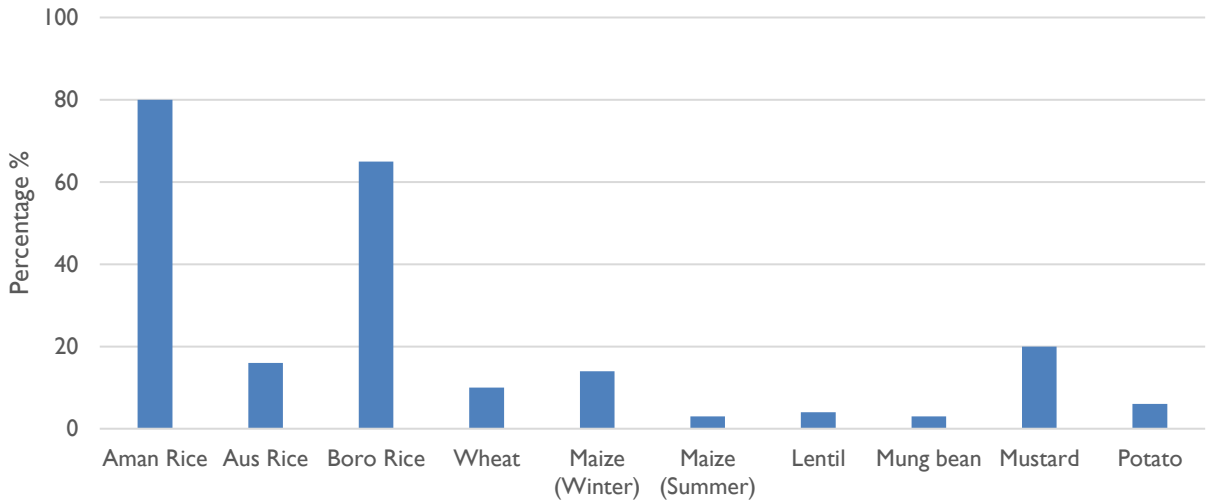
The ultimate goal for developing the tool is to provide agrometeorological advisory services to farmers at the grass-root level through the agricultural extension department, in particular through SAAOs. To understand the user experience, farmer coverage and their expectations, CSISA conducted a telephone survey among the registered SAAOs and farmers. First, 430 sampled SAAOs were selected randomly from the total number of registered SAAOs, who provided farmer's contact details. A structured questionnaire was used to collect the information from SAAOs and farmers. A team of trained enumerators were engaged for this survey with direct supervision of CSISA's MEL unit.



Above: SAAOs provided the most crop-wise advice to farmers through Agvisely.

Analysis found that almost 96% of the SAAOs installed the app on their android devices, of whom 88% received virtual training on Agvisely. Of these, 66% SAAOs used the app when they required the information, and almost 96% shared the information from the app with farmers; 87% of SAAOs shared both weather forecasts and crop advisories with farmers; 93% delivered the information face-to-face with farmers; 41% SAAOs shared it using mobile calls, informing lead farmers (38%) and via a Facebook farmers groups (8%). When sharing information, about 52% SAAOs modified the advisories to suit the local context.

A total of 587,474 farmers were reached with information derived from Agvisely by the SAAOs. Almost 99% reported receiving information from Agvisely and the majority (98%) received the information from SAAOs; 25% obtained information from neighboring farmers, followed by the Internet (13%), a mobile app (8%) and farm input dealers (5%). About 82% of the farmers surveyed received both weather forecasts and general crop advisories on pests and diseases; 89% received information directly from SAAOs and 53% through direct phone calls. About 97% of the farmers said the information was helpful and 94% shared the information with others.



Above: Farmers who received crop-wise weather advisories derived from Agvisely and delivered by extension agents employed by DAE during the reporting period.

Stempedia: development of a weather forecast-driven early warning system for lentil crop diseases

Background

Lentil, an essential component of many cropping systems in South Asia, is constrained by the fungal disease *Stemphylium blight* (SB). Its management through manipulation of genotypes is limited, and calendar-based fungicidal control, with three applications, is recommended for disease control; however, this is not always effective or profitable, as the severity of the disease (which is driven by weather conditions) varies between years and locations. To ascertain the actual number of need-based fungicide applications, the CSRD project and subsequently CSISA III attempted the development of a weather-based model. Consequently, the Stempedia model was developed, calibrated and validated through multi-country, multi-location and multi-year large-scale farmers' field survey data. Further, using the validated model, CSISA developed a weather forecast-driven early warning system for precision, on-time-no-less-no-excess-frequency application of fungicide to control *Stemphylium blight* (SB–EWS) disease. The previous CSISA III report presented the success of the forecast validation in the farmer's field in both Bangladesh and Nepal, and national endorsement of SB–EWS in Bangladesh.

Activities during the reporting period

The Activity prepared a Plan of Action was prepared to hand over the SB–EWS to interested national agencies in Bangladesh. The Director General of DAE expressed by letter (15 September, 2021) to CSISA their wish to take over operational ownership and dissemination of EWS, resulting in the Activity organizing a meeting (21 October, 2021) to discuss the incorporation of the CSISA-innovated 'Stempedia model-based weather forecast-driven early warning system for precision fungicide application on controlling *Stemphylium blight* (SB–EWS) disease of lentil' into the Bangladesh Agro-Meteorological Information Systems (BAMIS) portal (the portal is run and maintained by DAE).

CSISA III in Bangladesh had been exploring ways to resolve the issue of availability of forecast sunshine hours (an essential weather variable for the Stempedia model); this challenge is however still not resolved. The Activity conducted further consultations with national partners on the availability of denser grid data for the forecasting system; in the meantime CIMMYT Bangladesh acquired access to such data, meaning that a team in CIMMYT Bangladesh could be formed and use the forecast weather data to work on the development of the SB–EWS. The next step is to validate the system, after which it will be used to forecast the risk of SB and provide a fungicide application advisory during the 2022–23 growing season. This will then be applied in Bangladesh and negotiation carried out to introduce its application in Nepal.

A.2.2 Building precision nutrient management approaches around scaling pathways

This activity was de-emphasized by CSISA after funding shortfalls and delays experienced in 2017 and 2018, which resulted in the departure of scientific staff leading the research. Since then, only limited work on precision nutrient management has been conducted in Bangladesh. As such, and as indicated in previous reports, no major activities were undertaken in this work package during the reporting period.

A.2.3 Aiding the Fight Against Fall Armyworm in Bangladesh

Fall Armyworm (FAW), an invasive Lepidopteran crop pest native to the Americas, migrated to Africa in 2016. FAW feeds on more than 80 species of plants, but maize (*Zea mays)* is its preferred host. Although the species causes limited damage to maize in the Americas – a condition that is likely the consequence of its long-term presence there and strong degree of biological control and availability of cultivars with plant resistance – migration of FAW from North America has been unprecedented and concerning. 2018.

The USAID/Bangladesh and Michigan State University supported Fighting FAW Activity, which ran from 2019-2022, tackled these issues by generating evidence and developing educational strategies to facilitate FAW IPM training for the public and private sector, while also addressing institutional issues needed for efficient FAW response. The Activity is implemented by the International Maize and Wheat Improvement Center (CIMMYT) and commenced efforts in late 2019 and through September of 2022 supported the response to FAW in Bangladesh. Importantly, the Activity collaborates closely with other USAID Implementing Partners, most notably the Cereal Systems Initiative for South Asia (CSISA) which co-financed activities during the reporting period. The Fighting FAW activity was also aligned with the FtF Bangladesh Integrated Pest Management Activity, supported by USAID/Bangladesh and led by Virginia Tech University since its inception in 2021.

Key research highlights of these synergistic activities that benefited from CSISA staff technical support and time during the reporting period include the following activities, in which CSISA scientists were involved in supporting national agricultural research partners in Bangladesh.

- Field surveys were conducted in Saturia *upazila*, Manikganj district, Burirhat, Rangpur, and the

research field at BARI, Gazipur, between December 2021 and June 2022, to identify and assess the abundance of FAW's natural enemies attacking the maize crop. FAW was collected fortnightly at various points in its life stage (egg mass, larvae and pupae) from 10 randomly selected farmers' maize fields in Manikganj and three fields each in Rangpur and in Gazipur. Two species of egg parasitoid (identified as *Telelomus remus* and *Trichogramma pretiosum*), two species of larval parasitoid (*Cotesia* sp. and *Campolities* sp.), and one species of pupal parasitoid (*Brachymeria euploeae*) were found parasitizing the FAW egg mass, larvae and pupae in the farmers' fields in Manikganj. They were identified using available taxonomic keys, and their identity confirmed by molecular analysis. In Manikganj the egg mass parasitism rate by the two egg parasitoids (*T. remus* and *T. pretiosum*) was 20% and 1.74%, respectively, and 7.96% by *Trichogramma pretiosum* along with *Telenomus remus*. Larval parasitism by *Cotesia sp*. and *Campolities sp.* was 0.28% and 0.14%, respectively; pupal parasitism by *Brachymeria* sp. was 5.88% (Table 2). At Gazipur, egg parasitism by *T. remus* was 31.25%; larval parasitism was not found. Similarly, at Rangpur, egg parasitism by *T. remus* was 16.67%, and there was no larval parasitism.

- A study on the potential of using *Spodoptera litura* eggs for mass-rearing *Telenomus remus*, a promising egg parasitoid of FAW (*Spodoptera frugiperda*): was conducted to observe the parasitization efficiency of *T. remus* on eggs of the common cutworm *Spodoptera litura* (*S. litura*), in the IPM laboratory of the Entomology Division, BARI, Gazipur, May–June 2022. A no-choice test used test tubes as study areas and fresh eggs of the *S. litura* host. The eggs were collected from a stock culture of common cutworm at the IPM laboratory and were up to 24 hours old (that is, up to 24 hours after female oviposition). Results showed that *T. remus* developed successfully on *S. litura* eggs, with the rates of parasitization and adult emergence greater in second generation eggs: the percentage of parasitized eggs was 34.14 in Generation 1 and 53.36 in Generation 2; the emergence rate was 51.84 in Generation 1 and 63.55 in Generation 2. Thirteen to fourteen days were required for the emergence of the *T. remus* adult from the eggs; female-biased progeny were found in both generations. The results indicate that *S. litura* eggs are suitable as an alternative host for mass-rearing *T. remus*, although further studies are needed using fresh eggs and younger parasitoids.
- Farmers FAW pheromone traps located in their fields participated in a severity, incidence and management survey as part of these projects, with data analysis supported by CSISA. For 2021-22 Rabi season, 397 farmers had pheromone traps located in their fields, The third round of survey collected data from 297 farmers of the farmers with traps located in the fields in September 2022. Similar to other two rounds, data was collected by telephonic surveys. The data generated in 2019-20, 2020-21 and 2021-22 is used to assess the damage levels caused by fall armyworm using structural equation models. The completed model results shows moth counts in pheromone traps significantly predicted the combined damage score reported in the field showing the efficacy of the monitoring program. In case of 1st and 2nd round of survey, around 50% of farmers expressed that they are only partially confident on controlling FAW in their field while it dropped to 35% in third round of survey. The spaying behavior *i.e.* scouting and proper spraying of pesticide offset the yield damage by 0.3 tons per ha – an important result and as or more relevant than the number of pesticide sprays. Around 35-40% of the surveyed farmers are using more effective scouting techniques for FAW, which shows the effectiveness of the extension efforts, but continued support is required.

B. SYSTEMIC CHANGE TOWARD IMPACT

B1. Partnerships for inclusive growth around commercial pockets and neglected niches

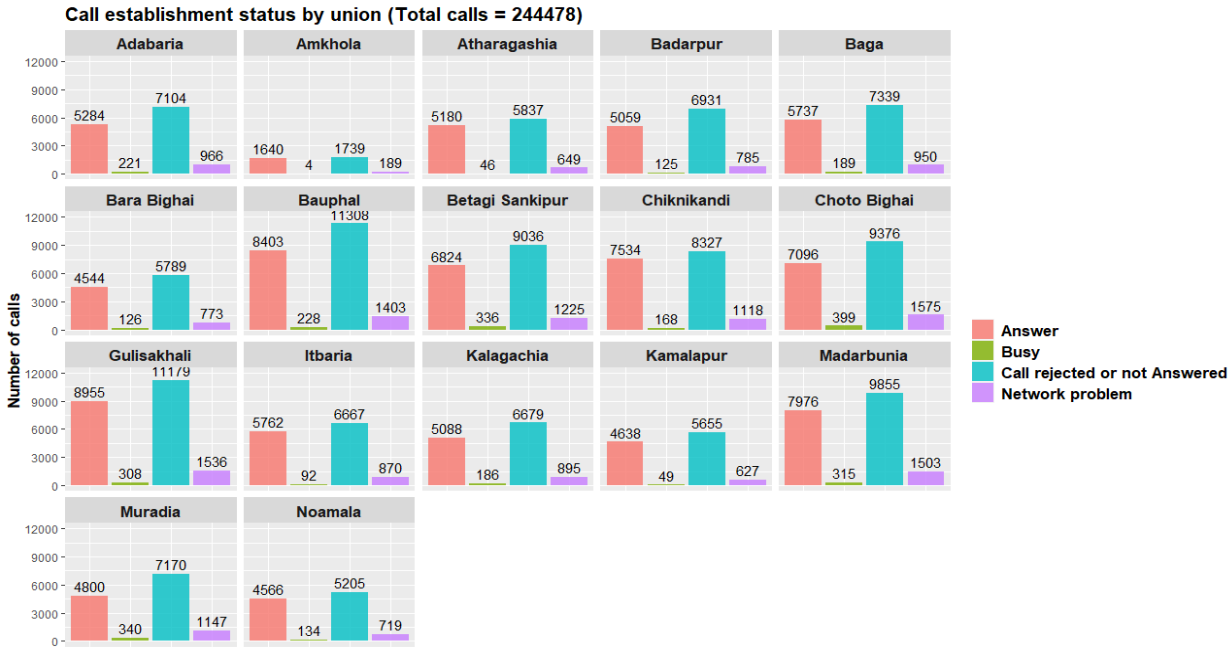
B1.1 Deployment of better-bet agronomic messaging through input dealer networks and development partners

B1.2 Building farmers' resilience to weather shocks and replacing fallow land with mung bean in Bangladesh: protecting against crop damage with climate services

Mung bean is a highly profitable legume crop, widely cultivated in the southern central coastal region of Bangladesh, especially Patuakhali, Barguna and Barishal districts. However, every year during the peak of the harvesting period, heavy rain and storm events from April to May cause large yield losses (and thus income loss) to mung bean farmers. In response, in 2019 CSISA partnered with a now-closed EKN and Mott MacDonald-funded pilot project (which ran from 2018–20) that built an interactive voice response (IVR) system for mung bean farmers in some coastal areas of Bangladesh (Patuakhali and Barguna districts). This IVR system provides real-time weather alerts, warning farmers to harvest their mung bean ahead of forecasted heavy rainfall events which could damage their crop. The system is interactive, in that farmers can push-dial to listen to the rainfall forecasts for four days with harvest advisories maximum for two times. Any farmer whose mobile phone number is registered in the IVR system can also dial 0960 450 0060 at any time to hear updates from the system. Details on work during this reporting period can be found below.

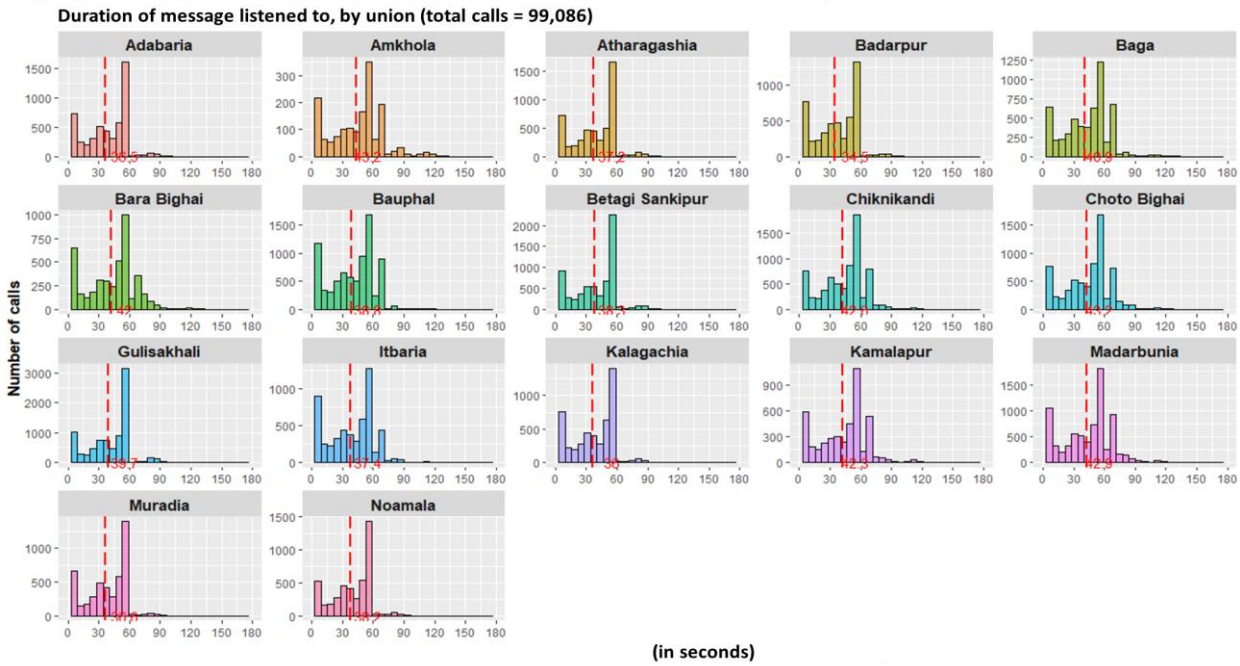
Activating the mung bean IVR system to deploy IVR calls on rainfall forecasts during the 2022 mung bean harvesting period: Based on the previous year's (2021) performance and evaluation, CSISA renewed the contract with ARENA Phone BD Ltd. to active the mung bean IVR system. The renewal contract process was completed before the mung bean harvesting season in Feb 2022 so that the system could be ready to deploy IVR calls on rainfall forecasts during the season.

Deploying IVR calls on rainfall forecasts during the 2022 mung bean harvesting period: CSISA issued a total of 2444,478 IVR calls to 10,446 mung bean farmers (668 women, 9,778 men) in 17 selected unions between 5 April– 22 May 2022, which was during the peak of the mung bean harvesting season. As there were no rain forecasts in March (year 2022) and the mung bean pods did not mature during that period, the team issued no IVR calls to the farmers in March. At the start of harvest the model forecast mainly no rain; nevertheless, the team issued IVR calls conveying 'no rain' information twice a week to avoid farmer anxiety.



Above: number of IVR mung bean harvesting alerts provided to farmers in 17 unions between 5 April–22 May, during the peak of the mung bean harvesting season.

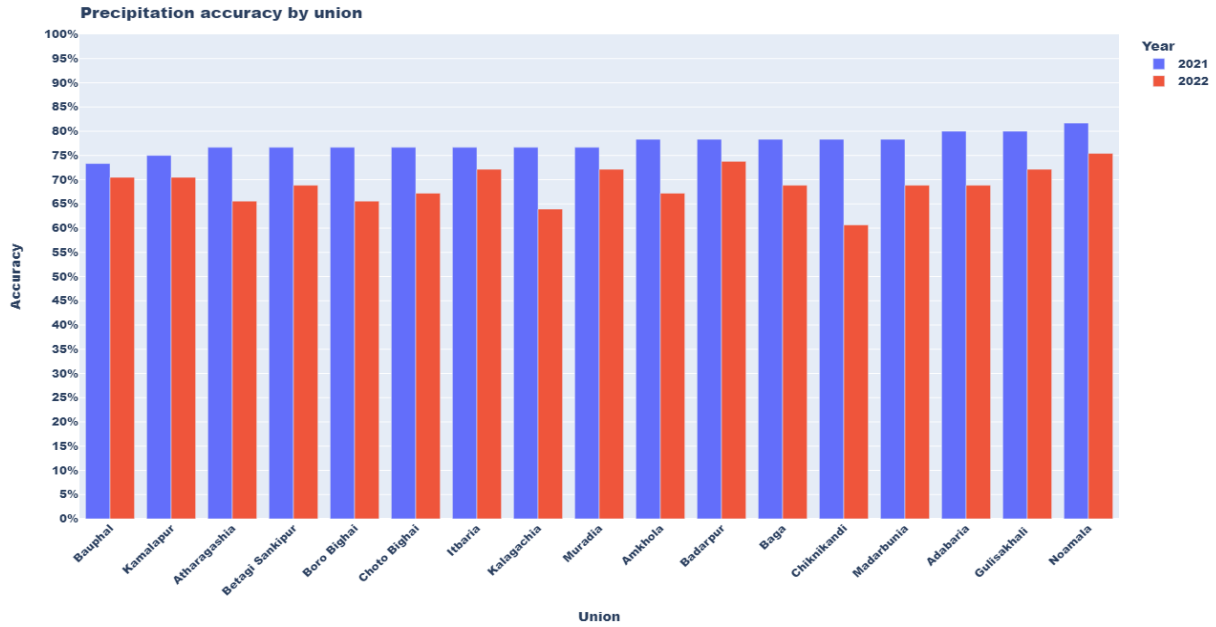
The CSISA research team analyzed the IVR call data and found that of the 310,269 location-specific advisory IVR calls automatically generated by the system, 99,086 (41%) were successfully received and listened to by farmers. The remaining 145,392 (59%) failed to reach the end user. The number of calls received was higher in Gulisakhali, Bauphal, Maderbunia, Chiknikandi, Choto Bighai and Betagi Sankipur unions during the 2022 mung bean harvesting season. The main reason for call failure was "call rejected/no answer" (86%); other reasons were network failure (12%) and mobile number busy (5%). Farmers can call the IVR system any time to hear updated messages and around 11,747 incoming calls were received between 5 April and 22 May 2022 during the peak of the mung bean harvesting period.



Above: IVR messages listening durations by the farmers in 17 unions, 5 April–22 May 2022. The dotted vertical line in each histogram indicates the average voice message listening duration in seconds by the farmers.

The above graph depicts the total IVR messages listened to and for how long by the farmers who took the calls, in selected 17 unions from April–May 2022. As in 2021, the duration of the whole voice message including advisories was between 40–72 seconds depending on the recipient's gender, forecast combination style and location (see CSISA PIII Annual Report, October 2020–September 2021). The variation results from the ways the messages are customized, as per these factors. The figure shows that most of the calls listened to by farmers were more than 35 seconds on average, indicating that most farmers listened to the full call before hanging up.

Forecast validation during the 2022 mung bean harvesting season: Like the 2021 season, during the reporting period CSISA trained 51 male mung bean farmers (6 March – 7 June 2022) to collect rainfall data from 51 rain gauges in 17 unions (see CSISA PIII Annual Report (October 2020–September 2021)). During the mung bean harvesting season (05 April–6 June 2022), the rainfall forecast model (using the UK Meteorological Office data) predicted heavy/very rainfall events for two days, light rainfall events for eight days, and no rain events for 51 days in 17 selected unions. CSISA's analysis of the observed rainfall data collected from 51 rain gauges in the 17 unions showed that an average of 69% of the rainfall forecasted was correct, matching the actual rain events. Among the 17 unions, Noamala had the highest forecast accuracy (75% in 2022), followed by Badarpur (74% forecast accuracy) and Gulisakhali, Itbaria and Muradia unions (each with 72% forecast accuracy) (see Annex 4)

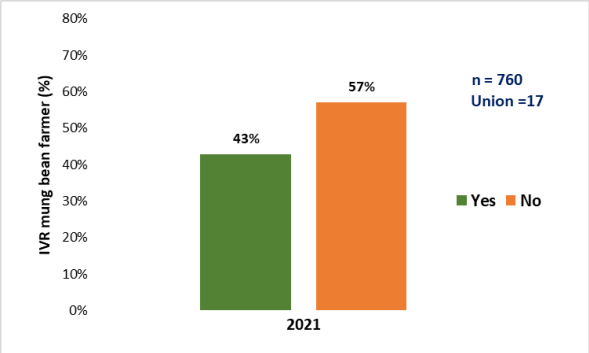


Above: Union-wise precipitation forecasts accuracy in two years (2021–222). In 2021, precipitation forecast data were obtained from the Bangladesh Meteorological Department (BMD); in 2022, the data were obtained from the UK Met Office due to a technical issue at BMD.

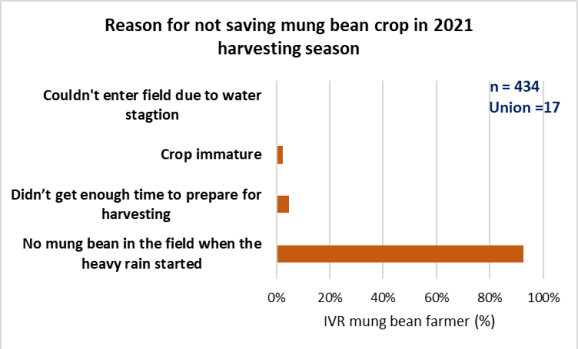
The 2022 forecast accuracy (using the UK Met Office's forecast data dure to interruptions in forecast delivery from the Bangladesh Meteorological Department (BMD)) is lower (69%) than that of 2021, which used BMD forecast data and was on average 77%. Due to technical issues at BMD, CSISA was not able to utilize the department's forecast data during the 2022 mung bean harvesting season and instead used data derived from the UK Met Office's 'Global 10 km' model.

Monitoring and evaluation of the 2022 climate-smart IVR pilot: After the 2022 mung bean season, 14 CSISA staff members conducted a telephone survey (10 July -26 September 2022) of a total of 1,565 mung bean farmers from 17 unions to monitor and evaluate the IVR study. Of the 1,565, 785 (62 women, 723 men) were randomly selected from the IVR call group; the rest (57 women, 723 men) were from the control group who had received no IVR calls during the mung bean harvesting period. At the time of writing, the CSISA team has started cleaning and processing the survey data for analysis. The results will be presented in the next report.

Summary of the telephone survey results in 2021: The CSISA PIII Annual Report (October 2020–September 2021) stated that the major findings from the telephone survey conducted after the 2021 mung bean season would be presented in this current report. Responses from a total of 760 farmers' (from the IVR group in 17 locations) were analyzed after cleaning the survey data. Of these, 326 (43%) saved their crop from heavy rainfall.

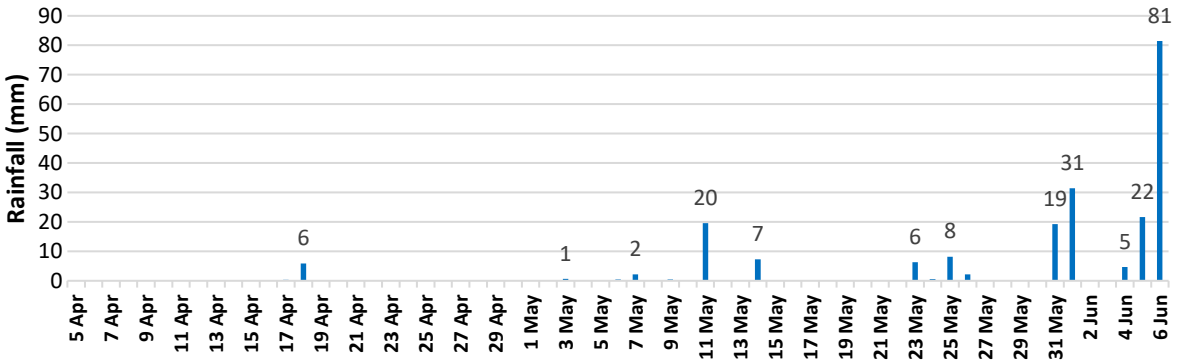


Above: response to the question "Do you think you saved the mung bean crop by harvesting early in response to the voice calls about the heavy rainfall forecast during the mung bean harvesting period".



Above: response to the question "The reason for not saving the mung bean crop by harvesting early in response to the voice calls about the heavy rainfall forecast during the mung bean harvesting period".

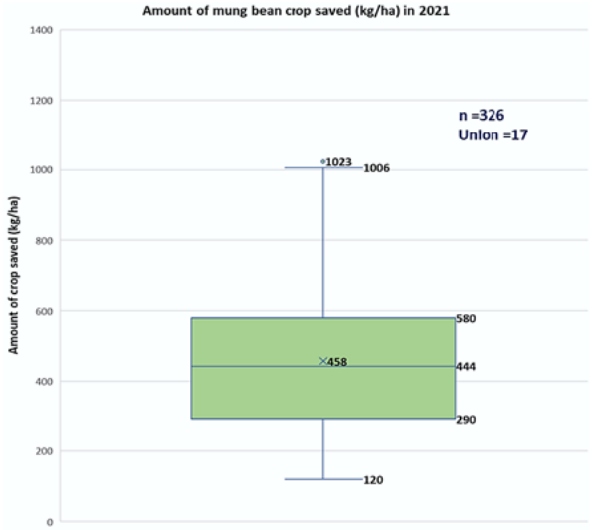
The main reason farmers reported not responding to the IVR calls was that 93% (402) harvested their mung bean before the heavy rains came, meaning that there was no crop in the field to harvest when they received the IVR voice messages; 5% of the farmers had insufficient time to prepare for harvesting, and the remaining 2% said their crops were immature and not ready to harvest. The above graph below that the heavy and very heavy rains came very late in 2021 and the survey found that most of the farmers had harvested the mung bean crop before the rains came.



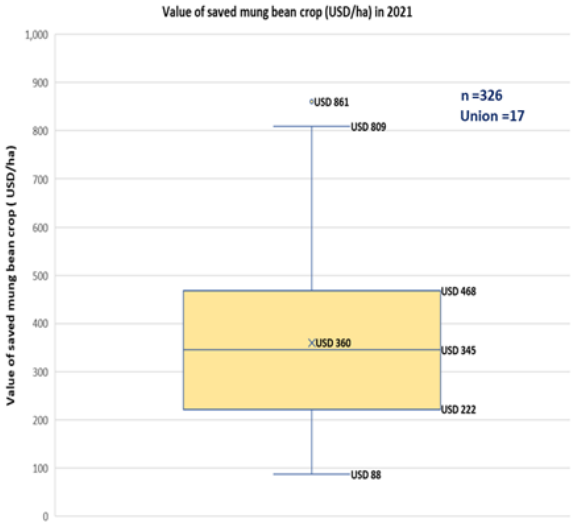
Above: Daily rainfall (mm) in the Patuakhali district during the mung bean harvesting period (5 April to 6 June), 2021. Source: CSISA rain gauge, Patuakhali

Above: *Farmers in Patuakhali, Bangladesh who actively used IVR alerts to save their mung bean crop. Photo: Timothy Krupnik.*

One of the survey's major findings is that the farmers who received IVR voice calls and took immediate action (harvesting early, opening/cutting drains around the field, moving all harvested/dried mung bean under shelter) saved on average 74% of their mung bean crop from the heavy/very rainfall events (see Annex 4).



Above: box-plot distribution of the amount of mung bean crop saved in (kg/ha) by harvesting early in response to the voice calls on the heavy rainfall forecast during the mung bean harvesting period in 2021.



Above: box-plot distribution of the value of mung bean crops saved in USD/ha by harvesting early in response to the voice calls on the heavy rainfall forecast during the mung bean harvesting period in 2021.

The graphs above show the distribution of the amount (in kg) and value (in USD) of mung bean crops per hectare of the farmer's biggest mung bean plot saved from the heavy/very rainfall damage after receiving IVR calls. In the survey, farmers reported saving on average 454 kg/ha of mung bean from heavy/very rainfall damage during the 2021 mung bean season after receiving IVR, which is worth USD 360 per hectare (BDT 4,088 per bigha/33 decimal).

The 737 farmers who stated they wanted the mung bean IVR service in 2022 were next asked about their willingness to pay a one-time payment per mung bean harvesting season (April–June) for the service when CSISA's involvement ended. The majority (68%) expressed a willingness to pay; 17% of farmers were not willing to pay because (1) they believed government should pay for the service, (2) their

financial condition was poor, and (3) they were able to obtain weather information from other sources. The remaining 15% said they needed to consult with family members before making a decision.

The 386 farmers willing to pay for the IVR service if the CSISA Activity ends next year were asked how much they could pay in BDT per mung bean harvesting season. The findings show that farmers can pay on average BDT 84 (less than USD1) per season.

Sustainable business models for mung bean interactive voice response-based advisory services:

To ensure the future sustainability of the mung bean IVR system service, in May 2022 CSISA put out a call for innovative business models (see EOI circular link: here). Nine companies/organizations expressed their interest, and based on a SWOT analysis (see Annex 5), CSISA selected five, of which three (Weather Impact, M-Word, and iPAGE Global BD) agreed to a Zoom meeting (29 August–5 September 2022).

CSISA's meeting objectives were to (1) explain the Activity's IVR weather alert service and its future, (2) explain what CSISA would expect from the selected company in terms of continuing the IVR service from 2023, (3) understand the company's idea for continuing the service and its sustainable business model, and (4) discuss ways to support the service moving forward in a sustainable way.

CSISA has planned face-to-face meetings with two of the three companies (M-word and iPAGE Global BD) in October (the third company, Weather Impact, dropped out after the Zoom meeting). These meetings aim to understand how technically (in terms of technical capacity and opportunities) and financially (in terms of expected revenue streams) the two companies would sustain the IVR service in a profitable way to ensure a win for both farmers and the company. The meeting findings will be presented in the next CSISA report.

B1.3 High-value, premium quality rice (PQR) expansion in Bangladesh

To increase farmers' profitability in rice production, CSISA has been working to expand the cultivation of premium quality rice (PQR) since Phase III of the Activity was initiated in 2016, starting in south-west Bangladesh (the Khulna region), and in 2019 in the northern region (Rangpur and Dinajpur). To begin with, BRRI dhan 34 (a traditional variety of PQR) was selected for the *aman* season, and BRRI dhan 50 and BRRI dhan 63 (modern PQR varieties) for the *boro* season. After the first season of expansion work with BRRI dhan 34, CSISA discovered severe issues with loading and neck blast in south-west Bangladesh and so replaced this traditional PQR variety with BRRI dhan 75 and BRRI dhan 87 for the *aman* season. These two varieties were accepted by farmers in the 2017 *aman* season and performed better than BRRI dhan 34. Both the modern PQR varieties selected for the *boro* season performed well in terms of yield and grain quality, since when farmers have expressed a preference for them.

During its PQR expansion activities, CSISA found there were no established market channels for these varieties, with the result that traders were showing no interest in purchasing them or providing a premium price to farmers. To address this, the Activity started working with local paddy traders (*farias* and *arotdars*) and auto rice mills to introduce them to the new PQR varieties and to ensure that the high quality translated into a premium price for farmers. In collaboration with DAE and lead farmers, CSISA established several collection points in its working areas, where local traders and auto rice millers could purchase a large volume of quality PQR paddy directly and provide a fair premium price to farmers. The Activity also worked on developing a post-milling market channel, by introducing both local and city level rice traders to new varieties of PQR. In collaboration with several auto rice mills; a few one kilogram sample packs were provided to the traders to distribute to their elite customers who had a preference for premium rice. CSISA thus developed an integrated market channel to establish a premium price for PQR varieties.

To facilitate the expansion of PQR production at the farm level, the Activity has been working with DAE, local seed companies, NGOs and farmer groups. To kick-start this, CSISA provided a sub-grant to local seed companies, and PQR seeds to farmers free of cost. As a result, significant numbers of auto rice mills began milling BRRI dhan 50 and BRRI dhan 63 and marketing them throughout Bangladesh under the brand names Bangla Bashmoti and Banglamoti, and in Dhaka as Jashore Bashmoti. CSISA's efforts have resulted in Jashore becoming positively associated with the Bashmoti brand, with demand for this variety increasing daily. By switching from non-PQR to PQR rice varieties, farmers throughout CSISA's two working areas are now realizing 10%–20% higher profits. Where CSISA has a presence in south-west Bangladesh, around 30%–40% of farmers' fields are occupied by PQR *boro* varieties and 10%–20% by PQR *aman* varieties.

High-value premium quality rice expansion and market development activities in Khulna division. CSISA has two field offices in Khulna division. During the reporting period, the Jashore field office worked mainly with six local seed companies, local traders, DAE and at least 12 auto rice mills to facilitate PQR seed multiplication, branding of PQR varieties and marketing using the variety's actual name. The Faridpur office worked with two local seed companies and two auto rice mills, DAE and a farmers group on the expansion and branding of PQR varieties. The specific activities conducted in the Khulna region during the reporting period are:

Working with local seed companies to facilitate the multiplication of PQR seeds. CSISA supported local seed companies to obtain access to PQR breeder seeds from BRRI, and provided training to their staff and their contract farmers in quality PQR seed production. During the reporting period, eight local seed companies produced and sold around 400 tons of PQR seeds in the CSISA working areas.

Above: top left: linkage meeting at Jahurul Auto Rice Mill, Kaliganj, Jhenaidah. Photo credit: Md. Salim Billah; top right: PQR festoons developed by CSISA, distributed to stakeholders. Photo credit: Md. Salim Billah; bottom left: linkage meeting at Satota Auto Rice Mill, Dakbangla, Jhenaidah. Photo credit: Md. Salim Billah; bottom right: linkage meeting at Shiraj Auto Rice Mill, Alamdanga, Chuadanga. Photo credit: Atik.

Conducting PQR linkage events. CSISA organized six business linkage meetings with a total of around 150 participants, including representatives of auto rice mills, local seed companies, lead farmers, local traders and DAE field-level staff, to link the stakeholders relevant to achieving PQR expansion and integrated market channel development.

Working with auto rice mills on the branding of PQR varieties BRRI dhan 63 and BRRI dhan 75. Most auto rice mills in the Khulna region mill BRRI dhan 50, usually mixing it with BRRI dhan 63 and selling it under the name of Bangla Bashmoti, Bashmoti or Banglamoti. This reporting period, CSISA worked with 10 auto rice mills on the separate branding of each variety and the use of its original varietal name ('Bangla Bashmoti BRRI 50' for BRRI dhan 50 and 'Bangla Bashmoti BRRI 63' for BRRI dhan 63). Eight auto rice mills milled around 16,000 tons of BRRI dhan 63 rice using its actual name and without mixing it with BRRI dhan 50. In addition, for first time in Bangladesh two auto rice mills branded BRRI dhan 75 using the name 'Premium BRRI 75', producing 750 tons.

Combined harvester use and service provision to harvest PQR. In collaboration with CSISA–MEA, about 756 farmers received combined harvester services to harvest their PQR varieties, especially in the *boro* 2022 season.

Festoon distribution. A total of 120 festoons were distributed to seed companies, DAE, input dealers (seed, fertilizer, pesticide) and auto rice millers for the promotion, branding and demand creation of PQR varieties throughout the Khulna region.

High-value premium quality rice expansion and market development activities in Rangpur division. In 2019, CSISA started work on PQR expansion in Rangpur division, following more or less the same strategies it had applied in the Khulna region. During this reporting period, the CSISA Dinajpur office conducted several promotional activities and linkage programs with stakeholders for the expansion and integrated market systems development of PQR varieties:

- **Farmers group formation to facilitate community-based PQR expansion**. With the support of seed companies, auto rice mills and DAE, in the *boro* 2021–22 season CSISA identified and formed 30 new PQR groups totaling 805 farmers (125 women, 680 men). Together with the 79 groups already established in the Khulna region, the Activity worked with a total of 109 PQR farmers groups, providing them with technical support for the production and marketing of PQR.
- **Capacity building for collaborative partners**. CSISA conducted 13 batches of training for lead farmers/PQR group leaders, SAAOs and seed company technical personnel, totaling 287 participants, focusing on the production of PQR healthy rice seedlings through community-based seedbeds, good agronomic practices, post-harvest management, and market linkage strategy. The training equipped participants to provide technical information to PQR farmers.
- **PQR seed production and marketing through seed companies and lead farmers**. CSISA worked with six local seed companies to increase availability of quality PQR seed at the local level. This involved providing technical support, including three batches of training, to seed companies to enhance their skills in quality seed production and preservation, and facilitating market expansion through meeting/training/visiting with seed company farms. During the reporting period, CSISA's partner seed companies and PQR farmers retained a total of 63.5 tons

of *boro* PQR seed (BRRI dhan 50 and BRRI dhan 63) for the next *boro* season, and 38 tons of *aman* PQR seed (BRRI dhan 75 and BRRI dhan 87) were sold and disseminated in Rangpur division through seed companies.

- **PQR grain marketing through collection points to facilitate a premium price**. The Activity conducted four market linkage meetings involving PQR lead farmers and owners of auto rice mills. These resulted in the formation of a total 16 of collection points facilitating PQR paddy sales directly to auto rice mills, with the aim of ensuring a premium price for PQR varieties.
- **Milling and branding PQR using its original varietal name through auto rice mills**. CSISA has worked with eight auto rice mills to brand PQR varieties using their original variety name. This included Shamsul Haque Auto Rice Mills Pvt Ltd and Bengal Auto Rice Mill, which branded 1500 tons of BRRI dhan 50 using its actual name. For the first time ever in Bangladesh, BRRI dhan 87 was also branded under its varietal name, with Shamsul Haque mill producing 30 tons.
- **Awareness-building activities**. CSISA organized one farmer field day (FFD) with 120 participants in the summer monsoon *aman* 2021 season to facilitate the branding, quick expansion and popularization of the BRRI dhan 87 variety in the region**.** The Activity also distributed about 10,000 leaflets on healthy rice seedling production for PQR varieties, 1000 copies of a handout on PQR blast management, and 60 festoons promoting PQR.

Above: top left: PQR training at Nilphamari. Photo credit: Kanai Lal, IRRI; top right: a PQR collection point, Dinajpur. Photo credit: Bappy); bottom left: BRRI dhan 87 branding by Shamsul Haque Auto Rice Mills. Photo credit: Kanai Lal, IRRI; bottom right: a branded packet of BRRI dhan 87 milled by Shamsul Haque Auto Rice Mills. Photo credit: Kanai Lal

Challenges and learning of PQR expansion

CSISA–MEA conducted a survey of local seed companies and DAE on PQR seed production and cultivating PQR varieties in CSISA working areas. Data collected from DAE offices indicated that in *aman* 2021, PQR varieties were cultivated in 79 of their 107 upazilas and that a total of 934,196 farmers cultivated PQR on 215,145 hectares of land. The variety name, land coverage and total production were as follows:

Variety	Total land (ha)	Total Number of farmers	Total production (unprocessed) (tons)
BRRI dhan 87	56,611	269,230	282,085
BRRI dhan 75	43,777	194,223	205,718
BRRI dhan 34	91,387	368,068	307,376
BINA dhan 17	23,370	102,675	117,873
Total	**215,145**	**934,196**	**913,052**

During the reporting period the CSISA III team also worked with 12 seed companies[5] in nine of the country's districts: Narail, Chuadanga, Jhenaidah, Meherpur, Kusthia, Faridpur, Nilphamari, Dinajpur and Rangpur. Seed company representatives stated that a total of 695.35 tons of PQR seed were sold in these nine districts in the *aman* 2021 season. Based on this, it was estimated that this involved a total of 115,892 farmers (at an average of five farmers per hectare), and that 23,178 hectares of land (at an average of 30 kg of seed per hectare) were covered by their sold amount. Detailed data regarding the total quantity of rice sold according to variety is as follows:

Number of districts covered	9
Number of seed companies	12
BRRI dhan 34 sold (tons)	83.45
BRRI dhan 75 sold (tons)	287.34
BRRI dhan 87 sold (tons)	224.50
BINA dhan 17 sold (tons)	100.06
Total seed sold (tons)	**695.35**
Total Number of hectares of land coverage (at an average of 30 kg seed per hectare)	**23,178**
Total farmer coverage (at an average of five farmers per hectare)	**115,892**

Key challenges identified by the research team and opportunities for future interventions are summarized below:

- Traditional PQR varieties have a very lower yield; also, most grow to a tall height, which makes lodging a concern. Their growth duration is also usually 140–160 days.

[5] UOMCSL, Modern Agro Seed Pvt Ltd, Friends Seeds Pvt Ltd, Adorsha Chashi Ghar, One X Crop Care Square Seed Ltd, BADC Chuadanga, INSAF SEEDS, Nur Seed, SRIZON AGRO, Nilsagor Agro Industries Ltd, J. R. Agro, and BRAC Seed and Agro Enterprise.

- Compared with modern PQR or even non-PQR varieties, the profitability of traditional PQR is low.
- Except for a few locations, the market system for PQR is not well-established all over Bangladesh.
- Although the *boro* season has several good modern PQR varieties the same cannot be said about *aman* season PQR varieties.
- Modern PQR seed is not available at the local level.
- Cultivating modern PQR varieties is the easiest intervention to increase farmers' profit.
- Big national companies currently market mostly traditional PQR and not modern PQR.
- Farmers often fail to obtain the premium price for PQR varieties due to the absence of a market system for PQR.
- In general, PQR varieties are comparatively more susceptible to disease and pest infestation than non-PQR varieties.

There is further scope to focus on developing best practices to boost production and efficient management of PQR by region, and to link production with the different stakeholders in the value chain. Together, this will increase the quality of the rice, its profitability, and the overall income of the stakeholders in the PQR rice value chain in Bangladesh.

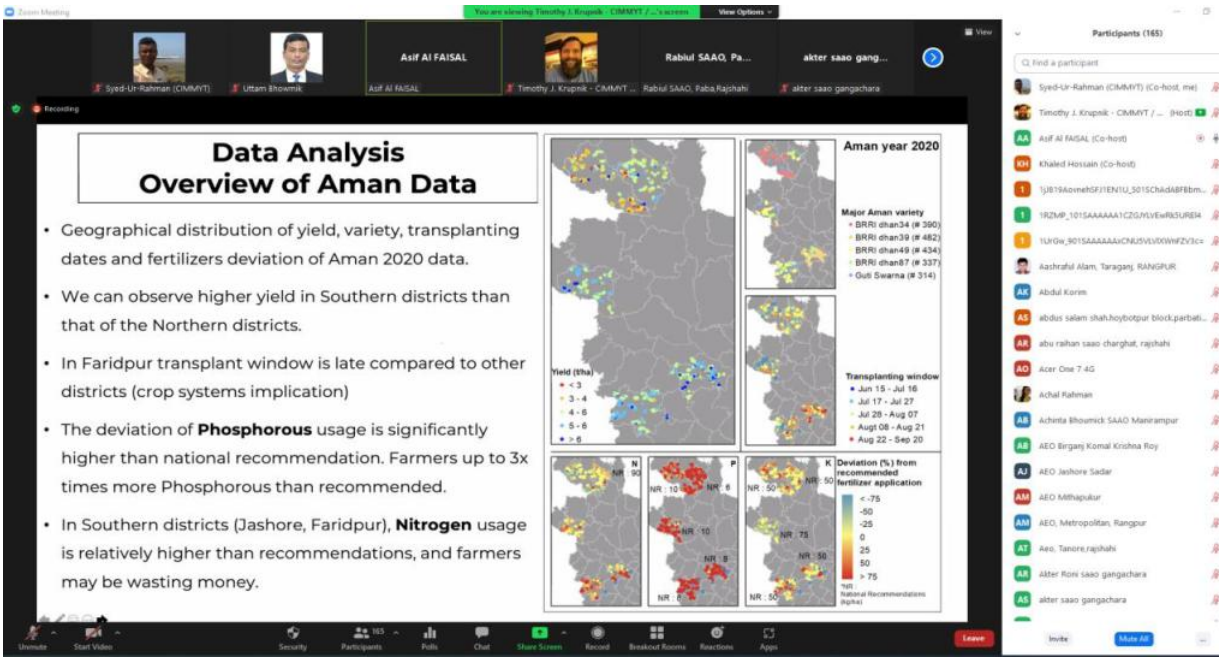
B2. Bringing participatory science and technology evaluations to the landscape and back again

B2.1 Increasing the capacity of the National Agriculture Research and Extension System to conduct participatory science and technology evaluations

This CSISA workstream suffered setbacks and delays in 2017 and 2018, resulting from the uncertainty in Activity funding. Despite these issues, CSISA however was able to attract additional synergistic and complementary funding from the CGIAR Research Program on Climate Change, Agriculture, and Food Security (CCAFS) through the project Big data analytics for climate-smart agricultural practices in South Asia (Big Data^2 CSA). Funds invested by CCAFS were a complement to the USAID investments by CSISA to work with national partners – most notably DAE – to collect crop cut data and management practice information from farmers at a large scale. These data have been used characterize the challenges farmers face and to identify, using novel machine learning and data mining analytics, new methods and ways that famers can increase productivity and resilience while reducing their environmental impact. Key activities are detailed below.

Big data and large-scale agronomy diagnostics

This reporting period, DAE expressed an interest in modernizing and digitalizing its regular national program on seasonal crop cuts and estimating regional yields. In response, CSISA worked to support and coach DAE to conduct thousands of crop cuts and production practice surveys for *boro* and *aman* rice, and wheat, executed by the DAE SAAOs (field-level officials). A total of 26,541 crop cuts and survey data spread across six crop seasons have been collected by DAE with funding from CCAFS and CSISA. During the reporting period, CSISA organized a workshop with DAE (on 2 December 2021) held partially virtually via Zoom because of COVID–19), which was attended by the Director General of DAE; Field Service Wing Director; Planning, Project Implementation, ICT Wing Director; Additional Director of Monitoring and Implementation, and CIMMYT country representatives.



Above: big data crop cut results. These were presented to DAE officials at a workshop, 2 December 2021.

The CSISA team presented the crop cut survey data analysis key results, which results showed (1) a good correlation between crop cut yield and farmers' self-reported yield, (2) farmers use significantly higher fertilizer rates than the national recommendation, (3) farmers still use some older wheat varieties which are susceptible to different wheat diseases including wheat blast, and (4) most wheat farmers plant on time but with a tendency to plant towards the end of the window. DAE strongly emphasized the need to develop and adopt the electronic questionnaire for the crop cut survey and digitalizing the crop cut submission. In order to modernize the crop cut system, DAE formed a high-level committee to investigate the scope of the development of the system and embed them in the national crop cut program.

The 26,541data points that have been collected are all geo-tagged, and of these approximately 22,000 have been found with valid contact numbers of the farmers. CSISA now has a large database of farmers' contact information; the data are stored in the CSISA ODK Aggregate server. This large number of farmers will be utilized in ongoing and future activities for farmer surveys, and is in the process of being made open-access, and is summarized below:

Crop (season)	District					
	Dinajpur	Faridpur	Jashore	Rajshahi	Rangpur	Total
aman	1,314	1,299	1,030	1,421	1,181	6,245
boro	1,805	1,672	1,617	1,710	1,767	8,571
wheat	1,575	1,611	1,182	1,604	1,367	7,339
				Grand total		**22,155**

Importantly, these data were also used to support other initiatives by sharing the database for further research. In the Nuffic-funded project "Open-Source Scientific Computing for Agro-Geospatial Big Data Analysis, Tailor Made Training Plus", a Bangladesh Agricultural Research Institute (BARI) research group used CSISA *boro* crop cut data in its investigation of yield prediction of *boro* rice, by linking crop cuts with phenological analysis of Sentinel-2 time series. The Australian Center for International Agricultural Research (ACIAR) funded project "Mitigation and Adaptation Co-Benefits (MAC-B) Modelling Trial in

Bangladesh" also used these datasets extensively in its models and found significant outcomes. In addition, 400 data points in the Rajshahi region are being used in an ongoing irrigation scheduling project.

C. ACHIEVING IMPACT AT SCALE

C1. Growing the input and service economy for sustainable intensification technologies

C1.1 Integrated weed management to facilitate sustainable intensification transitions in rice

In Bangladesh, weed competition causes 15%–40% yield losses in transplanted rice and the cost involved in controlling weeds constitute a major share (10%–20%) of total production costs. Traditionally, hand-weeding has been the main method of weed control in the country, but because of rising labor scarcity, non-availability of timely labor and increasing labor wages, farmers are shifting to herbicide-based weed control. This is cost-effective but not environmentally sustainable if it involves heavy reliance on just herbicides. Integrated weed management (IWM) is therefore key to achieving sustainable weed control while reducing environmental hazards by reducing reliance on herbicides, and reducing the high cost associated with manual hand-weeding. Since 2016 CSISA has worked closely with public and private sector partners, taking a catalytic role to develop and raise awareness among Bangladeshi farmers about the multiple benefits of adopting IWM. The principles of IWM include:

1. carefully monitoring fields, identifying problems, selecting appropriate control measures, and minimizing the economic impact of weeds on the crop
2. working to prevent weeds from establishing or multiplying, emphasizing controlling the production and spread of weed seeds or weed parts that reproduce vegetatively
3. considering and integrating cultural, mechanical/physical, biological (including the use of weed competitive cultivars) and chemical control options as needed
4. where possible, reduce and minimize the use of herbicides, particularly those which are comparatively more toxic.

In collaboration with BRRI, through on-farm research in 2016–17 and 2017, CSISA identified the most effective and profitable IWM options (that is, the safe application of Mefenacet+Bensulfuron methyl as a pre-emergence herbicide, followed by either Bispyribac-sodium or Penoxsulam as post-emergence herbicide, followed by one hand-weeding) for transplanted rice. This study was published in Weed Technology journal and details can be found at: https://doi.org/10.1017/wet.2021.50. Building on these research results and in close partnership with the private sector, CSISA has conducted awareness activities including demonstrations, farmers training and linkage meetings with DAE field level staff to increase the use of less toxic products than those typically applied in rice production in Bangladesh, along with their safe handling with appropriate application technologies. In addition, to strengthen IWM and reduce reliance on herbicides, dedicated efforts were made to screen rice varieties for their weed competitiveness. The results of this study are explained in the next section.

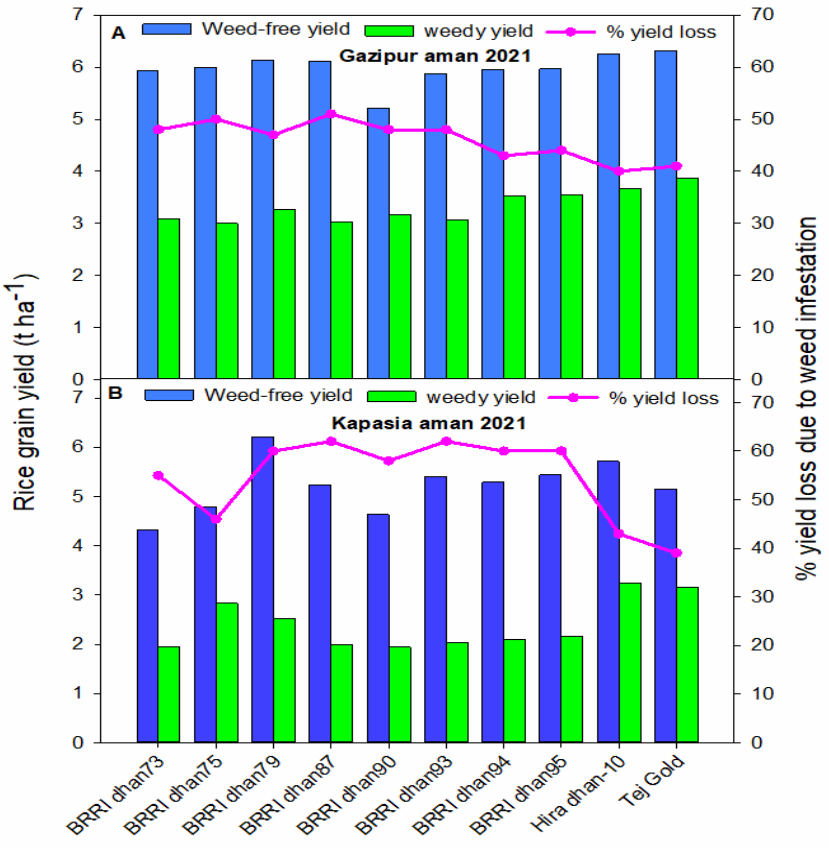
Identifying high-yielding and weed-competitive rice cultivars as a tool for IWM to reduce reliance on herbicides

Identifying high-yielding and weed-competitive rice cultivars is an attractive low cost and eco-friendly strategy of an overall IWM program and easy to disseminate to farmers. The superior weed competitive rice cultivars could play an important role in reducing herbicide loads by reducing use and enhancing

performance. In Bangladesh, limited information is available on the weed-competitive ability of high-yielding rice varieties that farmers currently cultivate. To address this, since 2018, CSISA, in partnership with BRRI, has been jointly conducting both on-station and on-farm research activities in order to identify high-yielding and weed-competitive rice varieties under transplanted conditions in the *boro* and *aman* seasons.

During the summer monsoon *aman* 2021 season (July to December), CSISA conducted weed competitive trials using the latest released (but popular) hybrid and inbred *aman* varieties at two locations (on-station: BRRI, Gazipur; on-farm: farmers field, Kapasia, Gazipur). Ten varieties (eight inbreds and two hybrids) were evaluated for their ability to compete with weeds. To assess their weed competitiveness, these varieties were grown under weed-free (no weed competition allowed, by manual weeding at regular intervals) and weedy (no weed control) conditions; to assess their weed-suppressive ability, weed density, weed biomass and rice yields were measured in each plot. The mean rice grain yield and percentage of yield losses due to weed competition in both trial sites are presented in the graph below.

Overall, weed pressure was lower at the on-station site compared to the on-farm site at all crop growth stages. Yield losses due to weed competition ranged from 39%–50% at Gazipur and 39%–62% at Kapasia. The results show that variability in weed-suppressive ability among this set of tested varieties was very low and very high weed competitive varieties were not found. However, among the tested varieties, hybrid rice cultivars Hira dhan -10 and Tej Gold were found to be the most weed suppressive, as well as



Above: mean rice grain yields of different rice varieties under weed-free and weedy plots and percentage of yield loss due to weed competition at on-station (A) (Gazipur) and on-farm (B) (Kapasia) sites in the *aman* season

2021. high-yielding at both on-station (Gazipur) and on-farm (Kapasia) sites, with yield reductions of 39%–43% under full-season weed competition.

At on-station sites, in addition to hybrid cultivars, inbred cultivars BRRI dhan 94 and BRRI dhan 95 were also found to be weed suppressive but not at the on-farm site. At the on-farm site, of the inbred varieties, BRRI dhan 75 was found to be more weed suppressive but this result was not consistent with the on-station site.

At both sites, in-bred cultivars such as BRRI dhan 79, BRRI dhan 87, BRRI dhan 93, BRRI dhan 94 and BRRI dhan 95 gave good yields in weed-free conditions but yield losses were high under weedy conditions. These results suggest that there is a need to improve the weed competitiveness of these varieties by manipulating their crop geometry with closer spacing to avoid yield losses due to weed competition and by integrating other weed control practices to avoid yield losses caused by weeds.

Above: (left) varietal weed competitiveness in an on-station study field in BRRI, Gazipur; (right) varietal weed competitiveness in an on-farm study field in Kapasia. (Photo credit: Md. Khairul Bhuiyan, Principal Scientific Officer, Agronomy Division, BRRI)

C1.2 Accelerating the emergence of mechanized solutions for sustainable intensification

C1.2 Commercial expansion of two-wheel tractor-based machinery and associated service provision models for reapers and seeders

In the first two years of its third phase (2015 and 2016), CSISA worked intensively to establish enabling market conditions in order to scale-out the use of multi-crop reapers and two-wheel tractor-based seeding equipment in northwestern Bangladesh. Activities were undertaken to complement the successful market initiatives undertaken in south Bangladesh's FtF zone through the USAID/Bangladesh Mission-funded CSISA–Mechanization and Irrigation initiative. However, activities in the Dinajpur–Rangpur Division had to be cancelled in 2017/18 due to budget delays and shortfalls. This resulted in the decision to cancel joint venture agreement contracts with several private sector partners and a leading micro-finance institution.

Since this time, budgetary flow to CSISA has remained somewhat uncertain, with disbursements often coming late. This has slowed progress in some areas, including mechanization. In particular, the ebb and flow of funding has complicated the Activity's ability to enter into joint business arrangements with partners companies. Without certainty on fund flow, it is risky – both from the perspective of CSISA and from the private sector – to invest in large-scale commercialization activities. As such, mechanization

activities in Rangpur Division have still not fully resumed and are unlikely to do so before the completion of the Activity, unless funding levels and consistency can be restored. Staff involved in CSISA Phase III nonetheless continue to cooperate and jointly implement the USAID Bangladesh Mission-funded CSISA Manufacturing and Extension Activity (CSISA–MEA), which began in October 2019 and is described briefly below.

CSISA III's synergistic support to the expanding CSISA Manufacturing and Extension Activity (CSISA-MEA)

Building on the successes of the CSISA-Mechanization and Irrigation (CSISA–MI) Activity, which ran from 2013–19 and which emerged from the set of USAID/Washington core investments in CSISA, the Feed the Future Bangladesh Cereal Systems Initiative for South Asia Mechanization Extension Activity (CSISA-MEA) began on 1 October 2019. CSISA-MEA is a five-year project, funded by USAID and implemented by CIMMYT and its partners: iDE and Georgia Institute of Technology (GT). The project aims to support the growth and expansion of agricultural mechanization in Bangladesh so that smallholder farmers can affordably access cost and resource-saving sowing, irrigation, harvesting, and other types of machinery. CSISA-MEA supports market actors along the entire value chain including machinery manufacturers, ag machinery importers and retailers, dealers, mechanics, spare parts vendors, and machinery "local service providers" who provide services directly to farmers.

Some of the key achievements of CSISA-MEA in the reporting period are described below[6]

- CSISA–MEA has now supported 194 agriculture-based light engineering (ABLE) small and medium-scale enterprises (SMEs) to develop and expand their business through the provision of training for staff, technical advice, and access to finance.
- With the Activity's technical support, ABLE SMEs learnt how to make the high-quality spare parts needed for new machines (such as combine harvesters and rice transplanters). SMEs can now offer spare parts that matched imported parts for quality and cost, and this resulted in substantial sales. The total value of sales by ABLE enterprises to dealers through the links facilitated by the Activity was USD 969,371.50
- Engineering support from Activity partner Georgia Institute of Technology has resulted in the design and testing of a jute decorticator that strips jute fiber from jute stems without breaking the stem pith, known as the jute stick. This is a major technical step forward from previous machines, which break the jute stick. Other machines developed are an onion seedling transplanter and a garlic clove planter.
- Since the start of the Activity to the end of this reporting year, CSISA–MEA has facilitated the training of 1,352 workforce staff from 194 ABLE SMEs in machinery manufacturing skills. Of these, 60% were under 29 years old (classed as youth) and 16% were women. In addition, 151 managers and owners from 133 ABLE SMEs received managerial skills training. In Year 3, the Activity provided 760 workers with basic machining and foundry skills.
- A survey to assess the impact of the training provided from the start of the Activity to April 2022 showed that skills learnt in the training, even a year later had not been forgotten. It also showed that, when applied, the skills they learned supported workers to complete tasks quicker than before training, other employees could see that trained staff produced better quality products in higher volumes, and the trained workers were held in greater esteem by their

[6] Monitoring and evaluation data are reported separately for CSISA Phase III, CSISA–MEA, and the CSISA COVID–19 Response and Resilience Activity. Although all part of the broader CSISA program, their quantitative data are reported to USAID independently each year.

managers, co-workers, and families. Finally, many of the trained workers surveyed secured increased salaries, promotions and, in some cases, better jobs as a result of the training provided by CSISA–MEA.

- During the reporting period the Activity facilitated lead firms [The Metal Private Limited (TML), ACI Motors, Abedin Equipment, Alim Industries, Janata Engineering and RK Metal] to implement a program of demand creation events. These resulted in the sale of 145 combined harvesters (USD 2,303,267), one mini combine harvester (USD 5293), two Power Tiller-Operated Seeders (PTOSs) (USD 1873), 26 reapers (USD 22,102), 16 rice transplanters (USD 23,262) and 26 fodder choppers (USD 8535). The total value of private sector sales in Bangladesh's ZOI and ZOR in the year 2021–22 was USD 2,365,017.

C2. Managing risk and increasing resilience by coping with climate extremes

C2.1 Coping with climate extremes in rice-wheat cropping systems

C2.2 Early wheat for combating heat stress in Bangladesh

Detailed research into the response of new wheat varieties to different seeding dates

Optimum seeding time is an important management strategy to increase wheat production in short and mild winter conditions like those experienced in Bangladesh. Above-optimum temperatures hinder the physio-biochemical activities of plants; too-early sowing produces weak plants with poor root systems, while late-planted wheat has a shortened life cycle, making it less able to escaping high-temperature stress at the flowering to the grain-filling stages. In recent years, the Bangladesh Wheat and Maize Research Institute (BWMRI) has released some new varieties. These were developed by testing in optimum- (15–30 November) as well as late-sown (20–25 December) conditions (their performance in the intermediate time of seeding and their location-specific performance is not known). In this context, the experiment was conducted in three agro-ecological zones of Bangladesh (BWMRI, Dinajpur; RWRC, Rajshahi; RARS-BARI, Jashore) in five consecutive wheat seasons (2017–18, 2018–19, 2019–20, 2020–21 and 2021–22) to (1) evaluate the performance of these varieties at different sowing dates, and (2) identify the optimum sowing time, variety location interaction and wheat blast response for each specific variety.

In the first two seasons (2017–18 and 2018–19), six existing elite wheat varieties (BARI Gom 26, BARI Gom 28, BARI Gom 30, BARI Gom 31, BARI Gom 32 and BARI Gom 33), in the third year (2019–20) seven wheat varieties (six + newly released WMRI Gom 1) and in fourth and fifth years (2020–21 and 2021–22) seven wheat varieties (BARI Gom 26, BARI Gom 30, BARI Gom 32, BARI Gom 33, WMRI 1, WMRI 2, WMRI 3) were evaluated in five sowing conditions, between 25 November and 4 January, with a 10-day interval between each.

Above: *A bird's eye view of wheat experiments at the Bangladesh Wheat and Maize Research Institute in Dinajpur, Bangladesh. Photo: Timothy Krupnik.*

Under the environmental conditions of Dinajpur it was found that all of the wheat varieties sown in optimum sowing conditions (that is, on 25 November) produced the maximum yield and also escaped wheat blast (WB) in all five years in all three locations. The yield of every variety decreased when sown late in all three locations in all five seasons. Although no incidence of WB was recorded in Dinajpur in all five sowing conditions, in Rajshahi and Jashore the last three sowings (15 December, 25 December and 4 January in the first two seasons) while. Wheat blast was recorded in all sowing conditions in Jashore and Rajshahi in the third, fourth and fifth seasons.

Taking into consideration the yield performance of all varieties, BARI Gom 30 performed the best in all sowing conditions as well as late sown heat stress condition in Dinajpur, followed by BARI Gom 26, BARI Gom 32, BARI Gom 33, WMRI 1, WMRI 2 and WMRI 3. Under the environmental condition of Rajshahi and Jashore, BARI Gom 33 performed the best, followed by BARI Gom 30, BARI Gom 32, WMRI 1, WMRI 3 and WMRI 2. The highest severity of wheat blast in Rajshahi and Jashore was observed with BARI Gom 26; the lowest severity was found with WMRI 3 and BARI Gom 33. Varieties WMRI 3, BARI Gom 30, BARI Gom 32 and WMRI 2 were also showed comparatively lower disease severity when exposed to high disease pressure under late sown conditions in all three locations. After five years of observation, the CSISA research team and BWMRI are can conclude that there is a remarkable variety of location interaction with yield and disease incidence; as such, location- and sowing-date specific variety recommendations will be needed for optimal cropping. These results will be shared with DAE in the next reporting period and are anticipated to form the basis of new management recommendations which can be provided to farmers throughout Bangladesh.

2. Nepal – Achievements

A. INNOVATION TOWARD IMPACT

A1. Reducing risk to facilitate uptake of sustainable intensification practices

A1.1 Direct-seeded rice to address labor and energy constraints to precision rice establishment

Because efforts in Nepal during the 2021-22 reporting period pivoted to focus on accelerated implementation of CSISA's Response and Resilience Activity's Objective III (detailed in subsequent sections of this report), no major activities in directly sown rice were undertaken in the last year.

B. SYSTEMIC CHANGE TOWARDS IMPACT

B1. Partnerships for inclusive growth around commercial pockets and neglected niches

Scaling up of mechanized maize seeding in Nepal through adoption of precision maize planters

CSISA has played a pivotal role in establishing a culture of mechanized maize seeding in Prime Minister Agriculture Modernization Project's (PMAMP's) Dang Maize Super Zone since 2016 (see CSISA's previous annual reports for details of CSISA's collaboration with PMAMP). The Activity supported national level machinery importers to import prototypes in 2016 which were tested for the first time in Nepal in Dang Maize Super Zone. The most preferred precision maize planter for mechanized maize seeding in Dang later started being adopted across the Terai districts where maize is commercially grown. As demand for the machine increased tremendously, a greater number of importers expressed their interest in importing it, and in this CSISA played a facilitative role by providing technical details/specifications and linking them with government subsidy programs.

During the reporting period, the maize planter were also tested and farmers awareness of the machine was raised through CSISA's collaboration with the Agriculture Implements Research Center of Nepal Agricultural Research Council (NARC). Currently, national level importers including SKT Nepal, BTL, Kuber & Sons and D-KAM microsystems Pvt. Ltd have established market linkages with manufacturers abroad and are importing the maize planters on a regular basis with assurance of proper stock at their stores. CSISA's facilitative role in the scale-out of precision planter technology in maize has been significant. Several hundred precision maize planters have been already sold by dealers and adopted by maize growers across maize growing areas in Nepal. As a result of CSISA's technical facilitation and in close partnership with PMAMP and the USAID/Nepal supported Nepal Seed and Fertilizer (NSAF) project, precision maize planters are also being used in maize hybrid seed production by seed companies in the Dang, Rupandehi and Chitwan districts of Nepal. To overcome emerging challenges with planters, a major objective of CSISA has accordingly been to ensure better market availability of precision maize planter spare parts.

Above: A Twitter post on the benefits of precision maize planter published in ekantipur.com, shared by the proprietor of SKT Nepal on Facebook and expressing appreciation for the work of CIMMYT and CSISA for its support to dealers in introducing the technology in Nepal (news link). Ekantipur.com is a popular news media in Nepal

Above: A precision maize planter adopted for maize seeding in Dang and other maize producing areas of Nepal. CSISA had a pivotal role in the testing of protypes when in 2016 it supported national level importers to bring this machine to Nepal and test it locally (Photo credit: Sagar Kafle)

Utilizing the remote sensing approach for area and yield estimation in Dang and its potential uptake by government stakeholders

At the request of PMAMP, CSISA began collaborating with national research and extension institutes to estimate maize area and yield using satellite-based remove sensing techniques, as detailed in the CSISA III Annual Report 2021. Initial work in this area – which has advantages over physical field surveys as a time- and cost-saving activity for PMAMP – has been positive. As a result, CSISA continued communicating with PMAMP's leadership during the reporting to design a concrete action plan based for future research and application of remote sensing techniques.

The Activity identified two areas to be improved for ensuring the endorsement of the approach and its sustainable uptake by PMAMP and allied government agencies: (1) human resource development in the related government agencies, and (2) establishing linkage between related stakeholders to raise awareness and use of remote sensing tools for yield estimation. Following an extended period of fund uncertainty in 2022, and with the extension of CSISA to the end of 2003, the research team will now incorporate qualitied University researchers in Nepal, in close coordination with PMAMP and the Statistical Division of the Ministry of Agriculture Development, to take next steps in actioning preliminary remote sensing research. CSISA will play a facilitative role to strengthen the capacity of and establish linkage between research and extension workers; this will contribute to inducing PMAMP and the Ministry to utilize the approach as their usual activity more confidently and independently. During the process, CSISA will also partner with international service providers, including VENμS to obtain the high-resolution satellite images required for the analysis. Further details on this collaboration will be detailed in the 2022-23 Semi-Annual Report.

Cropping systems and value chain intensification with mung bean

Mung bean is a short-duration (70 to 90 days maturity) leguminous crop that easily fits into the rice-wheat cropping system of Nepal. The inclusion of mung bean in the rice-wheat system plays a crucial role in sustainable profitability by enhancing soil fertility, thus increasing the system's productivity. In Nepal, the land remains fallow for 80 to 90 days after wheat harvesting, and this fallow land can be utilized for growing mung bean. However, the land remains fallow due to a need for more awareness and knowledge about mung bean cultivation. CSISA has been conducting research and facilitating market linkages between mung bean farmers and industry in the Far western Tarai since 2014. It coordinates with producer groups, rice millers, seed companies, agro vets, and government offices (AKCs and PMAMP).

As a result of these efforts, government offices have started integrating mung bean into their program; for instance, in the fiscal year 2022, PMAMP developed a mung bean block covering 100 hectares in Suklaphata municipality. Similarly, agriculture offices of local governments in Kailali and Kanchanpur have started offering price discounts to smallholder farmers wishing to purchase mung bean seeds. CSISA has also strengthened seed companies by providing them with mung bean seed production training. As a result, in 2022, Panchshakti seed company in Kailali sold about 2.2 M tons of mung bean seed, and GATE Nepal seed company sold 2.5 M tons of mung bean seed.

Above: smallholder farmers harvesting mung bean, Godawari-1, Kailali. CSISA has been collaborating with private and public partners to scale up mung bean cultivation in five provinces where the Activity has a presence. Photo by Lokendra Khadka.

B1.1 Deployment of better bet agronomic messaging through input dealer networks and development partners

During the reporting period, CSISA has distributed 2000 printed crop production advisory leaflets and brochures (rice, wheat, maize, lentils, mung beans) and nearly 500 machinery manuals that were distributed to agriculture knowledge centers, PMAMP, municipalities, agriculture training centers, machinery dealers, and agro-vets. The stakeholders utilize these products as reference material and also replicate them using their own resources to provide recommendations to farmers/producers. The production tips for the major crops, including the revised recommendations, are also circulated through social media posts. Moreover, all the communication products prepared by CSISA are documented on its website, and the information about this is delivered to the stakeholders during the official events and meetings with them.

B1.2 Income-generating maize production in neglected hill and plateau ecologies

CSISA has been instrumental in providing technical backstopping to the concerned stakeholders involved in the maize value chain in western Nepal. Partnering primarily with PMAMP, the project has supported custom hiring centers (CHC) in each PMAMP zone or superzone of project districts to advise on the technical specifications of machines that were to be purchased by the CHC, to operate the available machine efficiently for hiring services, to increase capacity/skills of the operators and mechanics in their locality, and to increase management skills of CHC leadership. Likewise, the new maize-based feed industries, including the silage industries established in Dang, have received technical support to bring reliable machinery for *in situ* silage production. Silage production area in terai districts is growing steadily because it is a relatively shorter duration (60-80 days) and gives more profit margin for farmers in such a short duration. Besides this, CSISA has been providing support to the related stakeholders in the project districts on the following activities:

- Expanding commercial maize area in new sites by PMAMP zones/super zones and Smart Agriculture Villages.
- Introducing and evaluating new technologies related to maize production through dealers (e.g., maize grain dryers).
- Helping PMAMP to carry out action research on maize-based systems utilizing PMAMP's linkage with agricultural universities.
- Helping dealers of the project districts to showcase the maize-based machinery on various occasions like agricultural mechanization fairs.
- Machinery training for service providers.

B2. Bringing participatory science and technology evaluations to the landscape and back again

B 2.1 Increasing the capacity of the National Agriculture Research and Extension System to conduct participatory science and technology evaluations

Because efforts in Nepal during the 2021-22 reporting period pivoted to focus on accelerated implementation of CSISA's Response and Resilience Activity's Objective III (detailed in subsequent sections of this report), no major activities on participatory science and technology evaluations took place during the reporting period.

C. ACHIEVING IMPACT AT SCALE

C1. Growing the input and service economy for sustainable intensification technologies

C1.1 Integrated weed management to facilitate sustainable intensification transitions in rice

Weed management plays a crucial role in rice productivity. During the reporting period, CSISA facilitated local service providers to demonstrate integrated weed management (IWM) techniques for use with directly sown rice. With CSISA's support, Badayak Krishi farm, Belauri-6, Hattibojha, demonstrated the use of "dhaicha" (*Sesbania* spp.) as a brown-manuring and weed suppressive crop in a DSR field. In this practice, dhaicha is knocked down after 20–25 days through the use low-environmental impact herbicides. During the reporting period, CSISA also collaborated with machinery services providers to experiment with power tillers for mechanical control of weeds in recently transplanted rice.

Above: demonstration of dhaicha use in DSR field in Hattibojha-6, Belauri, Kanchanpur. Dhaicha (*Sesbania* spp.) is a leguminous manure crop that grows together with rice, but after 20-25 days, dhaicha is suppressed by applying herbicide. This helps to suppress the weed at an early stage of rice. Photo by Lokendra Khadka, CIMMYT

Above: an machinery service provider demonstrating the use of a power tiller to control weeds in a directly sown rice field. in Kailali district. Photo by Lokendra Khadka

C.1.2 Accelerating the emergence of mechanized solutions for sustainable intensification

Machinery specifications and service provider training

During the reporting period, CSISA provided technical support to government partners (mainly PMAMP, AKCs, and local governments and palikas) to facilitate the organization of 23 training sessions on agricultural machinery. These involved a total of 615 participants (109 women, 506 men), and resulted in 258 machinery services providers receiving basic operation and basic repair training, 18 mechanics receiving detailed machinery repair training, 42 Green Volunteers (local agriculture resource persons recruited and developed by Lumbini Province) receiving basic machinery operation and maintenance training, and 297 farmers receiving training on agricultural machinery whose usage reduce cost of production of field crops and vegetables.

Above: *Green Volunteers of Banke participating in five days of basic repair and maintenance training, 24 May 2022. Lumbini Province has been developing the Volunteers as local agriculture resource persons* Volunteers to support farmers. Photo credit: Rashmi Gyawali

Similarly, CSISA also supported PMAMP offices of three Districts (Dang, Bardiya and Kapilvastu) in selection and procurement of appropriate agricultural machinery which they provide to farmers at a discounted rate. The CSISA support mainly technical advice on what types of machinery are most suitable, with budget estimation and validation of the machinery purchased with the specifications prepared by CSISA. Most of the agricultural machinery includes four wheeled tractor (4WT) and associated implements, two wheeled tractors (2WT), small irrigation machinery (which includes pump sets, shallow tubewells, Monoblock electric motor pump), power weeders , rice transplanters, reapers, and post-harvest equipment including combine mills, oil expellers, pallet-making machinery, silage-making and packing machines). With CSISA's technical advising, PMAMP has published a machinery booklet (available here). In most of its machinery activities prior to 2018 (including specification preparation and training), CSISA staff were involved directly as resource people in PMAMP trainings, which slowly decreased as PMAMP began hiring agricultural engineers and CSISA started training them. In April 2021

CSISA provided training to 30 agricultural engineers including seven PMAMP agricultural engineers through ToTs on machinery training. There are currently around 16 agricultural engineers hired by PMAMP; this is part of achieving CSISA's exit strategy, with the Activity's direct involvement now limited to Bardiya, Dang and Kapilvastu districts (where PMAMP has yet to hire engineers).

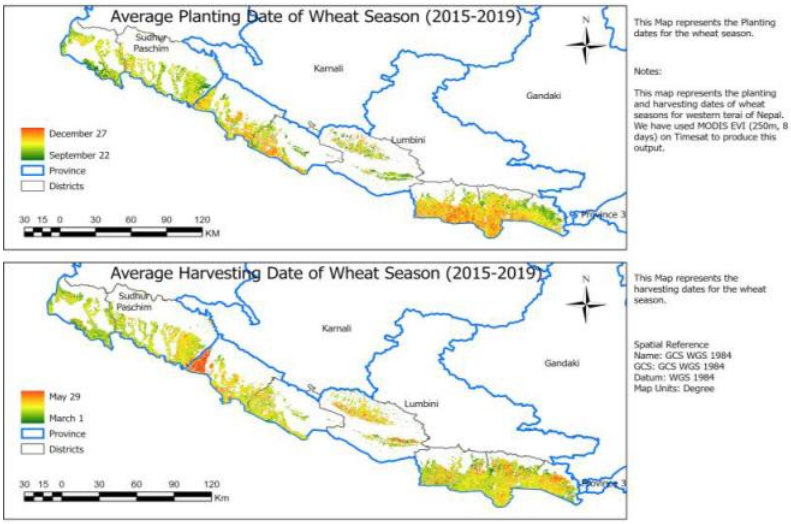
C1.3 Commercial expansion of scale-appropriate machinery and associated service provision models for reapers and seeders in Nepal

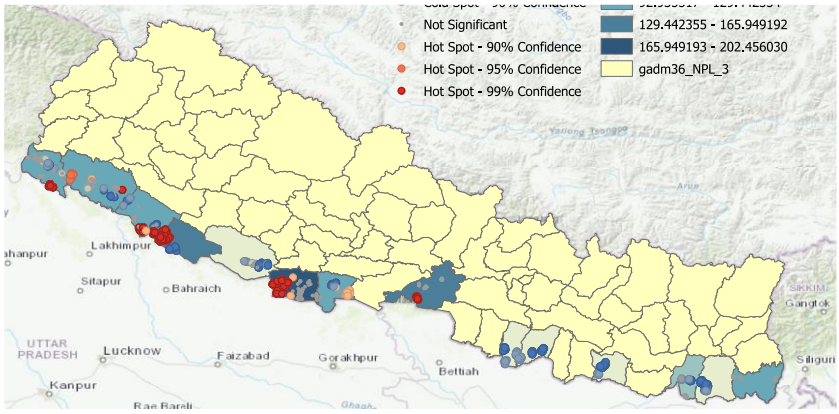
During the reporting period, CSISA provided financial support to the 5th Agrimech fair held on 23–26 March 2022 and organized by Nepal Agriculture Machinery Entrepreneurs' Association (NAMEA) in Chitwan. The exhibition supported agricultural machinery entrepreneurs from across Nepal, linking them to national and international business. CSISA was also provided with a space to raise awareness of agricultural machinery technology. Attendants visiting the stall received 390 factsheets on agricultural machinery prepared and published by CSISA. Nearly four stalls displayed different types of seed drills, which can plant maize (called maize planter) or multiple crops (called multi-crop seed drill). In addition, CSISA provided technical advice on agricultural financing in which the project team shared its experience in facilitating loans to machinery service providers who were returned migrant workers that came back to Nepal after the first COVID-19 pandemic wave.

Above: A four-wheeled tractor seed drill displayed at 5th Agrimech Expo, Chitwan. CSISA provided financial support to the expo and occupied a stall there; the seed drill is one of the main conservation agriculture technologies that was initially popularized by CSISA. Photo credit: Subash Adhikari

C2. Managing risk by coping with climate extremes

Farmers in Nepal remain very vulnerable to climate shocks and extremes. Late monsoon onsets and ongoing dry spells remain significant barriers to increasing farmers' productivity and income. Since 2016, CSISA has investigated barriers to and pathways for scaling irrigation to buffer against dry spells and cope with late monsoon onsets. The delayed 2022 monsoon was a case in point; reportedly, more than 60% of farmers transplanted their rice paddy late – with consequences for rice production and following crops that will likely be planted late due to a late rice harvest. A related CSISA study from neighboring Bihar, India, has shown that wheat yield is reduced by 25kg for every planting after the 20th of November





Above: (Top) Average planting and harvesting dates of wheat in Nepal's Western Terai. Zones in red show late wheat planting and harvesting often caused by inadequate access to irrigation and posing key barriers to increasing yields. Source: CSISA. (Bottom) Red dots show hotspots of locations where increases in irrigation are predicted to achieve the highest return across Nepal's Terai. Source: CSISA.

At the same time, the growing food crises make fuel for irrigation costlier and further increases farmers' investment risk for irrigation infrastructure. Furthermore, inadequate scheduling water use in irrigated rice has been found by CSISA and other researchers to be a major driver of low productivity and high greenhouse gas emissions in agriculture.

In response, CSISA, GoN, and other development partners are facilitating smallholder resilience through inclusive irrigation development. To ensure its sustainability, CSISA has piloted a digital groundwater management system (pilot: www.gw-nepal.com) and presented a framework for inclusive and sustainable irrigation development to the Ministry of Energy, Water Resources, and Irrigation in a workshop in Kathmandu in March 2022. The Ministry has endorsed these outputs and CSISA is now focusing on coordinating with the GoN and developing partners for implementing and scaling these approaches in Nepal's Feed the Future Zone.

In addition, CSISA deployed its data assets to understand better and map likely hotspots where irrigation investments are likely to produce the highest returns on investments. Analysis conducted by CSISA during the reporting period indicate that some locations in the Western Terai districts of Banke, Bardiya, Dhan gadi, and Kapilvastu are especially responsive to investments in irrigation. However, detailed data on irrigation practices still need to be more extensive, and CSISA collected additional field-level data on irrigation and field hydrology. These data preliminarily indicate that productivity can be increased and greenhouse gas emissions decreased by changing irrigation schedules. At the same time, these hotspots also partially overlap with hotspots of late rice planting, as shown in remotely sensed planting date analyses that CSISA produced. The project plans to develop further a targeting and recommendations strategy that ensures that additional investments secure the highest possible returns and synergies with different sustainable development goals.

3. Policy Reform – Achievements

D1. SEED SYSTEMS

Bangladesh

As described in the 2018–19 CSISA PHASE III Semi-Annual Report (September 2018–March 2019), activities in Bangladesh around seed system policy reform were phased down due to transitions in CSISA's leadership within the International Food Policy Research Institute (IFPRI), and Activity funding uncertainties. These are described in the Executive Summary and 'Challenges Faced During the Reporting Period' sections of previous CSISA reports.

Nepal

During this reporting period, no new activities were carried out around seed system policy reform in Nepal.

D2. SCALE-APPROPRIATE MECHANIZATION

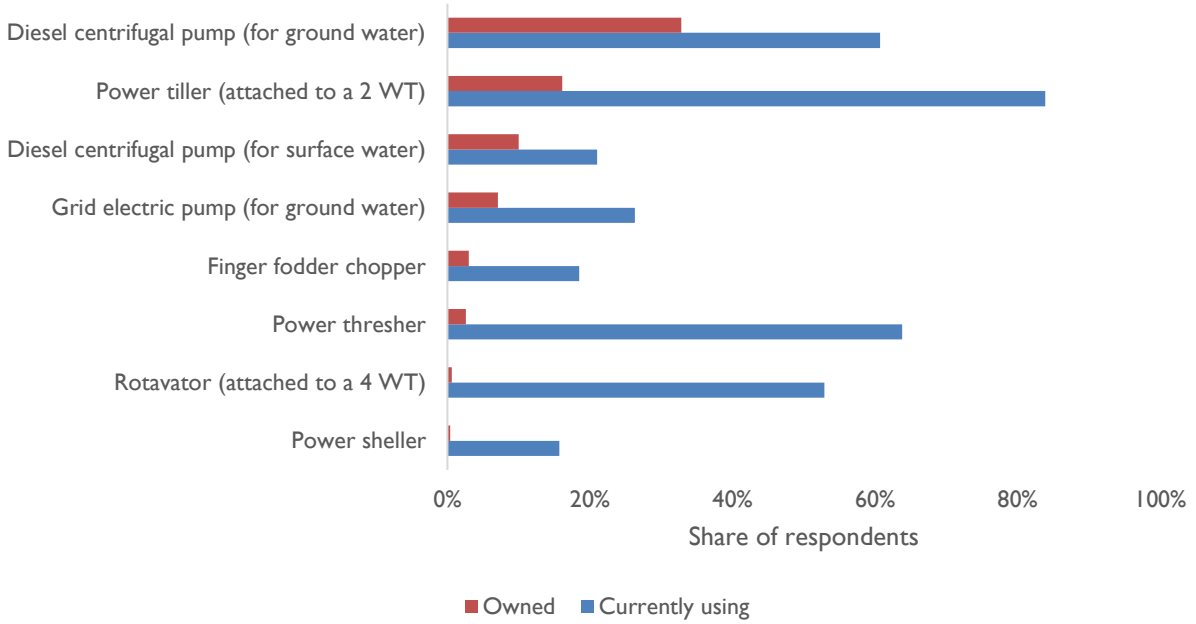
Bangladesh

CSISA in collaboration with CSISA–MEA is conducting research to improve policy makers' understanding of the factors determining smallholder farmers' ownership and use of agricultural machinery in Bangladesh, and service provision for these machines. Given the importance of hiring systems in facilitating affordable access to machinery services among smallholder farmers, the study also looks at the existing rental markets for these machines and factors that may predispose farmers to hire machines.

The findings are based on data collected from 1000 farmers in 10 districts (Cox's Bazar, Dinajpur, Faridpur, Jessore, Jhenaidah, Magura, Natore, Patuakhali, Rajshahi, and Rangpur); the study covers 203 villages across 20 *upazilas* in these districts. Although data were collected on 22 common agricultural machines, the study focuses on just eight types of machinery used across various stages of farming: land preparation and planting, irrigation, and harvest and post-harvest operations. Machines considered include:

- land preparation and planting: power tiller (attached to a 2WT) and rotavator (attached to a 4WT)
- irrigation: diesel centrifugal pump (for surface water), diesel centrifugal pump (for groundwater), grid electric pump (for groundwater)
- harvest and post-harvest operations: power thresher, power sheller, finger fodder chopper

The study found that among machines used for land preparation and planting, use of both the power tiller and rotavator was high; however, ownership was quite low. Among irrigation machinery, use and ownership was highest for groundwater diesel centrifugal pumps and lowest for groundwater grid-connected electric pumps. Use and ownership was lower for grid electric pumps than diesel centrifugal pumps. Ownership of machinery used in harvest and post-harvest activities was the lowest among all types of machines.



Above: Percent of survey respondents owning and using different types of agricultural machinery in Bangladesh.

Among machine owners, just three main types of machines were being used intensively for service provision: the power tiller (attached to a 2WT), the groundwater diesel centrifugal pump, and the surface water diesel centrifugal pump. Among these, the highest proportion of farmers were providing services for the groundwater diesel centrifugal pump. None of the machines owned by farmers for harvest and post-harvest operations were being rented out.

From a perspective of hiring agricultural machinery services, the rental market for most of these machines seem to be rather well-developed in the sense that although not many farmers in the sample rent out machines, a considerable share of farmers hire machines. Consistent with the overall hiring patterns in the country as highlighted by other studies, a "fee-for-service" arrangement was used by nearly 50% of farmers in the sample for hiring a power tiller, rotavator and power thresher. Moreover, almost 50% o ffarmers hire at least one type of irrigation machinery out of the four.

The study observed that an average farmer has access to more than one service provider for all machines. Farmers hiring machines from service providers were also asked what cost they incurred (in BDT) for each machine for 33 *decimals* of land in the last agricultural season. The lowest average cost was for renting machines for land preparation and planting; the highest was the average rental cost of the ground water diesel centrifugal pump, despite a high level of competition among service providers. Among machines used for harvest and post-harvest operations, the rental cost was highest for the finger fodder chopper, followed by the power thresher and power sheller. There were considerable variations for almost all machines across the districts in terms of rental costs and number of service providers that customers had access to.

The study findings also highlight considerable heterogeneity with respect to the influence of socio-economic factors on ownership and service provision of various machines. Factors such as age, education, inclination to take risks, and livestock ownership were found to be mostly positively

associated with owning, service provision and hiring decisions for most machines. However, findings around factors such as farm size, off-farm income, household members contributing to farming, wealth score and communication scores were not very conclusive and need further investigation.

Given that mechanization is critical for improvements in agricultural productivity while reducing the cost of cultivation and human drudgery, the findings from this study will contribute to government efforts and other development initiatives in Bangladesh, in supporting them to customize their approaches to enhancing adoption of agricultural machinery. Understanding what influences a farmer's adoption of mechanization can help identify and categorize target groups based on demographic characteristics. The draft paper on this is currently under review and expected to be published as a journal article in the next reporting period.

D3. SOIL FERTILITY MANAGEMENT AND FERTILIZER MARKETS

Bangladesh and Nepal

Based on the policy work around soil fertility management and fertilizer policies in Bangladesh and Nepal carried out from 2019–20, CSISA planned to organize a regional workshop in the last quarter of 2021 or first quarter of 2022 in Dhaka, Bangladesh. The objective of this event was to reflect on the Activity's findings from both countries and highlight the need for evidence generation and extension to encourage balanced fertilizer application by farmers. However, owing the third wave of COVID–19 and the rise of the Omicron variant during this period, the workshop could not happen as planned; CSISA is now looking at organizing this event in the next reporting period.

D4. AGRICULTURAL RISK MANAGEMENT

Nepal

Examining risks and extension options for Fall Armyworm mitigation in Nepal

The Activity conducted an experiment in Dang district, Lumbini province in 2020 to explore the effectiveness of phone-based extension approaches in building farmers' knowledge on the diagnosis and management of Fall Armyworm (FAW). This included efforts to quantify the ways in which extension messaging influences the adoption of Integrated Pest Management (IPM) approaches appropriate for FAW. Phone-based extension approaches included auto-recorded voice calls, and phone calls from trained personnel with information on FAW management. Both treatment groups received the same set of information, followed by four weekly SMS reminders on the same topics. The experiment reached more than 2300 farmers from 134 villages across four municipalities in Dang using phone surveys. Around 70% of the participants were women agriculture decision-makers.

In addition to the descriptive findings discussed in the previous reporting period on incidence of FAW infestation, information sources, and knowledge and adoption of recommended practices, the Activity further analyzed which form of extension (IVR or phone calls) was more effective in influencing knowledge on IPM practices among farmers. It also assessed the effect of household and individual characteristics on knowledge around IPM practices.

The analysis reveals that those belonging to socially privileged caste communities (Brahmin and Chhetri) were more likely to know about FAW compared to less privileged caste groups. Female respondents

were less likely to know about FAW than males; older respondents were more likely to have heard of FAW at the time of the baseline survey.

Although the regression coefficient is not statistically significant for both IVR and phone calls, it shows that the difference in average weighted score between the treated and control groups was higher in case of phone calls compared to IVR. Moreover, there was a decline in average weighted scores between baseline and endline in the control group. This establishes the relevance and effectiveness of the interventions and indicates that in absence of IVR or phone-based information, farmers' knowledge around FAW is likely to have declined during this crucial period when FAW infestation was quite high and access to information was limited.

Further, respondents from households with farming income were more likely to score higher across all treatment and control groups compared to those with no household farming income. It is encouraging to note that the knowledge scores for respondents from households with a female agriculture decisionmaker were higher than those with male decisionmakers. However, female respondents across all groups were likely to have lower knowledge scores on average, compared to male respondents. Factors such as remittance income or households with migrant members, caste and gender of household head did not demonstrate statistically significant impact on knowledge scores. With respect to the influence of individual characteristics on knowledge scores, respondents across treatment and control arms who were members of village-level or community-based groups including cooperatives were likely to have higher knowledge scores, compared to those who were not members of any such groups. We observe that the knowledge scores are likely to be higher for more educated respondents across both treatment groups, especially those educated up to middle school level and beyond.

Results from this experiment can inform a variety of stakeholders, including the National Fall Armyworm Taskforce, the Government of Nepal, research institutions and civil society, on ways to design more effective extension approaches which address the specific needs of maize farmers, especially smallholder farmers, during periods of crisis. Further results from the study will contribute to communicating to policymakers the impact and feasibility of deploying ICT tools to aid agriculture extension systems in the country. The draft paper on this is currently under review and we expect it to be published as a journal article in the next reporting period.

Phone surveys to understand gendered impact of the pandemic in Nepal

A major methodological finding from the phone surveys conducted to understand the gendered impact of the COVID–19 pandemic among farmers in Nepal (a subset of the sample for the FAW experiment was interviewed for this study) was the widespread use of speakerphone by female respondents. We found that this precluded us from including sensitive questions in the survey, but also affected responses to other seemingly innocuous questions on intra-household decision-making. These findings have been published as an IFPRI discussion paper, and have important implications for the design and analysis of phone survey data. Our insights on this have been very impactful and several organizations including Michigan State University, World Bank and other IFPRI studies have included questions on speakerphones in their own COVID–19 survey modules.

Also based on the findings from the phone surveys, an article on "Food security and women's well-being: Insights from rural Nepal" has been published in an online magazine issue published by All India Disaster Mitigation Institute (AIDMI). Further, findings on "Food security, livelihood, migration, and mobility amidst COVID-19 in India and Nepal" were presented at a training program on "Understanding intersectionality of women-led disaster preparedness and resilience" jointly organized by National Institute of Disaster Management and All India Disaster Mitigation Institute in March 2022.

4 CSISA COVID–19 Response and Resilience in Nepal

The CSISA–COVID–19 Response and Resilience Activity was originally an 18-month (July 2020–December 2021) buy-in from the USAID/Nepal Mission to the wider CSISA program. Its aim is to rapidly and effectively respond to the threats posed by the COVID–19 crisis that undermine the recovery and sustained resilience of farmers in the FtF Zone of Nepal, with two initial objectives:

Objective I: Enable rapid, targeted, and effective agricultural COVID–19 crisis response through scale-appropriate farm mechanization and rural services provision.

Objective II: Break the smallholder irrigation bottleneck and build rural resilience to the COVID–19 crisis.

Following the second COVID–19 wave in Nepal during the second and third calendar quarters of 2021, a third objective was added, with planned activities spanning September 2021 to the end of June 2023. This objective is as follows:

Objective III: Supporting rapid response and resilience-building from Nepal's second COVID–19 wave.

Objectives I and II were finalized by April 2022 and the outcomes were presented in the CSISA–COVID Response Activity Semi-Annual Report. The passages below therefore provides updates only on Objective III during the October 2021–September 2022 reporting period.

Above: Women farmers in Surkhet, Nepal, who have enrolled in the Kisan Credit Card to access low-interest finance from Mega Bank as part of the CSISA Response and Resilience's Third Objective. Photo: Timothy Krupnik

Objective I: Enable rapid, targeted and effective agricultural COVID-19 crisis response through scale-appropriate farm mechanization and rural services provision

The objective's highlights below were included in the semi-annual report (October 2021 – April 2022). This objective was completed in April 2022. For the further details on Objective I, the semi-annual report is available here

Highlights

- Since the start of work on Objective I of the CSISA Response and Resilience Activity, CSISA's market systems work and focus on entrepreneurial farm machinery services provision has resulted in 4,531 farmers (1,487 (33%) were women, and 880 (19%) were youth) gaining access to affordable machinery services for land preparation, planting, intercultural operations including irrigation, and harvest and post-harvest services.
- In this reporting period in the CSISA Response and Resilience Activity, to enhance the working efficiency of mechanics trained earlier by the Activity, CSISA provided them with toolkits. These were distributed to 40 of the most advanced mechanics through local machinery dealers established in their serving area. To increase the availability of spare parts and to facilitate the extension of their network, the Activity linked these mechanics with 18 different machinery dealers in their respective districts. During the reporting period, this resulted in a total of 817 small machinery service providers benefitting through timely access to agriculture mechanics to repair their machines and the timely availability of spare parts. Now, mechanics are able to reach a greater number of machine service providers in the peak season. A rapid telephonic survey that the Activity conducted with mechanics found that their clients increased by eight to ten percent after receiving the toolbox and trainings.
- During the reporting period, the CSISA Response and Resilience Activity developed a record-keeping book, a simple to fill-out business record template, that helps service providers to maintain records easily. Before this, service providers tended to use a small notebook, with a higher possibility of losing business records. After testing these new record-keeping approaches with machinery service providers, CSISA finalized the design of the record-keeping book. One thousand copies of the book are being printed for distribution during the next reporting period(s).
- A total of 550 poor and marginalized households (primarily Dalit and 29% of whom were women) used two-wheel tractor reapers for rice harvesting during October 2021. Their access to machinery services was facilitated by the CSISA Response and Resilience Activity, and was the first time that they had experienced machine-aided harvesting. Many reported that this has greatly increased farm efficiency. To assure service availability, CSISA worked with machinery owners and farmers to provide access to information, such as the contacts (mobile numbers) and working locations of service providers.

Above: CSISA has begun to extend agricultural market facilitation activities to remote parts of Surkhet District in Nepal's Feed the Future Zone. Photo: Timothy Krupnik

Objective II: Break the smallholder irrigation bottleneck and build rural resilience to the COVID-19 crisis

The objective's highlights below were included in the semi-annual report (October 2021 – April 2022). This objective was completed in April 2022. For the further details on Objective II, the semi-annual report is available here

Highlights

- During the reporting period, CSISA released a report that identified policy, social and institutional barriers that prevent women, smallholder farmers and members of disadvantaged groups from accessing irrigation technologies and information, and related financial and technical services. This information was discussed in a comprehensive report released by the Activity titled Understanding barriers and opportunities for scaling sustainable and inclusive farmer-led irrigation development in Nepal. The findings, which maintained a strong focus on gender and social inclusion (GESI) in planning irrigation development, were disseminated through virtual multi-stakeholder dialogue at the central and provincial levels conducted in the last quarter of 2021. The discussions in the workshops, in turn, also informed additional analysis and verification of the data and findings of the social component of the research.
- As detailed in the CSISA Annual Report (October 2020–September 2021), CSISA has partnered with Nepal's Groundwater Resources Development Board (GWRDB) to develop a digital groundwater monitoring system for the Feed the Future Zone. This system is a first of its kind in Nepal, and will replace the current approach of maintaining records on paper and in non-digital, decentralized databases. This work aims to provide decision-makers of all types with access to a publicly available database that can be used to plan improved use and management of groundwater resources. The dashboard can be accessed at https://gw-nepal.com/ until it is incorporated into the GWRDB's website. Its source code with dummy data are freely available for anybody for their own use, and to provide feedback or improvements here.
- During the reporting period, the Activity held an experience sharing workshop in Kathmandu with GWRDB officials to (1) train hydrogeologists in the Ministry of Energy, Water Resources and Irrigation on using and improving the piloted digital monitoring systems, and (2) deliberate with stakeholders about cooperation for digital groundwater monitoring to avoid resource depletion.
- During the final stage of Objective II, the Activity evaluated the three tested groundwater monitoring approaches, trained hydrogeologists of the Ministry of Energy, Water Resources and Irrigation on the learnings of the Activity and improving and scaling of the digital monitoring systems, and finally supported policy dialogues across sectors to discuss and plan future cooperation on building digital information systems and more adaptive groundwater management. The evaluation led by the GWRDB further showed that the 'Android-based monitoring method' – that is, manual groundwater level measurement with Android-based data entry – is both the most cost-effective and the lowest in terms of risk of technical failure in comparison to the use of technical logging devices.
- Optimal irrigation use is potentially influenced by factors including soil type, landscape drainage characteristics, rainfall distribution, planting dates, crop variety characteristics, and higher order interactions. In complex production environments like Nepal's Tarai, bigger data combined with advanced machine learning analytics are opening new avenues for untangling the influence of these factors to identify circumstances where there are significant opportunities for irrigation-led sustainable intensification. Data explorations suggested a five-fold higher median increase at +3 additional irrigations versus a single (+1) additional irrigation for summer season rice production. Notably, increasing nitrogen fertilizer to non-limiting rates unlocks the value of irrigation, increasing yield up to 1 ton/ha.

- During the reporting period, the Activity also explored the spatial distribution of yield responses to irrigation and nitrogen fertilizer. The analysis helped identify locations within the terai where irrigation and improved fertilizer management are most likely to result in significant yield gains. The identified areas, which will require additional field experimental validation, are likely to be the logical focal zones for increasing access to affordable irrigation through the coordination of public and private sector investment.
- Over the last six months, CSISA also conducted multiple stakeholder workshops at the provincial and district levels within the FtF zone to identify potential irrigation and cropping system intensification scenarios that could be assessed for sustainability – with groundwater aquifer maintenance as the primary indicator – in partnership with the Texas A&M University-led FtF Innovation Lab for Small Scale Irrigation. Scenarios were developed by combining crop rotation, irrigation, and fertilizer management based on water resource availability, crop suitability and diversification potential, market access, and the interest of stakeholders, among other criteria. The model scenario results, which focused on five potential pathways for irrigation development and cropping systems management, suggest that the use of surface and groundwater will be sustainable if their flow/storage are retained dynamically for long-term, inclusive, equitable use with effective management and governance. This report provides detailed results on the range of scenarios examined, which the Activity can now use to advise irrigation and agricultural development planners to target their activities more effectively while also avoiding negative environmental consequences from groundwater over-withdrawal.
- The guiding framework developed by CSISA, entitled "*A framework for sustainable and inclusive irrigation development in Western Nepal*", was released during a stakeholder workshop (April 28, 2022) with participants from different levels of government offices, USAID, INGOs, NGOs, civil society, private organizations and donor agencies. Key investment priorities were identified in the framework: (1) Ensure adaptive technology prioritization and water management practices that respond to local resource constraints and equity considerations. (2) Build robust data and information systems to allow adaptive planning, prepare for climate change impacts, and support digital agriculture and targeted farm advisories. (3) Expand and upgrade irrigation and agricultural value chains to ensure access to water, returns on investments, and the creation of better, more inclusive jobs. In highlighting the framework's relevance, a federal ministry policymaker expressed that the lack of irrigation is a challenge for agricultural development in Nepal. The findings and recommendations presented in the framework are relevant to the Government of Nepal (April 28, 2022). Another policymaker, in their opening remarks, also acknowledged the research outputs of the CSISA Activity, remarking that it has developed a knowledge base on sustainable and inclusive irrigation development in Nepal. The research findings are relevant for planning and policymaking related to water resources and use (April 28, 2022).

Above: CSISA's work in Objective II focused on sustainable and inclusive irrigation development – with a focus on areas currently lacking reliable access to water – in Nepal. Photo: Anton Urfels

Objective III: Supporting rapid response and building resilience to Nepal's second COVID-19 wave

Background: From April to late September 2021, Nepal experienced its second (large) and then its third (minor) wave of COVID–19, resulting in additional and significant threats to agri-food systems and livelihoods. These have occurred due to lockdowns, transportation and marketing disruption, social distancing (which decreased the ability of farmers and value chain actors to interact with each other) and increased infection rates (which significantly reduced crucial farm labor availability, especially among marginal and women farmers). At the same time, small and medium scale enterprises throughout the FtF ZoI suffered economically. Concerns have been widely raised that national food/nutrition security has been undermined by increased costs for imported staples, the unreliability of cross-border trade, and shortfalls in national production both before and during the crisis. The pandemic and resulting lockdowns have also exacerbated the need for reliable and timely information about input and output market access, crop diseases and pests, and insurance and credit, while highlighting the inequalities which limit women's and marginalized groups' access to information and their disproportionate economic burden.

In response, USAID/Nepal provided additional funding buy-in as part of the wider CSISA portfolio to support rapid response and continued resilience building in Nepal's agri-food systems. These activities include, firstly, immediate response activities being put into place from September 2021 until June 2023, aimed at rebuilding effectively key elements of Nepal's agri-food systems and marginalized groups in the FtF zone which have been disproportionately affected by the second wave of the COVID–19 crisis. Key areas of intervention focus on provision of access to finance for small- and medium-scale agricultural input and services provision businesses, recovery and response in the post-harvest value chain (with emphasis on financial products to benefit businesses involved in perishable farm product marketing and distribution), and expansion of digital banking services supporting socially distanced agricultural finance transactions. In addition, interventions focus on scaling-out agricultural mechanization services through geographical expansion to new districts in which CSISA is not currently working as part of Objective I activities, while also working to increase national food security and bolster agricultural economies in times of crisis. Lastly, Objective III focuses on ensuring that recovery from the shock of COVID–19 is complete, while at the same time building the resilience of key elements of the agri-food system to better withstand future shocks, including but not limited to COVID–19.

Key reporting period highlights from Objective III are detailed below:

Highlights

- CSISA's resilience building activities increased the capacity of micro-, small- and medium-scale enterprises (including agricultural input retailers) to improve business skills in financial record keeping. The Activity also trained agricultural machinery mechanics, machinery owners, and farm machinery retailers in farm machinery operation, maintenance, and business planning. The activity provided technical support to 15 financial institutions and farmer cooperatives to develop finance programs targeting loans for cost-saving and resource-conserving farm machinery. CSISA also trained 128 entrepreneurial beneficiaries (90 female and 38 male) as community-based facilitators (CBFs) to extend the business service delivery of agricultural input retailers. This model entails agro-vets paying CBFs commissions on agricultural inputs sold to smallholder farmers.
- During the reporting period, 5,976 women benefited as clients of farm machinery and agro-input service providers. The Activity assisted 89 women to commence new businesses as micro-, small-

and medium-scale enterprises focused on a range of agricultural value chains. Finally, exempting locations that experienced flooding the Activity enabled 304 resource-poor women and members of marginalized communities who had not previously hired farm machinery services to do so for the first time under a product discount model implemented in partnership with machinery entrepreneurs. Lastly, the Activity explicitly targeted women, women's groups, and marginalized communities as recipients of the Kisan Credit Card that CSISA supports in partnership with Mega Bank.

- CSISA advanced the use of digital development tools through its program to expand farmer and agrovet's use of the Kisan Credit Card, an innovative point of sale banking solution by which farmers can purchase inputs at low-interest rates using a QR-Code enabled card and internet-enabled point of sale (PoS) machines. A total of 299 Kisan Credit Cards were adopted by farmers during the reporting period. CSISA also helped 21 small- and medium-scale agro-vets to enroll as vendors who accept the Kisan Credit Card . CSISA is planning to register and enroll and an additional 370 agricultural input suppliers as Kisan Credit Card vendors in the next reporting period.
- During the reporting period, farmers accessed bank loans in Surkhet District with facilitation from CSISA and purchased a total of 39 agricultural machines (30 mini tillers, seven power tillers and two reapers). Similarly, a total of 139 farmers (78 women, 61 men) from two municipalities (Panchapuri and Lekbesi) used the mini tiller under the voucher scheme. In Bardiya, 18 farmers each bought a power tiller through subsidized loans from Mega Bank and three farmers purchased a mini tiller using a loan from a cooperative. Nepal's liquidity issue meant that the loan approval process of the bank was significantly delayed, which affected the purchase and uptake of machines.
- CSISA works closely with farmers from marginalized castes and ethnicities, predominantly Dalits and Tharu, who receive limited extension or governmental support. CSISA provided 690 farmers from marginalized ethnicities or castes with an innovative cost-offset and discount that enabled them to access mechanized harvesting services for the first time. The activity also provided farm machinery toolkits to 207 individuals from marginalized groups to support their ability to provide repair services and generate income from farm machinery owner clients. Lastly, the Activity specifically targeted Dalits and Tharu communities who experience exclusion from the formal banking sector as beneficiaries of the Kisan Credit Card in partnership with Mega Bank.
- During the reporting period, the CSISA Response and Resilience Activity assisted 19 returnee migrant youth who had been repatriated from India at the onset of the pandemic. The Activity helped these youth obtain agricultural finance loans from banks and purchase farm machinery. CSISA trained these youth in machinery operation, maintenance, and business models offering land preparation, planting, irrigation, harvesting and/or intercultural services to farmer clients on an affordable fee-for-services basis. As a result, these youth gained access to income generation, while farmers also benefited from lower production costs. Overall, 19 percent of all CSISA beneficiaries in the reporting period were youth.

Objective III of the CSISA COVID–19 Response and Resilience Activity has four primary Work Packages, described in detail below.

WORK PACKAGE 1: ENSURING SMALL- AND MEDIUM-SCALE INPUT AND SERVICES PROVISION BUSINESS RECOVERY AND REHABILITATION THROUGH ACCESS TO FINANCE

Background: This work package develops customized business models for finance and to facilitate rapid access to response and recovery loans from financial institutions to mitigate the effects of the second and third waves of COVID–19, with emphasis on specialized products for women and marginalized groups in the agricultural sector. To achieve this, the Activity is leveraging agreements with banks held on behalf of CSISA developed as part of Objective 1 to offer quick opportunities to facilitate access to finance for other agricultural businesses including agrovets, agricultural machinery dealers, and businesses associated with agricultural inputs or services owned or operated by women or members of marginalized groups that have been impacted negatively by lockdown and COVID–19-induced losses. As such, CSISA is deepening these relationships to develop customized COVID–19 response business models, with the aim that banks will provide input business support loans to small- and medium-scale agricultural inputs, machinery-dealing businesses, or agriculturally oriented businesses owned by women or members of marginalized communities (or those who employ these groups).

1.1 Develop customized business models for financing and facilitate rapid access to response and recovery loans from the second wave of COVID–19, with emphasis on specialized products for women and marginalized groups

Agricultural businesses impacted by lockdowns and losses resulting from COVID–19 include agricultural input dealers (commonly referred to as agro-vets in Nepal) and agricultural machinery dealers, particularly businesses associated with agricultural inputs and services owned or operated by women or members of marginalized groups, among others. At the beginning of the reporting period the Activity conducted a rapid assessment to identify the impacts of the COVID–19 crisis on these small/medium scale agricultural input enterprises.

The assessment interviewed 144 respondents throughout the seven Activity districts comprising 115 agrovets, 24 machinery dealers, and five cooperative members, including agrovets working with NSAF and KISAN-II. This rapid study proved very beneficial not only in terms of identifying key challenges but also to determine some of the important interventions needed to address the challenges these small enterprises face. Similarly, several supply chain-related constraints arose as a result of the lockdown situation. This included difficulty encountered by businesses in obtaining supplies of agricultural inputs from importers and wholesalers, increased prices, and wholesaler/importer unwillingness to give credit.

The study showed that compared to the first wave of COVID–19, restrictions in the second wave had a less severe impact for businesses. This may be attributed to the increased adaptive capacity of the business community and the early preparedness of the government system. At the same time, it has been observed that micro and small enterprises (mainly those which are newly established) were most affected by COVID–19 restrictions, in both phases. This is partly because of their narrow networking with supply chain agents and their inadequate experience and skill to deal with the risks associated with their businesses. Nonetheless, the study provided information that allowed the Activity to refocus and fine-tune interventions that were presented and vetted among stakeholders in Provincial-level inception workshops.

Inception meetings

Inception meetings were conducted in each district with the objective of informing stakeholders about CSISA's activities and focus areas. These were in-person meetings except in Kapilvastu and Surkhet, which were conducted virtually amid the lockdown situation during the third wave of COVID–19. Participants included representatives of the *palikas*, key government offices in the districts, district Chamber of Commerce and Industry officials, banks and financial institutions, and private sector actors, as well as other projects and non-governmental organizations. These inception meetings were highly conducive not only to sharing project information with stakeholders but also for future collaboration.

Date	District	Total number of participants
December 9, 2021	Kanchanpur	32
December 8, 2021	Kailali	40
December 10, 2021	Bardiya	31
December 10, 2021	Banke	35
December 12, 2021	Dang	31
January 31, 2022	Kapilvastu	23
January 30, 2022	Surkhet	31

Above: Inception workshop, December 12, 2022, Dhang, Ghorahi. Mr. Sagar Kafle, Assistant Research Associate, CSISA, shed light on the CSISA Covid–19 Response and Resilience Activity. Photo credit: Ashta Prajapati

Identifying and facilitate micro/small/medium scale agricultural input enterprises to link with banks

Following each inception meeting the Activity coordinated with local *palikas*, Agriculture Knowledge Centers (AKCs), Prime Minister Agriculture Modernization Program (PMAMP) offices, and cottage and small industries and cooperatives to identify COVID–19-affected agricultural input suppliers, machinery dealers and service providers in need of finance and willing to take out a loan. It then engaged them through individual coaching support to navigate loan processes and procedures, and to assemble the documentation required to demonstrate the business solvency needed for a loan application.

Collaboration with the banks

The primary focus of Objective III is to improve access to finance for small- and medium-scale agricultural input and services provision businesses, and post-harvest enterprises, and the expansion of digital banking services to smallholder farmers. During the reporting period, CSISA initiated a number of high-level meetings and interactions with the banks, starting with Muktinath Bikas Bank Ltd and Mega Bank Nepal Ltd, leveraging existing partnerships with these firms for Objective I. The Activity also reached

out to Nepal Bangladesh Bank Ltd, Global IME Bank Ltd, Laxmi Bank Ltd and Century Bank Ltd, seeking possible collaboration.

Orientation of bank staff from all the branches in the project districts

To expedite collaboration in the field, CSISA arranged district-level interaction meetings with bank staff from all the branches in the Activity district. Ten orientations conducted in seven districts have engaged a total of 119 representatives from branches of the major banks in the district.

Above: District level interaction meeting with bank representatives, Surkhet, January 30, 2022. Mr. Lalit Bahadur Saru, CSISA Program Officer, explained CSISA's intervention supporting MSMEs. Photo credit: Dipendra Chaudhari

These interaction meetings have been pivotal in orienting bank staff to the Activity's objectives and its interventions to support MSMEs and farmers. Several of the banks at each meeting expressed an interest in working with CSISA and requested the application information.

Business linkage meetings with banks conducted by CSISA from April through May of 2022

Date	District	Number of bank representatives
13 April, 2022	Banke	5
12 April, 2022	Bardiya	7
22 April, 2022	Dang	19
16 August, 2022	Dang	4
19 April, 2022	Kapilvastu	15
17 August, 2022	Kapilvastu	5
12 April, 2022	Surkhet	12
19 May, 2022	Surkhet	24
22 April, 2022	Kailali	12
23 May, 2022	Kanchanpur	16

1.2 Expand and scale access to recovery and resilience-building loans following the second wave of COVID–19

Develop/strengthen last-mile supply chain actors linking them with the agricultural input enterprises

The majority of Nepal's local agricultural input retailers (agrovets) are located in market towns, with a large supply chain gap between them and end-user smallholders in remote villages. CSISA is working to develop and strengthen last-mile supply chain actors, linking them with the agricultural input enterprises to promote access to inputs and finance. Community business facilitators (CBFs) are last-mile actors supported by the Activity. CBFs are individual entrepreneurs who travel and work within a designated territory of rural communities, selling agricultural products/inputs on commission. They are trained to provide private sector extension services, to support their customers to improve, intensify and expand market-oriented agricultural production smallholders with technical services to use the products correctly. CBFs are linked to agricultural input retailers and paid commission by them on the sales they make on their behalf.

Midway through the reporting period, CSISA team members participated in comprehensive training on 'CBF Approach and Sales Skill Development' (2–5 March 2022), covering the recruitment, capacity building and effective management of CBFs. They then worked with agricultural input suppliers in the district to identify and recruit CBFs; 128 CBFs have so far been recruited and trained and linked with the 80 agricultural input suppliers of their respective districts.

CSISA's recruitment of community business facilitators in the Activity areas

District	Total Number of CBFs	Female CBFs	Male CBFs
Dang	12	11	1
Kapilvastu	9	8	1
Banke	19	14	5
Bardiya	17	14	3
Surkhet	24	12	12
Kailali	28	19	9
Kanchanpur	19	12	7

CBFs in turn participated in the three-day 'Sales Skill Training' and three-day technical training that equipped them to promote to farmers the various inputs and technologies related to CSA.

Above: Sales skills training for CSISA's community business facilitators, Bardiya district. Participants engaged in roleplay as part of the training. Photo credit Mr. Khadga Jung Gurung

Agricultural business skills trainings facilitated by CSISA during the reporting period

Date	District	Number of CBFs trained
29–31 May, 2022	Banke	17
18–19 September, 2022	Banke	15
8–10 June, 2022	Dang	13
16–18 June, 2022	Kailali	22
20–22 June, 2022	Kanchanpur	19
8–10 June, 2022	Kapilvastu	8
1–June, 2022	Surkhet	22

Group sales meetings

After completion of sales skills and technical training, CBFs began door-to-door visits to farmers in their villages to sell appropriate agricultural products and inputs. To trigger sales, they also conducted several group sales meetings/presentations, each of which were attended by 10–15 farmers. These have been successful in facilitating enhanced knowledge and use among farmers for improved varieties of seed, and IPM products including traps, lures, and use of polytunnels for growing off-season vegetables. All the agrovets who have hired CBFs report that their sales have increased dramatically as a result.

Above: Farmers displaying the packets of improved vegetable seeds, purchased from community business facilitators after a group sales meeting. Meetings like these are coordinated by community business facilitators, such as Ms. Rekha Kumari Tharu (left) in Rapti Sonari Municipality, Banke. Photo credit: Raj Kishor Ray

Group sales presentations/meetings facilitated by CSISA as part of the Activity held in the following locations during the reporting year

Date	District	Number of group sales presentations/meetings	Number of participants
September 2022	Banke	109	1558
September 2022	Bardiya	99	1482
August 2022	Dang	97	1501
July–September 2022	Kapilvastu	68	826
June–September 2022	Surkhet	233	2446
July–September 2022	Kailali	168	2184
July–September 2022	Kanchanpur	99	1333

Business management training to agrovets

During the reporting period, CSISA facilitated Business management training for the MSMEs enrolled under Work Package 1; alongside this, CSISA facilitated two such training programs for the agrovets of Kanchanpur and Kailali districts, participated in by a total number of 35 agrovets.

Date	District	Location	Number of participants
20–21 September 2022	Kanchanpur	Mahendranagar	16
23–24 September, 2022	Kailali	Chisapani	19

The main focus of the training was on orientation to the Business Model Canvas (a software tool for developing and analyzing business models), operation management, customer relationship management and financial management. Training employed practical exercises to address these and participants have found it very useful in managing their businesses.

Above: Business management training for agrovets, facilitated by CSISA, Kailali district, September 2022. Participants engaged in the session of financial management. Photo credit: Mr. Ashta Prajapati

Periodic review meetings with CBFs

CSISA-trained CBFs are the Activity's key actors in terms of promoting various technologies and expanding the businesses of the MSMEs. As they work on commission, it is important that they are well-motivated and in regular contact with the agrovets they are associated with. During the reporting period, CSISA conducted periodic review meetings with its CBFs, ensuring a space for them to share any on-the-job challenges and to learn from each other's experiences. Meeting participants comprised agrovets, CBFs and the CSISA team members; dates and locations of the CBF periodic meetings are presented below.

Dates and locations of periodic community based facilitator review meetings

District	Date	Number of participants
Banke	September 8, 2022	5
Bardiya	September 8, 2022	6
Dang	July 1, 2022	17
Kailali	July 18, 2022	22
Kanchanpur	July 15, 2022 September 26, 2022	14 19
Surkhet	2 August, 2022	11

WORK PACKAGE 2: SPECIALTY FINANCIAL PRODUCTS AND SERVICES TO REDUCE POST-HARVEST LOSSES IN AT-RISK PERISHABLE FARM PRODUCT VALUE CHAINS

Background: This work package works to increase response to and recovery from the second wave of the COVID–19 and other economic shocks for farmers and businesses involved in producing, distributing and selling perishable and healthy commodities. Specifically, it focuses on developing and deploying specialty financial products from banks and lending institutions suitable for unique perishable value chains. Activities target at-risk businesses owned by women and/or members of marginalized communities which deal in post-harvest horticultural, drying operations, dairy processing, canneries, essential oil distillers and packaging operations. An additional sector that may be targeted is dairy marketing cooperatives.

2.1 Increase response and recovery from the second wave of the COVID–19 crisis for farmers and businesses involved in the production, distribution and sale of perishable and healthy commodities

To kickstart this Work Package, CSISA facilitated a rapid study within the rural/urban municipalities of four districts (Kailali, Banke, Surkhet and Dang), with the aim of reducing losses to farmers caused by the COVID–19 crisis. Its main objective was to identify and assess the prospects of various post-harvest enterprises (mainly in the vegetable, horticulture and dairy sectors) in the Activity districts in terms of their feasibility, viability and desirability for the development of an appropriate business model. It mainly targeted specific enterprises with the potential to (1) provide post-harvest services to rural communities, and (2) engage more women and/or members of marginalized communities.

Rapid assessment of the potential of post-harvest enterprises to produce at-risk perishable farm products

As described above, CSISA conducted a rapid scoping study of post-harvest enterprises mainly in the vegetable, horticulture and dairy sectors, to reduce losses of farmers due to the COVID–19 crisis. The study was carried out within rural/urban municipalities of four districts – Kailali, Banke, Surkhet and Dang. Its main objective was to identify and assess the prospects for different post-harvest enterprises in the project districts in terms of their feasibility, viability and desirability for the development of an appropriate business model. The study mainly targeted specific enterprises with the potential to provide postharvest services to rural communities and to engage more women and/or members of marginalized communities. The most common enterprises with the greatest business potential identified by the study are (1) pickle making, (2) dairy and dairy processing, (3) small cold chamber, and (4) packaging materials for fruits and vegetables, and hermetic bags for cereal grain storage. The study indicated that these are the most potential and common enterprises in all four districts.

Training of Trainers in enterprise and business model development:

During the reporting period the Activity facilitated Training of Trainers on 'Enterprise and Business Model Development' for field team members in Nepalgunj, Banke district (25–29 April, 2022). The main objective was to enhance the team's competence in developing and supporting entrepreneurship including the capacity to devise bankable business plans for local entrepreneurs, and to explore their possible roles in strengthening the agricultural entrepreneurship ecosystem at large, with a focus on post-harvest enterprises. The training followed was intensive and experiential, with participants working together on 'case-based simulations' of seven potential businesses – essential oils, *sinki* (fermented vegetables), a grain dryer, cold storage, dairy, pickle- and tomato ketchup/sauce-making. The Activity is now working with potential post-harvest enterprises, providing them with technical support to prepare business plans.

District-level interaction meeting of potential farmers/businesses involved in post-harvest activities and banks

The CSISA team also facilitated three district level interaction meetings between potential farmers/businesses involved in post-harvest activities and bank representatives. The objective was to create a platform for potential post-harvest enterprises to interact with banking officials, to clarify to entrepreneurs the different possible post-harvest enterprises and loan availability processes through direct interaction with banking officials, so that they might expand their business in a sustainable manner. It was also an opportunity to inform participants about CSISA activities and the possible support the Activity can offer in the promotion of post-harvest enterprises. Participants discussed potential post-harvest enterprises including pickle-making, dairy, vegetables and spice-drying, vegetable-storing in mini cold chamber (Cool Bot) and tomato ketchup/sauce-making. Three such meetings were conducted during the reporting year, attended by a total of 56 participants.

Above: participants in the interaction meeting held between potential farmers/businesses (involved in post-harvest activities) and banks in Surkhet, June 28, 2022. CSISA facilitated three such meetings during the reporting period, creating a platform for potential small business owners and banking representatives to discuss possible business ideas and the available support. Photo credit: Ms. Nisha Malla

District-level interaction meetings between potential farmers/businesses involved in post-harvest activities and bank representatives

Date	District	Participants	Venue
7 June, 2022	Banke	13	Nepalgunj
20 August, 2022	Dang	21	Ghorahi
28 June 2022	Surkhet	22	Birendranagar

2.2 Build resilience to the second wave of the COVID–19 crisis for farmers and businesses involved in the production, distribution and sales of perishable and healthy commodities

The Activity's next step under this work package is to follow up with the banks and entrepreneurs to ensure the loans are disbursed and utilized according to each applicant's business plan. Various capacity-building activities are now underway for the entrepreneurial businesses, including business management and technical training. The Activity also aims to provide initial backstopping for the marketing and promotion of the new post-harvest enterprises, including linking them with the target market in coordination with the district chapter of the Chamber of Commerce and Industries and other stakeholders. In addition, CSISA is likely to provide a 1:1 cost-share to support promotion of the

products, such as the printing of promotional materials for advertising. During the reporting period, the Activity approved a total of 52 loans for new post-harvest enterprises. An additional 20+ loans have been applied for to financial institutions under this work package which are expected to be approved in the near future.

Above: A post-harvest entrepreneur from Lamahi-8, Dang district, using an electric dryer to dry chilies. Mr. Shiv Kumar Chaudhary purchased the dryer with a loan from Mega Bank, facilitated by CSISA. Photo credit: Janga Bahadur Gurung

Technical orientation to potential cold storage entrepreneurs

CSISA conducted a one-and-a-half-day basic orientation (June 27, 2022) for 19 potential entrepreneurs interested in starting a cold storage enterprise. Those attending found the experience very useful, with all but one unaware of the new 'Cool bot' technology, and all having very little knowledge of fruit and vegetable post-harvest technology prior to the training. Seven participants expressed an interest in taking out a loan and starting a business as soon as possible, and one have taken the bank loan has started the business during the reporting period. The Activity is now following up with the others interested to facilitate establishment of business in next year.

Exposure visit for potential entrepreneurs interested in establishing post-harvest pickle production enterprises

During the reporting period, CSISA also conducted an exposure visit for those interested in establishing a pickle production enterprise (September 2, 2022), arranging for seven potential entrepreneurs from Dang and Kapilvastu districts to view the Pansu Agri processing and packaging Pvt. Ltd in Kohalpur, Banke. Visitors gained first-hand knowledge and understanding of the pickle production process, its branding and marketing, and the business registration process.

The visit included discussion of possible options to support the entrepreneurs, with Pransu management expressing interest in providing technical support to facilitate quality production of the product, and purchasing and marketing it under the Pransu brand, or alternatively providing marketing/promotion support if the producer wants to promote their own brand. Modalities will be finalized through further discussion among Pransu management and interested entrepreneurs facilitated by the Activity.

Above: Pickle producers from Dang and Kapilvastu observing the packaging unit of Pransu Agri processing and packaging Pvt. Ltd. at Kohalpur, Banke, during an exposure visit on September. Photo credit: Janga Bahadur Gurung

WORK PACKAGE 3: DIGITAL BANKING SERVICES TO SUPPORT IMMEDIATE RESPONSE TO BUSINESSES AND CONSUMERS AFFECTED BY THE COVID–19 CRISIS

Background: Leveraging CSISA's burgeoning partnership with Mega Bank – Nepal's only woman-led banking institution – the Activity is now working to scale a "farmer credit card" product that will capitalize on the context of the existing CSISA COVID–19 Response Activity. This QR-coded, mobile digital card, linked to the buyer's mobile phone, can be used to purchase a range of products related to farming, including small machinery at pre-identified vendors, up to a total of USD2000. The card has been designed as part of a business model to provide highly competitive interest rates (with the government subsidy) and long payback periods. In addition, Nepal's Agricultural Development Bank has been working to support similar digital financial services that could be used as part of the immediate response to COVID–19 by facilitating mechanisms for socially distanced money transfer.

3.1 Rapidly increase agro-vet access to digital tools enhancing the sale and purchase of agricultural inputs and commodities in key locations suffering from the economic shock of the second wave of COVID–19 in the Feed the Future Zone

Lack of access to finance creates a significant bottleneck for agriculturally oriented businesses and smallholder farming families in Nepal. Despite the government's introduction of a subsidized interest credit program for the agriculture sector, banks are reluctant to provide loans to smallholder farmers, particularly to those from marginalized communities or women-headed households which may not have land title information or sufficient capital to back loans. Estimates suggest that almost 99% of small and marginal farmers are in need of capital to access finance and increase productivity.

Above: Women in Surkhet have recently enrolled in the Kisan Credit Card program. Photo credit: Timothy Krupnik

To address these challenges, CSISA is working with the company Innovative Solution Pvt. Ltd. to increase awareness and use of the Kisan Card, which can be used with a simple feature phone. The Kisan Card aims to facilitate access to finance for smallholder farmers, enabling them to invest in and practice climate-smart/appropriate agricultural technologies, and thus to progress from subsistence to commercial agriculture. The Kisan Card is being added to the banks' subsidized loan schemes; an application needs to be accompanied with a personal PAN number, a photocopy of proof of citizenship, family details, and one-page business idea or plan following a pre-designed format. Farmers can use the card with registered input suppliers/vendors who use the Kisan credit app on a smartphone. Kisan card intends to ensure controlled financing, as farmers cannot use it to withdraw cash or purchase non-agriculture-related products.

CSISA has signed an agreement with Innovative Solution to facilitate activities. A virtual orientation program with Mega Bank briefed the Activity team about the Card and its working modality. During the reporting period, CSISA also approached agrovets, agriculture machinery dealers and farm machinery service providers individually to get them onboard with the Kisan Card as vendors/merchants. So far, 21 SMEs have been onboarded as vendors; the Activity is in the process of enrolling 370 agricultural input suppliers as Kisan Card vendors. Mega Bank is also a key partner for the use of the Kisan Card; the Activity has met with them and an agreement to collaborate has now been finalized. This agreement has unlocked the use of more than 2500 Kisan Cards – named the 'Mega Smart Krishi Card' – under this partnership, of which 500 are expected assist in loans to individual farmers and agriculturally oriented businesses.

3.2 Scale-out access to digital tools enhancing the sale and purchase of agricultural inputs and commodities in the Feed the Future Zone

Interaction program between CSISA, Mega Bank Ltd and R&D Innovative Solutions Pvt. Ltd

On June 4, 2022, a CSISA-organized interaction program was conducted at Nepalgunj, with participants from CSISA, Mega Bank Ltd and R&D Innovative Solution Pvt. Ltd. The 39 participants included key team members of Mega Bank (branch managers and relationship managers from all 16 branches from the CSISA Activity district, and the provincial heads of Sudurpaschim, Karnali and Lumbini provinces), R&D Innovative Solution Pvt. Ltd. and key CSISA team members. This event was extremely useful in orienting the bank and the R&D team to the CSISA COVID–19 Response and Resilience Program, and its interventions supporting farmers and MSMEs. It was also very beneficial in orienting the CSISA team to the Kisan Card, in particular its technical and managerial aspects, and clarifying loan modality, the process to expedite the Kisan Card, and other subsidized loans as per the agreement between CSISA and Mega Bank.

Above: Agreement signing between the CSISA COVID–19 Response Activity and Mega Bank at the bank's central office, Kamaladi, Kathmandu on May 6, 2022. Photo credit: Mega Bank.

Firms onboard as Kisan Card vendors

Recognizing that Kisan Card promotion will be fruitless without sufficient affiliated vendors to effect farmers' purchases, CSISA approached agricultural input suppliers, agriculture machinery dealers and farm machinery service providers individually to achieve buy-in to the Kisan Card, with a target of enrolling a minimum of 370 as vendors. At the time of writing 135 small- and medium-scale have been onboarded Kisan Card as vendors. This figure is expected to grow dramatically in the coming reporting year.

Capacity-building of vendors on the proper uses of digital banking schemes for purchases done through the Kisan Credit Card

In the first week of August 2022 CSISA conducted a half-day orientation to the agricultural input suppliers interested to become Kisan Card vendors. Representatives of agricultural input suppliers were provided with technical know-how and practical demonstrations, after which they expressed their confidence in its use.

Kisan Credit Card Training dates, location and number of participants.

Date	Districts	Total number of vendors
1 August, 2022	Kanchanpur	20
1 August, 2022	Kailali	20
2 August, 2022	Bardiya	31
2 August, 2022	Banke	20
3 August, 2022	Surkhet	31
4 August, 2022	Dang	29
5 August, 2022	Kapilvastu	16

Above: Capacity building of vendors on the proper uses of digital banking schemes for purchases using the Kisan Credit Card. In August 2022, 167 representatives of agricultural input suppliers were provided with technical know-how and practical demonstrations, enabling them to utilize banking with confidence. Photo by: Dipendra Chaudhary

Awareness-raising and demand creation for the Kisan Card

During the reporting period, CSISA conducted marketing activities to promote digital banking, targeting vendors (agricultural input suppliers, agriculture machinery dealers, farm machinery service providers) as well as smallholder and marginal farmers, in coordination with the bank. Most of this activity has been achieved through CSISA team members (primarily field supervisors) approaching farmers and CBFs directly. The Activity has also conducted target group meetings in some location including some identified by ward members, key persons and field supervisors. It has also produced brochures promoting the 'Mega Kisan Card' and distributed them to the target group through various promotional events. At the time of reporting, a total of 299 farmers have been linked to the digital banking tool (87 taking out a Mega Kisan Card and 212 taking out a ADBL Kisan Card). Of the total number of Kisan Cards issued, 228 are linked to agricultural loans having lower interest rate.

Above: Mega Kisan Card handover to Ms. Sima Chaudhary at Chandrauta Branch in the month of September 2022, Dang. Photo credit: Janga Bahadur Gurung

Working with Agriculture Development Bank Ltd

CSISA also coordinated with Agriculture Development Bank Ltd. (ADBL) to facilitate farmers' access to digital banking, mainly in Banke, Bardiya, Kailali and Kanchanpur districts. ADBL has also launched its own Kisan Card, linked to its agriculture loan packages, and was looking for partners to assist with outreach to farmers. The CSISA team in the above districts collaborated with local ADBL branches, supporting them to identify farmers interested in taking out an ADBL Kisan Card and conducting the necessary facilitation. Capacity building of vendors on the proper uses of digital banking schemes for purchases made through the Kisan Credit Card scheme was facilitated by CSISA in Banke district in coordination with ADBL, Khajura, Banke 0n August 6, 2022, As a result of CSISA's facilitation, 212 farmers were linked to the ADBL Kisan Card during the reporting period.

District-level review meetings with Mega Bank

In August 2022, the Activity facilitated a district-level half-day review meeting with Mega Bank. Branch managers and Relationship Managers of all the Mega bank branches in the district were invited to participate and review overall progress in the loan approval and disbursement. The status of each loan file that CSISA was facilitating was discussed; this has proved valuable in identifying bottlenecks and ways to enhance the collaboration, and thus speed up loan disbursement and issuance of the Kisan Card.

Orientation on financial literacy and loan utilization for farmers

Strengthening the capacity of the farmers on basic financial management and know how is as important as improving their access to the finance. As part of CSISA's work to increase farmer access to and utilization of bank finance, the Activity supported Mega Bank to conduct two financial literacy orientation programs at Tulsipur Sub-Metropolitan City and Lamahi Municipality, Dang district (2 and 9 September 2022, respectively). Facilitated by the respective Mega Bank branch managers of Tulsipur and Lamahi branches, these focused on the importance of access to finance, saving account and monthly savings

systems, the interest rates of different saving systems, and various loan products and their utilization. A total of 77 farmers participated in the two events, out of which 23 farmers opened the bank account linking to the Kisan Card, during the event itself.

Above: An orientation on financial literacy conducted by Mega Bank, Dang district, with the support of CSISA during September 2022. A total of 77 farmers participated in two locations, to hear about the best ways to manage their finances. Photo credit: Janga Bahadur Gurung,

WORK PACKAGE 4: GEOGRAPHICAL EXPANSION OF SOCIALLY DISTANCED AND COVID–19-SAFE AGRICULTURAL MECHANIZATION SERVICES

4.1 Horizontally expand socially distanced and COVID–19-safe agricultural mechanization services in the Feed the Future Zone

The key activities in Work Package 4 during this reporting period were (1) the expansion and re-establishment of offices and staff in Surkhet district, making CSISA operational in seven districts, (2) the recruitment of additional staff (two market systems specialists based in Dang and Surkhet, and a finance and logistics assistant based in Surkhet), and (3) assessment and refinement of the Activity to ensure GESI-responsive programming.

Progress in Surkhet (a district CSISA recently began work in) and Kapilvastu has been substantial. The office set-up and staffing in Surkhet is complete; similarly, in Kapilvastu, additional human resources/trainees were deployed and the roles and responsibilities of existing CSISA staff were re-organized, greatly enhancing service delivery, communication and partnership with Government and private sector partners. Slow but significant progress on agricultural mechanization was observed in Surkhet, where the mountainous landscape and small land parcels mean that many farmers are attracted to buying mini tillers. During the reporting period, farmers accessed bank loans with facilitation from CSISA and purchased a total of 39 agricultural machines (30 mini tillers, seven power tillers and two reapers). Similarly, a total of 139 farmers (78 women, 61 men) from two municipalities (Panchapuri and Lekbesi) used the mini tiller under the voucher scheme. In Bardiya, 18 farmers each bought a power tiller through subsidized loans from Mega Bank and three farmers purchased a mini tiller using a loan

from a cooperative. Nepal's liquidity issue meant that the loan approval process of the bank was significantly delayed, which affected the purchase and uptake of machines.

Above: Target beneficiary group meeting in Kapilvastu, during March 2022, to identify youth interested in becoming agricultural MSP entrepreneurs. Photo credit: Janga Bahadur Gurung

Significant achievements were also observed in gender and social inclusion (GESI) responsive programming. The CSISA team and CSISA partners have adopted the recommendations of the GESI assessment (commissioned by the Activity in 1.1.2 Rapid preparatory situation analysis on GESI conducted by the Activity has been beneficial. Since the last report, participation of women in CSISA activities such as training and orientation has increased dramatically. In Kanchanpur for example, women constituted 75% of participants in training on mini tiller operation. Similarly, 35% were in the power tiller repair and maintenance training. Examples of other key changes observed during the reporting period are:

- **Data disaggregation adopted by partners:** PMAMP's customer hiring centers (CHCs) are starting to keep disaggregated data of their participants and customers as a result of persuasion by CSISA. For example, 20 agrovets and two CHCs maintained the record of their customers as per their ethnicity, gender and economic status.
- **Inclusive staffing and trainees/on-the-job trainees:** A number of agrovets in CSISA's working areas are starting to give priority in recruiting female CBFs and interns. For example, Shikha agrovet in Bardiya has seven female on-the-job trainees undertaking training while at the same time supporting the agrovet in the services it provides.
- **Beneficiary targeting:** Some activities conducted by CSISA's partners during the reporting period were exclusively for women farmers. For example, RK Traders, Dhangadhi, targeted women farmers to operate a small handy machine (a 'spreader') for urea application. As a result, women farmers obtained the opportunity to learn about machinery operation, repair and maintenance, and can now operate the machine and fix minor issues independently.
- **Continued efforts in GESI sensitization:** CSISA also ensures that all trainings associated with the Activity include a session on GESI, and that each participant is asked to prepare an action plan indicating their commitment to ensuring internalization of GESI in their daily business. Similarly, each new partner is assessed for their sensitivity to GESI at the start of the partnership and a commitment plan is drawn up to support them to achieve GESI programming. For example, CSISA extended its partnership with cooperatives as the banks stopped approving loans due to liquidity issue. As a new partner, CSISA conducted a GESI assessment survey of the cooperatives, which looked particularly at the status of women's participation in the cooperatives' services and assessed whether they had

any priority actions or provisions to attract women's participation. The findings of the survey were not positive and so with CSISA's support an action plan for each cooperative was developed to make their services and provisions more women-friendly. One visible outcome of this intervention with the cooperatives is that the 50% of those who took out a loan from them for agri-business and small enterprises are women. Other changes observed included three CHCs in Bardiya following through their commitment to offer 10%–15% discount to women lead farmers, and Swastik Traders, the machinery dealer in Bardiya, providing 10% discount to women wanting to buy agricultural machinery.

- **Women's engagement in leadership and decision-making roles:** after GESI orientation, some CHCs had women elected in their executive committees. For example, Shantipur CHC now has a woman manager; Dakshin Gidarpur Farmers Group, Bardiya has one woman board member, and Tractor Farmers Group in Bardiya comprises 14 women and 13 men.

4.2 Deepen the scaling of socially distanced and COVID–19-safe agricultural mechanization services

To address challenges related to women's participation in agricultural machinery value chains, during the reporting period CSISA carried out awareness raising programs and advocated to machinery suppliers and dealers, CHCs, Nepal Government's Prime Minister Agriculture Modernization Project (PMAMP), Agriculture Knowledge Centers (AKCs) and other donor-funded programs in the FtF Zone to take affirmative action and make special provision on subsidy policy to motivate women to participate. The Activity provided a counseling service to interested machine service providers (MSPs) on which types of machinery have a high potential for scaling and facilitated the preparation of required loan documents which they submitted to the banks and cooperatives for their loan approval. to the banks and cooperatives. As a result, 120 MSP loans have been approved and disbursed in the past year. Also during the reporting period, 20 mobile mechanics were trained and mobilized.

Business management training for new farm machinery service providers

During the reporting period, CSISA facilitated five business management training sessions for a total of 90 new farm MSPs. The main objective of the training was to equip participants with the business management knowledge and skills essential to ensuring sustainable business development.

Above: Business management training for new farm machinery service providers; 17 new MSPs were developed by CSISA during the reporting period. Photo credit: Mohan Raskoti.

Business management trainings conducted by CSISA during the reporting period

Date	Number of MSPs	District
23–24 May, 2022	17	Bardiya
19–20 July, 2022	16	Kailali
20–21 July, 2022	16	Kapilvastu
14–15 September, 2022	24	Surkhet
21–22 July, 2022	17	Kailali

Backstop farm machinery service providers to generate sustained business through various marketing activities

During the reporting period, CSISA continued to support newly developed farm machinery service providers in the marketing of their businesses. This included printing and providing business cards, danglers and signboards for the promotion of individual businesses. In May 2022, a van campaign program facilitated by CSISA was conducted to promote the business of newly developed farm machinery services providers at Rajapur and Geruwa, Bardiya district. An autorickshaw with a speaker was driven around the villages where different MSPs are based and the name, phone number and services provided by each service provider in their catchment area was read out repeatedly. In addition, pamphlets were distributed to interested persons on the way. The campaign was carried out for one day in the month of May around the catchment areas of all 17 newly developed farm machinery services providers.

Above: An advertising signboard of Mr. Ramlal Tharu, an MSP from Ghodaghodi Municipality, Kailali. Photo credit: Mr. Surya Bahadur Khadka, District Program Officer

Above: An advertising signboard of Ms. Usha Aagri, an MSP from Bheriganga Municipality, Surkhet. Photo credit: Mr. Yamraj Adhikari

Challenge fund

In 2022, CSISA deployed a Challenge Fund to encourage innovation in agricultural mechanization. The goal of the challenge fund is to enhance private sector involvement in agriculture mechanization by facilitating its financial contribution to activities as well as by securing its commitment to sustaining service delivery to farmers through mobile mechanics, particularly women. Among 21 machinery suppliers selected following a call for expressions of interest in the challenge fund, 16 will develop 69 mobile mechanics through training and post-training learning and job opportunities, and five will conduct promotional activities including demonstrations, information-sharing, communication and education materials, and broadcasting radio programs (such as radio jingles) to promote the adoption of agriculture mechanization. The training of 57 mobile mechanics (12 women, 45 men) began in September 2022, and includes on-the-job training for three months with suppliers. To facilitate this, the supplier and trainee

signed an agreement that confirms training till December 2022 followed by three months on the-job-training.

Above: Trainees learning to repair an engine in Tirahut Baba Trade and Machinery Suppliers Pasal, Banke district. Photo credit: Mr. Subash Adhikari, Agricultural Machinery Engineer, CIMMYT

Above: Demonstration and training in the operation of the mini tiller, by RK Hardware and Suppliers, Challenge fund implementer, Kanchanpur. Photo credit: Mr. Subarna Angdembe

Also during the reporting period, CSISA conducted several capacity building activities for suppliers including orientation on financial management and reporting requirements. Regular catchups with suppliers have been instrumental in ensuring their compliance to the contractual agreement. It also facilitated self-assessment sessions with the trainees to track their progress before and after training, as well as scheduling regular meetings with the trainees. These interactions and follow-up meetings have been useful means of feedback exchange. For example, suppliers have asked CSISA to conduct this

program at the start of land preparation and harvesting season so they can conduct live demonstrations and practice in the field, which CSISA is willing to adopt in the next batch of challenge fund program.

Strengthening capacity of custom hiring centers to increase their efficiency

Custom hiring centers (six in Dhangadhi, three in Bardiya) were also provided with training during the reporting period in maintaining a logbook to track costs and income from their businesses. They were provided with register books followed by hands-on training on how to record data. This use of a register has improved their administration and financial management system; service delivery also is more efficient, and their business has expanded received training on the use of register.

Farm machinery service provider advertising assistance

During the reporting period, CSISA provided 16 new machinery service providers in Kapilvastu and 15 in Bardiya with signboards /danglers; those in Kapilvastu also received visiting cards. These media are important for the establishment continuity of farm service provision businesses.

Above: Signboard distribution to machinery service providers during business development training at Rajapur, Bardiya. Photo credit: Roshan Bhandari

Business linkages/demand creation for farm machinery services

During the reporting period, CSISA organized several meetings were organized among banks and cooperatives with prospective machine buyers and suppliers, to generate awareness on various types of machines available in the market, their utility, and where and how to access funds to purchase them. These meetings have been quite useful in increasing sales and the uptake of appropriate and resource-conserving agricultural machinery. For example, in Dhangadhi two meetings were organized among buyers and cooperatives, after which eight agricultural machines (two combine mills, three power tillers, two pumpsets and one tractor and trolley) were purchased by the cooperatives using government loans-CSISA facilitated to access these loans. Similarly, in Nepalgunj, the Activity facilitated two meetings with the result that 15 additional machines were purchased with loans from the banks and cooperatives; in Dang, 12 MSPs received loans at a discounted rate from cooperatives and micro-finance companies.

Capacity building of new farm machinery service providers

Two types of training were provided to new farm machinery service providers during the reporting period: 113 participants received capacity building training on machine use and repair while 90 were trained on business management. The latter was aimed at equipping service providers with a basic knowledge of running a business and helped new machinery entrepreneurs to expand their client network and cross-learning. In Dhangadhi, 33 service providers were trained while 24,17 and 16 were trained in Surkhet, Nepalgunj and Dang hubs respectively.

In the former trainings, a total of 113 new farm machinery services providers (16 in Surkhet, 14 in Kapilvastu, 62 in Dhangadhi and 21 in Nepalgunj) participated. The training which was aimed at providing basic skills in repairing and maintaining a power tiller and mini tiller. The Activity also facilitated similar training events organized by its government and private sector partners. Approximately 100 machinery services providers were trained in repair and maintenance through these partner-led training events.

5. Challenges Faced During the Reporting Period

CHALLENGES IN BANGLADESH AND NEPAL

- **Omicron variant:** Between January and February 2022, both Bangladesh and Nepal experienced the third COVID-19 surge fuelled by the Omicron variant. This caused again restrictions on travel and in-person engagement, which limited communication between project partners, reduced the depth of in-person workshops for scenario development, and required an adapted approach to training workshops.

- **Liquidity crisis:** CSISA's development hypothesis focuses on how access to finance can unlock smallholder and small business productivity in Nepal. This approach was however complicated by Nepal's financial liquidity crunch that started at the end of 2021 and resulted in banks being forced to reduce overall loans, including the productive sector. This has significantly affected CSISA's efforts in Objective III of the CSISA Response and Resilience Activity, with many banks reluctant to take risks on new agreements of innovative loan products such as those encouraged by CSISA. The MoU with Mega Bank, which was planned for the beginning of 2022, was delayed by four months and only signed on May 6, 2022. As such, progress towards targets in Objective III, in which all work packages depend on cooperation with financial service providers, has been slower than anticipated.

  Some key contributing factors are Nepal's increased dependence on imported goods and the drop in remittance inflow in recent months. Remittances are a leading contributing factor in the increased disposable income of individuals and a country's GDP (in Nepal's case, constituting about 30% of GDP). The steep drop in remittances due to the COVID-19 crisis has raised concerns that any further decline in the figure could lead to a structural imbalance at the macro level. Liquidity problems may also be affected by the Russia-Ukraine crisis and resulting speculation, inflation, and use of FOREX reserves to secure staple foods.

  To ease the liquidity crisis, Nepal's central bank has taken several measures, from injecting additional money into the financial market, requiring importers to deposit 100% cash in banks to open letters of credit for imports of luxury goods (including vehicles), as well as a temporary ban on the import of various products. However, the situation has not improved significantly at the time of writing.

  For this reason, after a discussion with USAID, the activity changed the strategy to expand loan services provision to include agricultural cooperatives, increased focus on the most receptive banks, and various other mechanisms. This has been very helpful in triggering the quantitative targets mainly related to access to finance.

- **Increasing consumer good prices, including in the agricultural sector:** Economic speculation amplified by the Russia-Ukraine conflict's effect on international trade and national monetary policies that increased interest rates influenced inflation and liquidity at a national level in Nepal and Bangladesh during the reporting period. This resulted in challenges that significantly affected the activity's ability to assure that the banking sector dispersed loans in the CSISA Response and Resilience Activity in Nepal, ultimately undermining CSISA's efforts to expand access to finance for Nepali small- and medium-scale enterprises. At the same time, rising fuel costs meant that many farmers experienced increased production costs and higher farm machinery hiring fees that limited access to machinery services popularized by the activity. Consequently, the Activity was not able to achieve the level of progress it aspired to in Nepal, resulting in an inability to meet some planned targets. In response, the Activity adopted strategic and technical changes in how the project operates, as detailed in the FY 22-23 Annual Report.

- **Bank rates increment:** Following the liquidity crisis, banks' interest rates in Nepal have increased recently. This has also impacted the program as some of MSMEs who showed interest in taking loans have expressed reluctance to take loans due to the high cost.

- **Flooding in Nepal:** Expansive flooding in the FtF Zone in western Nepal just prior to the 2022 harvest resulted in the loss of much of the rice crop grown in key areas in which the CSISA Response and Resilience Activity works. Rice that did not rot had to be carefully harvested by hand. As a consequence, the activity was unable to meet targets for business agreements between farmers and agricultural harvesting machinery services providers. The large-scale and sudden nature of the flooding events meant that CSISA could do little for managing the loss of affected farmers within the context of approved technical work plans. However, CSISA identified those farmers and targeted them for financial support from banks and cooperatives to recover from the economic shock of the flooding. CSISA also provided technical advice to local governmental partners on how to harvest flood affected crops more efficiently. Based on these challenges, CSISA is now exploring options to support these farmers with discount machinery service schemes in FY23. 144 per

- **Elections in Nepal:** On May 13, 2022, local government elections were held in 6 metropolitan cities, 11 sub-metropolitan cities, 276 municipalities, and 460 rural municipalities. These were the second set of local-level elections to be held since the promulgation of the new constitution in 2015. Due to the election code of conduct effective about a month before the election date, the CSISA COVID-19 Activity had to withhold all the events and activities that required participation from the local government stakeholders as it could be against the code of conduct that 'no resources and property of the public entity or any project to be used or caused to be used in favour of or against any party or candidate.'

Additional Information

ENGAGEMENT WITH MISSIONS, FEED THE FUTURE PARTNERS AND PROJECT SUB-CONTRACTORS[7]

USAID/Nepal and Mission

The Activity continued to engage with the USAID Bangladesh and Nepal missions during this reporting period, with new investments in CSISA provided by the USAID/Nepal Mission to the CSISA COVID–19 Response and Resilience Activity. It also supported the Fighting Fall Armyworm Activity and CSISA–MEA (the second phase of the CSISA–MI Activity). The latter was awarded in 2019 by USAID/Bangladesh which works in synergy with CSISA.

Feed the Future partners

During the reporting period CSISA also collaborated directly with the following FtF Activities

Feed the Future Integrated Pest Management Activity: The Bangladesh Integrated Pest Management Activity (IPMA) project aims to strengthen the capacity of agricultural stakeholders in Bangladesh by controlling and preventing the spread of current and emerging threats to ensure more efficient, profitable, and environmentally safe agricultural production and productivity. The Activity is led by Virginia Tech University and CSISA has been a strategic and fund supporting partner since its initiation.

Rice and Diversified Crops Activity. The Rice and Diversified Crops (RDC) Activity is led by the Agricultural Cooperative Development International and Volunteers in Overseas Cooperative Assistance (ACDI–VOCA). It aims to increase incomes and improve food security and nutrition in the FtF ZOI through systemic market changes which promote a diversified farm management approach, oriented to intensified rice production and higher-value, nutrient-rich crops. CSISA Phase III provided regular technical advice to RDC, which ended activities during the reporting period

Fighting Fall Armyworm in Bangladesh. Supported by the University of Michigan and USAID, this Activity cooperates with national research and extension partners, Centre for Agriculture and Bioscience International (CABI) and Food and Agriculture Organization (FAO) to strengthen efforts to mitigate impact of the pest on farmers' income, food security and health. It is supported in kind by CSISA Phase III. The Activity works to (1) develop educational materials to help reach audiences with information to improve understanding and management of Fall Armyworm, (2) support DAE in the deployment of awareness-raising and training campaigns, (3) encourage institutional change to improve crop protection and extend integrated pest management, (4) prepare the private sector for appropriate FAW response, (5) support the development of a Bangladesh standing multi-threat pest emergency taskforce, and (6) generate data and evidence to guide integrated FAW management. The Activity spans 2019–21 and was completed in September of 2021.

Cereal Systems Initiative for South Asia Mechanization and Extension Activity. Building on the successes of the CSISA–MI Activity, the FtF Bangladesh Cereal Systems Initiative in South Asia Mechanization Extension Activity (CSISA–MEA) began on 1 October 2019. It has three main objectives, namely, to (1) increase the competitiveness and efficiency of domestic and private sector-led agricultural machinery manufacturing, assembly, use and servicing, (2) enhance institutional capacity for agricultural

[7] A full list of partners and details can be found in Annex II.

mechanization through the development of a skilled and youth workforce, and (3) facilitate the widespread uptake of sustainable intensification practices in Rohingya refugee-impacted communities in south-eastern Bangladesh. Through activities designed to meet these objectives, the Activity aims to address a number of challenges faced by the light engineering sector involved in the manufacture of agricultural machinery and spare parts. These include poor manufacturing processes, use of old and inefficient manufacturing equipment, limited supply of good quality materials, limited access to appropriate financial services, and low levels of workforce skills.

Nepal Seed and Fertilizer (NSAF) Project (2016–21) is a USD15 m USAID–Nepal initiative and a direct outshoot of progress made by CSISA on seed systems and integrated soil fertility management. CSISA staff collaborate frequently and deeply with NSAF on scientific and operational matters.

KISAN Project. The Knowledge-based Integrated Sustainable Agriculture and Nutrition project is part of USAID's global Feed the Future initiative. It is a five-year project (2017–22) which is facilitating systemic changes in the agricultural sector including: (1) greater climate-smart intensification of staple crops and diversification into higher value commodities, (2) strengthening local market systems to support more competitive and resilient value chains and agricultural related businesses, and (3) improving the enabling environment for agricultural and market systems development. KISAN reaches hundreds of thousands of farmers, many of whom have been exposed to CSISA information, materials and technologies through the partnership between CSISA and KISAN.

Feed the Future Nutrition Innovation Lab. The FtF Nutrition Innovation Laboratory pursues applied research that supports the goals of USAID's Feed the Future initiative, builds institutional capacity for analysis and policy formulation in developing countries, and offers scholarships that support individual capacity development through formal degree education in the United States and elsewhere. Tufts University's Friedman School of Nutrition Science and Policy has served as the Management Entity for USAID's Nutrition Innovation Laboratory since October 2010. Tufts manages the activities of the Lab and conducts research in close partnership with several US university partners. CSISA collaborates with the Nutrition Innovation Laboratory in the analysis of survey data and modeling of the intrahousehold nutritional status implications of agricultural development interventions in Bangladesh.

Feed the Future Sustainable Intensification Innovation Lab (SIIL). Since 2015, Kansas State University (KSU) and International Rice Research Institute (IRRI) in collaboration with Sustainable Intensification Innovation Lab (SIIL) and other national research and development agencies has been working in the coastal zones of Bangladesh. The FtF SIIL is a USAID-funded program that supports research, knowledge sharing and capacity building in relation to smallholder farming systems, and increasing ecological intensification for the production of food, fiber and other products in Asia and Africa. From the fourth reporting quarter of the 2019–20 period, CSISA has initiated a collaboration with the SIIL 'Pathways of scaling agricultural innovations for sustainable intensification in the polders of coastal Bangladesh' project (SIIL–Polder Project: Phase II) in screening fodder species for tolerance and growth in salt-affected soils in coastal Bangladesh.

Feed the Future Innovation Lab for Small-Scale Irrigation (ILSSI). Based at Texas A&M University, ILSSI is a research-for-development project which aims to expand farmer-led, small-scale irrigation, principally in Ethiopia, Ghana, Mali and Tanzania. Sustainable, profitable and gender-sensitive irrigation contributes to agricultural growth, resilient food systems and better nutrition and health, particularly for vulnerable populations. Now in its second phase (2019–23), ILSSI is working to identify the best ways to expand the use of small-scale irrigation within environmentally sustainable limits. ILSSI is a part of the US Government's Feed the Future initiative. With the new CSISA/Nepal buy-in to the CSISA program – with the CSISA COVID–19 Resilience Activity – the ILSSI team has begun to work on hydrological modeling, with a focus on working towards the development of a sustainable irrigation

development strategy for the FtF Zone in Nepal.

Activity sub-contractors

CSISA Phase III maintains three sub-contractual partners in Bangladesh, who are essential for scaling-out project-supported technologies and for reaching farmers. This is particularly important as the Activity is coordinated through a partnership of three research institutions. These partnerships enable the dissemination of CGIAR research findings to farmers through knowledge products. Details of the achievements of each of these partners can be found throughout this report, particularly in the sections on Bangladesh and Nepal.

CSISA vets and selects partners based on their alignment with the CSISA approach and their ability to generate impact at scale. In this reporting period, the Activity maintained partnerships with the following three organizations:

Bangladesh Rice Research Institute (BRRI) was founded in 1970 and is the country's apex rice research body. BRRI assists the Activity with the following:

- implementing on-farm trials of new PQR varieties in six *upazilas* (sub-districts) in three CSISA hubs to identify best-bet premium quality varieties in terms of yield and farmers', millers' and traders' preferences
- on-farm performance evaluations of integrated weed management options to increase yield and profits in farmers' fields
- on-station trials to develop and fine tune the mat nursery method of raising rice seedlings for manual transplanting
- organizing additional on-farm trials.

The Bangladesh Wheat and Maize Research Institute (BWMRI). The Activity's agreement with BWMRI, established in 2019, has established a cooperative and mutually beneficial relationship for carrying out activities with CIMMYT on the following topics:

- germplasm exchange, development, delivery, intensification and diversification
- promoting sustainable intensification-based conservation agriculture crop management and improved seed system farm equipment and machinery
- addressing socio-economic and policy constraints that affect the adoption of new technologies
- mainstreaming gender concerns in research for development
- building the capacity of national scientists and partners through training
- engaging the private sector on value chain and market development to benefit maize and wheat farmer.
- CSISA leverages this agreement and cooperates with BWMRI on all wheat-related work in Bangladesh that the project focuses on.

The Bangladesh Department of Agricultural Extension (DAE). The vision of DAE, under the Ministry of Agriculture, is to provide eco-friendly, safe, climate resilient and sustainable productive good agricultural practices while sustaining natural resources, to ensure food security as well as commercial agriculture, with a view to accelerating the country's socioeconomic development. DAE's mission is to provide efficient, effective, decentralized, location-specific, demand-responsive and integrated extension services to all categories of farmer, supporting them to access and utilize better knowhow to increase sustainable and profitable crop production. CSISA collaborates widely with DAE on a range of initiatives and activities in Bangladesh, detailed in this report.

International Water Management Institute (IWMI) is a non-profit research organization with headquarters in Colombo, Sri Lanka, and offices across Africa and Asia. Research at the Institute focuses

on improving how water and land resources are managed with the aim of underpinning food security and reducing poverty while safeguarding vital environmental processes. With the new CSISA/Nepal buy-in to the CSISA Activity – with the CSISA COVID–19 Resilience Activity – the IWMI team in Nepal has been engaged in working towards the development of a sustainable irrigation development strategy for the FtF Zone in Nepal.

Details of partners' achievements during the reporting period are given throughout the report, principally in Chapters 2 and Chapter 3. Please see Annex 3 for details of Activity subcontractors and key partners.

International Development Enterprises (iDE) in Nepal is a global development organization that co-creates with foundations, governments, individuals, for-profits, and nonprofits to develop lasting solutions to poverty dedicated to creating income and livelihood opportunities for poor, rural households. With the new CSISA/Nepal buy-in to the CSISA Activity – the CSISA COVID–19 Resilience Activity – the iDE team in Nepal has been engaged in working towards entrepreneurship opportunities and access to finance for the FtF Zone in Nepal.

Annex 1: Publications and media produced by CSISA in 2021-2022

PEER-REVIEWED PAPERS & REVIEWED PUBLICATIONS

1 Krupnik, T. J., Hossain, K., Timsina, J., Uddin, M. M., Baksh, M. E., Hasan, M. Z., & Gathala, M. K. (2022). Performance of a hermetic device and neem (*Azadirachta indica*) in storing wheat seed: Evidence from participatory household trials in central Bangladesh. Journal of Stored Products Research, 99, 102024. https://doi.org/10.1016/j.jspr.2022.102024

2 Emran, SA., Krupnik, T.J., Aravindakshan, S. et al. Impact of cropping system diversification on productivity and resource use efficiencies of smallholder farmers in south-central Bangladesh: a multi-criteria analysis. Agron. Sustain. Dev. 42, 78 (2022). https://doi.org/10.1007/s13593-022-00795-3

3 Krupnik, T. J., Hossain, M. K., Timsina, J., Gathala, M. K., Sapkota, T. B., Yasmin, S., Shahjahan, M., Hossain, F., Kurishi, A., Miah, A. A., Rahman, B. M., & McDonald, A. J. (2022). Adapted Conservation Agriculture Practices Can Increase Energy Productivity and Lower Yield-Scaled Greenhouse Gas Emissions in Coastal Bangladesh. Frontiers in Agronomy. https://doi.org/10.3389/fagro.2022.829737

4 Medendorp, J. W., Reeves, N. P., Sal y Rosas Celi, V. G., Harun-ar-Rashid, M., Krupnik, T. J., Lutomia, A. N., Pittendrigh, B., & Bello-Bravo, J. (2022). Large-scale rollout of extension training in Bangladesh: Challenges and opportunities for gender-inclusive participation. PLOS ONE, 17(7), e0270662. https://doi.org/10.1371/journal.pone.0270662

5 Paudel, G. P., Khanal, A. R., Rahut, D. B., Krupnik, T. J., McDonald, A. J. (2022). Smart precision agriculture but resource constrained farmers: Is service provision a potential solution? Farmer's willingness to pay for laser-land leveling services in Nepal. Smart Agricultural Technology, 3, 100084. https://doi.org/10.1016/j.atech.2022.100084

6 Mason, S. J., Krupnik, T. J., Hansen, J. W., Braun, M., Ghulam Hussain, S., Shah Kamal Khan, M., Mannan, A., Curtis, A., Han, E., & Kruczkiewicz, A. (2022). Re-prioritizing climate services for agriculture: Insights from Bangladesh. Climate Services, 27, 100306. https://doi.org/10.1016/j.cliser.2022.100306

7 Ladha, J. K., Peoples, M. B., Reddy, P. M., Biswas, J. C., Bennett, A., Jat, M. L., & Krupnik, T. J. (2022). Biological nitrogen fixation and prospects for ecological intensification in cereal-based cropping systems. Field Crops Research, 283, 108541. https://doi.org/10.1016/j.fcr.2022.108541

8 Aravindakshan, S., AlQahtany, A., Arshad, M. et al. A metafrontier approach and fractional regression model to analyze the environmental efficiency of alternative tillage practices for wheat in Bangladesh. Environ Sci Pollut Res 29, 41231–41246 (2022). https://doi.org/10.1007/s11356-021-18296-3

9 Kishore, A., Saini, S., Alvi, M., Assessing Direct Benefit Transfer of Agricultural Subsidies in Bihar and Odisha. Economic & Political Weekly. Vol. 57, Issue No. 16, (2022) https://www.epw.in/journal/2022/16/special-articles/assessing-direct-benefit-transfer-agricultural.html

10 Sandhu OS, Jat ML, Gupta RK, Thind HS, Sidhu HS, Singh Y. Influence of Residue Type and Method of Placement on Dynamics of Decomposition and Nitrogen Release in Maize-Wheat-Mungbean Cropping on Permanent Raised Beds: A Litterbag Study. Sustainability. 2022; 14(2):864. https://doi.org/10.3390/su14020864

11 Ajay et al. 2021, Open Data Journal for Agricultural Research, vol. 7., p. 20-26. https://doi.org/10.18174/odjar.v7i0.17959

12 Risal, A.; Urfels, A.; Srinivasan, R.; Bayissa, Y.; Shrestha, N.; Paudel, G.P.; Krupnik, T.J. Impact of Climate Change on Water Resources and Crop Production in Western Nepal: Implications and Adaptation Strategies. Hydrology 2022, 9, 132. https://doi.org/10.3390/hydrology9080132

13 Montes, C., Hussain, S.K., Krupnik, T.J. (2022) Variable climate suitability for wheat blast (Magnaporthe oryzae pathotype Triticum) in Asia: results from a continental-scale modeling approach. In Press: International Journal of Biometeorology. https://doi.org/10.1007/s00484-022-02352-9

14 Nayak, H.S., Silva, J.S., Parihar, C.M., Krupnik, T.J., Sena, D.R., Kakralia, S.K., Jat, H.S., Sidhu, H.S., Charma, P.C., Jat. M.L., Sapkota, T. (2022) Interpretable machine learning methods to explain on-farm yield variability of high productivity wheat in Northwest India. Field Crops Research. 287: 108640. https://doi.org/10.1016/j.fcr.2022.108640

15 Montes, C, Acharya, N., Hossain, R., Babu, T.S.A., Krupnik, T.J. (2022) Developing climate services for aquaculture in Bangladesh: towards a seasonal early warning system for high temperatures and intense rainfall events. Climate Services. 26: 100292. https://doi.org/10.1016/j.cliser.2022.100292

16 Choudhary, D., Banskota, K., Khanal, N., McDonald, A.J., Krupnik, T.J., Erenstein, O. (2022) Rice sub-sector development and farmer efficiency in Nepal: Implications for further transformation and food security. Frontiers in Sustainable Food Systems. https://doi.org/10.3389/fsufs.2021.740546

17 Simon, W.J., Krupnik, T.J., Aguilar-Gallegos, N., Halbherr, L., Groot, J.C.J. (2021) Putting social networks to practical use: Improving last-mile dissemination systems for climate and market information services in developing countries. Climate Services. 23: 100248. https://doi.org/10.1016/j.cliser.2021.100248

DISCUSSION PAPERS, REPORTS AND POLICY BRIEFS

1 Muzna Fatima Alvi, Prapti Barooah, Shweta Gupta, Ruth Suseela Meinzen-Dick and Claudia Ringler (2022). Hello, can you hear me? Impact of speakerphones on phone survey responses. IFPRI Discussion Paper 02123. https://ebrary.ifpri.org/utils/getfile/collection/p15738coll2/id/135926/filename/136137.pdf

DIDACTIC MATERIALS AND TRAINING MODULES

1 Urfels, A., Khadka, M., Shrestha, N., Pavelic, P., Risal, A., Uprety, L., Shrestha, G., Dile. Y., McDonald. A.J., Pandey, V.P., Srinivasan, R., Krupnik, T.J.(2022) A framework for sustainable and inclusive irrigation development. in Western Nepal. Cereal Systems Initiative for South Asia, Kathmandu, Nepal: CIMMYT. Available online: Click here

2 Islam, Kh.S., Ali, Md.M., Shahrin, S., Cheesman, S., Alam, S.N., Krupnik, T.J. 2022. Simple and effective management methods that can improve Soybean production in Bangladesh. Cereal Systems Initiative for South Asia, Phase III (CSISA III), Dhaka, Bangladesh: CIMMYT. Available online: Click here

3 Khadka, M., Uprety, L., Shrestha, G., Minh, T.T., Nepal, S., Raut, M., Dhungana, S., Shahrin, S., Krupnik, T.J., Schmitter, P. 2021. Understanding barriers and opportunities for scaling sustainable and inclusive farmer-led irrigation development in Nepal. The Cereal Systems Initiative for South Asia (CSISA). Kathmandu, Nepal. Available online: Click here

EDUCATIONAL VIDEOS

1. How to use fire extinguisher in agricultural machinery workshops (Nepali)
2. How to check firing order and timing of a four-cylinder four-stroke farm machinery engine
3. How to start power tiller if it doesn't start (Nepali)
4. How to fit an engine start rope for agricultural machinery (Nepali)

Annex 2: CSISA III key leadership staff

Name	Role	Institution	Address	Phone	Email
Timothy Krupnik	Senior Scientist (Systems Agronomy) and CSISA Project Leader (Nepal and Bangladesh)	CIMMYT	Dhaka, Bangladesh	+88 0175 556 8938	t.krupnik@cgiar.org
Cynthia Carmona	Project Manager	CIMMYT	Kathmandu, Nepal	+977 9851197994	c.carmona@cgiar.org
T.S Amjath Babu	Agricultural Economist	CIMMYT	Dhaka, Bangladesh	--	T.AMJATH@cgiar.org
Virender Kumar	Senior Scientist, Weed Science/Systems Agronomy and Coordinator of Direct-Seeded Rice Consortium	IRRI	Philippines	--	
Prakashan Chellattan	Senior Scientist I	IRRI	New Delhi, India	--	pc.veettil@irri.org
Arindam Samaddar	Monitoring, Learning and Evaluation Lead	IRRI	New Delhi, India	--	a.samaddar@irri.org
Muzna Alvi	Research Fellow	IFPRI	New Delhi, India	--	M.Alvi@cgiar.org
Avinash Kishore	Senior Research Fellow	IFPRI	New Delhi, India		A.Kishore@cgiar.org
Prapti Barooah	Senior Research Analyst	IFPRI	New Delhi, India	--	P.Barooah@cgiar.org
Manohara Khadka	Country Representative	IWMI	Kathmandu, Nepal	--	M.Khadka@cgiar.org
Corey O'Hara	Country Director	iDE, Nepal	Kathmandu, Nepal	--	cohara@ideglobal.org
BANGLADESH					
A. K. M. Saiful Islam	Monitoring, Evaluation & Learning Manager	CIMMYT	Dhaka, Bangladesh	+880 1714 041708	a.s.islam@cgiar.org
Khaled Hossain	Research Associate and Lead Research Coordinator	CIMMYT	Dhaka, Bangladesh	+880 1717 765505	k.hossain@cgiar.org

Syed Nurul Alam	Senior Consultant	CIMMYT	Dhaka, Bangladesh	+880 1711 907886	alamsn09@gmail.com
Syed Mahmudul Huq	Training Coordinator	CIMMYT	Dhaka, Bangladesh	+880 1713 031892	S.HUQ@cgiar.org
Hussain, Ghulam	Senior Consultant	CIMMYT	Dhaka, Bangladesh	+880 1715 885608	G.HUSSAIN@cgiar.org
Frances Hunt	Consultant Editor	CIMMYT	Manchester, UK	+44 7789 821387	greenworld01@yahoo.co.uk
Shafiqul Islam	Jashore Hub Coordinator	CIMMYT	Jashore, Bangladesh	+880 171145 1064	Shafiqul.Islam@cgiar.org
Hera Lal Nath	Faridpur Hub Coordinator	CIMMYT	Faridpur, Bangladesh	+880 171686 6635	h.l.nath@cgiar.org
Nur-A-Mahajabin Khan	Communication Coordinator	CIMMYT	Dhaka, Bangladesh	+880 1717488913	N.KHAN@cgiar.org
Alanuzzaman Kurishi	Research Associate (responsible for Dinajpur field office)	CIMMYT	Dinajpur, Bangladesh	+880 1715 803856	a.kurishi@cgiar.org
Sharif Ahmed	Senior Specialist – Agronomy Extension	IRRI	Dhaka, Bangladesh	+880 1723 916674	s.ahmed@irri.org
Md. Mizanur Rahman	Monitoring, Evaluation and Learning Officer	CIMMYT	Dhaka, Bangladesh	+880 1713 706422	md.m.rahman@cgiar.org
Titus Doffo	Project Assistant	CIMMYT	Dhaka, Bangladesh	+880 1835 046120	T.DOFFO@cgiar.org
Achal Rahman	Project Assistant	CIMMYT	Dhaka, Bangladesh	+880 1718 700024	A.RAHMAN@cgiar.org
Stephanie Chessman	Post-Doctoral Fellow	CIMMYT	Dhaka, Bangladesh	--	s.cheesman@cgiar.org
NEPAL					
Rudriksha Rai Parajuli	Technical Partnerships Manager	CIMMYT	Kathmandu, Nepal	+977 9851243486	r.parajuli@cgiar.org
Ashta Prajapati	Market Development & New Business Lead	iDE, Nepal	Kathmandu, Nepal	+977 9851069343	aprajapati@ideglobal.org
Subash Adhikari	Agricultural Mechanization Engineer	CIMMYT	Banke, Nepal	+977 9841893657	s.adhikari@cgiar.org
Lokendra Khadka	Area Coordinator	CIMMYT	Kailali, Nepal	+977 9845198379	l.khadka@cgiar.org

Salin Acharya	Area Coordinator	CIMMYT	Banke, Nepal	+977 9851223521	s.acharya@cgiar.org
Sagar Kafle	Assistant Research Associate	CIMMYT	Dang, Nepal	+977 9845156044	a.kafle@cgiar.org
Saral Karki	GIS Analyst	CIMMYT	Kathmandu, Nepal	+977 9851239936	s.karki@cgiar.org
Krishna Kafle	Data Management and Analysis	CIMMYT	Kathmandu, Nepal	+977 9851229519	krishna.kafle@cgiar.org
Narendra Niroula	Market Systems Coordinator	CIMMYT	Kathmandu, Nepal	+977 9851333574	n.niroula@cgiar.org
Anton Urfels	Post-Doctoral Fellow	CIMMYT	Kathmandu, Nepal	--	a.urfels@cgiar.org

Annex 3: Project subcontractors and key partners

BANGLADESH

Partner	Partnership objective	Alignment with themes	Leveraging opportunity	Status of partnership
Government of Bangladesh				
Bangladesh Agricultural Research Institute (BARI)	Development, validation and refinement of technologies and new research methods, boosting scaling capacity	Innovation towards impact	With a network of regional research stations and strong input into the development of extension materials, approaches and policies, and being integrated in the Ministry of Agriculture, BARI provides leveraging opportunities to mainstream sustainable intensification innovations into the Government of Bangladesh's National Agriculture Research and Extension System.	In 2016, the previous sub-grant was amended and the deliverables shifted towards the newly established Bangladesh Wheat and Maize Research Institute (BWMRI) (see below).
Bangladesh Wheat and Maize Research Institute (BWMRI)	Development, validation and refinement of technologies and new research methods, boosting scaling capacity	Innovation towards impact	With a network of regional research stations and strong inputs into the development of extension materials, approaches and policies, and being integrated in the Ministry of Agriculture, BWMRI provides leveraging opportunities to mainstream sustainable intensification innovations into the Government of Bangladesh's National Agriculture Research and Extension System.	The Wheat Research Centre (WRC), a former component of BARI, became BWMRI in mid-2018. In 2019 CIMMYT signed a sub-grant agreement with BWMRI to continue research on wheat blast and other matters. The second Sub-grant letter for "Purchase of Truthfully Lebel Seeds (TLS) of blast resistant wheat variety BARI Gom 33 for strengthening farmers to farmers seed promotion" in 2020–21.
Bangladesh Rice Research Institute (BRRI)	Development, validation and refinement of technologies and new research methods, boosting scaling	Innovation towards impact	With a network of regional research stations and strong inputs into the development of extension materials, approaches and policies, and being integrated in the Ministry of Agriculture, BRRI also provides leveraging opportunities to mainstream sustainable intensification innovations in the	The International Rice Research Institute (IRRI) maintains a formal partnership with BRRI. BRRI collaborated with CSISA in Phases I and II, continuing in Phase III.

	capacity		Government of Bangladesh's National Agriculture Research System.	
Department of Agricultural Extension (DAE)	Extension and scaling	Achieving impact at scale	DAE has over 13,000 field extension agents located across Bangladesh. The Department collaborated with CSISA Phase II and the USAID/Bangladesh Mission-funded CSISA Expansion Activity in Bangladesh in the Feed the Future zone and Dinajpur hub. The sensitization of DAE agents to sustainable intensification technologies and approaches provides large opportunities for reaching and raising the awareness of farmers, with sustainability through messaging after Phase III ends.	The Activity continues to collaborate with DAE informally and synergistically, despite funding cuts. The volume of activities was reduced in the reporting period due to the Activity's inability to support large field campaigns and collaborative meetings with DAE. CIMMYT also worked with DAE through a CSRD and USAID/Bangladesh mini-grant on wheat blast, an activity that closed in September 2019. As a part of CSISA activities, DAE works with CIMMYT to disseminate better bet agronomic practices. In this reporting period, DAE disseminated messages developed by CIMMYT, BARI and BWMRI on EWS and fighting wheat blast, fighting back against FAW, and mung bean cultivation.
Agricultural Information Services (AIS)	Production of extension materials for DAE use	Achieving impact at scale	AIS is a government agency that produces extension materials and media used by DAE. Strategic partnerships with AIS facilitate the integration of sustainable intensification principles into extension materials and messaging.	Collaboration continued informally. In Dinajpur, AIS supported CSISA activities by conducting village level video screenings and training on healthy rice seedlings and EWS in 2020. The Activity is exploring further opportunities to work with AIS to disseminate better bet practices among farmers.
Bangladesh Meteorological Department (BMD)	Conduct collaborative research and development activities related to weather,	Achieving impact at scale	BMD provides clientele services related to weather and climate to more than 100 national and international organizations. It has a network of meteorological stations across the country, and	BMD completed a sub-grant during 2017–19. After completion, the collaboration continues under the Memorandum of Understanding signed on September 15, 2019.

	agro-climatology and climate services, and undertake programs for strengthening the capabilities and dissemination of useful research findings, advisories and technologies within Bangladesh		BMD-generated weather forecasts are used in the field of agriculture by GOs and NGOs to provide agro-meteorological advisory services to farmers.	
Bangladesh private sector				
Janata Engineering	Development and sales of scale-appropriate machinery	Achieving impact at scale	Domestic production and import of sustainable intensification scale-appropriate machinery and sales through the private sector	The commercial joint venture agreement with this firm was terminated in 2017 due to funding uncertainties and fund transfer delays to CSISA from USAID. However, since then CSISA has maintained active discussions with this partner and could re-establish relations if clear funding timing and commitments can be provided by USAID.
The Metal Pvt. Ltd	Development and sales of scale-appropriate machinery	Achieving impact at scale	Domestic production and import of sustainable intensification scale-appropriate machinery and sales through the private sector	The commercial joint venture agreement with this firm was terminated in 2017 due to funding uncertainties and fund transfer delays to CSISA from USAID. However, since then, CSISA has maintained active discussions with this partner and could re-establish relations if clear funding timing and commitments can be provided by USAID.
Advanced Chemical Industries (ACI)	Sale of scale-appropriate machinery, fungicides,	Achieving impact at scale	Import of sustainable intensification scale-appropriate machinery and sales through the private sector, along with a range of chemical and	The commercial joint venture agreement with this firm was terminated in 2017 due to funding uncertainties and fund transfer delays

	weed control products and seed. IRRI works with ACI to produce a range of hybrid and open-pollinated rice seeds.		cereal seed products	to CSISA from USAID. However, since then CSISA has maintained active discussions with this partner and could re-establish relations if clear funding timing and commitments can be provided by USAID.
Ispahani Agro Ltd	Scale-up commercialization of the recently registered biological product Fawligen, SfNPV, a highly specific natural pathogen, as well as other biological products against FAW	Achieving impact at scale	Agreement covers 10+ activities (e.g. TOT for sales teams, video development and screening, promotional material development and disbursement, crop consultant program, IPM championship program, educational and marketing campaign, dealers, retailers and farmers training, advertisements such as those put out by road shows) aimed at rapid commercialization of the products	The 1:1 matched fund agreement with IAL started on August 2020 and ended in June 2021.
Syngenta Bangladesh Ltd	Awareness-raising to contribute to the rapid commercialization of Fortenza 60FS (Cyntraniliprole) a low-toxic seed treating agent against FAW	Achieving impact at scale	CSISA implements several activities to provide technical support to Syngenta by training its channel line dealers and village-level sales and commission agents in aspects of FAW. Agreement also includes video development/showing, promotional material development and disbursement, dealers, retailers and farmers training, aimed at rapid commercialization of the products	The 1:1 matched fund agreement with this company began in October 2020 and ended in June 2021.
Auto Crop Care Ltd (ACCL)	Commercialization of safe and less toxic herbicide molecules found through on-farm research; create awareness among	Achieving impact at scale	Increased sales of less toxic and safe herbicide molecules, including safety equipment	CSISA and ACCL's partnership started at the beginning of the *boro* season 2019–20 (November 2019) and continues till now.

	farmers through on-farm demonstrations; make the safe herbicide molecules available with the local input dealers			
Srizon Agro, Saidpur, Nilphamari	In collaborative initiative through private sector/seed company and CSISA, expand PQR involving farmers groups, targeting total 10,000 tons of new PQR production aiming to achieve a sustainable mechanism after existing CSISA III. This collaboration focuses on 3400 tons of new PQR production in Rangpur, Nilphamri, Dinajpur and Thakurgoan districts.	Achieving impact at scale	To increase PQR quality seed production through this seed company, increase PQR farmers through selling PQR seed locally, expansion of new PQR varieties (especially BRRI dhan 50, BRRI dhan 63 in *boro* & BRRI dhan 34, BRRI dhan 75 and BRRI dhan 87 in *aman*), achieving sustainable development among all stakeholders (e.g. millers, local service providers, DAE, private sector organizations) through CSISA and company collaboration activities	CSISA and Srizon Agro's partnership started at the beginning of *boro* season 2020 and continues till now.
J.R. Agro, Chotokollani, Mahigonj, Rangpur	In collaborative initiative through private sector/seed company and CSISA, expand PQR involving farmers groups targeting a total of	Achieving impact at scale	To increase PQR quality seed production through this seed company, increase the number of PQR farmers through selling PQR seed locally, expansion of PQR new varieties (especially BRRI dhan 50, BRRI dhan 63 in *boro* and BRRI dhan 34, BRRI dhan 75 and BRRI dhan 87 in *aman*), achieving sustainable development among all stakeholders (e.g. millers, local service providers,	CSISA and J.R. Agro's partnership started at the beginning of the 2020–21 *boro* season (November 2021) and continues till now.

	10,000 tons of new PQR production aiming to achieve a sustainable mechanism after existing CSISA III. This collaboration will focus on achieving 3400 tons of new PQR production in Rangpur, Nilphamri, Dinajpur and Thakurgoan districts.		DAE, private sector) through CSISA and company collaboration activities.	
One X crop care "Square Seed"	Expand PQR production, considering large scale famers, availability of premium quality seed in local level farmers, sustainable linkage building among local level stakeholders	Achieving impact at scale	This activity increases farmers' profits from rice farming, targeting all stakeholders' proper involvement.	Agreement between CSISA and One X crop care "Square Seed" started on 1 November 2020 and ended on 31 December 2021.
Friends Seeds Pvt. Ltd	Expand PQR considering large scale famers, availability of premium quality seeds in local level farmers, sustainable linkage building among local level stakeholders	Achieving impact at scale	This activity increases farmers' profits from rice farming targeting all stakeholders' proper involvement.	Agreement between CSISA and Friends Seeds Pvt. Ltd. started on 1 November 2020 and ended on 31 December 2021.

Konika Seed Company (Pvt.) Ltd	Expand PQR considering large scale famers, availability of premium quality seeds in local level farmers, sustainable linkage building among local level stakeholders	Achieving impact at scale	This activity increases farmers' profits from rice farming targeting all stakeholders' proper involvement.	Agreement between CSISA and Konika Seed Company (Pvt.) Ltd. started on 1 November 2020 and ended on 31 December 2021.
Modern Seeds Agro Pvt. Ltd	Expand PQR considering large scale famers, availability of premium quality seeds in local level farmers, sustainable linkage building among local level stakeholders	Achieving impact at scale	This activity increases farmers' profits from rice farming targeting all stakeholders' proper involvement.	Agreement between CSISA and Modern Seeds Agro Pvt. Ltd started on 1 November 2020 and ended on 31 December 2021.
Uzirpur Organic Multipurpose Cooperative Society Ltd	Expand PQR considering large scale famers, availability of premium quality seeds in local level farmers, sustainable linkage building among local level stakeholders	Achieving impact at scale	This activity increases farmers' profits from rice farming targeting all stakeholders' proper involvement.	Agreement between CSISA and Uzirpur Organic Multipurpose Cooperative Society Ltd started on 1 November 2020 and ended on 31 December 2021
Adarsho Chashi Ghar	Expand PQR considering large scale famers, availability of premium quality seeds in local level farmers, sustainable linkage building among local	Achieving impact at scale	This activity increases farmers' profits from rice farming targeting all stakeholder's proper involvement.	Agreement between CSISA and Adarsho Chashi Ghar started on 1 November 2020 and ended on 31 December 2021

	level stakeholders			
INSAF Seed (Pvt.) Ltd	In a collaborative initiative through private sector/seed company and CSISA, expand PQR involving farmers groups, targeting 5000 tons seed production and aiming for a sustainable mechanism after exit of CSISA PIII	Achieving impact at scale	Expand PQR involving INSAF Seed farmer's groups through quality PQR seed production and ensure availability in the market	This agreement to collaborate was effective from 1 November 2020 to 31 December 2021 and may be renewed further up to a mutually agreed date.
NUR Seed	In a collaborative initiative through private sector/seed company and CSISA, expand PQR involving farmers groups, targeting 5000 tons seed production, aiming for a sustainable mechanism after exit of CSISA PIII	Achieving impact at scale	Increase PQR through NUR Seed farmers groups with a view to increasing availability of PQR seed through BADC and different seed agents	This agreement to collaborate was effective from 1 November 2020 to 31 December 2021 and may be renewed further up to a mutually agreed date.
NGOs				
Agricultural Advisory Society (AAS) (a CSISA subcontractor)	Facilitate village screenings of training films and conduct follow-up studies	Achieving impact at scale	The Activity worked with AAS in Phase II and CSISA Bangladesh to reach 110,000 farmers with village training video screenings accompanied by question-and-answer sessions, to raise awareness among farmers on scale-appropriate machinery and associated crop management practices. During	AAS works under Activity sub-grants to conduct village-level video shows and to train farmers on core CSISA topics. It organized a total 1080 video shows in 921 villages watched by a total of 132,358 farming community members. Video content covered

			CSISA III, AAS is working to promote better bet agronomy practices including healthy rice seedlings, early wheat sowing and fighting FAW.	healthy rice seedlings, early wheat sowing and FAW awareness.
Agro-Input Retailers Network (AIRN) (CSISA subcontractor)	Train input dealers and retailers	Achieving impact at scale	AIRN was awarded sub-grants in 2018/19 to (1) train AIRN dealers in principles and practices of integrated weed management, and (2) equip them to fight the threat FAW.	Partnering with the Activity, AIRN trained input dealers on the principles and practices of integrated weed management and FAW management. In the reporting year, AIRN provided FAW training to 42 batches (totaling 1047) of agro input dealers in nine districts. Training covered FAW management: an introduction, its life cycle, IPM usage and methods, monitoring system and pesticide use.
Universities				
Department of Crop Sciences, University of Illinois at Urbana-Champaign (UIUC)	Strategic research on precision nutrient and rice crop management	Innovation towards impact	The project leader is an active academic committee member for Shah-Al Emran, a Bangladeshi PhD student at this university. Emran is working to produce two papers using CSISA data.	Ongoing successful partnership
Wageningen University	Strategic research on farmer decision making processes and the intensification of fallow fields	Innovation towards impact	Strategic high-end research capacity to assist in the analysis of farmer decision-making processes on intensification decisions	A formally established working relationship with CIMMYT to produce research deliverables in support of CSISA III
Georgia Tech University	Technical support for the development of	Innovation towards	Laboratory facilities for the rapid prototyping of machinery innovations and technical support on	An established informal relationship in support of CSISA III, with ongoing

	scale appropriate machinery	impact	testing in collaboration with BARI	collaboration on papers related to machinery engineering and development. A manuscript on the prototype laboratory is under development.
Bangladesh Agricultural University	Bangladesh's largest and first agricultural university	Innovation towards impact	BAU is Bangladesh's largest agricultural university, with strong influence over the next generation of agricultural scientists, many of whom will go on to work in BARI, BRRI and DAE.	The relationship with this university continued informally. Increased collaboration on FAW control is underway at the time of reporting.
Tufts University	Modelling linkages of farming systems with nutritional deficiencies in Bangladesh	Innovation towards impact	Collaboration allows sharing of data and methodological expertise in assessing diets of rural households of southern Bangladesh for nutrition deficiencies and study linkages to farming systems (as well as markets). It offers insights on nutritional outcomes from agricultural investment relevant to national and international programmes and policies.	Active since 2020
Projects				
Cereal Systems Initiative for South Asia – Manufacturing Systems Activity (CSISA–MEA)	CSISA–MEA supports Bangladeshi manufacturing firms to (1) develop well-structured business cases which describe the business problem and opportunities to be addressed, (2) articulate alternative solutions, (3) identify potential costs and benefits, and (4) identify the motivations and incentives for	Achieving impact at scale	CSISA–MEA, through its Manufacturing Systems Activity, will work with micro-, small- and medium-sized businesses in the agricultural machinery manufacturing sector in Bangladesh to research and develop business cases for four distinct scenarios: (1) larger companies with dealership networks that will adopt a business model to assemble machines from parts made by smaller companies (OEM-supplier network), (2) larger manufacturing firms venturing into the domestic manufacture, assembly and/or spare parts production of more complex agricultural machines, such as combine harvesters, (3) all-sized	Active since 2019

	businesses to adopt the most suitable one for them, if any		firms that will domestically manufacture a wider range of spare parts as a means to reduce dependency on expensive imported parts, and (4) the feasibility of manufacturing for export machines, such as threshers, by all sized firms that must meet export standards. CSISA Phase III leverages this work by aligning its themes with geographies where local service providers have emerged, particularly with respect to fallows development through irrigation, reapers to facilitate rapid rice harvesting and early wheat sowing, and DSR aligning with CSISA–MEA Objective 4.	
Rice and Diversified Crops (RDC) Activity	RDC is led by ACDI-VOCA and is working to (1) improve food security through systemic changes which increase rural incomes, (2) increase farm productivity, and (3) increase farmers' participation in profitable market systems	Achieving impact at scale	The USAID Feed the Future Bangladesh Rice and Diversified Crops (RDC) Activity is increasing incomes and improving food security and nutrition in the Feed the Future zone through systemic market changes that promote a diversified farm management approach oriented to intensified rice production and higher-value, nutrient-rich crops. RDC is working towards its goals through targeted technical assistance to create scalable market system impacts, ultimately benefiting rural households and expanding opportunities for women and youth.	Active since 2016. CSISA Phase III is in discussions with RDC regarding collaboration on integrated weed management and linkages with the private sector. CSISA also advises RDC on a regular (although informal) basis.

NEPAL

Partner	Partnership objective	Alignment with themes	Leveraging opportunity	Status of partnership
Government of Nepal				
Ministry of Agriculture and Livestock Development	Technical guidance for Government of Nepal investments in agricultural development	All themes	The Government's Agriculture Development Strategy (2015–2035) was approved in late 2015. CSISA acts as a technical partner to shape the loan and investment programs associated with the strategy, which may exceed USD100 million.	Active and sanctioned by CIMMYT's host country agreement
Nepal Agricultural Research Council (NARC)	Strategic and applied research into sustainable intensification technologies, crop diversification and crop management practices	Innovation towards impact	NARC is responsible for providing the scientific basis for all state recommendations, their endorsement, and the ownership of emerging sustainable intensification technologies.	Active and long-standing
Provincial government	Strengthen provincial level policies and provincial government support for agricultural development activities	Achieving impact at scale	Provincial governments are the middle tier of government under the new federal constitution and have a large degree of independence. They have important policy-making and oversight roles in terms of agricultural development. In this reporting period, the Activity engaged with and supported the Province 5 and Far Western Province governments.	Active and new since federal government restructuring
Local government	To strengthen local government support for agricultural development activities	Achieving impact at scale	Local governments are the local tier of government under the new constitution. They have a significant roles in implementing agricultural development in their areas and are thus important stakeholders that the Activity seeks to engage.	Active and new since federal government restructuring
Nepali private sector				
D-KAM microsystems Pvt. Ltd (farm machinery	Introduction and market development of reaper-	Achieving impact at scale	Rapid expansion of investments in scale-appropriate machinery and support for emerging service	Initiated in first half of project year 2018/19

Partner	Partnership objective	Alignment with themes	Leveraging opportunity	Status of partnership
importer/dealer)	harvesters in Dang (Province 5)		provision markets	
Innovative Solution Pvt. Ltd	Kisan Credit Card	Achieving impact at scale	Close collaboration with Mega Bank	Initiated mid 2021 and ongoing
Mega Bank Ltd	Access to finance and Kisan Credit Card	Achieving impact at scale	An MoU between iDE and Mega Bank established on behalf of CSISA facilitates expansion of the Kisan Credit Card to smallholder and women farmers in particular.	Initiated May 2022 and ongoing
Agriculture Development Bank Ltd.	Access to digital banking services	Achieving impact at scale	ADBL has also launched its own Kisan Card, linked to its agriculture loan packages, and is looking for partners such as CSISA to achieve outreach to farmers.	Initiated mid 2022 and ongoing
Muktinath Bikas Bank Ltd	Access to Finance	Achieving impact at scale	Finance provision opportunities for smallholder farmers	Initiated early 2022 and ongoing
Naya Tulsi Trade Link (farm machinery importer/dealer)	Introduction and market development of reaper-harvesters in Dang (Province 5)	Achieving impact at scale	Rapid expansion of investments in scale-appropriate machinery and support for emerging service provision markets	Initiated in first half of project year 2018/19
BTL Trade Pvt. Ltd (farm machinery importer/dealer)	Introduction and market development of scale-appropriate machinery	Achieving impact at scale	Rapid expansion of investments in scale-appropriate machinery and support for emerging service provision markets	Active and long-standing
SK Traders (farm machinery importer/dealer)	Introduction and market development of scale-appropriate machinery	Achieving impact at scale	Rapid expansion of investments in scale-appropriate machinery and support for emerging service provision markets	Active and long-standing
Dahal (farm machinery importer/dealer)	Introduction and market development of scale-appropriate machinery	Achieving impact at scale	Rapid expansion of investments in scale-appropriate machinery and support for emerging service provision markets	Active and long-standing
Nimbus (Nepali feed mill	Introduction and market	Achieving	Registration and market development for hybrids in	Active since 2015

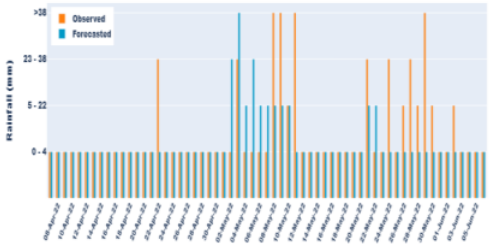
Partner	Partnership objective	Alignment with themes	Leveraging opportunity	Status of partnership
company)	development for new crop varieties and hybrids	impact at scale	the Feed the Future zone from a base of zero in 2015	
Muktinath Bikas Bank Ltd	Access to finance	CSISA–COVID response	Developing risk-reducing financial services arrangements that could facilitate increased access to loans for agricultural machinery	Active since 2020
Nabil Bank Ltd	Access to finance	CSISA–COVID response	Developing risk-reducing financial services arrangements that could facilitate increased access to loans for agricultural machinery	Active since 2020
Mega Bank Nepal Ltd	Access to finance	CSISA–COVID response	Developing risk-reducing financial services arrangements that could facilitate increased access to loans for agricultural machinery	Active since 2020
Century Commercial Bank Ltd	Access to finance	CSISA–COVID response	Developing risk-reducing financial services arrangements that could facilitate increased access to loans for agricultural machinery	Active since 2020
Trade associations				
Nepal Agricultural Mechanization Association (NAMEA)	Trade association formed CIMMYT's help to create an enabling environment and policy dialogue for scale-appropriate mechanization	Systemic change towards impact	Important voice for the private sector with GON as Agriculture Development Strategy support programs take shape	Active since 2014
Seed Entrepreneurs Association of Nepal (SEAN)	Trade association strengthened with help of CSISA to create an enabling environment and policy dialogue for strengthening seed system and small and medium seed enterprises in Nepal	Systemic change towards impact	Important voice for the private sector with GoN as Agriculture Development Strategy support programs take shape. Provided input to studies on maize hybrids in Nepal	Active and long-standing
Universities				

Partner	Partnership objective	Alignment with themes	Leveraging opportunity	Status of partnership
Agriculture and Forestry University (Rampur, Chitwan)	Expanded use of digital data collection tools for field diagnostic surveys	Innovation towards impact	Engagement with students and professors to conduct field work and do thesis with CSISA	Previously established and re-invigorated in the reporting period
Wageningen University	Role of livestock and value chains in farmers' willingness to invest in maize intensification	Innovation towards impact	Collaboration with advanced research institution increases the quality of science conducted in Nepal. National partners learn new research methods and contribute to formulating new research questions.	Active since 2012
Tribhuvan University	Strengthening groundwater monitoring and governance and assessing safe operating space from a hydrogeological perspective	Coping with climate variability and COVID–19 Resilience groundwater monitoring	Collaboration with local research institutions establishes strong local science–policy linkage, builds capacity and institutionalizes novel governance mechanisms to strengthen innovations and policy solution networks in a rapidly changing political environment.	Active
Projects				
Knowledge-based Integrated Sustainable Agriculture and Nutrition (KISAN)	Strategic partnership to co-support the large-scale deployment of extension information and technologies	Achieving impact at scale	The KISAN project, part of USAID's global Feed the Future initiative, is a USD20 million five-year program to advance food security by increasing agricultural productivity. KISAN uses CSISA's technical and extension materials and advice to improve the uptake of better-bet sustainable agriculture production and post-harvest practices and technologies for cereals. KISAN reaches hundreds of thousands of farmers and exposes them to CSISA information, materials, and technologies.	Active since KISAN's first phase
Nepal Seed and Fertilizer Project (NSAF)	Strategic partnership to co-support the large-scale deployment of extension	Achieving impact at scale	The USAID Nepal-funded NSAF project (USD15 million for 2016–21) focuses on the applied science-to-development continuum, including market	Active since 2016/17

Partner	Partnership objective	Alignment with themes	Leveraging opportunity	Status of partnership
	information and technologies		facilitation to expand private sector-led fertilizer and seed sales. CSISA is disseminating the better bet technologies at scale through NSAF's networks.	

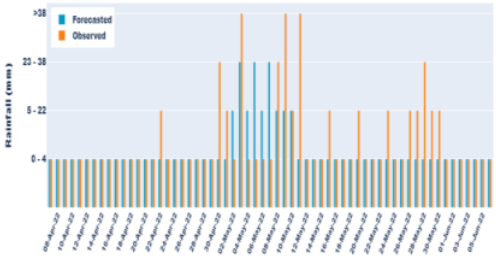
Annex 4: Union-wise precipitation forecasts validation for the 2022 mung bean harvesting period (7 April–6 June, 2022)

Rainfall of Adabaria



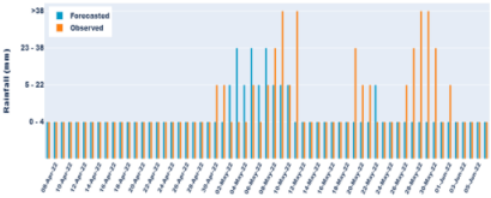
Forecast Accuracy: 69%

Rainfall of Amkhola



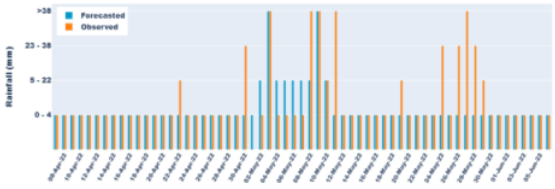
Forecast Accuracy: 67%

Rainfall of Atharagashia



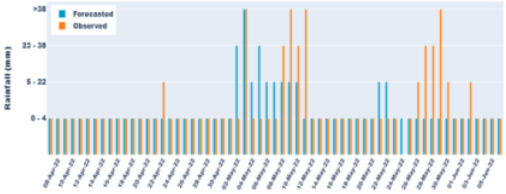
Forecast Accuracy: 70%

Rainfall of Badarpur



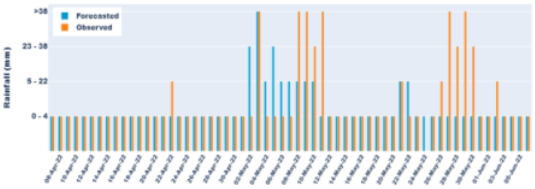
Forecast Accuracy: 74%

Rainfall of Baga



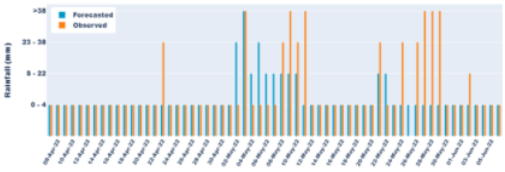
Forecast Accuracy: 69%

Rainfall of Bauphal



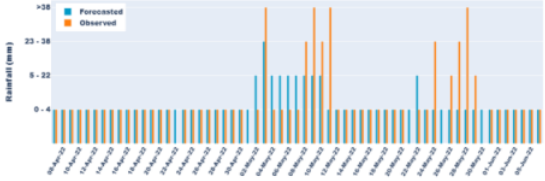
Forecast Accuracy: 66%

Rainfall of Betagi Sankipur

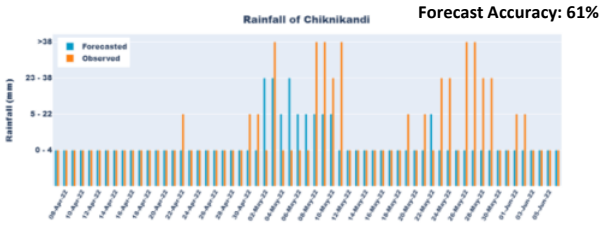


Forecast Accuracy: 69%

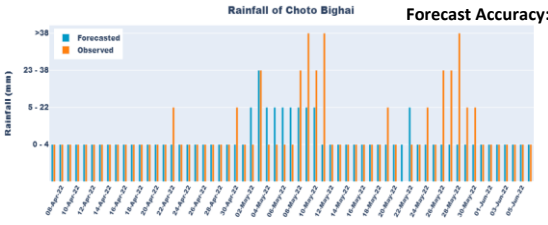
Rainfall of Boro Bighai



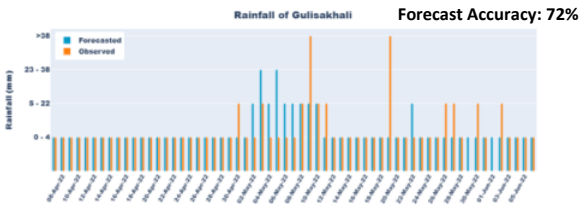
Forecast Accuracy: 66%



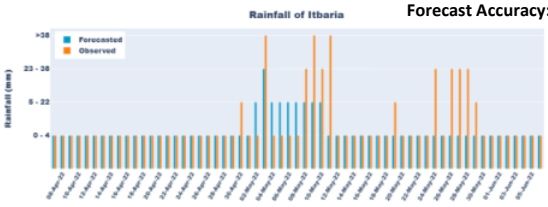
Forecast Accuracy: 61%



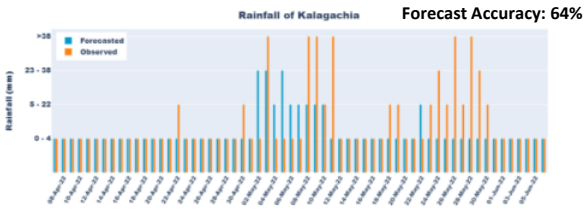
Forecast Accuracy: 67%



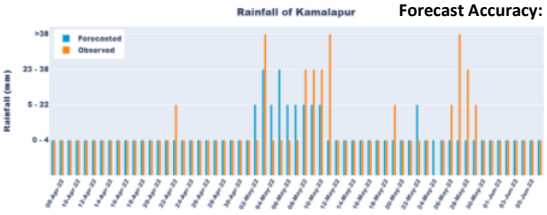
Forecast Accuracy: 72%



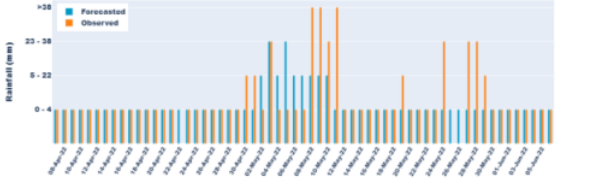
Forecast Accuracy: 72%



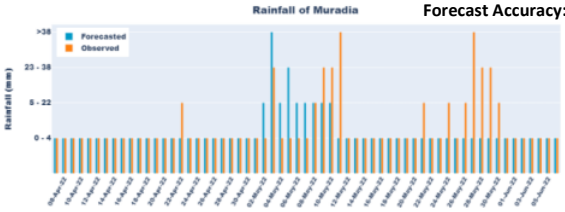
Forecast Accuracy: 64%



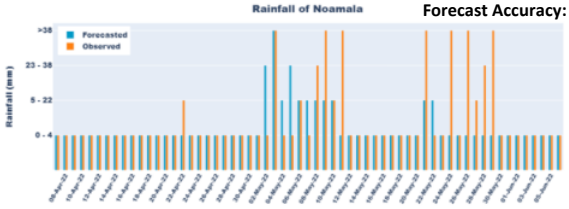
Forecast Accuracy: 70%



Forecast Accuracy: 69%



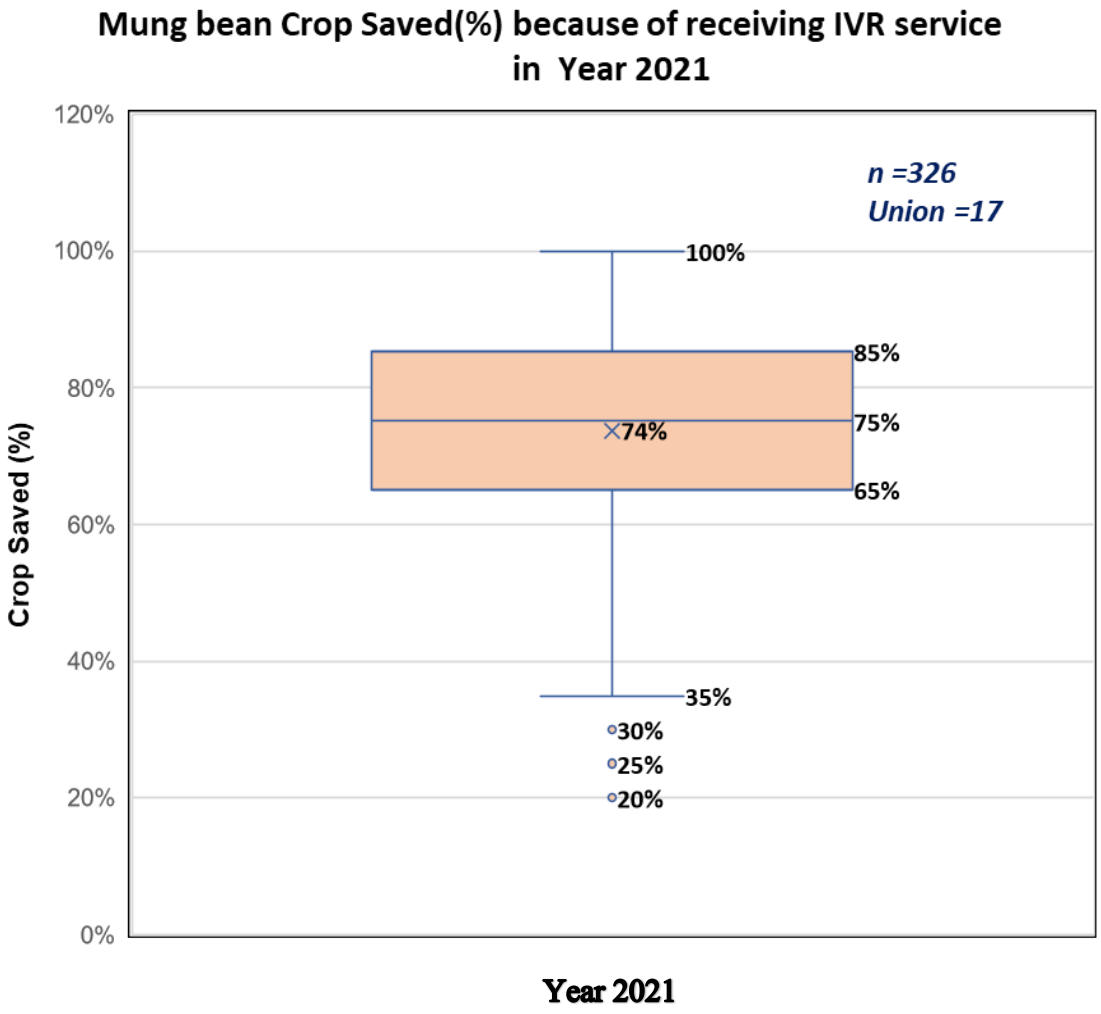
Forecast Accuracy: 72%



Forecast Accuracy: 75%

Above: Box plot distribution of mung bean crop saved by harvesting early in response to the voice calls on the heavy rainfall forecast during the mung bean harvesting period

Percentage of mung bean crop saved because of IVR voice call services in 2021



Above: Box plot distribution of mung bean crop saved by harvesting early in response to the voice calls on the heavy rainfall forecast during the mung bean harvesting period

Annex 5: SWOT (strengths, weaknesses, opportunities, threats) analysis of nine companies considered for partnership in sustaining mung bean IVR advisories in Bangladesh

Companies	Strength	Weakness	Remarks
1. Weather Impact BV	1. Weather Impact BV has submitted a business model for the mung bean IVR (combining the IVR system with Weather Impact's weather forecasts and index insurance) 2. It has a clear picture of the cost and revenue (€5.76 = BDT530 per farmer per annum) of the business model 3. It uses satellite data from ESA/NASA 4. It has already developed a weather model for Bangladesh as it is involved in the Netherlands Water Partnerships Water for Food Programme 5. Its staff includes weather and climate specialists	1. Only SMS and mobile apps. No work on IVR 2. In Bangladesh, Weather Impact BV provides weather forecasts via SMS; however, the number of farmers under the project is not mentioned 3. No work has been done on crop/index insurance in Bangladesh 4. Its reports contain success stories but no forecast validation/accuracy	Weather Impact BV provides weather forecasts via SMS in Bangla to farmers in Khulna, Patuakhali, Mymensingh, Sylhet and Natore (funded by Netherlands Water Partnership under the Waterapps project)
2. M-World	1. M-World has submitted a business model for mung bean IVR (combining the IVR system with an online mung bean market and world telemedicine and nutrition services for farmers and nurseries) 2. The organization is currently in partnership with on an online market mechanism in Jashore and Barishal region 3. It has strong technical capabilities, a wider network, acceptability, and the field level staff to disseminate information and implement the project's activities	1. No experience disseminating information via digital tools (e.g. SMS, IVR, mobile apps) 2. M-World's business model provides no clear explanation of how it will charge money from the farmers and the revenue earned	1. The organization/NGO works with Government, UNDP, WorldFish, hospitals, Nutrition International and Ministry of Education, gain and others. to promote activities including nutrition, new varieties of carp, mental health, digital marketing 2. It works in collaboration with different stakeholders and radio stations to promote the campaigns
3. Barokupot Ganochetona Foundation (BGF) Shyamnagor, Satkhira	1. BGF has started working to motivate farmers in coastal areas under the DAE 'Production, Storage, and Distribution of Quality Seeds of Pulses, Oils, and Spices at Farmers Level' project' 2. It has experienced and strong field teams in the coastal area	1. BGF did not submit a business model for the mung bean IVR 2. No experience in disseminating weather information among farmers	This organization might help the company to disseminate the business product in the coastal area or product campaign area

		3. No experience disseminating information via digital tools (e.g. SMS, IVR, mobile apps)	
4. ADN Diginet	1. ADN DigiNet is legally partnered with all the telecom companies to provide quality SMS gateway services and voice gateways	1. ADN DigiNet did not submit a business model for the mung bean IVR 2. It has no experience in disseminating weather information among farmers/others	This ICT solution company is mainly a service provider of voice and SMS gateways, email gateways, server solutions and software solutions (e.g. web design, web hosting, e-commerce, online banking)
5. Matrix Business Development Ltd	1. The company is running contract farming (agribusiness) to produce vegetables, maize, strawberries, vegetables and potatoes to sell to the market 2. It has established a knowledge center and customized mobile apps to deliver farmers advisories 3.75% accuracy in soil testing	1. MBD did not submit a business model for the Mung bean IVR 2. It has no experience in disseminating weather information among farmers/others via SMS/IVR	1. This ICT solution company is mainly a service provider of, among others, mobile apps, business process optimization, business intelligence, software solutions 2. Very limited information is available as it did not supply a company profile 3.. There is no clear explanation of the company's agribusiness on its website 4. It has provided no information about the locations and number of farmers in its agribusiness
6. iPAGE Bangladesh Ltd	1. iPAGE has developed a hardware-software integrated (soil testing device) decision support engine 2. The device collects data on small farmers' soil, weather, and farming practice and generates specific advisory based on the soil test	1. iPAGE did not submit a business model for the mung bean IVR	1. This solution is for B2B partners 2. 1000+ farmers use the iPAGE device but locations are not named on the site 3. It is not clear from iPAGE's website how it facilitates farmers to sell their crops directly to the local market and earn more 4. For every subscription, iPAGE charges the B2B partner USD15 (BDT1320)/season-farmer

			to USD35 (BDT3080)/season-farmer
7. Metatude (a Fellow Digitals company)	No strength is found as the company did not provide their profile or past/present activities in Bangladesh/Asia	1. Metatude did not submit a business model for the mung bean IVR. 2. No experience in providing information in the agricultural sector in Bangladesh	1. Software development organization headquartered in The Netherlands 2. It is interested in submitting the proposal as a group of organizations, so wants to know about the mung bean IVR system
8.SSD-Tech	1. One of the largest technology companies in Bangladesh with 1200+ employees 2. High capacity of pushing voice messages and SMS to end-users (monthly average SMS push volume is around 45 million)	1. SSD-Tech did not submit a business model for the mung bean IVR 2. No experience in providing information in the agricultural sector in Bangladesh	1. SSD-Tech is an ICT company providing solutions for telecommunication operators and enterprises. Main activities are IVR solutions, internet, voice, SMS, WAP, voice chat, radio, infotainment 2. The company is an authorized partner in Bangladesh to provide any end-user access to the well-known English learning program "BBC Janala".
9.GUS	1.GUS is an NGO with experienced and strong field teams in the coastal area (Barishal, Bhola and Patuakhali)	1. GUS did not submit a business model for the mung bean IVR 2. No experience disseminating information via digital tools (e.g. SMS, IVR, mobile apps)	1. This regional NGO worked for many years with CIMMYT in Bhola on maize trials

CSISA