Cereal Systems Initiative for South Asia-Mechanization & Irrigation (CSISA-MI)



Annual Report (Oct 16 to Sep 17)

Submitted by

International Maize and Wheat Improvement Center (CIMMYT)

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AFP	Axial flow pumps
AMDO	Agriculture Machinery Development officer
BADC	Bangladesh Agriculture Development Corporation
BARI	Bangladesh Agricultural Research Institute
BDS	Bangladesh Development Society
BDT	Bangladeshi taka
BINA	Bangladesh Institute of Nuclear Agriculture
BRAC	Bangladesh Rural Advancement Committee
BRRI	Bangladesh Rice Research Institute
BTV	Bangladesh Television
CA	Conservation agriculture
CIMMYT	International Maize and Wheat Improvement Center
CLA	Collaborative Local Agreements
CSISA-BD	Cereal Systems Initiative for South Asia in Bangladesh
CSISA-III	Cereal Systems Initiative for South Asia – Phase 3
CSISA-MI	Cereal Systems Initiative for South Asia Mechanization and Irrigation
DAE	Department of Agricultural Extension
DEMs	Digital Elevation Models
DQA	Data quality assessment
DSR	Direct-seeded rice
EC_a	apparent electrical conductivity
FFD	Farmers' Field Day
FtF	Feed the Future
GIS	Geographic information system
GJUS	Grameen Jano Unnayan Songstha
iDE	International Development Enterprises
IFDC	International Fertilizer Development Center
IR	Intermediate results
JCF	Jagoroni Chakra Foundation
JVA	Joint Venture Agreement
LoA	Letters of Agreement
LSP	Local Service Provider
M&E	Monitoring and evaluation
MRM	Monitoring and Results Management
NGO	Nongovernment organization
PMP	Project Monitoring Plan
PMUK	Padakhep Manabik Unnayan Kendra
PNGO	Partner nongovernment organization
PTOS	Power Tiller Operated Seeder
SAAO	Sub-Assistant Agriculture Officer
SDC	Society Development Committee
TMSS	Thengamara Mohila Sabuj Sangha
USAID	United States Agency for International Development
USG	United States government
WEP	Women's Empowerment Program

EXECUTIVE SUMMARY

The Cereal Systems Initiative for South Asia – Mechanization and Irrigation (CSISA-MI) project is a five-year (July 2013 – September 2018) program funded by USAID under its Feed the Future (FtF) initiative. The CIMMYT and iDE team under CSISA-MI is unlocking the potential agriculture productivity in Southern Bangladesh through increased adoption of agriculture mechanization technologies and services, by strengthened local service provider (LSP) networks and value chain for agricultural machinery services.

CSISA-MI was developed to address pressing development needs for agricultural machinery, irrigation and efficient crop production practices in response to increasing labour costs and land scarcity in southern Bangladesh. CSISA-MI promotes rural entrepreneurship through collaboration of Bangladeshi machinery importers, manufacturers, distributors, dealers, and mechanics, to assure that a viable and profitable value chain for scale-appropriate agricultural machinery is established domestically.

The fourth year strongly indicates that the project is on-track in meeting its aims and scaling outcomes. Sales of fuel-efficient axial flow pumps (AFPs), power tiller operated direct seeders (PTOSs), and multi-crop reapers by CSISA-MI's private sector partners have increased dramatically in the last 12 months. Against a training target of 9,725 individuals, the project has trained 10,270 farmers, among them 19% were women. The project has intensively extended training to 968 private sector actors against a target of 976. In addition, 91 Government staff and 149 participants from civil society against a target 200 were also trained this year.

The project established linkages between LSPs and MFIs to ensure availability of financial services and agricultural-related credit. In the last year 91 LSPs received USD 54,825 for 93 machines, which was a 96% achievement against the Year 4 target, of this, two women LSPs received USD 563 during this year. The major portion of the credit went to 40 reapers, while 38 PTOS and 15 AFP were purchased with lines of credit from partner NGO MFIs.

Against a target of 85,966 farmers that are utilizing or applying new agricultural technologies, early season and prolonged rainfall, followed by flooding, severely reduced crop production and consequently the use of three technologies. Additionally, wheat blast continues to significantly limit production in FtF districts. Thus, the overall achievement for this indicator only 50% farmers were reached. As for irrigation, the project reached 9,201 farmers (24%) against the targeted farmers. Whereas, PTOS and reapers, the project reached 70% of its farmer target.

Against a target of 29,813 ha of land under improved technologies or management practices, CSISA-MI achieved 21,198 ha which was a 10% increase on Year 3 achievements. This was despite the heavy rainfall, flooding and wheat blast losses which affected 71% of wheat production in the FtF zone. It would also appear that 54% of reaper and 33% of PTOS LSP's are not meeting the required capacity of 13.5 ha per year so as to reach these targets, which has considerable implications for year 5.

The project technically assisted 673 informal firms (LSPs) and 31 formal firms, mainly agro-machinery dealers, against a target of 705 firms in Year 4. The project provided training and facilitated the purchase of agro machineries by LSPs, who then service their clients (farmers). At the end of fourth year a total 1,843 LSPs classified as informal firms were developed.

In year four private sector investment achieved more than USD 757,000. The largest investment was in harvesting and post harvesting technology at around USD 502,000. Investment on water conveyance technology was the least USD 29,000. During year 4, LSPs invested over USD 445,000, while Dealers invested USD 450,000, providing a total investment of USD 2,369,000 over the life of the project.

CSISA-MI project management has continued to utilize an adaptive management approach and by rotating staff, stepping-up communication among CIMMYT and iDE. Dr. Allen David (Jack) McHugh from CIMMYT China, took charge of the project in November 2016, and Ansar Ahammed Siddiquee (Iqbal) also took over the responsibility of Project Manager of CSISA MI. The iDE Dhaka Office team has also completed many changes following the departure of Kevin Robbins. With oversight from Connor Riggs,

Jeremy Davis now leads the iDE team. Also, after departure of Mr. Mizanur Rahman (DPM), Mr. Zahidul Islam Chowdhury has resumed this role.

USAID (Washington)'s Bureau for Food Security Division Chief for Asia/Latin American, Ms Charisse Adamson along with CSISA's regional Program Officer Dr. Biniam Iyob (Water and Irrigation Advisor, Research Division, Office of Agriculture, Research and Policy, Bureau for Food Security, USAID) visited Bangladesh in mid-March. Of the trip Ms Adamson said "I have come away from the trip with a deeper understanding of your program and the important role it plays in improving food security in Bangladesh. It is clear that these projects are making a difference!"

Dr Louise Fox, USAID's Chief Economist, accompanied by USAID/Bangladesh Mission Director, Janina Jaruzelski, Senior Food Security Advisor Anar Khalilov and Scott A. Smith Program Economist USAID-BD, paid a visit to Jhenaidah and Jessore on 19 September. Janina Jaruzelski said to the farmers, "Mechanization is a very important part of the future of agriculture in Bangladesh. And you are part of the future in this way".

Dr Andre Barannik the USAID Regional Environment Advisor (REA) and the local advisory team visited CSISA-MI activities in July at Polerhat, Jessore Hub, positively advising us on chemical use and impacts. Dr Hans Joachim Braun, Director of CIMMYT's Global Wheat Program (GWP) visited CSISA's demonstration strip tillage wheat sites (early vs late sowing) and Tillage x Genotype trial sites suported by CSISA-MI staff.

Three lead firms: Janata Engineering, Metal (Pvt.) Ltd., and RK Metal remain key partners in year 4. These and other private sector partners (ACI and RFL) continue to independently and pro-actively engage others in the development of domestically produced AFPs and PTOs and imported reapers. Janata Engineering continues to expand its business and its range of agricultural products, through importation and in-house manufacturing, with the support of CSISA-MI. R.K. Metal, is fabricating high quality AFP and PTOs with close technical support from CSISA-MI engineers. Metal Ltd. has improved product quality utilising their AFP testing rigs and are working closely with CSISA MI to develop the Indian imported zero-till seed drill for Bangladeshi conditions. Discussions are well advanced in piloting small combine harvesters with CSISA-MI as part of the development of a maize value chain.

Project wide bi-monthly learning and technical workshops were instrumental in refining project execution. The learning workshops sought out constraints to project, training delivery and identified potential areas for improvement. A networking workshop enhanced engagement with DAE and our PNGOs in which we reviewed training materials and their delivery. Technical workshops identified issues and formulated an R&D "sprint" to enhance the marketability and operational utility of the equipment. The design sprint included; increased seed metering precision and operations, improved seeding operations on the newly imported zero-till planter, grading of maize seed for improved seeding, ride-on components for enhanced reaper and PTOs operations, improved quality of locally manufactured AFPs, endurance testing of AFPs and pocket guide for setting up AFP for efficient operations. All of which have been completed in Year 4 ready for testing in Year 5.

The socio-economic research to fully evaluate the effectiveness of local machinery service provision models is nearing completion. The preliminary results have given CSISA-MI options to adapt and learn during the promotion of the technology's business cases in Year 5, especially for LSP land coverage and their business development.

We have increased employment and entrepreneurship by strengthen the agricultural production systems resulting in inclusive and sustainable agriculture-led economic growth. The CSISA MI team is also looking beyond the next 12 months with an aim to bring strengthened and inclusive agricultural systems that are productive and profitable into the FtF zone by; assessing cloud based digital financial support systems for LSP and their clients, zero tillage farming technology, introduction of machine management and tracking systems, giving public access to our networking database, early maturing bio-fortified crops under triple cropping (maize, rice and jute in rotation), mobile maize dryer and advanced mechanisation, i.e. non-puddled rice transplanter, ride on strip tillage planter, reaper for jute harvesting and small multi-crop combine harvesters for maize, rice, wheat, mustard, canola and some pulses.

1 INTRODUCTION

1.1 Background

The Cereal Systems Initiative for South Asia – Mechanization and Irrigation (CSISA-MI) is a five-year (July 2013 – September 2018) project funded by USAID under its Feed the Future initiative. CSISA MI is unlocking potential agriculture productivity in Southern Bangladesh through increased adoption of agriculture mechanization technologies and services, delivered by an augmented local service provider network for machinery services. It strengthens agriculture systems that are productive and profitable and in the value chain increases employment and entrepreneurship. The International Maize and Wheat Improvement Centre (CIMMYT) leads this project in partnership with the International Development Enterprise (iDE). The project is implemented in the Feed the Future (FtF) zone of Southern Bangladesh.

CSISA-MI Core Program Activities

- Promote innovative technologies
- Develop and strengthen local service provider network
- Leverage private sector investments to commercialize and scale agricultural technologies
- National research and private sector engagement

CSISA-MI focuses on commercial pathways and technical issues to achieve sustainable and scalable results. CSISA MI drives change by working with private sector actors and in collaboration with the Government of Bangladesh, primarily the Bangladesh Agricultural Research Institute (BARI) and the Department of Agricultural Extension (DAE).

CSISA-MI takes a collaborative learning and adaptive management approach in order to stay nimble and effective as the market for agricultural machinery evolves. In Year 4, CSISA-MI has capitalised on previous adaption and continues to significantly over achieve targets (Table 1).

Recent adaptions include: 1) Streamlining the geographical coverage to focus on 49 upazilas (rather than the previous105) in 16 districts (pls. see annex 1) with immediate and significant potential for mechanization development across the Jessore, Faridpur and Barisal Hubs (see map below); 2) In the past year, CIMMYT and iDE have stepped up communications and coordination to ensure improved synergies in project implementation and thus achieve quicker impact in the target areas. 3) Staff changes, including rotation were implemented to align skills with activities, recognition of seniority and where possible preferred domestic arrangements.

Table 1: Sales of Agricultural Technology by Project Year

Technology	Year 1	Year 2	Year 3	Year 4
AFP	134	168	434	152
PTOS	72	101	233	410
Reaper	28	27	75	218
Total	234	296	742	780

A major indication of achievement of this project can be gauged from the increase in sales of agricultural equipment and the willingness of the Joint Venture Agreement (JVA) partners (and others) to increase imports and manufactured equipment locally. This indicates that all market actors with direct and indirect project connections, see the potential of these agriculture machines and technologies introduced by CSISA-MI.

Sales of agricultural machinery are increasing in the market place these opportunities for importers to farmers are expanding. This means the technology is profitable and is gaining popularity largely through increasing crop production, especially during the winter season, when many farmer's fields are normally in fallow.

1.2 Project Objectives and Operational Area

CSISA-MI increases sustainable productivity by unlocking agricultural potential in Southern Bangladesh (Figure 1) through increased adoption of improved irrigation and agriculture mechanization technologies and practices, delivered by an augmented local service provider network for machinery services. This is realized through three broad objectives:

Strategic Objective 1: To sustainably intensify and diversify agricultural production in Southern Bangladesh through surface water irrigation to increase household income.

CSISA-MI promotes Axial Flow Pumps (AFPs), as well as other efficient surface water irrigation and conveyance machineries, and works to integrate them into local markets by building public private partnerships that address key components of the supply chain.

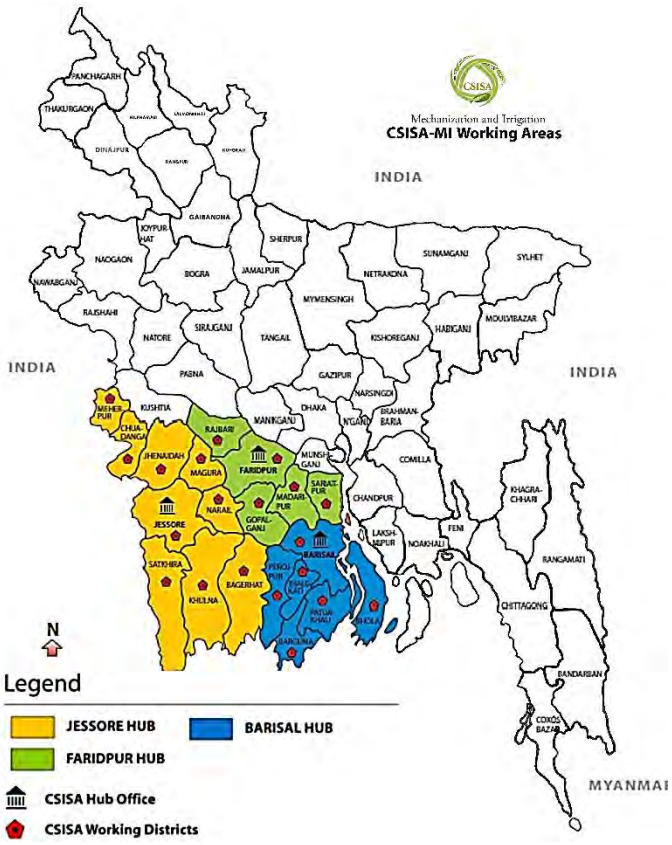
Strategic Objective 2: To sustainably transform agriculture in Southern Bangladesh through broad-based access to agricultural mechanization services.

Following the same comprehensive supply chain approach as in Strategic Objective 1, CSISA-MI strategically partners with the private sector to introduce efficient technologies that enable farmers to cultivate successful dry season crops. CSISA-MI further supports the supply chain for agricultural mechanization products by facilitating the development of targeted financial services.

Strategic Objective 3: To develop new models for public and private institutions to support irrigation and agricultural mechanization in Southern Bangladesh.

To assure the durability of strategic objectives 1 and 2, and to increase employment and entrepreneurship, CSISA-MI works with public and private sector partners to promote their familiarity with machinery engineering, manufacturing, sales, distribution, and their use in the field. CSISA-MI empowers key government stakeholders such as the Bangladesh Agricultural Research Institute (BARI), the Bangladesh Agricultural Development Corporation (BADC) and the Department of Agricultural Extension (DAE).

Figure 1: CSISA-MI Geographical Coverage



CSISA-MI's Barisal, Jessore and Faridpur delivery hubs are located in the South and South West of Bangladesh, which are highlighted in the Figure 1.

1.3 Project Management Approach

1.3.1 Project Management

The CSISA-MI project falls under the umbrella of the larger multi-national CSISA program, and hence receives some minor support from the CSISA Bangladesh, while allowing the CSISA-MI Project Leader to contribute to the wider CSISA platform. Through increased use of adaptive management, CSISA-MI has also been able to effectively and efficiently implement project activities. This is based on USAID's adaptive management approach[1] which is reflected as continuous and iterative in the organizational environment and monitoring and results management (MRM) system. Using this approach, CSISA-MI has stepped up coordination and communication between technical and field teams among CIMMYT and iDE. As a result, the scope of sharing observations and feedback from the field team to technical team is regular and at the same time enabling CSISA-MI to promptly generate consensus and speed the decision-

[1]USAID KDMD Project. 2013. "Learning about Learning: Lessons on Implementing a KM and Learning Project from the USAID KDMD Project: Adaptive Management," p. 2. USAID Learning Lab. http://usaidlearninglab.org/library/resources-learning-about-learning-lessons-implementing-km-and-learning-project-usaid-kdmd.

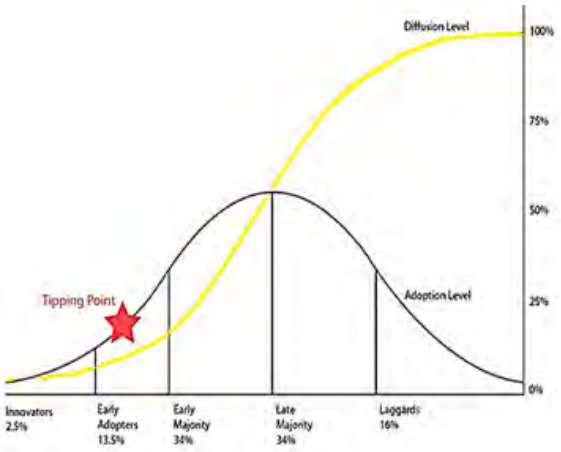
making process. The internal feedback together with the MEL system (section 4.2.6), Salesforce and dashboards reports, feeds updated and tangible information to the CSISA-MI team, providing informed decisions on required and prioritised adaptive measures.

1.3.2 Basis of CSISA-MI's Project Approach

CSISA-MI's theory of change is partly built on Roger Everett's diffusion of innovation theory, which is based on the premise that innovation is communicated to market actors through the process of diffusion over time and that the adoption of a given technology is influenced by the innovation itself, communication channels, time and the social system.

Figure 2 shows a segmented bell curve and accompanying cumulative adoption distribution where the different categories of adopters are shown. Following an initial effort to build markets, as more people adopt the innovation the total number of adopters increases at an exponential rate, producing an "s-curve" of adoption. There is a "tipping point" between the 15 and 20 % adoption rate, after which, diffusion of innovations is expected to spread independently or with less effort.

Figure 2: The distribution of innovation adoption patterns



CSISA-MI project interventions strive to reach this tipping point and "crowding-in" appears to indicate that it has been achieved. CSISA-MI recognizes that the tipping point requires qualitative changes to ensure the quantitative achievements, and that the tipping point may change with evolving market circumstances. Indications of qualitative changes include copying project activities by non-associated companies and service providers, crowding-in of these actors, and spontaneous adaptation and expansion of the business models that underlie the project's theory of change. These indications appear evident, demonstrating that the project is successfully contributing to an environment that is scale-friendly. CSISA-MI has reviewed MRM evidence and has a number of year 5 surveys planned, though initial indications suggest that the tipping point may soon be surpassed in selected districts, particularly for PTOS and AFP adoption.

1.4 Visitors

During the reporting period, key visits by high level representatives from the government, donor and CIMMYT included:

- USAID (Washington)'s Bureau for Food Security Division Chief for Asia/Latin America; Ms Charisse Adamson, along with CSISA's regional Program Officer; Dr Biniam Iyob (Water and Irrigation Advisor, Research Division, Office of Agriculture, Research and Policy, Bureau for Food Security, USAID) and Christopher Chibwana (Food Security Advisor, USAID/Bangladesh), visited Bangladesh in March 16-19, 2017. They visited farmers and agricultural machinery service providers in the Barisal, Jessore and Jhenaidah districts and also visited private and public sector partners to better understand how CSISA works across the diverse market actors in the FtF zone.

  Ms Adamson said "It was a successful trip executed without a hitch". She concluded that "I have come away from the trip with a deeper understanding of your program and the important role it plays in improving food security in Bangladesh. It is clear that these projects are making a difference!"

- Dr Louise Fox, USAID's Chief Economist, accompanied by USAID/Bangladesh Mission Director, Janina Jaruzelski, Senior Food Security Advisor Anar Khalilov and Scott A. Smith Program Economist USAID-BD, paid a visit to Jhenaidah and Jessore on 19 September. They talked to farmers, rice millers, LSPs and the owner of Janata Engineering a key partner in local manufacturing. Dr Jack McHugh and Deepak Dhoj Khadka led the visitors through aspects of Premium Quality Rice production, mechanisation and business development activities of CSISA-MI. Janina Jaruzelski said to the farmers, "Mechanization is a very important part of the future of agriculture in Bangladesh. And you are part of the future in this way". In their informal concluding remarks, the delegation expressed their enthusiasm for the project and the understanding taken from the displays during the perfectly executed tour by the CSISA-MI team and collaborators.

- Dr Andre Barannik the USAID Regional Environment Advisor (REA) and the local advisory team visited the CSISA-MI activities on11th July at Polerhat, Jessore Hub. Drs McHugh and Shafiqul Islam (Jessore Hub Coordinator) led the field program with Farmers and LSP. Following the field trip, Dr Andre Barannik was very satisfied with what he learnt and shared his observations on chemical use and USAID documentation requirements with Dr. McHugh, Project Leader and Ansar Ahmed Siddiquee, Project Manager, CSISA-MI at the USAID Mission in Dhaka.

- Mr. Todd Andrews, Director, Program Office, USAID, Dhaka and Muhammad Mohiuddin, Program & Development Specialist, Program Office, USAID Dhaka visited excavated canals and CSISA-MI activities on May 23-24, 2017 at Babugang and Mehendigang Upazila under Barisal Sadar where the BADC Executive Engineer (Name) and accompanying engineers discussed the effectiveness of the previous work in relation to farmer access and the proper operation of axial flow pumps as a result.

- Dr Hans Joachim Braun, Director of CIMMYT's Global Wheat Program (GWP) visited CSISA's demonstration strip tillage wheat sites (early vs late sowing) and Tillage x Genotype trial sites suported by CSISA-MI staff at various FtF locations and also Sundarban, Dinajpur Sadar and Dinajpur sites, on 24 February 2017. Dr Naresh Chandra Deb Barma, Director of Wheat Research Centre (WRC), BARI and Dr. T. P. Tiwari, Country Representative of CIMMYT-Bangladesh accompanied him during his visit.

- Deputy Commissioner, Barisal Dr Saifur Jaman, Senior Scientific Officer (SSO) Md. Shahidul Islam from Bangladesh Agriculture Research Institute (BARI) Bhola station and Chief Scientific Officer (CSO) Dr. Md. Abdul Ohab and Principal Scientific Officer (PSO) Dr. Md. Saleh Uddin both from BARI Barisal station visited the activities in Barisal Hub. The Additional Director, DAE Md. Omor Ali Sheik and DDs, DAE from Barisal, Bhola and Potuakhali also visited Barisal Hub activities, which included panel discussions on enhancing network capacity during bi-monthly meetings.

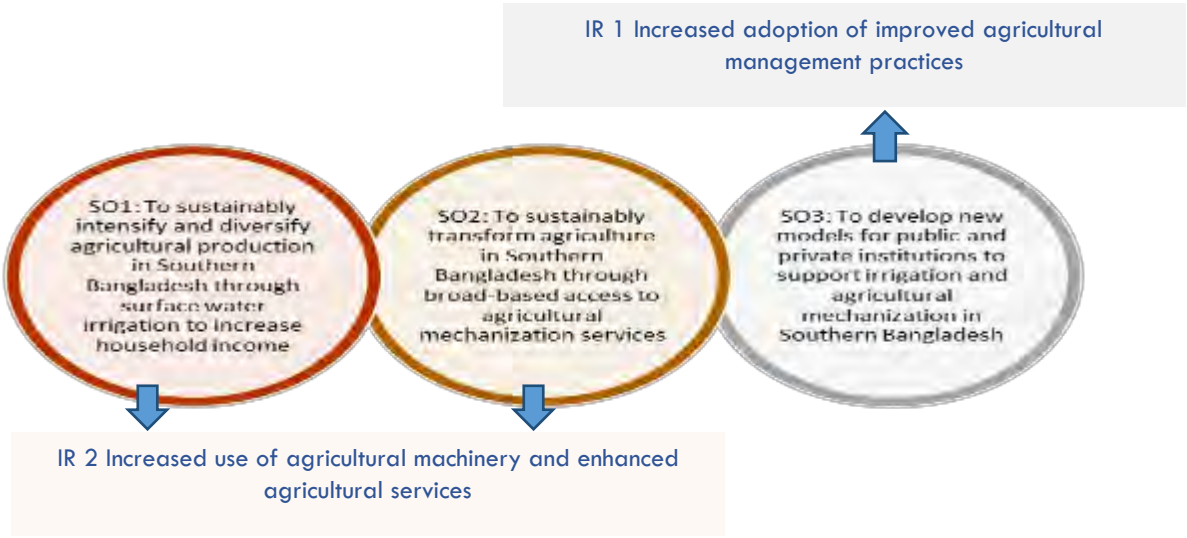
- Kingkar Chandra Das, AD, DAE and DDs Dr. Abdur Razzak, Shirinivash Debnath and G. M. Abdur Rouf from DAE visited Faridpur hub activities during the reporting period. Dr. Mohi Uddin, Principal Scientific Officer (PSO), OFRD-BARI, Faridpur also visited the project activities.

2 RESULTS AND ACHIEVEMENTS

CSISA MI's substantial progress has continued in its fourth year (Oct'16-Sept'17). Contributing factors to its success in the fourth year include; the improved availability of agriculture machinery, facilitating financial services from MFIs and the increasing presence of highly trained LSPs. Additionally, geo-specific targeting has enabled us to focus on areas of greater potential for implementing the project, with a view to eclipse the theoretical tipping point well before the project end date.

An important point in the project's progress was the visit and Data Quality Assurance (DQA) assessment by USAID's Accelerating Capacity of Monitoring and Evaluation (ACME). The projects second DQA visit of CSISA-MI in the field during May 2017 was very successful and significantly resulted in the inclusion of the loan provisioning indicator (EG 3.2-3) into the project. The M&E Plan has been revised accordingly, prepared and submitted. The flow diagram below (Figure 3) shows the logical sequence of the three strategic objectives described under section 1.2 and the associated intermediate results (IRs) based on USAID's FtF indicators.

Figure 3: CSISA-MI's strategic objectives and associated FtF's Intermediate Results



The DQA assessments in 2016 and 2017, suggested CSISA-MI to introduce a logbook for LSP designed to capture a real-time evidence on land coverage and farmer out-reach by LSPs. However due to the seasonal nature of machine operations, LSPs are extremely busy from the beginning of the season, with limited time for even the necessities of life. Moreover, they often work in muddy fields which make it difficult to carry anything with them, except the machine. On their return home in this "cash-only" society, they lack motivation to complete a logbook or even conduct any financial or business record keeping. Project members have tried several times to introduce the logbook as a business support document, especially for credit worthiness, but it was found unworkable due to uninterested LSPs and confirmed by the field visit. The field visitors/assessors also noted that the farmers are uncomfortable in providing information or signing off against any payments, which also appears to be linked to the cash economy situation. The introduction of a LSPs' logbook remains a large challenge, therefore the DQA Missions suggested a sub-set of LSPs to be provided with subsidies to encourage the use of logbooks. The project has introduced a smaller log book, but has still been unable to overcome the logistical and mindset challenges of completing the logs.

The introduction of electronic monitoring using applications and hardware such as; "Hello Tractor" data analytics may offer a way forward in understanding and monitoring machine operations and management in the FtF zone. Additionally, the introduction of digital financial services (piloting by CSISA-MI and SDC) may provide an alternative method of monitoring service provision activities.

To achieve the IRs towards increased on-farm productivity, CSISA-MI has identified five major sub-IRs as stated above. To achieve the results, based on the five Sub-IRs, CSISA-MI reports on 5 FtF Indicators from USAID's indicator's handbook, which are:

EG.3.2-1 Number of individuals who have received USG supported short-term agricultural sector productivity or food security training (Sub-IR1.1)

EG.3.2-3 Number of micro, small, and medium enterprises (MSMEs), including farmers, receiving agricultural-related credit as a result of USG assistance (Sub-IR 2.4) (newly included)

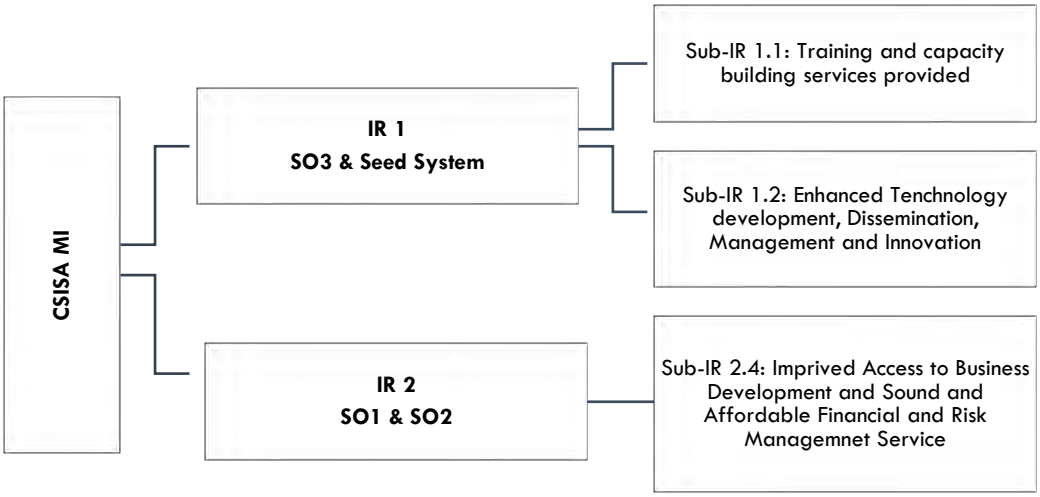
EG.3.2-17 Number of farmers and others who have applied new technologies or management practices as a result of USG assistance (Sub-IR1.1)

EG.3.2-18 Number of hectares under improved technologies or management practices as a result of USG assistance (Sub-IR1.2)

EG.5.2-1: Number of firms receiving USG-funded technical assistance for improving business performance (O) Replacing 4.5.2 (37) i.e. Number of MSMEs, including farmers, receiving business development services from USG assisted sources (Sub-IR 2.4)

In addition to these five indicators, CSISA-MI also reports against one 'Custom' indicator: Value of private sector investment in agricultural machinery and equipment resulting from project intervention (IR 3), which deal with MSME and related interventions. The value of private sector investment is calculated from the sum of the total investment incurred by LSPs, machinery dealers, manufacturers and importers with within a given reporting period. The strategic objectives and the associated indicators are given in Figure 4.

Figure 4: FtF's Intermediate Results and Sub IRs aligned with CSISA-MI



The fourth year results highlight CSISA-MI's private sector engagement which has been boosted due to the increase in demand for innovative agricultural machinery services, which is indicative of the current scaling success and the potential to scale-out further in the FtF zone.

Project progress is mapped according to project target indicators based on the Feed the Future (FtF) indicators. Overall results are also based on the CSISA-MI project monitoring plan that was approved by USAID in December 2015 and further revised on April 2017. The two main areas of CSISA-MI's results framework include; (i) inclusive and sustainable agriculture-led economic growth and (ii) Increased employment and entrepreneurship.

In general, the high achievement for most of the indicators indicate the project is progressing well and on target (Table 2) and the detail FtF result given in section 2.1 and annex 2.

Table 2: Summary of CSISA-MI's results by FtF Indicator

Ref. SO Ref. IR	Core Indicator	Description	Year-1 Achievement	Year-2 Achievement	Year-3 Achievement	Target Year 4	Achievement Year 4 (Oct'16-Mar'17)	%
SO 3 Sub-IR 1.1	New indicator number EG.3.2-1 Number of individuals who have received USG supported short-term agricultural sector productivity or food security training	Producer (Farmer*)	4,765	693	10,053	**8,549**	9,070	**106**
		Government Staff	16	128	275	**0**	91	
		Private sector	889	1,285	1,689	**976**	968	**99**
		Civil society[2]	139	87	351	**200**	149	**75**
		Total	5,809	2,193	12,368	**9,725**	10,278	**106**
SO 1 & SO 2 Sub-IR 2.4	EG.3.2-3 Number of micro, small, and medium enterprises (MSMEs), including farmers, receiving agricultural-related credit as a result of USG assistance	Number				**95**	91	**96**
SO 1 & SO 2 Sub-IR 1.1	EG.3.2-17 Number of farmers and others who have applied new technologies or management practices as a result of USG assistance	Irrigation (Water Conveyance)	9,073	12,939	39,975	**37,650**	9,201	**24**
		Others (Land Preparation and Planting & Harvesting and Post Harvesting)				**48,966**	33,836	**69**
		Total	9,073	12,939	39,975	**85,966**	43,037	**50**
SO 1 & SO 2 Sub-IR 1.2	EG.3.2-18 Number of hectares under improved technologies or management practices as a result of USG assistance	Irrigation	3,584	9,500	19,287	**14,713**	7,192.65	**49**
		Others				**15,100**	14,005.5	**93**
		Total	3,584	9,500	19,287	**28,813**	21,198	**71**
SO 1 & SO 2 Sub-IR 2.4	EG.5.2-1: Number of firms receiving USG-funded technical assistance to improve business performance (O)	Formal (Dealer)	45	43	32	**50**	31	**62**
		Informal (LSPs)	229	256	707	**655**	673	**103**
		Medium Enterprises (Importer/Manufacturer)	2	3	5			
		Total	276	302	744	**705**	704	**100**
SO 1 & SO 2 IR 3	Custom: Value of private sector investment in agricultural machinery and equipment resulting from project interventions (USD)	Water Conveyance	327,975	80,861	83,375	**315,000**	**29,126**	**9**
		Land Preparation and Planting	252,902	95,830	124,530	**221,825**	**225,863**	**102**
		Harvesting and Post Harvesting	229,191	42,815	373,565	**221,825**	502,275	**226**
		Total	810,068	219,506	581,470	**758,650**	757,264	**100**

[2] NGO representative, Local Elite, CBOs, CSOs, Research organizations' representative and School teacher are considered as civil Society

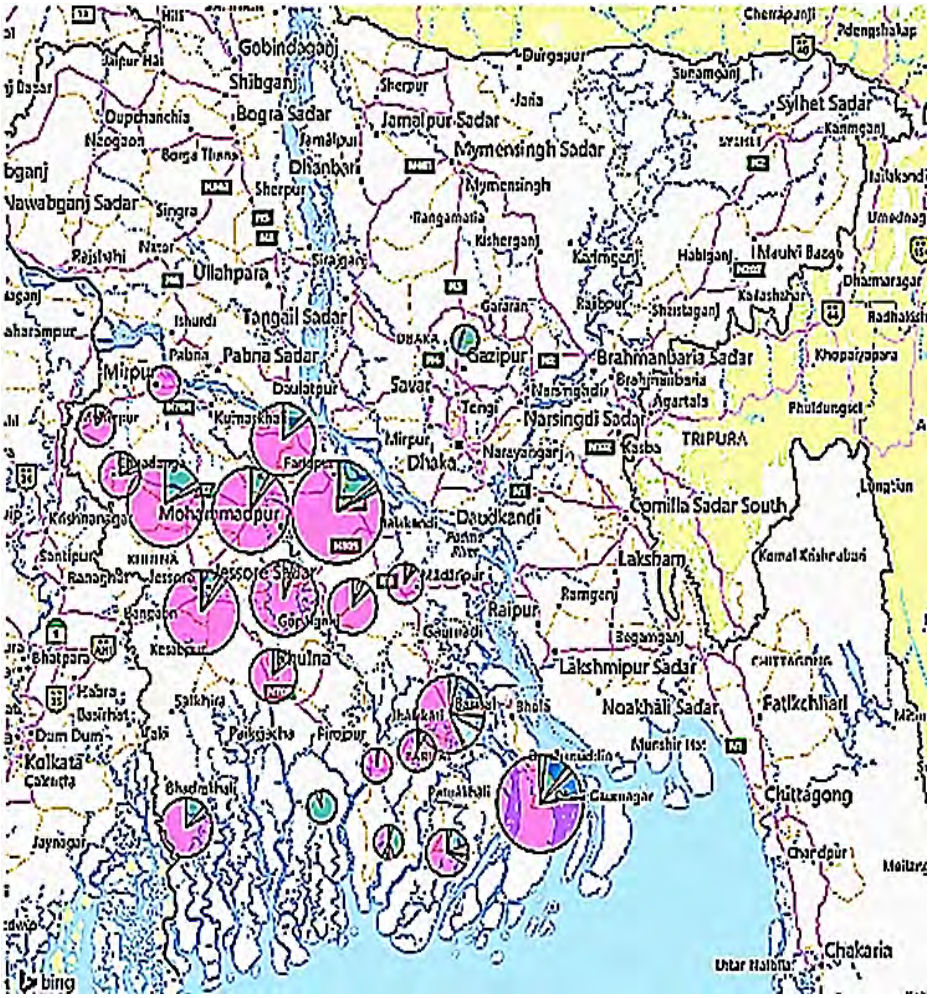
2.1 Progress by Indicator

2.1.1 Indicator EG.3.2-1

Number of individuals who have received USG supported short-term agricultural sector productivity or food security training (Sub-IR1.1)

Training is the key tool of knowledge transfer for CSISA-MI. LSP receive basic training on business management, as well as machine operation, maintenance and troubleshooting. Mechanics receive this plus some advanced training, while farmers, GoB staff and civil society receive appropriate training according to their needs. Field Days are major training events for communities and groups. The training achievement against target is above expectation. The activities under this indicator outlined previously contribute to increase awareness and enhancing business and technical skills as required by the various actors in the agriculture machinery value chain. Increasing numbers of farmers that live adjacent to the project demonstrations have pro-actively joined mechanized sowing, irrigation, and harvesting training events this year. Against a target of 9,725 individuals, the project has trained 10,270 farmers (single individual counting) among them 19% were women (Table 3). Due to the increased interest in the use of

Figure 5: CSISA-MI training activities



mechanised land preparation, irrigation and harvesting by farmers' broadly, CSISA-MI, in response, has increased training for private sector partners so that they can meet demand. In addition, all training modules are currently under revision in preparation for publishing to a wider audience. The project has intensively extended training to 968 private sector actors i.e. LSPs, mechanics etc. against target of 976. In addition, 91 Government staff and 149 participants from civil society against the target 200 were also trained this year; overall, CSISA-MI achieved 106% against the indicator in Year 4. Training modules that cover field events and conservation agriculture are also being developed.

Since farmers constitute the main source of demand (end users) stimulating the uptake and utilization of agricultural machineries, the project trained more than nine thousand farmers (20% women) in year 4 across an extensive geographical area (Table: 3). These efforts increased and aggregated demand for machinery services and positioned LSPs to capture additional business, which appears well balanced across the operational area (equivalent numbers from each hub). The totalled trained from the private sector was 968 individuals which included LSPs (523) and mechanics (103). Among the total participants a 19% women participation rate was observed.

*Table 3: Hub-wise Training Summery**

Hub Name	Event Type	Types of Participants	Male	Female	Total
Barisal	Civil Society	Local Elites	47	4	51
	Farmers' Training	Producers	476	65	541
	FFD for Method /Coaching	Producers	845	128	973
	FFD for Result	Producers	248	113	361
	LSP Training	LSPs	152	4	156
	Mechanic Training	Mechanics	45	-	45
	Training for GoB staff	GoB staff	83	8	91
Faridpur	Farmers' Training	Producers	599	143	742
	FFD for Method /Coaching	Producers	32	9	41
	FFD for Result	Producers	1,519	619	2,138
	LSP Training	LSPs	170	2	172
	Mechanic Training	Mechanics	44	-	44
Jessore	Civil Society	Local Elites	92	8	100
	Farmers' Training	Producers	446	14	460
	FFD for Method /Coaching	Producers	1,951	383	2,334
	FFD for Result	Producers	1,372	478	1,850
	LSP Training	LSPs	363	2	365
	LSPs' Refresher Training	LSPs	39	-	39
	Mechanic Training	Mechanics	140	-	140
Grand Total			**8,668**	**1,980**	**10,643**

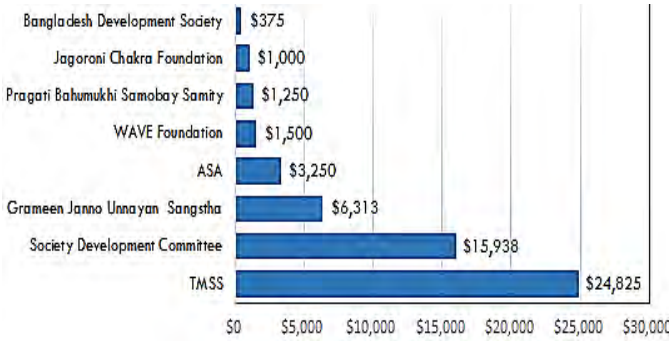
* Multiple count

2.1.2 Indicator EG.3.2-3

Number of micro, small, and medium enterprises (MSMEs), including farmers, receiving agricultural-related credit as a result of USG assistance (Sub-IR 2.4) (newly included)

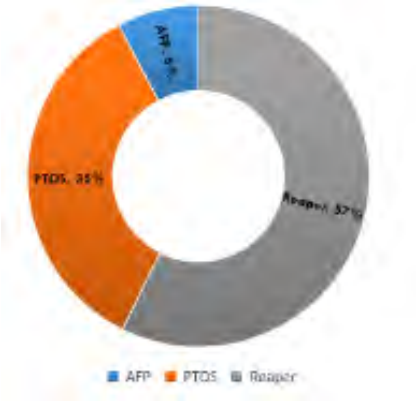
The project has established linkages between LSPs and MFIs to ensure availability of financial services. In the last

Figure 6: MFI wise Credit Distribution Details



year 91 LSPs received USD[3] 54,825 for 93 machines, which was a 96% achievement against the Year 4 target, of this two women LSPs received USD 563 during the reported year. The major portion of the credit went to 40 reapers, while 38 PTOS and 15 AFP were also purchased with lines of credit from partner NGO MFIs. Nine national and local MFIs provide financial services to the LSPs. ASA, BDS, BRAC, GJUS, JCF, PBSS, SDC, Wave and TMSS (Figure 6), amongst them TMSS provided the maximum proportion of credit (45%), followed by SDC with 29% of the total amount (Figure 7).

Figure 7: Technology wise credit



CSISA-MI's Access to Finance activities facilitated the credit processes by orientating MFI staff to the project and by enhancing their capacity to support value chain actors. Through "Krishi Machine Porichiti (KMP)" and "Sombhabbo Kreta Somabesh (SKS)" activities, the project identifies and enrols potential LSPs who are seeking financial services with the MFIs and links them to the Partner NGO MFI who initiate the formal line of credit process. LSPs are provided with Business Development training and financial planning to support their use of credit. Linkage meetings in the presence of Dealers, MFIs and LSPs smooth the process. Among the three technologies the reaper draws the largest credit request, due to higher initial cost (Figure 7).

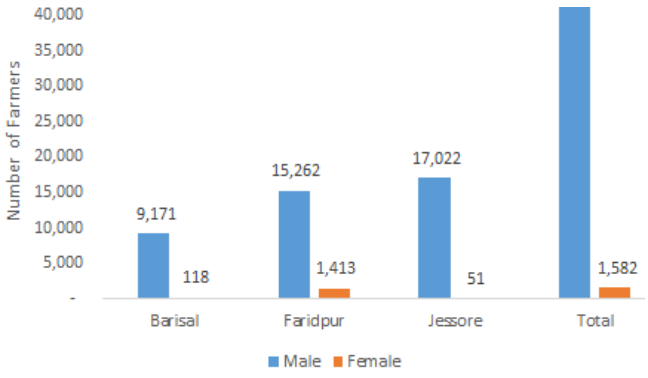
2.1.3 Indicator EG.3.2-17

Number of farmers and others who have applied new technologies or management practices as a result of USG assistance (Sub-IR1.1)

Following the DQA's recommendation to combine "custom indicator 2" from 2016 with the new FtF indicator 4.5.2 (5) to include farmers serviced by LSP, CSISA-MI's target was revised up to 85,966 farmers that were utilizing or applying new agricultural technologies. While the achievement against the current target remains low, the land area and number of farmers for both the indicators also remain below expectations (Figure 8). Based on the revised results framework, the under achievement is described below.

The incidence of wheat blast (*Magnaporthe oryzae)* significantly affected 7 of the 19 FtF districts, limiting wheat production for a great number of farmers. Utilization of AFPs expanded to aquaculture, more so than to winter crop irrigation on fallow land. These aquaculture ponds (Ghers) are small contained land areas, which are used for rice for half of the year, so very small areas utilising an individual pump. However, irrigated field crops may be tens of hectares in size and accommodate hundreds of individual farmers, yet utilise a small number of pumps. CSISIA MI's socio-economic data on the use of AFP indicates that 46% are used on areas of less than 4 ha. The expansion of pumps to gher aquaculture signifies an important and unexpected success of the project, while expanding the scope for sales and sustainable delivery of AFP products by CSISA-MI's private sector partners. Even so the overall sales of agricultural machinery, especially for the AFP remained low this year, due to early season and prolonged rainfall followed by flooding and protracted water logging. The inclement weather and other minor factors severely reduced Boro rice and wheat crop production. Consequently, the use of three technologies, for planting, harvesting and irrigating largely did not occur in 13 FtF

Figure 8: Hub wise Farmer Outreach

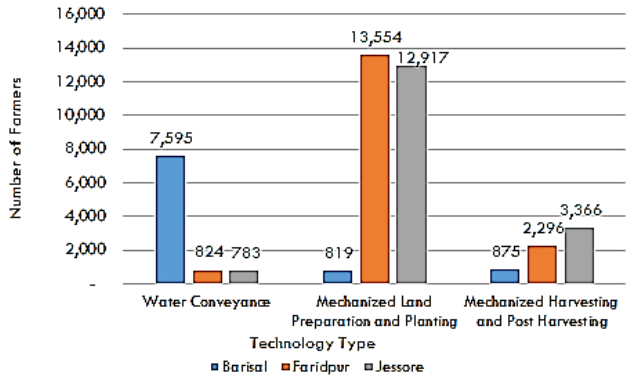


[3] 1 USD= BDT 80

districts. Thus, the overall achievement for this indicator was 50% at 43,037 farmers. As for irrigation, the project only reached 9,201 farmers (24%) against the targeted 37,650 farmers. Whereas, for PTOS and reapers, the project reached 70% of its farmer target. (Figures 8 & 9).

The technology most utilised by farmers and LSP was the PTOS for mechanised land preparation and sowing (Figure 9). According to technology and hub wise information 27,290 farmers utilised mechanized Land preparation services during the reporting period. The use of mechanized harvesting machinery (reaper) achieved the lowest use among the three technologies largely due to wheat blast, i.e. less area planted to wheat and Boro rice) and the cost of self-propelled reapers (up to USD 2000) limited purchase and general use of the reaper, under adverse weather conditions. To alleviate this particular cost issue CSISA-MI introduced the 2-wheel tractor front mounted reaper, which is comparatively less expensive at around USD 500, and it will continue to expand during year 5. In addition, CSISA-MI has developed ride-on attachments that make the self-propelled reaper (and PTOS) more attractive to buyers and farmers. Janata Engineering Ltd. has sold all their attached reapers that were initially brought in first import tranche and are now dealing with new imports and expanding this part of their business. It is expected that a cheaper version of the reaper, expansion into jute harvesting and ride on modifications will mitigate the demand-supply gap over time, and increase the use of mechanized harvesting machines dramatically.

Figure 9: Technology wise Farmer outreach by Hub



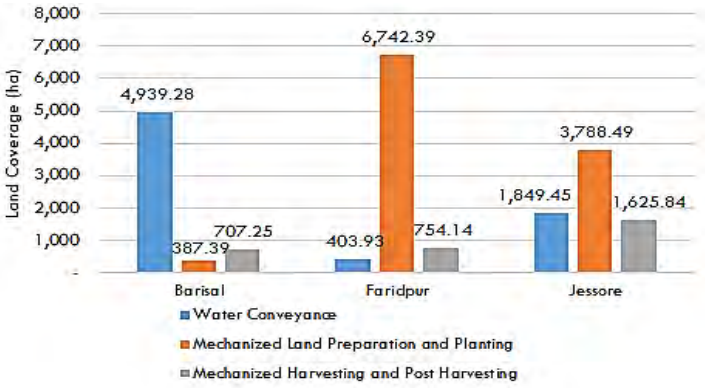
2.1.4 Indicator 3.2-18

Number of hectares under improved technologies or management practices as a result of USG assistance (Sub-IR 1.2)

CSISA-MI has researched and developed suitable agricultural machineries which have been introduced and marketed in the southern part of Bangladesh (FtF Zone in general). These include the fuel-efficient axial flow pump (AFP) for conveyancing surface water, Power Tiller Operated Seeders (PTOS) suitable for mechanized land preparation, sowing and basal fertilizing, and a multi-crop Reaper (and newly introduced Power Tiller Mounted Reaper) for mechanized harvesting.

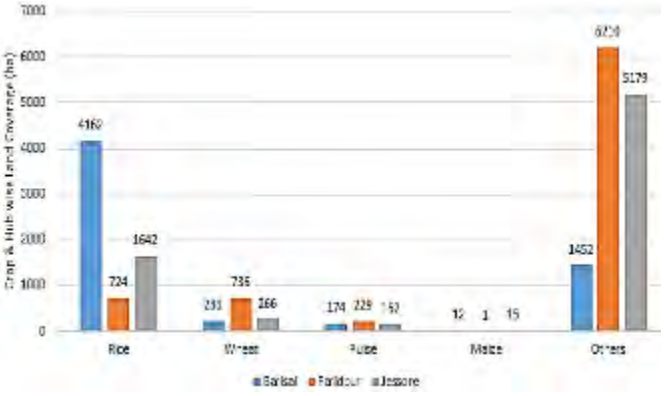
Against a target of 29,813 ha land coverage to be brought under improved technologies or management practices, CSISA-MI achieved 21,198 ha which is 10% increase on Year 3 achievements. This was despite the heavy rainfall, flood and wheat blast disease losses which affected 71% of wheat production (7 FtF districts were discouraged from growing wheat this year). At the inception of CSISA-MI it was calculated that Local Service Providers (LSP), could cover 12-15 ha per year. However, according to CSISA-MI's recent socioeconomic survey of 438 LSPs, it would appear that 33% of PTOS LSPs and 54% of reaper LSPs are operating below 13.5 ha per year, which has significant consequences for achieving the elevated land coverage and farmer number targets in year 5.

Figure 10: Technology wise Land Coverage by Hub



Year 4 results indicated that land coverage through water conveyancing was the largest in Barisal hub, mechanized land preparation and planting in Faridpur hub and mechanized harvest and post harvesting in Jessore hub. This geographical difference in adoption was due to cropping pattern in the three hubs (Figure 10). According to a hub-wise and crop-wise view AFP were mostly used in Barisal hub area and primarily for *boro* rice (Figure 11). AFPs were also used widely in Jessore, but mostly for aquaculture services in *ghers*, which have limited land area, as noted previously. Winter is the prime time for irrigation which was missed due to the inclement weather (limited planting of wheat and rice), and thus the overall achievement for irrigation was low in Year 4. Furthermore, water stagnation, prolonged raining and flooding caused considerable lodging in rice fields, thus the reaper could not perform to expectations. Moreover, in case of water conveyancing, AFP land coverage was lower than expected due to a wider adoption of the pumps in *gher* aquaculture (smaller arear), in comparison to irrigation for cropping which is typically on much larger areas. This indicates a shift in the clientele for AFPs, though CSISA-MI's private sector partners continue to focus on mechanisation sales to crop farmers. Technologies for harvesting and post-harvesting have also increased, but only to a limited extent. The incidence of wheat blast this year forced tens of thousands of wheat farmers to abandon traditional cropping or change crops, which impacted largely on reaper sales and to a lesser extent on PTOS and AFP. Expansion has been mainly in mechanized land preparation and seeding services to alternate horticultural crops and jute. Crop wise mechanized land preparation services in Jessore and Faridpur hubs, were largely used for onion, lentil, garlic, and wheat (Figure: 11). Overall, PTOS were used in land preparation for various crops i.e. Brinjal, cucumber, chili, garlic, okra, sesame, tomato sugarcane, jute and cereals. Although the self-propelled reaper has limitations in harvesting on "wet-land", a total of 6,529 ha of paddy fields and 1234.37 ha of wheat were harvested using the Reaper promoted by CSISA-MI. It is evident that more than 71% of the targeted land area was achieved during the reporting year. But, due to wheat blast, limited winter cropping overall, low numbers for AFP, and limited coverage attempted by LSP machinery, the situation was not perfect. The CSISA MI team has re-visited its implementation plan and to rectify the situation through engineering, business development training, mechanisation pilots and alternate cropping adaptive solutions. Both CIMMYT and iDE conducted various events i.e. video presentations, farmers' field days, promotional demonstrations, trainings, publications etc., to motivate and encourage more farmers to utilise services from CSISA-MI-trained LSP for land preparation, irrigation and harvesting. Concurrently, CSISA-MI facilitated increased supply of machines through LSPs, so that farmers could more easily avail themselves of the services.

Figure 11: Hub and Crop-wise Land Coverage (ha)



2.1.5 Indicator EG.5.2-1

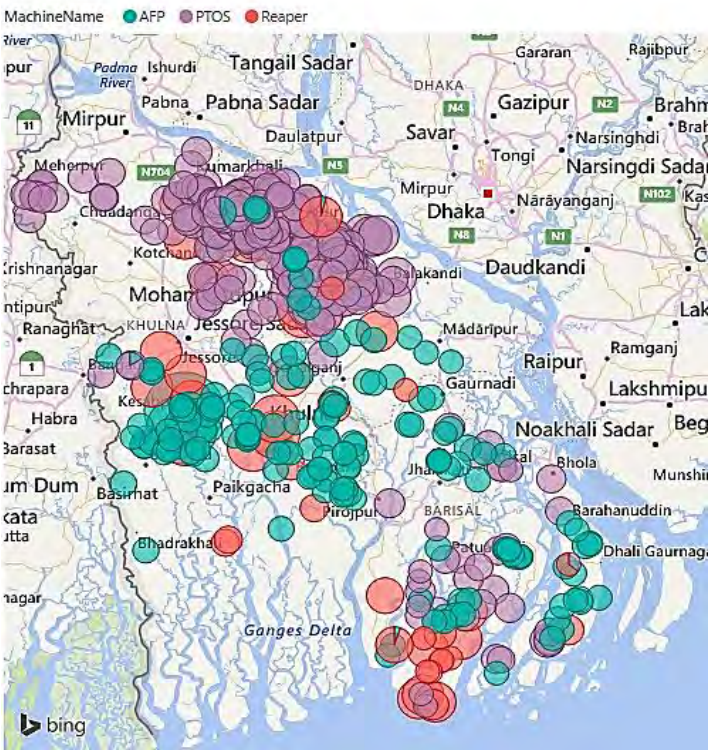
Number of firms receiving USG-funded technical assistance for improving business performance (Sub-IR 2.4)

Project has supported 704 firms in the Fourth year. In the reporting period the project has technically assisted 673 informal firms (LSPs) and 31 formal firms, mainly agro-machineries dealers. The project provides training and facilitates the purchase of agro machineries by LSPs who then service their clients (farmers). At the end of fourth year a total 1,843 LSPs classified as informal firms were developed. To support and ensure the availability of machinery, the project engages agro-machinery dealers and importer &/or manufacturers who have the role of formal firm in this value chain process (Figure 12). The progress is 100% against the target 705 firms. CSISA-MI conducted in excess of 447 local level market events, e.g. Krishi Machine Porichiti (KMP) to increase awareness about agricultural machinery, which was followed up with Shombhabbo Kreta Somabesh (SKS) to further persuade potential buyers (LSPs).

In addition to these events CSISA-MI has conducted a range of other activities in order to popularize agricultural machineries and create demand by attracting potential buyers and by creating awareness of USG funded CSISA-MI promoted agriculture machineries among the various market actors.

In detail the project has organized 204 KMPs, 57 SKSs, 57 Business Expansion Meetings, 37 Demonstrations-Method, 26 Learning Visits, 17 PSP representative meetings, 9 Linkage Meetings between LSPs, Mechanics and SAAOs, 9 MFI Representative Meetings, 7 Linkage Meetings between Dealers, Mechanics, LSPs and Workshops, 5 Gher owner meetings, 6 LSP Experience Sharing Workshops, 4 MFI Staff Orientation, 1 Linkage Meetings between LSP and FSP and 1 each of Market Information Sharing Meeting and Mechanic Motivational Event. The total outreach in terms of participants has been 15,408 within this period, however the participation by women was only 8% for those events, as the number of women LSPs remains low. Despite encouraging signs, it remains difficult to engage women in non-traditional roles that requires them to work away from home.

Figure 12: Location and relative size of agricultural machinery sales (AFP, PTOS and Reaper) in the FtF zone Southern Bangladesh



The size and distribution pattern of sales across all hubs is dependent on crop type, seasonal activity and geographical location (Figure 12). AFP is general restricted to Barisal in the Southern sector where water conveyancing is the main activity. Whilst the PTOS is popular in the Northern Sector across the Faridpur and Jessore hubs. In the reporting period project has involved total 704 LSPs in 3 technologies purchasing 736 machine. Data reveals highest number (307) of LSP developed in Faridpur hub with 318 machine and then Jessore and Barisal hub respectively. Among the three technologies, PTOS were purchased the most, then reaper and AFP was the lowest among three.

Table 4: Hub Wise LSP & Machine Number up to year 4

Hub	LSP Number Total	Machine Number			
		AFP	PTOS	Reaper	Total
Barisal	570	494	68	75	637
Faridpur	635	50	510	107	667
Jessore	638	344	238	166	748
Grand Total	**1,843**	**888**	**816**	**348**	**2,052**

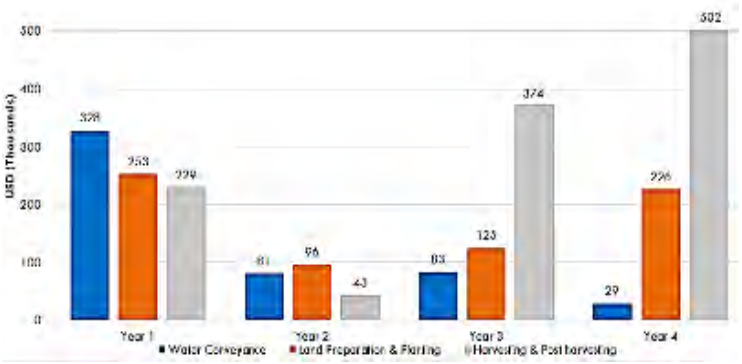
Since inception the project has developed a total of 1,843 LSPs across the three hubs and they are serving through 2,052 machines (Figure: 12). As stated previously AFP has the largest sales among the three technologies, followed by PTOS with 816 sales. Although reaper is selling the least, its initial cost is much higher than others (Table 4).

2.1.6 Custom Indicator

Value of private sector investment in agricultural machinery and equipment resulting from project interventions

Private sector investment is key to the assessing the impact and potential post-project sustainability of CSISA-MI. Despite variability in market demand for agricultural machinery, private sector investment continues as a result of CSISA-MI's transformative efforts. Overall, progress towards this indicator shows that that the project has been able to motivate and engage private sector partners through financial investment, resulting in the expanded use of CSISA-MI supported scale-appropriate machineries. In year four the private sectors' investment achieved more than USD 757 thousand. The largest investment was in harvesting and post harvesting technology at around USD 502 thousand of that The Metal Ltd. invested USD 286 thousand. Investment on water conveyance technology found was the least at USD 29 thousand (Figure: 13).

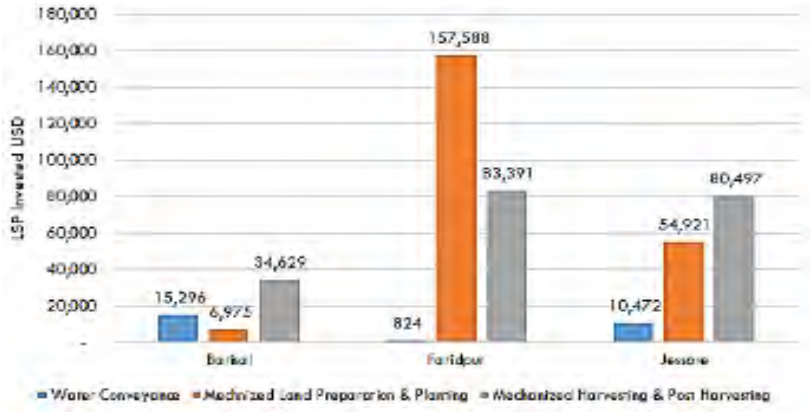
Figure 13: Technology wise Private Sectors' Investment by Year



During year 4, LSPs invested over USD 445 thousand, while Dealers invested USD 450 thousand. This activity is largely due to government provided subsidies on post-harvest machinery for companies like The Metal (pvt) Ltd. ACI and Chittagong Builders. For example; The Metal (pvt) Ltd. imports reapers for 170 thousand BDT, with government subsidy of 50% the final retail price is 85 thousand BDT.

The hub wise investment is linked to cropping type and geographical scenario. For example, AFP sell more in the coastal area of Barisal, while PTOS and Reaper sell wee ling the grain cropping areas of Faridpur Hub (Figure: 14). Thus, the private sector investment also indicates that the technologies remain beneficial and the private sector continues to accept the financial risk associated with promoting the expansion. The project facilitated financial serves with MFIs to ensure investment. PTOS are very popular in Rajbari and Faridpur districts, where farmers regularly use it across crops such as; rice, jute and onion fields. LSPs recognised the benefits in "line-sowing" in jute fields. Thus scaling is advancing to this and other crops, thus boosting private sector investment. CSISA MI is closely working with importers, dealers on the supply and demand side to ensure quality products are entering the production system. Moreover, the project is also facilitating and ensuring after sales services for LSPs as well as making available spare parts and repair services.

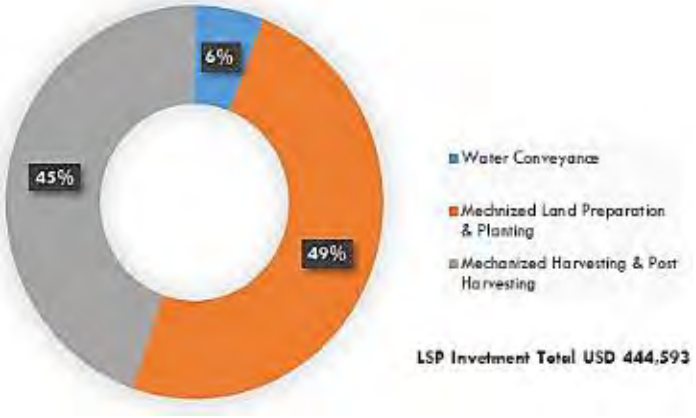
Figure 14: Hub wise Private Sector Investment by Technology



Our partner, RFL significantly reduce their importation of AFP due to manufacturing quality concerns of their inventory, which they have now rectified, but during this past year it dramatically reduced supply in the sector. Although demand remained high, CSISA-MI market development activities around the AFP were reduced and consequently investment in the last reporting year was also reduced and thus AFP

was only 6% of the total investment by LSPs (Fig: 15). However, the reduced imports created an opportunity to promote and build AFP local manufacturing capacity by Metal md RK Metal and fill some of the market demand. These companies are increasing output considerably in year 5 and along with RFL's refurbished AFP's, supply will be improved on year 4. The major achievement this year was on reaper investment at almost USD200 thousands which included both self-propelled and attached reapers. Although CSISA-MI's activities to increase employment and entrepreneurship have dramatically increased reaper sales since year two, further efforts during year 4 and continuing into year 5 to ensure that reapers are more appealing, marketable and efficient, thereby increasing ownership, reduce harvesting costs to farmers and remove crops faster with less effort. Apart from the issue of AFP, the other investments on PTOS and Reaper are well aligned with the targets and will continue to accelerate as we develop the products and strengthen the market (Fig: 15).

Figure 15: Technology wise LSP investment



3 PROJECT MANAGEMENT

CSISA-MI project management has continued to utilize an adaptive management approach by rotating staff, stepping-up communication among CIMMYT and iDE, reviewing and stream-lining geographical coverage, drafting future project implementation plans and implementing internal learning workshops. The pathway to implementation of agricultural development and human centred design on which CSISA MI is based is given in Annex 6.

3.1 Staffing

Dr. Allen David (Jack) McHugh took charge of the project in November 2016. A graduate of the University of Queensland; He is an Honorary Professor of the China and Tianjin Agricultural Universities, and a University of Southern Queensland Adjunct Research Fellow, who is highly motivated to provide strategic leadership and execution of R4D in Asia.

Dr McHugh recently led CIMMYT's 5-year national Conservation Agriculture R4D program in China for rice-wheat systems. This followed 20 years of experience and innovation in China, developing zero-tillage farming systems and mechanisation for Australian AID. Previously in Australia, he managed R&D programs within agricultural bio-systems & engineering thematic areas across the agricultural industries' peak bodies of; Cotton, Dairy, Horticulture, Turf, Flowers and Nursery. He also extended the research of new farming methods, tool development and demonstrations to end users. Internationally he has introduced and presented sustainable farming systems into China, Bangladesh, Egypt, India, Iran and Indonesia. Additionally, he has over 20 years of experience in organising learning events and conducting training across China and Australasia, whilst drawing on a substantial military career in resource management and personnel recruitment.

Ansar Ahammed Siddiquee (Iqbal) also took over the responsibility of Project Manager of CSISA MI, he's been with CIMMYT as Monitoring and Evaluation Specialist. Iqbal has been a USAID MEASURE Fellow of University of North Carolina. Prior to join CIMMYT, he worked in Bangladesh, India, Burkina

Faso, Ghana, Ethiopia, Nicaragua and Paraguay, he worked for many international organizations i.e. CARE, Asian Development Bank, Christian Children Fund of Canada, and ICDDR-B in diverse roles. Our lead Engineer Dr. Abdul Matin resumed duties in Year 4 to undertake technology development and provided support and expertise to the Agriculture Mechanization Development Officer positions at the field level. The iDE Dhaka Office team has also completed many changes following the departure of Kevin Robbins. With oversight by Connor Riggs, Jeremy Davis leads the group of Deputy Project Manager, and three Intervention Managers who manage; Relationships, Joint Venture Agreements, and Private Sector Implementation activities - a Manager of Public Sector Engagement, an MRM Specialist, and a Technical Specialist. Also, after departure of Mr. Mizanur Rahman (DPM), Mr. Zahidul Islam Chowdhury has resumed the responsibility of the Deputy Project Manager of CSISA MI.

3.2 CIMYT-iDE Coordination

CSISA-MI project activities are jointly implemented by CIMMYT and partner iDE in all the working areas as it was defined during the Detailed Implementation Plan (DIP) preparation. All the operational areas were selected based on the joint review mission across the Hub Offices during Q4 of 2017. Under the guidance of the new project leader the coordination and cooperation between project partners in the hubs has been stepped up enormously, which has created a positive boost in activity and stakeholder engagement. Newly introduced rotating bi-monthly learning workshops at the Hub Office level has increased interaction among field level staff, GoB agencies, PNGOs, specialists and private partners. This has been effected through:

- **Regular coordination** between iDE and CIMMYT: Although there is day-to-day communication in addition to the monthly and bi-monthly meetings between the partners at both Dhaka and Hub level the two organisations have a standing fortnightly meeting at alternating offices. On most occasions there is a formal agenda raised, but essentially they are not restricted, but are open and free discussions on any and all topics. Event based meetings are organized with relevant staff of CIMMYT and iDE at Dhaka and Hubs as required. Other strategic and planning meetings have also been organized jointly especially leading up to Bimonthly meetings and on joint communique matters. Regular informal communication is also maintained among the partners and staff to discussed and solve issues of the project.

- **Coordination meeting with USAID** has been a newly introduced by Dr McHugh at which CSISA MI's management team (Project Leader, Project Manager, iDE Lead) join to discuss updates and activities as we sit informally with the COR on a fortnightly basis, and where possible, on the alternate fortnight to the 'MI coordination meeting. This meeting is designed to enhance project implementation in accordance with the Missions requirements. Project activities are discussed, topical information is exchanged and the leadership team receives guidance on relevant and major issues as they arise.
- **Monthly coordination meetings** at the Hub level. All Hub level staff of both CIMMYT and iDE and senior staff from Dhaka office participate in the monthly meeting where discussion include field activities implementation, planning, budgets and problems/constraints are discussed in the meeting and agreements made for joint initiatives and efforts.
- **Bi-monthly project coordination meetings** with all field and senior level staff from CIMMYT and iDE. This has been coordinated to occur every two months in the hub offices by rotation. After joining Dr. McHugh, introduced this activity which created considerable impact. Issues and thus solutions are identified and solved in a timely manner with decisions taken by key officials and hub coordinators on the spot. The first learning workshop sought out constraints to project delivery and identified potential areas for improvement. This was followed by a technical workshop on the three technologies to identify issues and formulate an R&D sprint to enhance the marketability and

utility of the equipment. The most recent workshop had the objectives to enhance networking with DAE and our PNGOs and to review our training materials and their delivery.

3.3 Geography and Coverage

In Year 4, CSISA MI refocused on areas where activities would have the greatest potential to effectively support machinery commercialization. This resulted in a significant change in activities and the results they produced. CSISA MI has continued to revise the geographical targeting to strengthen inclusive agriculture systems around the FtF zone. Improved impact is achieved through a synergy of efforts to increase sustainable productivity. During the DIP preparatory work, CIMMYT and iDE M&E team gathered sales and intervention data from the MRM system and utilising "CSISA MI M&E Database" by conducting a mapping exercises where the number of *upazilas* where logically reduced from 105 to 69 in 19 districts. The mapping exercise was based on iDE market studies and field officer experience to select working areas with the most potential and those that could be better coordinated for 2016-17. The exercise looked at existing working areas, considered the market size for specific machines, sales data from the previous 3 years, and existence of dealer points, availability of mechanical services, cropping intensity and type and qualitative information from the staff in each hub. Considering all of these, the project further streamlined activities to 16 districts and 49 upazilas for implementation activities in year 5.

3.4 Detailed Implementation Plan (DIP)

The "Detailed Implementation Plan (DIP)" planning for Year 5 (2018) was conducted through series of workshops and planning meeting; started with a workshop, conducted on 8th June 2017 to identify core activities that would achieve year 5 targets. The DIP for Year 5 was finalized after consecutive workshops consider each element, through a final round of DIP Finalization meeting held on 24-26 September, 2017. The DIP was prepared through a participatory approach with the active participation of staff from all levels, including the partners and GoB. While planning the new DIP, innovative and scaling up activities were given priority along with the project exit process. This DIP includes following six broader areas:

- Intervention Area 1: Strengthening Value/Supply Chain for Agriculture machinery
- Intervention Area 2: Access to Finance
- Intervention Area 3: Conservation Agriculture
- Intervention Area 4: Networking and Capacity Building
- Intervention Area 5: Technology Adaption and Manufacturing
- Intervention Area 6: Public-Private Development Partnership

For coming year, the project has targeted more than ten thousand individuals from the private sector and producers for training. The local service providers, both new and continuing are expected to serve more than 125 thousand farmers over the year on their 43 thousand hectares of land. New firms, 865 in all, both formal and informal, will be technically supported and the project will also facilitate at least 80 LSPs to source credit from MFIs. Moreover, the project will facilitate a regional exit workshop with the stakeholders including DAE officials. New piloting activities will see the introduction of multi-crop combine harvesters, finalization of a 4-wheel tractor multi-crop zero tillage planters and a new ride on 2-wheel tractor strip tillage planter. Digital finance service will be launched and trialled along with an Uber style LSP with data analytics for optimizing machine management. Public private sector partnerships will be enhanced this year to ensure that what we have achieved over the life the project will remain and grow well into the future.

4 PUBLIC, PRIVATE SECTOR ENGAGEMENT

The proper alignment of incentives can create a virtuous cycle that is a positive spiral effect between supply and demand. With these incentives in mind, and an eye on the constraints and opportunities within the market, CSISA-MI continues to facilitate development within the private, public, and development sectors and support services that are connected to the agricultural machinery market. To understand how the market is evolving, CSISA-MI utilizes a monitoring and results measurement (MRM) system to analyze what is happening, why and when. The market systems development approach used by CSISA-MI considers incentive structures within a system:

- For the private sector companies and their dealers, profit and brand value should increase as a result of target machinery sales;
- For the local services providers (LSPs), profit and social capital should increase as a result of buying the target machinery and using it to provide services to farmers as a business;
- For the farmers, the purchase of mechanization services from LSPs should decrease the cost of farming, increase productivity, and/or provide other agronomic benefits;
- And for the government, public value – such as food security and the economy - should grow as the market system for agricultural machinery develops.

The following subsections describe CSISA-MI's private sector engagement, public sector engagement, supporting services work, and MRM system over the past year.

4.1 Public Sector Engagement

CSISA-MI works broadly with government agencies to 1) endorse, promote and technically advice appropriate technologies in agricultural machineries to the farmers and 2) conduct research to evaluate and develop machineries suitable to the project area.

CSISA-MI Faridpur Hub, along with its partner Society Development Committee (SDC) participated in the Agro Technology Fair 2017 in Kashiani Upazila at Gopalganj district. The four-day (9-12 April) fair was organized by the Department of Agricultural Extension (DAE). CSISA-MI exhibited different agricultural machineries like Reaper, Seeder, and Axial Flow Pump (AFP) in the fair. In front of the exhibition stall, training videos on Strip Tillage, Power Tillers Operated Seeder (PTOS), Reaper and AFP were also screened. Project Director (PGB)-DAE, Deputy Director of DAE, Gopalganj, Upazila Agriculture Officer (UAO) & Upazila Nirbahi Officer (UNO), Kashiani visited the stall and appreciated CSISA-MI activities. Besides, a huge number of farmers, service providers, and machine owners also visited the stall. The stall was awarded 1st prize by the organizers at the concluding ceremony.

The approach to work with the government is effected at three main levels:

At the field level, CSISA-MI conducts training for Sub-Assistant Agricultural Officers (SAAOs) of the Department of Agricultural Extension (DAE). The SAAOs are the front line of advice for the farmers on agricultural machineries. SAAOs also visit farmer's field in the project areas and provide suggestions as required on crop production cultivated by the project's promoted technologies that represent conservation agriculture.

At hub level, i.e. upazila and district level, CSISA-MI engages key DAE officials (Deputy Directors, District Training Officers and Upazila Agriculture Officers) to participate in various activities such as project stakeholder workshops, Farmer Field Days (FFD), farmers/LSPs training, demonstrations, as well as awareness and demand creation events and linkage meetings with MSMEs. This has helped the project gain a better understanding and endorsement from the government officials. CSISA-MI in turn has actively participated in agriculture fairs at Upazila and District levels organized by DAE and have received awards based on the performance demonstrated by CSISA-MI technologies. CSISA-MI is also closely working with the Farm Mechanization project of DAE to enhance the promotion of agricultural machinery in the project areas

CSISA-MI advocates a project collaborative approach and clear objectives with key government departments and ministries e.g. Bangladesh Agriculture Research Institute (BARI), Dept. of Agriculture Extension (DAE), Ministry of Agriculture (MoA), Bangladesh Agriculture Research Council (BARC), Bangladesh Agricultural Development Corporation (BADC).

4.2 Private Sector Engagement

CSISA-MI engages the private sector through a combination of efforts with 1) formal private sector partners (PSPs) or "lead firms" and 2) local-level market facilitation. These are described below.

CSISA-MI partnered with five lead firms: ACI Motors, Janata Engineering, The Metal (Pvt.) Ltd., RK Metal, and RFL. Between these five firms, there are at least two companies competing for sales of each target technology. This competition - over the long run - will support lower prices, higher quality, and more diverse options in design and embedded services (e.g., training, help lines, warranties, etc.).

By investing in cash cost-shares and other in-kind support (such as technical assistance), CSISA-MI leverages investments from these companies into the CSISA-MI target technologies. The investment detailed under the custom indicator previously.

4.2.1 Public Private Partnerships

CSISA-MI facilitates public-private partnerships in order to improve the extension services for farmers. Such partnerships have become in-built in most of the project activities at the field level.

The Farm Mechanization Project of DAE and the CSISA-MI project jointly organized a day-long learning sharing workshop on agricultural mechanization at the BARC conference hall in Dhaka. Md. Mosharraf Hossain, Additional Secretary (Extension Wing) of the Ministry of Agriculture was the chief guest on the occasion while Dr. Abul Kalam Azad, Executive Chairman of BARC was present as the special guest. The other sessions included stories from local service providers, dealers and mechanics, and presentations on various issues of agricultural mechanization by technical experts. The guests and the participants spoke highly of the rapidly growing agricultural mechanization scene and how it was benefiting many farmers to boost their productivity. Representatives from ACI Motors and Alim Industries also shared their experiences to illustrate the case of the private sector. The workshop assembled public and private sector partners in the agricultural mechanization sphere and served as a knowledge-sharing platform where both parties exchanged their ideas and experiences. The participants believed the event would help strengthen public-private partnerships and provide an opportunity to interact and build a network for the benefit of the farm and agriculture community.

Increasing cash and in-kind contributions from PSPs are an encouraging indicator of the private sectors' investment in CSISA-MI target technologies this year. These investments are having an important impact in the market. Illustrative examples from the recently concluded year include the following:

ACI organized several field demonstrations for the reaper in Faridpur, Madaripur and Magura districts in light of the wheat season, which showcased how the machinery worked. Potential buyers, farmers, dealers and government agriculture officials were present during the demonstrations. Participants were able to see the operation of the attachment firsthand.

The Metal provided free toolboxes and spare parts in addition to installation, operation and maintenance services by trained mechanics for reaper buyers. Their toolboxes included five spare upper cutter blades and lower cutter blades along with a lug chain. Through access to the trained mechanics, LSPs who purchased reapers had the opportunity to acquire skills on installation, operation, and maintenance of the machinery for future purposes.

Janata Engineering organized a special recognition event with dealers and commission agents in Chuadanga. This was an incentive type activity, based on the sales targets reached by the two aforementioned groups. Janata also shared the sales plan of the reaper attachment with dealers, further strengthening the dealership and commission agent network for product promotion and sales. They also provided free toolboxes, spare parts in addition to installation, operation and maintenance services to the reaper buyers by trained mechanics.

4.2.2 Local Manufacturing Capacity Building Assessment for AFP

The PSPs involved in the manufacturing of AFPs faced various challenges in maintaining quality and uniformity of the pumps during manufacture. As a consequence, two of the project's partners (The Metal and RK Metal) identified the need to develop Standard Operating Procedures (SOPs) with assistance from the project to help elevate the manufacturing skill of their staff. These SOPs will serve to maintain quality, minimize the likelihood of defects, wastage, re-work and thus ensure time and resources are utilized as efficiently as possible.

In this context, the development of AFP manufacturing SOPs started during the month of April with a participatory approach including PSPs and technical experts from the project in line with HCD principles. The SOP was developed through interviewing all levels of human resources engaged with the manufacturing process from PSPs. It was then reviewed by technical experts from CIMMYT and their feedback was incorporated in the document. The SOP version 1.0 is under review by users and it will be finalized with their necessary and relevant inputs. As a next step it will be translated into Bengali and based on this a training module will be developed to build the capacity of local manufacturers. The training is planned to be conducted in August this year before the PSPs start manufacturing of AFPs to achieve their fifth year goals. RK Metal, The Metal and RFL intends to have increased supplies of pumps for the year 5 Season, having made commitments to build many more than last year and RFL has refurbished a number of AFP from unsuitable imported stock.

4.2.3 Local-level Market Facilitation

CSISA-MI is engaged in various local-level market systems facilitation activities. The major categories of facilitation included awareness raising events, potential customer persuasion events, method demonstrations, learning visits, and UP Chairman Orientations. Below are brief descriptions of each activity, followed by a table quantifying the number of events and participation by project hub:

Krishi Machine Porichiti (KMP) are awareness events that promote agricultural mechanization generally with extra focus on the CSISA-MI target technologies.

Shombhabbo Kreta Shomabesh (SKS) persuasion events where potential customers meet with company and finance representatives as well as enthusiastic LSPs known as "Champions." The goal is to facilitate a space in which PSPs can work to convert *potential* customers into *actual* customers.

Method demonstrations – as opposed to the seasonal demonstrations sponsored by CIMMYT – are brief, one-day events where potential customers, lead farmers, and SAAOs of a specific area can observe the performance of machine and ask questions about the technology.

Learning visits are a form of "persuasion event" where potential customers visit a Champion LSP to see the target technology in action and learn firsthand about the financial and agronomic benefits of its use.

4.2.4 Market Strategies

In year-4, our project strategy for market system development was to have private sector partners lead all the activities. Previously in the last three years, the demand creation and awareness activities for the

agricultural machineries purchase was mostly led by the project team. Having met targets in year-3, we conducted meetings with private companies to inform them of our changed strategy to involve them more in awareness raising activities. CISIA-MI continues to build capacity in market development with the private sector so that may take the lead in successful sustainable technology adoption. As a result, the private sector has driven the marketing activities by themselves in 2017 and built networks with other market actors; i.e. dealers, commission agents, spare parts retailers, MFIs and mechanics. For, The Metal Ltd have developed an outreach training centre and machinery hub, along the lines of CSISA-MI for the development of LSPs and maintenance services.

4.2.5 Business expansion through engagement with different value chain actors

Machines, regardless of quality, will inevitably break down and without a functioning supply chain for spare parts and the availability of repair services, it is highly likely that customers will become frustrated with machine breakages and as a result, counterproductive negative word-of-mouth marketing will spread. This is particularly important for LSPs for whom reliability is a key feature of their business. To address these challenges, CSISA-MI has developed a two-pronged strategy: (1) working with lead firms and (2) working with other market actors such as spare parts shops and local mechanics.

Illustrative anecdotal examples of improvements in after-sales service from the fourth year include the following:

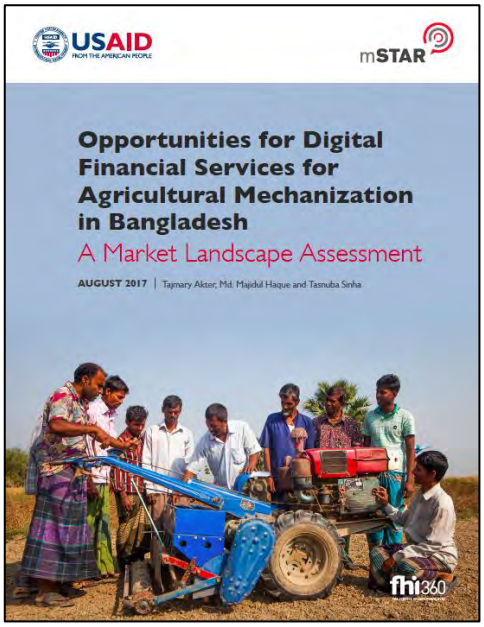
- The Metal provided free after-sales service and maintenance during the season and offers free spare parts within the warranty period to AFP purchasers. The Metal also took initiatives to modify their BG-AFPs to make them more efficient in terms of the overall operation and discharge. They demonstrated the modified version of the pump in Barisal during the quarter, which received a positive reception. They will continue to improve on the quality of the pumps next season.
- ACI organized their reaper-branded service van campaign to provide free after-sales service to the existing reaper customers. There was an assigned technician from ACI who made door-to-door visits of the reaper buyers and offered repairing services if needed. The campaign lasted 10 days and reached more than 50 buyers.
- Janata Engineering also provided free installation, operation and maintenance training to selected customers by trained mechanics during each sale.

4.2.6 Supporting Services

To support the market system, CSISA-MI has facilitated interventions in support services; e.g. spare parts and repair supply chain (infrastructure), and access to finance (related services). Third party marketing was necessary in the first three years of the project to help kick start the market for the technologies targeted by CSISA-MI. However, it was not sustainable unless private sector companies invested in them directly. Therefore, for the fourth year, the project no longer independently invested in third party marketing, but rather channeled this support through the PSPs.

4.2.7 Access to finance

As the customer profile of the LSPs progresses from early adopter (mostly middle income farmers) to early majority (larger numbers of lower income farmers), it is likely that more LSPs will need access to finance. To this end, CSISA-MI negotiated JVAs with four microfinance institutions (MFIs) to ensure that potential LSPs had at least one option, but sometimes two or more, for procuring a loan to help purchase one or more of the target technologies.



The USAID-funded mSTAR project, in collaboration with CSISA-MI, conducted a study to explore opportunities of integrating digital financial services in agricultural mechanization services. The assessment spanned six districts in southwest Bangladesh and included feedback from farmers, LSPs, dealers, the Government of Bangladesh, national and private companies, and microfinance

institutions. They studied the transaction patterns involving LSPs, dealers, farmers, and private companies to find out how much of the transactions were primarily cash-based.

The study proposed suitable financial products for farmers and LSPs that included a potential loan product for PTOSs and reapers, and a savings product for farmers and LSPs based on seasonal savings behavior. The study also talked about a possibility for integrating digital financial services in the transaction flows between both LSPs and dealers, and dealers and companies after completing a transaction mapping of agricultural mechanization service value chain actors.

4.2.8 Expanding markets and connecting the value Chain

The Private Sector Partners (PSPs) of CSISA-MI have always been interested to work in northern Bangladesh as the cropping intensity is higher there and thus afford greater opportunities. The third phase of the CSISA project has developed that opportunity to collaborate in the north. The CSISA-III project has signed JVAs (Joint Venture Agreements) with the CSISA MI partners in the FtF zone creating opportunities to transfer "best practice" and lessons learned from CSISA-MI into CSISA-III. Private companies like Janta Engineering are taking the opportunity to expand their markets and replicate activities in the north which were proven under CSISA-MI in the last 4 years.

An advanced farmer and LSP Md. Akter Hossain (34) of Charfassion, Bhola organized a farmers' club "Madhya Halimabad krishok club" with support from DAE and CSISA-MI. The club has now 50 members who received training and adopt advanced agricultural technologies. Akter received training on AFP and PTOS from CSISA MI which encouraged him to use modern agri machineries. He also has received five agri-machines from DAE and has purchased a seeder machine by himself. He received 12 days training on machinery troubleshooting, maintenance and operation from RDA, Bogra.

The CSISA-MI database will soon be open to and accessible to the farmers and the machinery value chain so that those seeking services and/or making contact will be simple and effective. Similar to electronic yellow pagers those with access will be able to search by upazilla for the services they require, be it and LSP, mechanic or dealer etc. The data base has been uploaded to the website and the access landing page is under construction.

4.3 Lessons from Monitoring, Evaluation & Learning

a. Crowding Effect Survey

In September of 2017 the MEL team with the assistance of other hub colleagues conducted a short survey of 30 agricultural machinery dealers who are not involved in the CSISA-MI project. The objective was to determine if they are mimicking CSISA MI and what they feel the future was for Agricultural Machinery in the FtF zone. The results are given below:

1. This business is not new in southern part of Bangladesh and we found the dealers' average experience was almost 18 years (ranging 1 to 35 years). However, experience in sales was 14 years.
2. The dealers were located in the project area were selling power tillers, irrigation pumps, locally made threshers and PTOS in roto-vator mode, mostly. In Barisal there were some dealers selling PTOS, reapers and the maize conversion kit as an initiative of Government Subsidy Program
3. Source of machinery was; Local Workshop, Reputed local manufacturer, as well as reputed importers.
4. As agricultural labour is scarce due to off-farm work such as; readymade garments (RMG) sector, the dealers projected a good future for Ag Machinery businesses. Especially for reaper and PTOS.
5. They suggested, low cost, cost saving and energy efficient machinery have good prospects in the future.
6. More demonstration and publicity for machinery is required to spread the message among farmers
7. Estimation of future (total) market size was difficult to determine as the response range was too dispersed. Some suggested a few dozens to more than one hundred machines are sold per year.

According to respondents' future sales were highly dependent on geographical location, cropping pattern and extent of labour crisis.

8. Finally, there was a strong indication that potential machinery markets were not reached or informed. We need to seek out those points/places and inform them about the appropriate machine they need. Demonstration and other common communication channels need to be used to increase popularity and awareness of the machines among the farmers.

We took from this small snapshot in time and place, that any cost saving and scale appropriate machine would be of a benefit and that the technology supported by CSISA-MI is being sold by them. It also suggests that the tipping point, especially in Barisal, might have been surpassed. Their plans did not seem to indicate that they were looking for, or planning for, anything more advanced than what is already on offer and under the subsidy scheme. It would appear that there remain "unknowns" amongst dealers and farmers that are constraining development and adoption.

b. Panel Survey

The first wave of Panel surveys conducted for CSISA-MI in September 2016 was conducted in Barisal, Bhola, Faridpur, Gopalganj, Rajbari, Bagerhat, Magura and Jessore districts of the FtF regions. The respondents included 44 Local Service Providers (including 22 fixed and 22 random), 14 Dealers, 14 Mechanics and 8 Spare Parts shop owners (Table 5).

The method of data collection was through Key Informant Interviews, using structured/semi-structured questionnaires. As the study was first of its kind, it is expected to serve as a baseline, setting the ground for further panel studies planned to be conducted throughout the remaining life of the project. The study produced a lot of interesting market insights into the project, which were previously uncaptured through the regular M&E framework. It was discovered that among the project promoted technologies, the reaper had the highest land coverage at around 36 acres in the preceding six months. The AFP was the costliest machine to operate but, the most profitable, with average operational cost per season ranging to around BDT 32,000, with average net income of BDT 44,220, followed by Reaper and PTOS. Among LSPs, for those that held other occupations, the consensus was that they earned more from other occupations as compared to their LSP business model, by an average margin of around BDT 45%.

However, more than a third (35%) of LSPs Total Household Income came from providing Machinery Service. LSPs reported the MFIs to be their most preferred source of financing, while an alarming indicator was that many of the (45%) reported that they did not implement training learnings in their daily activities- perhaps shedding some light into room for improvement in the skills and training component of the project. Local level mechanics are unanimously the primary source of maintenance and repair for the LSPs. For dealers, they reported, in almost 80% of the cases, that they had no problem in accessing desired type and number of machines from manufacturers/importers. All of them reportedly provide after sales service to their customers. Of their total income from their business, as much as 11% came from the sale of project promoted technology. Mechanics reported an average income from servicing project promoted technology of BDT 13,950, with a customer base of 306 members for project promoted technology. A Demand-Supply mismatch was identified however, as mechanics are reporting considerable levels of availability of spare parts, whereas LSPs identify unavailability of spare parts as their main concern. The spare parts shop owners reported the largest incidence of spare parts sale was for AFP, with 13 customers reached, and followed by 5 customers for Reaper, while none were sold for PTOS. More than half of the spare parts shop owners reported to selling AFP parts, one-third selling PTOS parts, and one-fourth selling Reaper parts. While the sales and investment figures were largest for Reaper spare parts, followed by PTOS and AFP respectively, it was seen that PTOS sales elicit the highest income, BDT 3,750 on average, followed by Reaper and AFP.

Table 5: Random LSP Selection Matrix

Currently, the 2nd Category/Machine	Number of Days of AFP	PTOS	Reaper
High Performer	> 69	> 50	> 45
Average Performer	30 - 69	21 - 49	15 - 45
Low Performer	< 30	< 20	< 15

According the selection criteria, machine-specific LSPs are chosen based on the number of days their machines remain in operation per year. LSPs have been chosen to reflect usage of all 3 project promoted technologies, and segregated according to category of performance.

Apart from the core panel participants, a spin-off quantitative study is also being conducted to congregate market information from Private Sector Partners and Financial Service Providers. Apart from findings similar to the previous study, new questions have been incorporated into the tools to assess new dimensions, which include a more in-depth look at what goes on at the dealer level, which is basically the project gateway into the entire market, including some behavioral aspects. Also, crowding-in and copying-in data will be captured in interviews with some of the actors, to help summarize project direct and indirect outreach. Some of the objectives of this study include:

- Measuring enterprise/ household level impacts. State of current yields and reductions in costs due to an access to service provisions by LSPs. Yield and reduction in cost require to be segmented by machine and area specific;
- Measuring dealers, LSPs and mechanics business status in terms of volume of transaction and customer base (LSP-land coverage) per year/season;
- Map relationships among dealers-manufacturer, dealer-LSPs, farmers-LSPs, mechanics-LSPs, and mechanics-spare-part shops and assess the areas within their relationship can be improved;
- Existing service delivery & payment modality within the actors and required support services in terms of new machines in their business areas
- Level of satisfaction with the services provided by each actor to their customers

Md. Rafiqul Islam, owner of M/S. Al Imran Traders, Shibpur, Tala, Satkhira, is currently working as a mechanics under farm mechanization project of DAE besides running his own business. Earlier he managed a fertilizer & seed business in his locality. After receiving CSISA-MI training back in 2014, he purchased an AFP to dewater his 3 Ghers and to provide irrigation services to others during Boro season. Then he started selling his service of dewatering to other Gher owners also. During that year he made profit of around 25,000 Taka (US$ 313) by selling irrigation service.

In 2015, he bought a Reaper to run reaping service business. At one point he thought to start his own dealer/distributor business. With the help of CSISA-MI he managed to establish his agri-machinery dealer point showroom in 2016 and hired two other technical persons to assist him in sales and mechanics services. With his profit he bought two pieces of land to cultivate. Rafiqul said, "Now I got the courage to run a bigger agro-technology business, thanks to CSISA MI project, it really works not only for me but for the benefit of the poor farmers. I am also grateful to DAE."

5 TURNING RESEARCH INTO IMPACT

5.1 Socioeconomic Survey

Commercial viability of the small-scale farm mechanization technologies (e.g. PTOS, AFP, and REAPER)

In 2017, a survey was conducted by CIMMYT to measure the economic and financial performance of the small-scale farm mechanization technologies promoted by CSISA MI (e.g. PTOS, AFP, and REAPER). A stratified random sampling procedure was followed to select LSPs from three CSISA MI hubs (Jessore, Barisal and Faridpur). The stratification was done at the technology level considering 95% confidence interval and 5% margin of error. A list of about 904 LSPs were provided by the CSISA MI team for sampling. We collected detailed cost and return information of all the machinery. The survey started on

Table 6: General information of the machinery operation

Items	PTOS (n=214)	REAPER – Mounted (n=14)	REAPER - Self Propelled (n=82)	AFP (n=209)
Annual area coverage (ha)	**25.12**	**6.66**	**11.83**	**7.44**
Area coverage by season (% of total area)				
Rabi	83.03	93.39	88.53	73.52
Kharif - I	15.27	2.80	8.38	14.28
Kharif - II	1.69	3.81	3.09	12.20
Area coverage by crop (% of total area)				
Rice	4.96	62.00	61.39	47.66
Wheat	9.00	35.40	38.37	1.52
Maize	0.81	-	-	0.37
Garlic	9.39	-	-	0.08
Onion	44.44	-	-	0.10
Pulses	9.82	2.02	-	2.55
Aquaculture	-	-	-	34.85
Others	21.57	0.57	0.23	12.88
Area coverage by purpose (% of total area)				
Tilling	97.12			
Ploughing and seeding	2.87			
Ploughing and seeding (DSR)	0.01			
Irrigation				65.20
Dewatering				34.80
Reaping		100.00	100.00	
Average service charge (BDT/ha)				
Tilling	3,096			
Ploughing and seeding	3,847			
Ploughing and seeding (DSR)	4,199			
Irrigation				11,109
Dewatering				14,654
Reaping		3,434	3,831	

January 2017 and was completed on May 2017. The study covered the information of the production cycle of 2016. Survey indicated that about 10% of the sample LSPs owned more than one CSISA-MI promoted machine. The total number of CSISA MI machinery owned by the sample LSPs were 519 (PTOS: 214; Mounted reapers: 14; Self-propelled reaper: 82; AFP: 209). The survey results indicated that about 68% for AFP owners and about 95% of the PTOS and Reaper owners used the machinery for business operation after using them in their own fields. About 32% of the AFP owners who used the AFP exclusive in their own farm reported that they have no scope to use the machine for business purpose as the full capacity is utilized in their own farm.

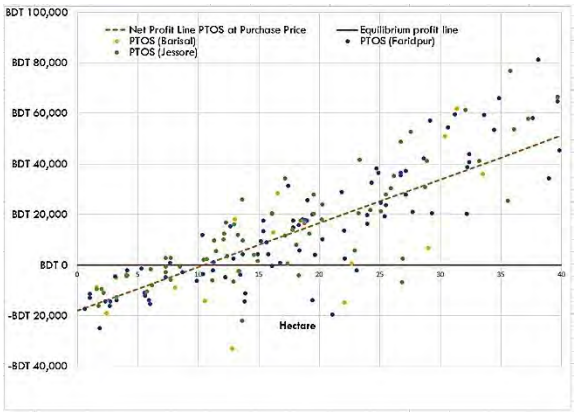
The service charge is usually paid in cash across all machinery types, where 50%-60% receive money in cash, 30% to 40% of LSPs in both cash and in-kind, and the remaining 2%-6% is all in-kind. The payment is usually made in two stages, before starting work and after completion of the work. The first payment is intended to be used to buy fuel, oil and other cash costs by the machinery owners. In some cases, the hiring farmers failed to pay off the payment at the second stage i.e. after completion of the work. In this case, they paid after harvesting without any additional charge for that late payment.
Table 7 showed that the average annual use of the machinery was 25.12 ha/year, 6.66 ha/year, 11.83 ha/year and 7.44 ha/year for PTOS, Self-propel reaper, mounted reaper and AFP respectively. According to the LSPs, the road infrastructure conditions in their local area, limited skill of the machinery operators, higher number of frequency of machinery breakdowns and time required to fix the machinery are the major factors that influence the annual use of the machinery. Disaggregation of the data by annual area coverage by cropping season showed that these machineries are mainly used in Rabi season followed by Kharif-I and Kharif-II.

Table 7: Annual cost and benefit of the machinery operation for business (BDT/machine)

Items	PTOS (n=203)	REAPER – Mounted (n=12)	REAPER - Self Propelled (n=76)	AFP		
				Irrigation (136)	Dewatering (37)	Total (n=142)
Area coverage for business (ha)	24.58	5.64	11.65	6.27	2.75	6.72
A. Fixed cost	**8,731**	**8,292**	**23,147**	**8,013**	**2,182**	**8,243**
Depreciation cost: machinery and engine	8,223	7,446	19,244	4,218	1,594	4,455
Depreciation cost: machinery shed/irrigation canal	148	329	244	3,744	588	3,739
Others	359	532	3,450	51	0	49
B. Variable cost	**30,507**	**7,107**	**14,386**	**52,088**	**10,642**	**52,660**
Fuel quantity	241	52	75	531	62	525
Fuel cost	16,256	3,468	7,151	35,235	4,228	34,848
Lubricant cost	907	272	361	1,605	1,225	1,857
Operator cost (Hired)	2,823	707	2,884	5,173	1,225	428
Operator cost (Family)	8,806	1,741	2,209	5,878	2,183	6,199
Repair and maintenance: machinery	1,225	511	785	1,931	558	1,995
Repair and maintenance (machinery shed & irrigation canal)	340	328	315	1,946	658	2,035
Others	150	79	681	320	146	345
C. Total cost (A+B)	**39,238**	**15,023**	**37,476**	**60,101**	**12,823**	**60,903**
D. Service charge (Tk./ha)	3,155	3,434	3,831	11,109	14,654	10,322
E. Total Return from business (Service charge X Total area coverage)	81,160	24,653	48,531	65,817	28,428	81,032
E. Gross Margin (E-B)	**46,067**	**13,440**	**30,677**	**13,729**	**17,786**	**17,783**
F. Net margin (E-C)	**37,336**	**4,403**	**7,397**	**5,716**	**15,604**	**9,540**

Results also showed that the PTOS are mainly used for providing the tilling services (97% of total coverage). The PTOS are used for the land preparation for onion (44% of total coverage), Garlic (9% of total coverage) and other crops such as okra, sesame, sunflower, tomato and jute etc. Reapers are mainly limited to rice and wheat crop (more than 95%). However, we found a very few

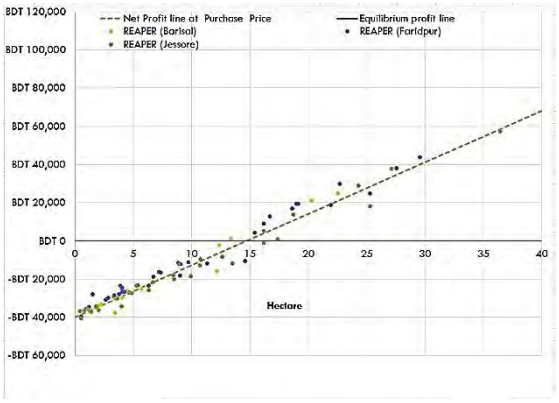
Figure 16: Net profit of PTOS investment



LSPs have used the reaper for harvesting sesame and lentil with success. The AFPs are mainly used for irrigating the rice field (48% of total area coverage) followed by aquaculture (35% of total area coverage). AFPs offered the services of both irrigation (65% of total area coverage) and dewatering (35% of total area coverage).

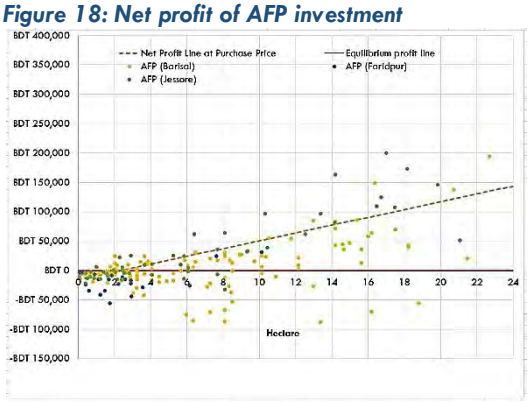
Data indicate that the farmers are paying higher prices for the additional services offered by the PTOS, for example, the service charge of PTOS ploughing and seeding (BDT 4,199 per ha) is more compared to only tilling services (BDT 3,096 per ha). The average per ha service charges were BDT 3,434 and BDT 3,831 for the mounted and self-propel reaper respectively. In case of AFP, the service charge is varied for different operations: the rate for dewatering (BDT14, 654 per ha) is higher compared to the normal irrigation services (BDT11, 109 per ha).

Figure 17: Net profit of Self-Propel Reaper investment



The annual gross margin and net margin were calculated to evaluate the performance of the PTOS, Reaper and AFP. Gross margin was determined by subtracting variable costs (operating costs) from gross return. Net margin was calculated by subtracting operating and fixed costs from gross return. Results show that many of the AFP owners adopted both dewatering irrigation practices. From Tables 6 and 7 it is evident that all machinery was able to generate profits on average (PTOS: Mounted reaper: Self-Propelled Reaper: AFP). This indicates that farms were effectively managing operating expenses relative to the value of output. The highest gross margin came from PTOS (BDT39,238) followed by self-propelled reaper (BDT30,677), AFP (BDT17,783) and mounted reaper (BDT13,440). Tables 6 and 7 also show that farmers across technologies received positive net margins from the aquaculture production, on average. Ranking machineries in terms of net margin exhibits a different pattern compared to gross margin. The highest net margin came from PTOS (BDT37,336) followed by AFP (BDT9,540) self-propelled reaper (BDT7,397) and mounted reaper (BDT4,403). Higher investment for reaper is relative to its yearly return probably due to low net margin.

Figure 18: Net profit of AFP investment



The annual economic viability for PTOS, Reaper (Mounted and Self-Propel) and AFP was evaluated in terms of simplistic profit (ignoring fixed costs Item A in Table 6) and the result is illustrated in the following figures; 16-18. The analysis result indicates that profits are generated after servicing 11 ha/year, 15 ha/year and 3 ha/year for PTOS, Self-propelled reaper and AFP respectively. The results, Table 2, showed that the actual average annual use of the machinery for business was 24.58 ha/year, 5.96 ha/year, 11.70 ha/year and 6.72 ha/year for PTOS, Self-propel reaper, mounted reaper and AFP respectively. It is reasonable to conclude that the CSISA-MI supported machinery used for custom service hiring, on average, make profit from their operations. However, It would also appear that 54% of reaper and 33% of PTOS LSP's are not meeting the required capacity of 13.5 ha per year so as to reach reasonable profits, which has considerable implications for achieving targets and business case development in year 5.

5.2 Research on Mechanization

Development of strip-till solutions for cropping in excessively moist clay soil in southern Bangladesh
Normally used "C" type blades on the rotary seeders perform well for traditional full disturbance soil tillage. However, their use for strip-tillage tends to result in excessive soil throw out of the seeding slot (furrow) producing inadequate slot backfill, resulting in poor seed coverage, increased seed predation, reduced germination, and sub-optimal plant stands. The excessive soil throw occurs mainly during the exit of the blade's side section (Matin et. al., 2014). In order to reduce soil throw, Matin et. al. (2015,

2016) suggested an alternate blade design (straight blade) for strip-tillage that can reduce soil throw, improve furrow backfill, produce soil optimal tilth for seed germination, and also reduce energy requirement. However, preliminary field testing with straight blades in a moist clay soil of the southern Bangladesh has shown that these (at the common setting of 4 blades/row, 50–60 mm operating depth) cannot break the soil completely enough to create a suitable seed slot; merely create two independent slots (each 6–10 mm wide) and thus are not suitable for strip-till seeding. Since the soil carrying ability of a certain width of blade is fixed, it is expected that increase in tilling depth would produce a complete furrow while reducing soil throw, increasing backfill and improving soil tilth due to increased re-tillage. Therefore, a soil bin study tested the conventional, straight and medium (shorter sidelong section) blade designs (Fig. 19a) at a range of operating depths to quantify their effect on furrow depth, width, backfill, and soil tilth and recommend a blade design and setting for strip-tillage in excessively moist clay soil condition.

Figure 19: (a) Blades tested: conventional, medium, and straight (left to right); b) Setting of the blades on the rotor (4 blades/row): conventional, medium, and straight (left to right)

a) b)

To maintain accurate tillage depths and a uniform soil condition, the study was conducted using the indoor soil bin and seeding test rig facility at the Bangladesh Agricultural Research Institute, Gazipur, Bangladesh. The soil bin was filled with clay soil (47.2% sand, 22.0% silt and 30.8% clay) collected from the field. The soil was watered, spaded, mixed, levelled, and finally compacted with 50 passes of a roller to obtain a 125 mm soil bed ready for testing (1440 kg m^{-3} bulk density and 28.4% moisture content that corresponds to 85% of field capacity). A two-factor completely randomized design with three replications conducted over time with newly remolded bins, was thus used for the experiment, with treatments being as follows.

Factor A (blade design) – 3 treatments: conventional, medium, and straight

Factor B (blade operating depth) – 3 treatments: 50 mm, 75 mm, and 100 mm

The forward travel and rotary speeds were maintained at 0.4 m s^{-1} and 480 rpm (forward rotation), respectively using the rig. The conventional and the medium blades were 43 mm and 23 mm wide, respectively while the straight blades were 4 mm thick. As shown in Fig. 1(b), the blades were set for a cutting width of 50 mm (4 blades/row as recommended by Lee et. al., 2003 and Matin et. al., 2014) and a rotor diameter of 355 mm.

Data collection process in the following three days included cleaning away the soil clods thrown outside the furrow, collecting loose soil (i.e., furrow backfill) from a 500 mm furrow section, oven drying the collected soil at 105 °C at least for 24 hours, weighing, and hand sieving through 20 mm and 1 mm sieves. Amount of furrow backfill was calculated as the weight of dried soil collected from the furrow and expressed in kg m^{-1}. Similarly, amounts of large, optimum, and fine clods were calculated as the weight of the dried soil retained on 20 mm sieve, 1 mm sieve, and pan, respectively and also expressed in kg m^{-1}. The furrow center depth and top width were also calculated as mean of readings taken at 10 consecutive locations spaced 50 mm along the furrow run using a 0.5 mm graduated ruler as described by Matin et. al. (2014). The collected data sets were statistically analyzed for variance (F-test).

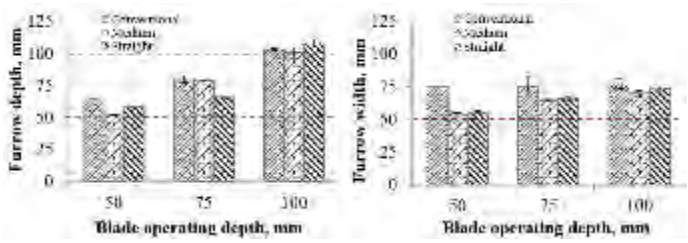


Figure 20: Effect of blade design and operating depth on furrow depth (left) and furrow width (right) (Vertical bars represent standard error of means)

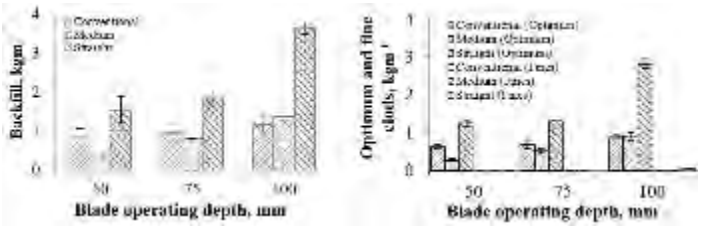


Figure 21: Effect of blade design and operating depth on furrow backfill (left), and soil tilth (right) (Vertical bars represent standard error of means)

Analyses of variance (F-test) of furrow parameters showed that the furrow width, backfill, and amounts of optimum and fines clods were significantly affected by both the blade design and the operating depth. However, the furrow depth was not significantly affected by the blade design, but by the operating depth. The interaction effect of the blade design and operating depth was significant for all the furrow parameters except furrow width. Considering the straight blades ability to till a complete furrow of desired depth and width that contains high amounts of backfill and optimum soil clods (Figs. 20–21), the study recommends the use of straight blades (slightly longer to provide a rotor diameter of 420–450 mm) and an operating depth of 75–100 mm so that the rotor shaft or blade holders do not touch the ground or rake residues.

6. CHALLENGES

6.1 Plans and partnerships for addressing wheat blast

The first ever outbreak of wheat blast-a fearsome fungal disease caused by *Magnaporthe oryzae* pathotype *Triticum* (MoT) outside the Americas was recorded in Bangladesh in February, 2016 affecting 15,442 hectares in eight south-western and southern districts of which six was within the Feed the Future Zone. Wheat land area in last years' blast affected eight districts of Bangladesh shrunk from 105556 hectares in 2016 to 47278 hectares in 2017, as risk averse farmers avoided the crop. This has become a major challenge of CSISA-MI success as PTOS and reaper adoption is directly correlated to cultivated wheat area in the country. However, other crops have quickly replaced wheat and the demand for LSP services are increasing.

In 2017, blast infection was found in three new districts Magura, Rajshahi and Faridpur (Pic. 1) in addition to previous years eight. The severity of infection was however very light, as an unusually low amount of precipitation at flowering (disease susceptible) stage of the crop was observed in 2017. Yield losses were 5-10%, although this does not reduce the ongoing risk of outbreak in subsequent years.

Working closely with the BARI, CSISA organized an intensive two-week training program entitled "Taking action to mitigate the threat of wheat blast in South Asia: Disease surveillance and monitoring skills training," the first of its kind in South Asia with the financial support of the United States Agency for International Development (USAID) Mission in Bangladesh and Australian Center for International Agriculture Research (ACIAR) in February 2017. Forty wheat pathologists, breeders and agronomists from Bangladesh, India and Nepal participated in the training. Analysis of field samples showing symptoms of the disease is now ongoing at BARI's laboratories. This training will increase the capacity of Bangladesh and neighboring country scientists, strengthening research on wheat blast and monitoring disease through intensive surveillance," Our hub staff were vigilant in all CSISA-MI field learning centers for any further outbreaks, but no infection was found which was due to strictly following the advice given through factsheet, adherence to protocols, reduction in

wheat area and close attention to the activities of the wheat blast program. CSOSA MI Hub staff adhere to current protocols regarding wheat production and offer appropriate advice to our stakeholders.

Collaborative research with BARI to develop a forecasting model for wheat blast in Bangladesh will provide a significant tool to CSISA-MI. Farmers however continue to request the rapid development of wheat blast resistant varieties and management technologies to hedge against the risk of stronger infections in the future. To this end, CSIAS-MI through the larger CSISA program and BARI will continue to collaborate with international partners including the USDA on breeding and screening programs for new varieties and blast management technologies. Blast tolerance has been found on a preliminary basis in advance lines BAW 1260, BAW 1208, and Borlaug 100, are waiting for release. Two seed treating, four foliar spray fungicides and optimum time of seeding have been found effective in controlling wheat blast. However, these findings will be confirmed by further study.

6.2 Engaging women as entrepreneurs

At the CIMMYT strategy meeting in Nepal, linkages through nutrition and households reinforced the need to work with women through non-traditional pathways, to that end CSISA-MI is exploring partnerships with world vision, Blue gold, GIZ, and other USAID supported groups. A key component of this year's activities has been identifying technology and organisations that can overcome barriers to access and enhance the inclusion of women in agriculture for example; access to digital financial services through Mstar, the use of the Acard and other forms of digital money for LSP transactions to improve women's control of household income. Even so awareness raising and promoting gender inclusion is a standing item on our team agenda.

CSISA-MI has requested hub office personnel to prioritise women involvement in the workforce especially for our focussed mechanization, but just as importantly post-harvest work in the homestead. This priority for CSISA-MI was expressed in Jessore Faridpur and Barisal with DAE staff and officials. These discussions raised awareness and promoted gender inclusiveness for our joint activities, which aligns with DAE's policy to recruit more female extension officers, their target is to have to 60% women in this role.

The recent Washington USAID visitors witnessed the significant contribution women are playing in the agricultural community and the success of CSISA MI supporting gender inclusivity. The team profiled a number of women retailing chemicals, one expressed that she has won the respect of the men in the village and district as an agronomic advisor. The visitors also talked with empowered local women farmers who were engaged in a number of agricultural production activities. These ladies took the opportunity to have their "own voice" and provided feedback on the support they have received from CSISA-MI.

The project has already reported on a number of empowered women success stories who have benefited from and or developed business opportunities as a direct result of our intervention. Generally, these success stories involve partnerships with their "significant other". One such story comes from a lady in manufacturing and sales who defines herself as her husbands "partner" at RK Metal. In this partnership they have embraced each other's strengths to their mutual benefit. She works to advance and support the business on the administrative and operational components, while her husband advances the technical and engineering side. The workshop and office is set beside the family home, which allows her to continue in her parenting role of their two children. Their recent business expansion comes from a request to export their products to India, which is a result of their local successful partnership with CSISA-MI. She confided that the relationship with the project was the catalyst for their improvements and as they expand into exports she hopes for a continuing relationship with USAID and CSISA-MI.
The project leader and partners recognise that there are gaps in building capacity of such women in agriculture, for a number of cultural and situational reasons. They have been developing opportunities and identified training facilities, organisations and female training personnel that would be appropriate to deliver CSISA-MI's training modules to prospective female entrepreneurs in a residential school setting, that can also support families for the period of the training. To assist in driving this and other agenda around gender inclusivity the team have attended the USAID Gender Workshop and are members of the gender working group.

Nevertheless, since its inception CSISA-MI has found it difficult to involve women in machine-related activities as this is a non-traditional profession for women. Usually men operate and own agricultural machines in Bangladesh. Women and their families prefer women to engage in work that is near the home, a result of deep social prohibitions on engaging women in alternative activities. To become an LSP would also require travel to different farmer fields and extended stays outside the home. This represents a significant barrier. However, CSSIA-MI has and will continue to work towards engaging women entrepreneurs as LSPs and in partnerships with family members to support businesses that can be operated from within the home and by hiring male operators.

6.3 GoB subsidies

GoB is providing subsidies for selected agricultural machineries (Reaper, Seeder, Mini Combined Harvester, Rice transplanter, Power Thresher and Sprayer) in selected areas through DAE. The subsidies for the selected machineries were 50% for most of the country. This year (2017), GOB-DAE increased subsidies from 50-70% for selected coastal districts and for particular machine types, but the number of subsidies are limited. This has created significant enthusiasm amongst importers, dealers and farmers, which it is anticipated to accelerate growth of the agricultural machinery market in Bangladesh. However, the number and level of subsidies are limited to around 1 machine per upzilla. The sales of mini-combine harvesters by ACI were significantly boosted by the subsidy, which led to the development of training by CSISA-MI on 90 machines and their owners. However, circumstances caused a postponement of the activity until later in the year, i.e. 1st quarter year 5.

6.4 Fine tuning machinery

CSISA-MI has been working continuously with the local manufacturing and importing companies to developing innovative solutions to the problems evolving from the growing and diversified use of the machinery in the field. Problems addressed since October 2016 include – i) frequent failure or unreliability of seed on-off clutch of PTOS; ii) leaking of mungbean and other smaller seeds though the seed meter in case of brush type PTOS; iii) slipping off the seed meter control lever of the PTOS altering seed rate; iv) row spacing adjustment problem on the ACI PTOS; v) lack of soil cover over seeds in case of 4WT zero-till drill leading to poor germination and crop growth, vi) development of a seed calibration kit for PTOS to be used by LSPs; vii) modification of 2WT reaper for jute harvesting from muddy fields, viii) development AFP installation, set-up and operational guide to aid LSPs and mechanics to efficiently use the pumps etc. The following pictures (Figures. 22-28) summarize these modifications. Machinery importers and local manufacturers are trained on these useful modifications so that interested LSPs get help locally and fix the problems.

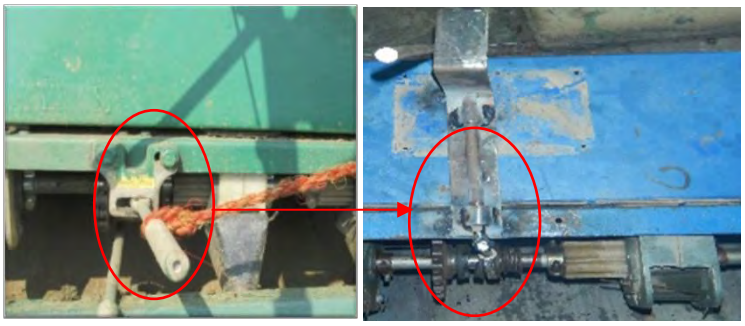


Figure 22: Replacement of the Chinese type seed on-off clutch by a simplified dog type clutch. Left - Chinese type seed on-off clutch, right - simplified dog type clutch. This modification will cost about US$ 9.00 per PTOS (parts and mechanic charge)

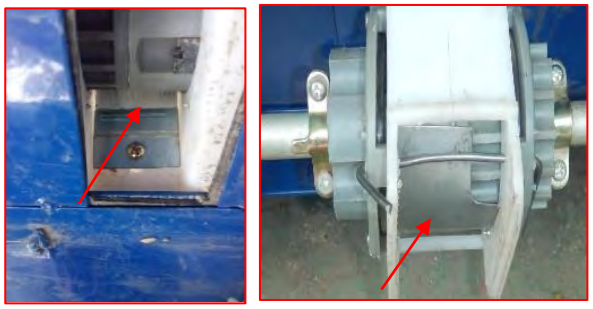


Figure 23: Modification of the brush type seed meter of PTOS. Left – nylon brush type meter through which mung bean and other smaller seeds leak. Right – replacement of the nylon brush with steel sheet flap and pin. Cost of this modification is about US$ 7.50/PTO

Figure 24: Modification of the seed meter control lever locking mechanism on the PTOS. Left – existing seed metering control lever with in appropriate locking mechanism, which easily slips thus altering the seed rate. Right – improved locking mechanism (2 mm hole and a pin lock- slip proof). Cost of modification is about US $ 2/PTOS (parts and mechanics charge)

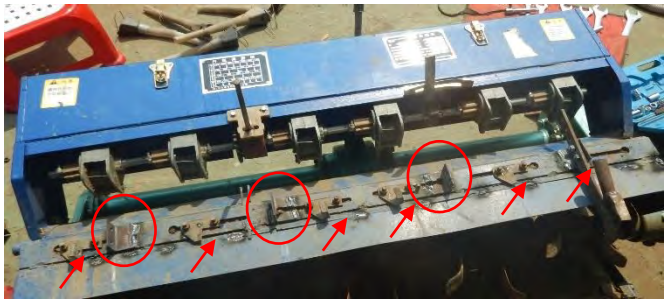
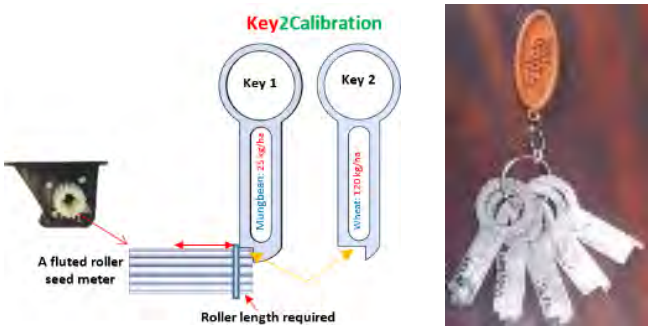


Figure 25: The existing furrow opener clamps (marked with arrows) on the ACI model PTOS do not allow enough adjustment to obtain 300 mm row spacing required for mung bean or other crops sown on a 300 mm row. Therefore, three additional clamps (marked with circles) are welded beside the existing clamps to allow sowing crops on a 300 mm row spacing. Cost of modification is about US $ 2.5/PTOS (parts and mechanics charge)

a. b. c.

Figure 26: Design and development of press wheels for 4WT Zero-till drill to cover the seed furrow slots with loose soil. a) Uncovered slots left by the ZT furrow openers causing poor germination and plant growth, b) furrow opener (painted in greens) fitted with the press wheels (parts circled and painted in reds), and c) nicely covered slots left by the furrow opener when fitted with the press wheels.



a. b.

Figure 27: Development of seed calibration key: a. CAD Model, b. Porotype fabricated for field testing.

Figure 28: Jute harvesting by the attachable reaper (modified) in Faridpur. The 2WT rubber wheels where replaced with cage (iron) wheels which allow use of the reaper in muddy fields, as is common during jute harvesting.

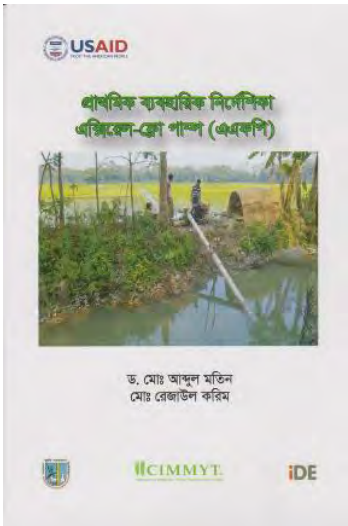


Figure 29: AFP Pocket book (in Bangla) – detailing installation, set-up and operation for the best performance

Future challenges includes field validation of the developed press wheel in wet clay soil in the Southern Bangladesh, further modification and field testing of 2WT reaper for jute harvesting, improvement of maize seed meters and field testing of seeder calibration key and its commercial manufacturing, etc.

During 2017 the standard protocol for the evaluation of surface water irrigation pumps was revised. This document details procedures to reliably and accurately measure water discharge flow rates, total dynamic head fuel consumption, power input parameters and related fuel efficiency variables for the comparative testing and evaluation of surface water irrigation pumps in South Asia. The links to the document are in annex 7

7 COLLABORATION WITH OTHER USAID PROJECTS

CSISA MI continues to work with and engage AIP, AEP, WEP, RDC and DFAP projects funded by USAID. After completion of USAID's RVC project, CSISA MI started working directly with the aforesaid projects. It continues to engage pre-existing networks and groups to assist in scaling across the zone of operations. For examples 818 AIRN Dealers across the FtF zone have been trained up by CSISA. This network has been instrumental in scaling specific information through factsheets supplied by CIMMYT on wheat blast by distributing more than 30,000 factsheets. AEP has also been working with the project through which DAE-AIS has made it possible for a range of CSISA-MI videos to be uploaded onto website. Moreover, WEA was working in the project areas to identify potential women LSP and facilitate them to purchase by CSISA-MI promoted machinery. Over the last few months the CSISA team and CSISA-MI lead have had a number of important interactions with RDC to seek out potential options for collaboration and alignment of activities. Working groups have been established, but at this early stage progress has been limited to establishing a dialogue and limited verbal reviews of prospective activities. CSISA-MI is also looking forward to sustainable options of collaboration with DFAP.

ANNEX 1: CSISA MI Year 5 Working Area

Hub	District	Upazila
Jessore	Jessore	Keshobpur
		Monirumpur
	Jhenaidah	Jhenaidah Sadar
		Shailkupa
	Magura	Magura Sadar
		Sreepur
		Mohammedpur
		Shalikha
	Bagerhat	Farirhat
		Kachua
		Mollarhat
		Rampal
	Khulna	Batiagata
		Dumuria
	Sathkhira	Tala
	Meherpur	Meherpur Sadar
		Mujibnagar
	Narail	Kalia
		Lohagara
		Narail Sadar
Barisal	Bhola	Bhola Sadar
		Burhanuddin
		Charfasson
	Jhalokati	Jhalokati Sadar
		Nalchity
	Barisal	Barisal Sadar
		Wazirpur
		Agailjhara
		Babuganj
	Patuakhali	Dashmina
		Galachipa
		Kalapara
		Patuakhali Sadar
	Barguna	Amtali
		Patharghata
Faridpur Hub	Faridpur	Bhanga
		Boalmari
		Faridpur Sadar
		Madhukhali
		Nagarkanda
		Saltha
	Rajbari	Kalukhali
		Pangsha
		Rajbari Sadar
		Baliakandi
	Gopalganj	Kashiani
		Gopalganj Sadar
		Kotalipara
		Muksudpur

ANNEX 2: FtF Indicator Progress Report 2016-2017

Indicator Ref#	Indicator name	Cluster	Disaggregate Group	Disaggregate	Unit	FY 2016-17 Annual (October - September) Target	FY 2016-17 Annual (October - September) Actual	Deviation (%)	Deviation Narratives
EG.3.2-18	Number of hectares of land under improved technologies or management practices with USG assistance (RAA) (WOG)	None	Sex	Male	Hectare	28323	20723.03		The number of hectares planted to wheat in this year was significantly reduced as per government advice to combat wheat blast, only very small areas, designated as learning centres by CIMMYT were planted. Due to the risk of wheat-blast infection the number of farmers planting wheat using the PTOS LSP services was reduced and thus the harvestable area by LSP reapers services was dramatically reduced. Where possible some alternate crops such as maize, lentil and mung bean were planted, however they do not require reaper services. New (2016-17) LSPs were dissatisfied with the situation and conditions and their businesses did not flourish in their initial year. The very conditions that increase the incidence of wheat blast i.e. early and prolonged rainfall, which was followed by water-logging and flooding, considerably reduced the arable land under production and the use of all three technologies (AFP, PTOS and Reaper) across all 3 hubs. Thus, the overall achievement for land coverage is 71.1% of the yearly target.
				Female	Hectare	1490	475.12		
				Joint	Hectare		0		
				Association Applied	Hectare		0		
				Sub-total		29813	21198.15	-29%	
			Technology type	Crop genetics	Hectare		0		
				Cultural practices	Hectare		0		
				Pest management	Hectare		0		
				Disease management	Hectare		0		
				Soil-related fertility and conservation	Hectare		0		
				Irrigation	Hectare		7192.65		
				Water management (non-irrigation)	Hectare		0		
				Climate mitigation	Hectare		0		
				Other	Hectare	29813	14005.5		
				Total w/one or more improved technology	Hectare:	29813	21198.15		
				Climate adaptation	Hectare		0		
				Sub-total		---	---	---	
			Commodity	Maize	Hectare		27.81		
				Mung Bean	Hectare		0		
				Other crops	Hectare		12841.92		
				Rice	Hectare		6528.96		
				Disaggregates not available	Hectare		0		
				Lentil	Hectare		565.09		
				Wheat	Hectare		1234.37		
				Sub-total		0	21198.15	0%	

Indicator Ref#	Indicator name	Cluster	Disaggregate Group	Disaggregate	Unit	FY 2016-17 Annual (October - September) Target	FY 2016-17 Annual (October - September) Actual	Deviation (%)	Deviation Narratives
EG.3.2-17	Number of farmers and others who have applied improved technologies or management practices with USG assistance (RAA) (WOG)	Producers	Sex	Male	Number	81668	41455		The number of hectares and consequently the number of farmers that planted wheat in this year was significantly reduced as per government advice to combat wheat blast, and only a few farmers connected with CIMMYT's designated learning centres were involved. Due to the risk of wheat-blast infection the number of farmers planting wheat using the PTOS LSP services was reduced and thus the harvestable area by LSP reapers services was dramatically reduced. Where possible some farmers planted alternate crops such as maize, lentil and mung bean, but most were unable to adapt to compensate. The very conditions that increase the incidence of wheat blast i.e. early and prolonged rainfall, which was followed by water-logging and flooding, considerably reduced the arable land under production and the number farmers seeking the use of any or all three technologies (AFP, PTOS and Reaper) across all 3 hubs. In addition, the axial flow irrigation pumps are employed over significant areas, especially when dewatering fish ponds for rice production, the number of farmers engaged are relatively very small. Thus, the overall achievement for the number of farmers was 50% of the target.
				Female	Number	4298	1582		
				Sub-total		85966	43037	-50%	
			Technology type	Crop genetics	Number		0		
				Cultural practices	Number		0		
				Livestock management	Number		0		
				Wild fishing technique/gear	Number		0		
				Aquaculture management	Number		0		
				Pest management	Number		0		
				Disease management	Number		0		
				Soil-related fertility and conservation	Number		0		
				Irrigation	Number		9201		
				Water management (non-irrigation)	Number		0		
				Climate mitigation	Number		0		
				Marketing and distribution	Number		0		
				Post-harvest handling and storage	Number		0		
				Value-added processing	Number		0		
				Other	Number	85966	33836		
				Total w/one or more improved technology	Number:	85966	43037		
				Sub-total		---	---	---	
			Commodity	Maize	Number		126		
				Mung Bean	Number		0		
				Other crops	Number		29963		
				Rice	Number		12655		
				Disaggregates not available	Number		0		
				Lentil	Number		1394		
				Wheat	Number		3884		
				Sub-total		0	48022	0%	

Indicator Ref#	Indicator name	Cluster	Disaggregate Group	Disaggregate	Unit	FY 2016-17 Annual (October - September) Target	FY 2016-17 Annual (October - September) Actual	Deviation (%)	Deviation Narratives
		Others		Crop genetics	Number		0		
				Cultural practices	Number		0		
				Livestock management	Number		0		
				Wild fishing technique/gear	Number		0		
				Aquaculture management	Number		0		
				Pest management	Number		0		
				Disease management	Number		0		
				Soil-related fertility and conservation	Number		0		
				Irrigation	Number		0		
				Water management (non-irrigation)	Number		0		
				Climate mitigation	Number		0		
				Marketing and distribution	Number		0		
				Post-harvest - handling and storage	Number		0		
				Value-added processing	Number		0		
				Other	Number		0		
				Total w/one or more improved technology	Number:		0		
			Technology type	Sub-total		---	---	---	
			Sex	Male	Number		0		
				Female	Number		0		
				Sub-total		0	0	0%	
			Commodity	Maize	Number		0		
				Mung Bean	Number		0		
				Other crops	Number		0		
				Rice	Number		0		
				Disaggregates not available	Number		0		
				Lentil	Number		0		
				Wheat	Number		0		
				Sub-total		0	0	0%	

Indicator Ref#	Indicator name	Cluster	Disaggregate Group	Disaggregate	Unit	FY 2016-17 Annual (October - September) Target	FY 2016-17 Annual (October - September) Actual	Deviation (%)	Deviation Narratives
EG.3.2-1	Number of individuals who have received USG-supported short-term agricultural sector productivity or food security training (RAA) (WOG)	Producers	Type of Individual	Male	Number	6840	7173		CSISA MI as a market development project has been increasingly involving the Department of Agriculture Extension (DAE) as a partner to popularize and sustain Agriculture Mechanisation in south-west of Bangladesh. Collaboration with DAE Extension officers at most of our awareness raising events, farmer field days, demonstrations and training activities piqued considerable enthusiasm for official training and capacity enhancement of existing officers. Additionally, DAE is undergoing expansion and recruitment across the FtF, so during the fiscal year, DAE has recruited new SAAOs (extension
				Female	Number	1710	1897		
				Sub-total		8550	9070	6%	
		People in government	Type of Individual	Male	Number	40	83		
				Female	Number	10	8		
				Sub-total		50	91	82%	
		People in private sector	Type of Individual	Male	Number	780	959		
				Female	Number	195	9		
				Sub-total		975	968	-1%	
		People in civil society	Type of Individual	Male	Number	120	137		
				Female	Number	30	12		
				Sub-total		150	149	-1%	
EG.3.2-3	Number of micro, small, and medium enterprises (MSMEs), including farmers, receiving agricultural-related credit as a result of USG assistance (RAA)	None	Sex of owner	Male	Number		89		This indicator included in Year 4 after having feedback from the second DQA conducted by USAID in May '17; and thus no prior target was set up and causing the deviation.
				Female	Number		2		
				Joint	Number		0		
				n/a	Number		0		
				Sub-total		0	91	0%	
			Size of MSME	Micro (1-10 employees)	Number		91		
				Small (11-50 employees)	Number		0		
				Medium (51-100 employees)	Number		0		
				Sub-total		0	91	0%	
EG.5.2-1	Number of firms receiving United States Government-funded technical assistance for improving business performance (O)	None	Duration	Continuing	Number		0		This indicator has been a modified one compare to the previous "Number of MSME" and the target doesn't matches and as a result the target for this indicator has been set to 'null'.
				New	Number		704		
				Sub-total		0	704	0%	
			Type of firm	Formal	Number		31		
				Informal	Number		673		
				Sub-total		0	704	0%	

Indicator Ref#	Indicator name	Cluster	Disaggregate Group	Disaggregate	Unit	FY 2016-17 Annual (October - September) Target	FY 2016-17 Annual (October - September) Actual	Deviation (%)	Deviation Narratives
1	Estimated number and percentage of beneficiaries holding 5 hectares or less of arable land or equivalent units of livestock	None	Land	Estimated number of Smallholder beneficiaries	Number		42825		This idicator is reflecting the number of farmers who have 5 hectre or less arable land obtained from indictor EG 3.2-17. No prior target has been fixed for this indicator. This is a extrapolated figure and excludes the large farmers (>5ha).
				Estimated percentage of Smallholders among all FTF beneficiaries	Percent		100		
				Sub-total		---	---	---	
			Livestock	Estimated number of Smallholder beneficiaries	Number		0		
				Estimated percentage of Smallholders among all FTF beneficiaries	Percent		0		
				Sub-total		---	---	---	

ANNEX 3: JVA

Joint Venture Agreement

Between

IDE Bangladesh and The Metal (Pvt.) Limited

For the commercialization of Axial Flow Pump and Self-propelled Reaper within the CSISA-MI project

Joint Venture Agreement

Between

IDE Bangladesh and Janata Engineering

For commercialization of Power Tiller Operated Seeder (PTOS) and Power Tiller Mounted Reaper within the CSISA-MI project

Joint Venture Agreement

between

RFL and iDE Bangladesh

for the commercialization of RFL JUMBO PUMP within the CSISA-MI project

Joint Venture Agreement

Between

IDE Bangladesh and ACI

For commercialization of Power Tiller Operated Seeder (PTOS) and Self-propelled Reaper within the CSISA-MI project

Joint Venture Agreement

Between

iDE Bangladesh and **Alim Industries Limited**

For commercialization of Power Tiller Operated Seeder (PTOS), Power Tiller Mounted Reaper and Self-propelled Reaper within the CSISA-MI project

ANNEX 4: Media coverage during Oct'16-Sep'17

Sl	Name	Date	Type
1	NTV news clip	24.01.17	National TV channel
2	The Daily Ittefaq	24.01.17	National daily
3	Daily Sun	05.02.17	National daily
4	Ittefaq	05.02.17	National daily
5	Kaler Kontho	05.02.17	National daily
6	The Daily Star	07.02.17	National daily
7	Bangladesh Shongbad Shongstha (BSS)	16.03.17	National online
8	Daily Deshkal	20.02.17	National daily
9	Daily Khabar	21.02.17	Local daily
10	Matrikontho	07.03.17	Local daily
11	Bangalee Khobor	09.03.17	Local daily
12	Nagorik Dabi	13.03.17	Local daily
13	Nagorik Dabi	16.03.17	Local daily
14	Online Voice	04.04.17	Local online
15	Online Voice	04.04.17	Local online
16	Farmsandfarmers24.com	08.05.17	Local online
17	Daily Motobad	09.05.17	Local daily
18	AIS	09.05.17	National online
19	Farmsandfarmers24.com	25.05.17	Local online
20	Bangladesh Betar news	04.11.16	FM Radio
21	BTV news clip	08.12.16	National TV channel
22	Channel I	23.12.16	National TV channel

ANNEX 5: Success Stories during Oct'16-Sep'17

USAID
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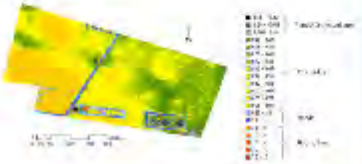
SUCCESS STORY

Drones for agricultural development

Unmanned aerial vehicles (UAV) or drones have become important tools in topographical surveying and on-farm decision making.

Dr. Zia and his team preparing the UAV and camera system for flight



Very high resolution Digital Surface Model (DSM) used to improve farmer's cropping decisions and increased use of normally fallow land during winter in the FtF zone of southern Bangladesh

This story is made possible through support provided by the United States Agency for International Development (USAID). The contents and opinions expressed herein are those of the project and do not necessarily reflect the views of the USAID or the United States Government.

In developed nations, high resolution digital elevation models (DEM) play a significant role in obtaining aerial views of agricultural landscapes. Accurate DEMs are essential in land management planning to optimize irrigation and drainage systems for high yielding cropping systems.

The readily available DEMs in Bangladesh, with moderate resolution, i.e. Shuttle Radar Topography Mission (SRTM) and ASTER Global DEMs (GDEM), have limitations due to their large vertical (elevation) error. Consequently, they are inappropriate for Bangladesh's agricultural riverine fringes, where elevation differences are very small. Farmers and extension officers in these low lying areas need a more accurate DEM to inform cropping and irrigation decisions.

With the aid of a drone, CIMMYT scientists applied the science of making measurements from photographs (photogrammetry) and obtained the exact positions of surface points in winter fallow fields in the Bangladesh FtF zone. This low-cost, accurate alternative to classical manned aerial vehicle photogrammetry or GPS-based topographic survey, provided very high resolution digital surface models (DSM), which were able to separate out features with elevation differences of less than 0.18 m.

An initial DSM allowed farmers in the test zone to select low lying areas for growing rice and elevated zones for crops sensitive to waterlogging i.e. mung bean. A subsequent DSM was used to select farm land that would immediately benefit from canal dredging. 50 Km of canal was dredged, which improved irrigation supplies to 5,000 ha, benefitting 21,000 farm households. Bangladesh Agricultural Development Corporation's engineers will be trained by CIMMYT to out-scale the use of the technology. "This UAV technology will be a milestone for cropping expansion into fallow land, improved agriculture and better livelihoods in Bangladesh", said Dr. Zia Uddin Ahmed, CIMMYT scientist.

CIMMYT's applied UAV technology was part of the Spurring a Transformation for Agriculture through Remote Sensing (STARS) project and supplemented by the USAID funded Cereal *Systems Initiative for South Asia – Mechanization and Irrigation* (CSISA-MI) project, which promotes on-farm technologies and sustainable intensification. CSISA-MI's interventions save farmers' time, labor, and money and strengthens the agricultural value chain.

CIMMYT
International Maize and Wheat Improvement Center

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SUCCESS STORY

SCALING OUT OF AGRICULTURAL MACHINERY IN BANGLADESH

Photo: Saikat/CSISA-MI

Photo: Saikat/CSISA-MI

Photo: Rana/CSISA-MI

(from top to bottom) The AFP, PTOS and Reaper service providers with their machines

'The CSISA-MI genuine PPDP model is a robust research-based model of sustainable agricultural development that has potential to be successfully adopted in other countries and contexts.'

- Dr. Richard Kohl,

Management Systems International, a Tetra Tech company, for the E3 Analytics and Evaluation Project, support provided by the United States Agency for International Development (USAID)

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Bangladesh has rapidly developed its agricultural sector over the past 20 years, which is partly due to the replacement of traditional cultivation practices with mechanized agriculture.

Initial costs and farmers' lack of access to credit often constrains transformational change processes. However, through the USAID-funded Cereal Systems Initiative for South Asia – Mechanization and Irrigation (CSISA-MI), more than 1,800 locally developed agricultural entrepreneurs are providing affordable mechanization services to 92,000 small landholder farmers in the FtF zone. The widespread adoption of conservation agriculture practices and scaling out on more than 37,000 ha is achieved by these local service providers (LSPs) utilising power-tiller operated seeders (PTOS), reapers and axial flow pumps (AFP).

At the project's initial stage, the adoption of new agricultural machinery and services offered by LSPs and farmers was steady. It took two years of intensive collaborative activity by CSISA-MI to accelerate sales and adoption. Now in year 4, it is approaching the tipping point, where the market will begin to drive further adoption in the target zone.

In 2012, annual household income of early LSP adopters was US$ 2,970. Through CSISA-MI's training interventions of 28,442 individuals, it has grown beyond US$ 4,106, which is well above the average per capita income of US$ 1,086 for 2011-2016.

CSISA-MI focuses on both commercial and on-farm interventions to achieve sustainable and scalable results. It employs a genuine multi-sector partnership approach to promote the uptake of improved agronomic practices; the use of innovative and resource conserving agricultural machinery and by strengthening the entire value chain; and is in collaboration with the Government of Bangladesh (GoB), primarily the Bangladesh Agricultural Research Institute (BARI) and the Department of Agricultural Extension (DAE).

Dr. Richard Kohl recently studied CSISA-MI which ratified the above statements by identifying key factors that facilitated its success, which included: (a) Pre-existing experience with cropping systems, (b) develop local machinery agricultural services; (c) start with locally tested multiple technologies; (d) involvement and expansion of private agricultural machinery sectors; (e) partnering with private sector who are willing to share risks; (f) the presence of a dense network of agriculturally orientated micro financing institutions; (g) GoB subsidies to lower market prices; and (h) supplement monitoring, results, and measurement (MEL) with sophisticated tools to provide feedback.

Dr Kohl's report also captured the innovations and successes and forecasted the impact of the project on Bangladesh agriculture, which could be read in full at; https://agrilinks.org/library/scaling-agricultural-machinery-bangladesh-review-successful-agricultural-technologies

CIMMYT.

iDE

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Dhamsor, the irrigation village in Barisal

Within just three years, farmers in Wazirpur have started using fuel efficient Axial Flow Pumps replacing their low lift pumps for irrigation in dry season.

Photo: JFOTRAMOYO/CSISA-MI

"AFP saves my fuel by 100 Liter in a year that is a saving in my investment. It is also easy to operate."

- Sohag, an LSP in Dhamsor, Barisal

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During the inception in 2013, the Cereal Systems Initiative for South Asia- Mechanization & Irrigation (CSISA-MI) project introduced the Axial Flow Pump (AFP) to farmers and local service providers (LSPs) in the FtF zone. The aim was to mitigate high fuel cost and to improve farmers' livelihoods who use surface water in the dry season to grow *boro* rice and other viable crops. Local farmer and service provider Md. Rahim Hawlader is one of the early adopters, who was motivated through CIMMYT's demonstrations at that time. Then the project implementing partner iDE's demand creation event made him the first user of a 6 inch diameter AFP as a new technology in December 2014.

In the first year he saved 120 litres of fuel while irrigating his 8 hectares of land, compared to using his previous centrifugal pump. As the consequence of successful operations, 7 more LSPs from the same village bought 7 new AFPs. In early 2017, hassle free quick irrigation service from these 8 AFPs successfully irrigated 50 ha of land and 300 farmers (1500 households) have been directly benefited. The LSPs saved 600 litres of fuel worth $ 490 and yield increases were worth $ 740. In addition to this, 2 mechanics received AFP training from CSISA-MI and one of them earned $ 495 by providing support to another 60 LSPs in Barisal district. Two LSPs are currently operating in nearby Bamrail village during the off season, however another 10 LSPs hope to start providing AFP irrigation services next season.

According to Alimur Raji, Sub Assistant Agricultural Officer (SAAO), Department of Agricultural Extension (DAE), in the villages of Dhamsor, Bamrail and Wazirpur, "Like many others in this territory, Dhamsor is a progressive village and the LSPs are mostly early adaptors. By using modern agricultural technology, they are now able to improve their economic and social condition. CSISA-MI's Mechanization and Irrigation activities are helping such farmers further develop their livelihoods."

An effective irrigation system provides extensive rice paddy opportunities each year in Barisal region. However high yields are dependent on the availability of surface water and local service providers (LSP) to supply them to the farmers' fields. Availability of surface water is associated with the tides, a natural phenomenon, which only provides water at sufficient depth for few hours a day. Therefore LSPs need to supply a considerable amount of surface water within a specific time. LSPs need an efficient high discharge pump which can meet the farmer's demand at a reasonable cost that is AFP. Like the LSPs and farmers in Dhamsor village, the farmers in adjacent Bamrail, Wazirpur is also pinning their hopes on a good *boro* season in next year.

CSISA-MI, a 5 year project in the FtF zone in Bangladesh led by CIMMYT partnering with iDE has been supporting these farmers with low cost and better performing AFPs with the support of USAID for the last 4 years.

CIMMYT
International Maize and Wheat Improvement Center

iDE

USAID delegation tours CSISA innovation hubs across Bangladesh

M. Shahidul Haque Khan

Dhaka, Bangladesh (CIMMYT) – Inclusive and sustainable agricultural-led economic growth is a key ingredient to lift the people out of poverty and hunger. This goal can be achieved by increasing availability of food, generating income from farm production, creating employment and entrepreneurship opportunities throughout value chains, and spurring growth in rural economies.

To observe how the CSISA (Cereal Systems Initiative for South Asia) works toward these aims in Bangladesh, a small leadership team from USAID visited the southern part of the country recently. The visit was to learn how CSISA through its program engages with partners, works to sustainably increase the productivity of cereal-based cropping systems, thus improving food security and farmers' livelihoods. Visitors also learned how CSISA leverages the private sector's role in producing farm machinery and secure output markets that benefit farmers.

Inside Ayla Traders, an agricultural input dealer who now advises farmers on integrated weed management. Photo: Akter-CIMMYT

USAID (Washington)'s Program Officer for the CSISA Charisse Adamson (Bureau for Food Security Division Chief for Asia/Latin American) along with her two colleagues Dr. Biniam Iyob (Water and Irrigation Advisor, Research Division, Office of Agriculture, Research and Policy, Bureau for Food Security, USAID) and Christopher Chibwana (Food Security Advisor, USAID/Bangladesh) visited Bangladesh in March 16-19, 2017. They visited farmers and agricultural machinery service providers in the Barisal, Jessore and Jhenaidah districts and also visited private sector partners and the public sector to better understand how CSISA works with a diversity of partners.

Ms Charisse Adamson said "It was a successful trip executed without a hitch". She concluded that "I have come away from the trip with a deeper understanding of your program and the important role it plays in improving food security in Bangladesh. It is clear that these projects are making a difference!"

Dr Pandit explaining the symptoms and effect of wheat blast disease. Photo: Farzana-CIMMYT

The team visited rural entrepreneurs who purchased and are using axial flow pumps (AFP) to irrigate at reduced cost and with less fuel in dry season rice productions. One of the major achievement of CSISA is its scaling effort through partnerships. The visitors also learned how CSISA engages farmers to grown healthy rice seedlings for higher yields in community based seedbeds. Working with the Department of Agricultural Extension (DAE) and its Sub-assistant Agricultural Officers (SAAOs) and screening farmer-friendly learning videos jointly produced by CSISA and the Bangladesh Rice Research Institute (BRRI) and shown by the Agricultural Advisory Society, over 35,000 farmers learned about healthy rice seedlings between November 2016 and January of this year,

The USAID team visited Bangladesh Agricultural Research Institute (BARI) Regional Agricultural Research Station in Jessore and spoke with the Director of Wheat Research Centre (WRC) Dr, Naresh Chandra Deb Barma and senior scientist Dr. Paritosh K. Malaker on CSISA's collaborative research to mitigate the threat of wheat blast disease in Bangladesh. They also visited wheat farmers in Jhenaidah and Meherpur Districts whose crops have been damaged and livelihoods placed at risk by wheat blast since 2016. Farmers shared their stories of the impact of the disease, and exchanged their views with USAID and CSISA's scientists on potential ways to mitigate the emerging crisis.

The USAID team also visited rice processing mills that partner with CSISA, and Janata Engineering, a small-scale, but rapidly growing agricultural machinery manufacturer, importer, and dealer that has been working closely with CSISA over the past seven years in the development of two-wheel tractor driven direct seeders, bed planters, maize shucking machines, and multi-crop reapers.

Dr Allen David Mchugh, CoP, CSISA-MI explaining the partnership activities of the project with Janata Engineering. Photo: Farzana-CIMMYT

In discussing the visit Biniam commented that, "I have learned so much. More importantly, I think you are doing a great job in making research outputs sustainable through strategic value chain pathways. Your work is a good example for other research projects to look up to. I look forward to continuing working with you. It is a privilege to be the activity manager of the CSISA project."

CIMMYT launched the Cereal Systems Initiative for South Asia (CSISA) program in 2009 to promote durable change at scale in South Asia's cereal-based cropping systems. Through this program, CIMMYT is operating rural "innovation hubs" in Bangladesh, India and Nepal to increase the adoption of various resource-conserving and climate-resilient technologies, and to improve farmer access to market information and enterprise development. Learn more about CSISA's impact here.

3 technologies that are changing agriculture in Bangladesh

-M. Shahidul Haque Khan, Khandakar Shafiqul Islam, Md. Syed-Ur-Rahman and Washiq Faisal

In agrarian countries like Bangladesh, agriculture can serve as a powerful driving force to not only raise family income, but the nation's entire economy.

Consistent policy and investments in technology, rural infrastructure and human capital boosted food security by tripling the Bangladesh's food grain production from 1972 to 2014. Between 2005 and 2010, agriculture accounted for 90 percent of poverty reduction in the country.

Bangladesh is now threatened by increasing droughts, flooding and extreme weather events due to climate change. In response, rural communities are adapting through innovative, localized solutions that combine sustainable practices and technologies.

"Mechanization is a very important part of the future of agriculture in Bangladesh," said Janina Jaruzelski, the U.S. Agency for International Development (USAID) mission director in Bangladesh, during a visit to areas where the International Maize and Wheat Improvement Center (CIMMYT) is helping commercialize three agricultural machinery technologies – axial flow pumps, reapers and seed drills – to help farmers thrive under increasingly difficult growing conditions.

Below we detail how these three technologies are transforming farming across Bangladesh.

Axial flow pumps

The axial flow pump is an inexpensive surface water irrigation technology that can reduce costs up to 50 percent at low lifts – areas where the water source is close to the field surface, and therefore is easy to pump up to irrigate fields. Surface water irrigation involves deploying water through low-lift irrigation pumps like the axial flow pump and canal distribution networks managed by water sellers who direct water to farmers' fields.

For example, 24-year old Mosammat Lima Begum, who lives in a village in Barisal District in Bangladesh, gained access to an axial flow pump and training on its use through CIMMYT's Cereal Systems Initiative for South Asia (CSISA). After the training, Begum started a business providing irrigation services to her neighbors, boosting her household income by nearly $400 in one year.

Groundwater extraction – a common approach to irrigation in much of South Asia – can result in high energy costs and present health risks due to natural arsenic contamination of groundwater in Bangladesh. Surface water offers a low-energy and low-carbon emissions alternative.

For more information on how axial flow pumps and surface water irrigation help farmers, click here.

Reapers

Reapers allow farmers to mechanically harvest and plant the next season's crops, and can save farmers 30 percent their usual harvesting costs. The two-wheeled mechanical reaper is particularly popular in Bangladesh, especially among women since it's easy to maneuver. It also helps farmers cope with increasing labor scarcity — a trend that has continued to rise as the country develops economically and more people leave rural areas for off-farm employment.

Like the axial flow pump, local service providers with reapers – entrepreneurs who purchase agricultural machinery and rent out their services – are now offering their harvesting services to smallholder farmers at an affordable fee.

Learn more about how reapers can reduce the cost of harvesting and risk of crop damage, making them a key tool to boost farmer efficiency in Bangladesh here.

Seed fertilizer drills

Seed fertilizer drills till, plant, and fertilize crops in lines simultaneously and with greater precision. These drills are frequently used as attachments on two-wheeled tractors.

Around 66 service providers in Barisal, Bangladesh have cultivated more than 640 hectares of land using seed drills for over 1,300 farmers since 2013. These drills cut 30 percent of their fuel costs compared to traditional power tillers, saving them about $58 and 60 hours of labor per hectare. In the FtF zone in south-western Bangladesh, so far 818 service providers have cultivated more than 25,500 hectares of land using seed drills for 62,000 small holder farmers till to date.

These drills can also allow farmers to plant using conservation agriculture practices like strip tilling, a system that tills only small strips of land into which seed and fertilizer are placed, which reduces production costs, conserves soil moisture and help boost yields.

Since 2013 CIMMYT has facilitated the sale of over 2,000 agricultural machines to more than 1,800 service providers, reaching 90,000 farmers. Through the CSISA Mechanization and Irrigation project, it will continue to transform agriculture in southern Bangladesh by unlocking the potential productivity of the region's farmers during the dry season through surface water irrigation, efficient agricultural machinery and local service provision.

ANNEX 6: Tech sheets

Pathway to Agricultural Development - CSISA-MI Overview

The USAID Feed the Future Zone in Bangladesh's southwest delta, faces greater food insecurity and lower crop productivity than anywhere else in the country. This is due to a combination of high energy costs, high labour scarcity, low crop intensity and minimal access to and use of innovative agricultural technologies. Family run smallholder farms in this zone rely on hired farm labour which perpetuate the low use of agricultural machinery. Historically these types of machinery are used on large scale farms and when labour is cost prohibitive.

To address the challenges, the USAID-funded Cereal Systems Initiative for South Asia-Mechanization and Irrigation (CSISA-MI) project was initiated in 2013 to promote the adoption of efficient and low cost agricultural machinery by smallholder farmers in the southern region of Bangladesh. This ongoing project is a partnership between CIMMYT and iDE, two organizations with both complementary and distinct expertise's. iDE brings in extensive experience in engaging private sector partners and other value chain actors to establish a sustainable market system solution. CIMMYT's role focuses on mobilizing public sector partnerships, agronomic research and technical expertise on agricultural machinery development.

CSISA-MI introduced the axial flow pump (AFP), power tiller operated seeder (PTOS), and the reaper in the project. Through human-centred design processes, the team contextualized the machinery to the Bangladesh context. These resource-conserving machines significantly decreased the costs of farming production and increased productivity across the crop life-cycle: irrigation, tillage and harvest.

Axial flow pumps (AFPs), which have much higher flow rates than previously used centrifugal low-lift pumps, are proving to be a game-changer for irrigation, including gher (fisheries) de-watering and watering purposes, as they are able to move much more water with less fuel. In this region, surface water—even in the dry season—is abundant.

Power Tiller-Operated Seeder (PTOS), is an attachment for two-wheel tractors that allows for ploughing, seeding, levelling in a single pass. The two-wheel tractors are saturated in the market and there are over 500,000 units in Bangladesh.

Mechanical Reapers, can measurably improve harvest efficiency, allowing farmers to save time and labour, avoid harmful, inclement weather, and expedite harvest, which makes it possible to plant the next crop more quickly and increase the productivity of the land. Farmers traditionally harvest rice and wheat by either contracting labourers or by themselves.

At the heart of CSISA-MI's solution are service entrepreneurs known as Local Service Providers (LSPs) who risk their own finances to purchase innovative agricultural machines from the local dealers. To gain return on their investment, they are highly motivated to provide faster and cheaper services to the smallholder farmers in their community. These LSPs are the risk takers and early adopters who provide the "seeing-is-believing" example for others to follow.

However, introducing improved technology alone was not the only solution, as adoption will not work in a vacuum. LSPs need a combination of useful technology and services that complement it: product knowledge, access to finance, after sales service, and awareness raising for demand creation among farmers where they can find steady paying customers using their service. This requires a connected network of market actors, ranging from large private sector companies, Government of Bangladesh ministries, to the local mechanics, that provide the different type of services, and each actor has a value proposition that motivates them to provide these services.

The project worked with machinery that had performed well in the research of previous projects and the Government of Bangladesh (GoB), but had not yet gone to market in widespread fashion. Among other challenges, the project team needed to figure out potential barriers to the adoption of these technologies in the market and to use this learning to adapt and refine strategies.

`CSISA-MI has worked with three types of partnerships in the project i.e. private sector companies, public sector organisations and microfinance Institutions (MFIs). These agreements were mutually beneficial as they allowed the partners to pool core competencies as well as share risks, responsibilities, resources, and expenses.

Starting with two private companies and its expansion to several other companies helped to broaden and increase the market competition. The project also worked intensively with two major public sector partners namely Bangladesh Agricultural Research Institute (BARI) and Department of Agricultural Extension (DAE). BARI provided quality control testing for domestically produced AFPs whereas, DAE, with its wide nationwide network, helped to increase the awareness and benefits of using the new technologies among the farmers in the project region. In addition to the private and public sector partners, another critical partnership was formulated with the MFIs. The MFIs worked closely with the LSPs to ensure that they can purchase the machineries on time and provide smooth services to the farmers. The project worked with several MFIs such as TMSS, GJUS, AID, Padakhep, JCF, and SDC, all located in the project sites.

The private companies were earlier selling the machinery only to the government institutions, which was not regular and also less profitable. The project approached and negotiated with several private companies to sell their machines directly to LSPs which allowed for a steadier, larger volume of sales and thus was more profitable for them. In order to alleviate initial scepticism on the part of private sector partners, the project agreed to buy down risk through cost sharing to help them leverage their brands and build their confidence in this new arrangement. The companies soon realized that by selling their machines to LSPs, they had the opportunity to enter into an expansive untapped market of small farmers across south-west Bangladesh. Additionally, the private companies realized that by providing embedded after-sales service and provision of spare parts, their brand value was improving. On the other hand, the project also helped LSPs, some of whom had limited finances available to invest in machine purchase, by linking them with MFIs for loans. Once they acquired machines, these LSPs found a business incentive in provide mechanized irrigation, ploughing and harvesting services to marginal and small-scale farmers throughout the year. In some cases, they have been able to recover the cost of the machines in just one season. With this new win-win partnership in place between private companies and LSPs, farmers in southwest Bangladesh were given access to mechanized farming services throughout the year - and the potential for higher yield and increased income.

The project applies a market approach which emphasizes the use of market system data to continuously inform program interventions. This approach requires market feedback through monitoring and evaluation design that collects and analyses sales data, trends, market actor distribution, customer segmentation, and business performance.

The project has worked with five large private companies who have integrated this practice into their existing business models and now engage in direct commercialization through LSPs. Significant income increases have been reported for all actors involved. Through mechanized services, farmers can benefit through higher yield and crop intensification; private companies realize higher profits through increased and more diversified machines sales; mechanics have increased demand for after-sales services (repairing and maintenance); local businesses see increased sales and demand for fabrication of spare parts; and finally LSPs have an increasing client base of satisfied farmers who are demanding services from them.

The rural economy throughout Bangladesh is still heavily reliant on agriculture, hence there is significant potential to introduce, adapt and scale these technologies to other regions. It is hoped that project experiences and results will encourage future development projects to adopt a similar market system development approach to commercial scaling of innovations, and donors to consider funding more of these types of projects.

Human-Centred Design

CSISA-MI's introduction of three new agricultural technologies - axial flow pump, reaper, and power tiller operated seeder (PTOS) - came with a promise of benefiting smallholder farmers to achieve decreased production costs and increased cropping intensity. To begin the journey towards reaching this challenging goal, the project searched for the right blend of products, partnerships, and business models that would create a synergetic effect and permeate the entire supply chain. They eventually found the right market system mixture with the help of human-centred design.

Human-centred Design (HCD) is a leading innovation methodology that maximizes the likelihood of adoption, long-term sustainability, and scalability of a market-based solution. HCD is a recognized best practice amongst the world's largest, market-based consumer goods and services firms, and has gained recent credence in the development sector as a means to improve the ROI (return on investment) as well as the probability of scale and sustainability of market-based initiatives.

It is used to design and deliver holistic solutions – usually a combination of product(s), service(s), marketing, financing, and distribution. HCD utilizes an ethnography-like approach to deeply understand latent user and stakeholder needs, and combines this with design methods and expertise from product design, industrial design, business design, service design, and marketing strategy. The result is a market-based solution that is desirable, accessible, usable, maintainable, and affordable to consumers, in addition to being technically feasible and economically viable.

All three of the products selected by CSISA-MI had previously been proven as technically feasible, but not necessarily desirable or viable in the market. CSISA-MI used the principles of Human Centred Design to identify design elements of these products that met not just one, but all three of these criteria. HCD was also employed to develop commercialization partnerships and service models that enable sustained business.

CSISA-MI worked to integrate HCD into all aspects of product, services, partnerships and business models. During the initial stages of research, the project realized that technology commercialization is more than just an engineering problem of product design, it is part of a larger web of interconnections between users and suppliers'/market actors. Through applying HCD research and collecting feedback from potential adopters, farmers and firms, project interventions in product refinement, partnership development, machine adoption and service delivery all benefitted through adapting their approach to meet the needs identified in the HCD research.

During the first "deep dives" (a key research tool in the HCD toolbox) the team listened to farmers and service providers of existing agricultural machineries to better understand their needs and demands to make traditionally unpopular machines more desirable. The deep dives explored how entrepreneurs would use the technologies to provide agricultural services to farmers. The answers eventually led CSISA-MI to develop the local service provision model.

The local service provider (LSP) is an entrepreneur who purchases agricultural machinery and then provides paid services to farmers to earn a return on their investment. Keeping the LSP at the focal point, the deep dives focused on the perceptions, needs and desires of the LSPs to generate insights into what they value as key features or benefits of agricultural machineries. The team used an empathy map to record sensory and behavioural feedback of the LSP's interactions with the technologies, which helped to understand challenges and opportunities in LSP business models.

As an additional tool, the team used a journey map to record the experiences of the LSP, starting from when they heard of the technology all the way to how they provide services to farmers. By exploring the journey of multiple LSPs, market actor insights were identified that were crucial to making the LSP business model work. The journey uncovered agricultural extension officers, machinery early adopters, influential political figures, dealers, private companies, mechanics and most importantly, farmers. The team realized that in order to enhance the LSP's business model to function more efficiently and sustain agricultural machinery adoption, project interventions needed to be based on an in depth understanding of value proposition in the market. Uncovering the underlying value propositions enabled the team to connect solutions to problems by identifying gaps in services, utilizing opportunities and minimizing

challenges. Maintaining the agricultural machinery market's value proposition became the guiding principle of CSISA-MI's strategy for sustained adoption.

Case Studies:

Power Tiller Operated Seeder (PTOS): The impetus for the PTOS was to introduce a technology that could till and seed in one go. In Bangladesh, the market for two wheel tractors, locally known as power tillers (PT), was already saturated with more than 500,000 in operation throughout the country. An attachment seemed the best approach to introduce a multi-functional technology.

PTs are the current practice for mechanized tilling, but with the seeder as an attachment, an acre of land could be tilled and seeded in one pass requiring only half the amount of time, and half the amount of fuel. Previous research had verified the agronomic utility of the PTOS, but HCD helped us better understand the user experience:

- Although the intent was for the machine to be used for line sowing and tilling together, LSPs would buy the PTOS, and unfortunately remove the seed box and only use it for tilling.
- LSPs did not like the way dust flew up into their faces as they used the machine, and they longed for a seat to reduce physical stress.
- When it came to purchasing the machines, dealers often unpacked the machines to display them in their shops and save space. However, the LSPs preferred buying machines packed in wooden crates as it was a sign of import and quality.

The CSISA-MI team decided to redirect a combination of people, time, and money to focus on improving the design and marketing for the machines. By addressing the desirability, viability and feasibility challenges, CSISA-MI is now reaping the rewards of adoption. PTOS has now passed the tipping point of 16% of the potential market in the FTF zone. Additionally, there are 4 private sector firms supplying PTOS with after-sales services and dealership networks beyond the FTF zone.

Axial Flow Pump (AFP): The push for adoption of AFPs in CSISA-MI aimed to replace traditional Low Lift Centrifugal Pumps (LLPs), which were a popular technology for irrigation in Bangladesh. The LLP is an astonishingly sturdy pump, lasting for more than 30 years. However, the AFPs have some key advantages:

- AFPs tap into the abundant amount of natural surface water available in Bangladesh, while the LLPs are concentrated on groundwater resources.
- AFPs require less fuel to pump the same amount of water in less time, saving farmers both time and money.
- The AFPs do not need to be primed by pouring water on them during the cold winter months which often involved farmers getting into the water and required at least two people to start the machine.

The AFP, based on a profitable business model, appeared to be agronomically and technically superior than the LLP. However, first year adoption was lower than expected. Potential buyers would *say* they were going to buy an AFP, and end up not purchasing. The first batch of AFPs were imported from Thailand, where farmers expected to use the pumps for one season and would discard them. These pumps were designed for the Thai context and had a lighter gauge steel than the existing LLPs. During *Deep Dives,* the team began to understand that although LSPs were excited about the greater water pumping and the fuel savings, they were deeply nervous about a pump they perceived as flimsy and unreliable in comparison to the LLPs. In a context where the LSPs' communal reputation as a reliable service provider was on the line, the pump proved too large a risk for many. To address the problem, the CSISA-MI team worked with its private sector partners to reverse engineer the AFPs using nationally available materials design the pump to suit the Bangladeshi context. This re-modelling made the AFPs *appear* more durable due the use of thicker gauge steel, addressing some of the visceral concerns of potential LSPs. The reverse engineered designs were open sourced, allowing Bangladeshi manufacturers to produce domestically. However, this created new challenges in production quality of the AFPs, leading to frequent breakages. Some of these breakages happened in the middle of service provision, embarrassing the LSPs which led to negative word of mouth and subsequently poor adoption. The team is now addressing the supply chain quality issues with a deep dive into the manufacturing process. By uncovering the specific challenges and by getting feedback from our private sector partners, the project plans to co-create a standard operating procedure (SOP) and train supply chain technicians and managers on the SOP to maintain a consistent quality standard.

Private Sector Engagement

The CSISA-MI project undertook a deep and broad market analysis process to identify why the agricultural machinery market in Bangladesh was not efficient. It listened to every stakeholder - the suppliers, producers, dealers, mechanics, and others who might have an influence on local service providers (LSPs) - and created a holistic understanding of the links on the value chain and the roles of each market player. The project built on the insights to develop business solutions that made new connections and strengthened existing ones to achieve a more robust market ecosystem.

CSISA-MI's role as a market facilitator, technical support provider and co-investor supported private partners' incentives in finding competitive advantage and the next big market opportunity. Similar to how the project targeted early adopters of agricultural machinery, it also targeted first mover firms for partnerships. The aim was to have private sector partners fold agricultural machinery into their strategic priorities, such as incorporating a dedicated unit focusing on the supply and sales of agricultural machinery products.

The project took four steps in selecting its partners: firstly, the CSISA-MI team conducted preliminary research on potential partner companies and then further screened them using interviews. The CSISA-MI private sector engagement unit and management reviewed and assessed the companies in order to develop a "short list". Additional dialogues were then had to gauge their interest in particular technologies and strategies. Lastly, the collaboration was formalized through the preparation of necessary legal documents.

The project used a set criterion for the preliminary selection of the private firms. One criterion was that the private firm had to have a pre-existing market presence in the ag-machinery sector. If this was met, the project evaluated the relative market demand for their products or services in the target areas of CSISA-MI. Partners were also required to have demonstrated ability to successfully compete in the target geographical areas in retailing their products or services; and, have a relative focus on the agricultural mechanization sector as the core business of the firm. Capacity for innovation was also important. The project analyzed their relative willingness to make investments to improve or expand relations with agricultural mechanization supply chain actors over an extended period of time, and their reputation for thought leadership/ market innovation. Lastly, the project also focused on the ability of the firms to deliver commercialization, such as established commercial linkages with a large number of suppliers/ dealers in the target areas; potential to influence other supply chain actors; and the potential to make investments or allocate resources to activities that resulted in improved and/or expanded relationships in the agricultural supply chain.

Technology	RFL	Metal	Janata	ACI	Alim
PTOS	2014	2016	2015	2016	2015
Reaper (and Reaper Attachment)	n/a	2015	2015	2013	2015
Axial Flow Pump	2013	2015	n/a	n/a	2015

The table below illustrates the private companies that have been associated with CSISA-MI over the course of the project and when they came on board.

In year one, the project worked with two very large private sector partners: ACI (to introduce reapers and bed planters) and RFL (to introduce PTOS and AFPs). Since the market was not yet tested and established for the new products and the companies were not fully ready to completely assume the financial and business risks involved, the project entered into a cost-sharing agreement. CSISA-MI also provided these companies with incentives such as capacity building of its sales agents and in-kind technical assistance. These two companies had large logistical networks and were willing and able to take measured risks by integrating a new strategy into their existing business model plan. RFL and ACI's success paved the way for other companies to enter into similar partnership agreements. In subsequent years, with the market partially established for the new machines through the two first mover companies, The Metal (Pvt.) Ltd. (for Reaper), Janata Engineering (Reaper Attachment) and Alim Industries (for Reaper and PTOS) formed partnerships with the project and entered into the market.

The cost share with these companies was gradually reduced during the project's third year, as companies were seeing increased sales, profit, confidence and ownership. In the third year, companies were increasingly willingly to implement activities at their own cost and by the end of the third year, private sector players such as RealPower, Janata (PTOS), and Chittagong Builders (Reaper) also stepped into the market. More partners coming forward and beginning to import or manufacture agricultural machines, helped to deepen and broaden the market and improve competitiveness. This also helped to bring down the retail cost of the machines and improve access for consumers - small farmers. The Metal (Pvt.) Ltd. expanded its product line and introduced two additional machines (Reaper and AFP) and RFL, Metal (Pvt.) Ltd and RK Metal began to manufacture AFPs.

Companies such as RealPower, Janata, and Chittagong Builders are examples of private sector companies "crowding-in" to the agricultural machinery market, reinforcing the project's theory of change. As a case in point, Janata Engineering, now known as Janata Industries, was an agricultural machinery workshop based in Chuadanga district that the project supported in its early years. Janata Industries grew their business exponentially, hiring additional staff to focus on business development, marketing, and after-sales service. Based on their success with the reaper attachment, the proprietor of the business along with a technology adviser from the project visited China to inspect and assess local manufacturers in that country. After the visit, they later placed orders for 192 customized reaper attachments.

In addition to Janata, RK Metal, a local workshop operating out of Faridpur, had previously fabricated two prototypes of the axial flow pump. The project facilitated assistance from BARI for prototype field-testing. RealPower purchased a reaper attachment from Janata Engineering in order to conduct their own assessment of the product. Based on farmers' responses to demonstrations, they later imported 20 reaper attachment units and one reaper binder to further test the market.

Private sector companies often prioritize efficiency and conventional practices that provide the fastest route to maximum profit. Thus, partnerships with them can have many challenges. From agreeing on a common goal, to building trust, and resolving possible conflicts, all these take time and require strategic communication. For CSISA-MI, although all the partner companies had prior experience in dealing with agricultural machineries, they had very little experience in handling the particular type of advanced machineries the project was introducing. The fear of taking a risk with these new machines, which involved testing a completely new market segment, was counteracted by the potential benefit of partnering with a development project and was an important factor in the decision-making process. Another challenge for the private companies was that their field staff was already promoting and selling several other existing products. With limited knowledge of the new products and no guaranteed sales, many sales representatives were reluctant to talk to LSPs.

CSISA-MI helped mitigate some of these risks through activities that were a part of the cost sharing. Activities included helping companies develop new marketing ideas, building the capacity of company sales agents to pitch the new products; and working with local mechanics to provide after sales service and spare parts. The idea behind focusing on sales agents was to build their enthusiasm at the prospect of exploring sustainable business opportunities that will lead to increased sales and a loyal customer base. The project has also learned that in an ever changing market system, there is no single pathway to getting it right. Rather, one has to try different routes, making mistakes along the way, and changing course when that is what the market says to do.

Adaptive Management

The objective of CSISA-MI is to introduce and promote adoption of new agricultural machinery to smallholder farmers to increase their productivity and incomes. This ongoing project is a partnership between CIMMYT and iDE. CIMMYT's role as the lead partner focuses on mobilizing public sector partnerships, agronomic research and technical expertise on agricultural machinery development.

iDE brings in extensive experience in engaging private sector partners and other value chain actors to establish a sustainable market system solution.

CSISA-MI operates in agri-machinery market systems, characterised by market forces, behaviours, and social and political norms that are dynamic and often invisible. To navigate the changing dynamics of the market system, CSISA-MI chose to use an adaptive management approach as part of its implementation strategy.

What is adaptive management?

Adaptive Management is defined as a structured, iterative process of robust decision making in the face of uncertainty, designed to reduce uncertainty over time via system monitoring. Adaptive management is a tool which can be used as a means to learn about a market system, as well as influence change within it.[1]Adaptive management is not about randomly 'trying' things to see what works; rather, it is about intentionally and strategically honing in on strategies that will yield specific, positive development outcomes. There is no clearly defined process or guidebook for adaptive management implementation; applying adaptive management is specific to the context of the project.

Application of adaptive management in CSISA-MI

Applying an adaptive management approach allows CSISA-MI to alter, or pivot, its strategy related to crops, technology or geographical locations targeted for commercialization, for example. CSISA-MI has been able to successfully adopt this approach at all levels of implementation, including overall strategy, work plans and activities. Because of this approach, CSISA-MI has improved impacts in commercial sustainability on the part of private companies who produce the machines, local service providers who adopt the machines, and farmers who use the services. CSISA-MI has identified four key principles through implementation that are required for building a supportive environment for adaptive management. Adaptive management helps CSISA-MI to find the right balance between gaining knowledge to improve implementation in the future and achieving the best results based on the current knowledge at all levels of implementation. This report ends with two examples of adaptive management in practice.

Four key principles for building a supportive environment for implementation of an adaptive management approach;

(i) Organizational Culture

One of the key elements in successfully implementing adaptive management is building an organizational culture that supports staff to learn through experimenting and failing with different ideas and individually analysing results as a means to identify new directions in which to go. In the Bangladesh context, CSISA-MI observed that staff found this process as they were accustomed to a top-down style of implementation. To address this challenge, the CSISA-MI leadership team championed a cultural shift toward the team working together to create innovative solutions rather than implementing handed down directives. This took the shape of routine meetings at all levels of implementation that provided the space for staff to discuss findings from activities and created a culture where management did not always know the right answer; peer review, respectful dissent and creative tension were encouraged. CSISA-MI has learnt that introducing adaptive management takes time to diffuse and become adopted by all levels

[1]*Mercy Corp. 2014. "Adaptive Management Tool: Concept Note System". https://www.mercycorps.org/sites/default/files/PRIM3E%20-%20Concept%20Notes%20System%20-%20Adaptive%20Management%20Tool.pdf)*

of staff, as it represents a significant behaviour change to traditional implementation style and inherently confronts embedded social hierarchies.

(ii) People and Skills

Implementing adaptive management requires a respected, empowered and accountable team that has the necessary skills to gather and use data to inform their work. For CSISA-MI finding the right structure and composition of the team did not come instantly. For instance, iDE originally designated their private sector engagement team as part-time, and their responsibilities were split with other projects, but this allocation proved inadequate to the task. The client relationship management, communication at the Dhaka and field levels, troubleshooting of agreements, and solving supply chain challenges required full-time intervention managers. Therefore, iDE redesigned the composition of the team to have three dedicated intervention managers replace the two-person, part-time private sector engagement team. CSISA-MI has learnt through trial and error that staffing too thin impacts implementation as there are not enough resources to effectively establish collaboration and feedback loops within teams and external partners.

(iii) Monitoring and Evaluation Tools

Monitoring and evaluation tools lie at the centre of adaptive management; to be able to test ideas, teams need a monitoring and evaluation system that can provide information feedback loops. The CSISA-MI monitoring and evaluation system was designed to track FTF indicators such as farmer adoption and hectares under cultivation from improved technology but proved inadequate at tracking technology and business model interventions. Therefore, the CSISA-MI team developed an additional M&E system in the second year of the project that focused on collecting sales and adoption data to inform team decisions regarding strategy and activities. In combination with developing this new system, the project also launched a "Digital CSISA-MI" campaign to encourage teams to use ICT to access and share information. ICT platforms developed included dashboards tracking progress against machine sales and data visualization through mapping of market actors and sales. CSISA-MI has learnt that building an environment that encourages project field staff to regularly engage with the data and perform some of their own analysis, requires intensive support and follow-up.

(iv) Navigating Reporting Regulations

Implementing an adaptive management approach requires buy-in from donor organizations to allow project teams to change their work plans rapidly to adapt to the needs and dynamic shift within the market system. In the first year of CSISA-MI, it became apparent that hitting the targets originally envisioned would be impossible both overall and in encouraging maize and wheat production in fallow land in particular and required CSISA-MI to change its targeting approach in collaboration with the USAID Bangladesh Mission. For CSISA-MI, having a donor that was not just willing to pursue what appeared to be a high-risk experimental approach but also champion the approach and change the targeting strategy provided to be the supportive environment needed to fully pursue an adaptive management approach. This was possible in part as CSISA-MI was a grant, not a contract or a cooperative agreement with USAID. CSISA-MI has learnt that regularly communicating with donors has improved their understanding and buy-in of CSISA-MI's approach and activities, and in turn builds the donor's comfortability with CSISA-MI pivoting and changing activities to follow market signals.

Adaptive Management in Practice

(i) Machinery commercialization

CSISA-MI has adapted its strategy around selecting machinery for commercialization over the course of the project. Initially, machinery was chosen based on its relevance to cereal production, and less emphasis was placed on farmer needs and market demand. Over the first year of the project, it became clear that the initially-selected machinery models, especially reapers and axial flow pumps, did not interest farmers as they were difficult to use and unreliable. Based on these early lessons, CSISA-MI applied adaptive management and made a few adjustments in its approach. Firstly, the project started field testing machinery with farmers and Local Service Providers (LSPs) in order to understand the consumer experience and support private partners adapting machinery to meet the needs of the market. CSISA-MI also learned that it needed to concentrate not only on commercializing pro-farmer machines, but also ensuring after-sales servicing and availability of spare parts for end users. The project found that some

farmers would be willing to pay for repairs from a private mechanic if it meant they would continue to receive uninterrupted quality services and save time in the field. CSISA-MI further determined that in addition to encouraging PSPs to offer more machine-focused training and increase availability of company mechanics, it also needed to train independent local mechanics to bolster accessibility of after sales service options to farmers.

(ii) Partnership

To build the necessary supply chains to support machinery commercialization, CSISA-MI needed to form partnerships with private sector partners to build demand at three different levels of the value chain: companies to dealers, dealers to LSPs, LSPs to farmers. Formal agreements played an important role in partnerships with the private sector. In Year 1, most CSISA-MI partnerships were established through letters of agreement (LOAs) which did not mention responsibilities, timelines, or budgets. CSISA-MI found that dictating terms to the PSPs to meet project goals did not work. Subsequently, the project switched to a joint venture agreement (JVA), which was in line with the company's goals, perception of value addition and was more adaptive in nature. The JVAs captured the spirit of co-investing, capacity building, and risk mitigation; they were less prescriptive, and more adaptive. JVAs captured key objectives, responsibilities, and financial contributions, and were amended over the course of time based on market feedback. One of the key successes of CSISA-MI has been demonstrated "crowding in" of private-sector companies. CSISA-MI began with two private sector partners, RFL and ACI, but other smaller companies such as the Metal (Pvt.) Limited, Alim Industries and Janata Engineering voluntarily approached the project to form partnerships after seeing the benefits these could bring. The crowding in has increased competition in the market, and increased sales volumes across the board as companies begin to perceive the immense potential of the ag machinery market.

Human-Centred Design

HUMAN-CENTERED DESIGN

Introducing three new agricultural technologies in CSISA-MI came with a promise of benefiting smallholder farmers to achieve decreased production costs and increased cropping intensity in the dry season. But to accomplish this goal, we had to perfect the mixture of products, partnerships and business models. Let's call this mixture the market. We have used the principle of Human Centered Design (HCD) to not only find products that are desirable, feasible and viable, but also to establish commercialization partnerships and service models that enable sustained business. All three of the products adopted by CSISA-MI had previously been proven as technically feasible, but not necessarily desirable to market actors or viable in the market.

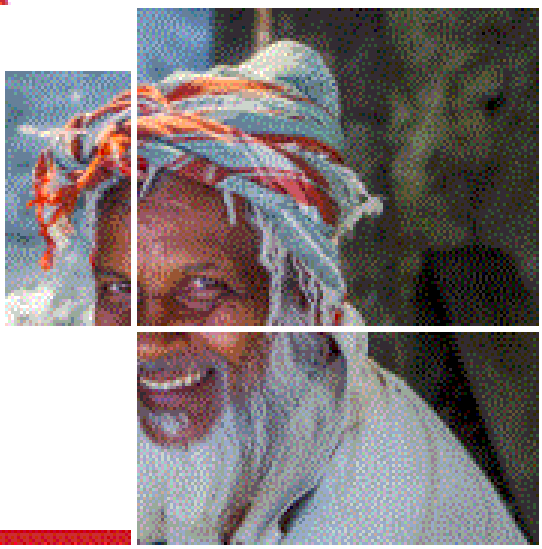
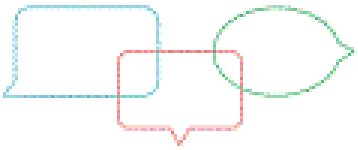


Photo: Ranak Martin/IDE

HEAR. CREATE. DELIVER.

The agricultural technologies CSISA-MI introduced in the market had promise of substantially benefitting smallholder farmers to achieve increased cropping intensity in the dry season. However, it depended on successful adoption first of the machines by the Local Service Providers (LSPs) and secondly of the services by the farmers. Which means, the CSISA-MI team needed to understand the critical bottlenecks and the potential barriers to the adoption of these technologies in the market and in the value chain systems and address those in order to initiate and sustain this adoption. There had to be sufficient demand creation for the services among the farmers for the LSPs to see a business incentive to invest in the machines, as well as sufficient adoption by the LSPs for the companies to see a business incentive to continue to either import or manufacture the machines.

In contrast to most technology transfer efforts, CSISA-MI moves beyond the conventional approach to improve the long-term commercial viability of the equipment, to facilitate improved machinery supply chain and to develop support services such as local repair, maintenance and availability of spare parts. CSISA-MI is working with machines that had performed somewhat well in the previous projects of the Government of Bangladesh (GoB), but had not yet gone to the market in widespread fashion. CSISA-MI has taken this one step further by applying Human Centered Design (HCD), which ensured that all actors on the supply and demand side are being heard, their problems addressed, and only desirable, feasible and viable solutions are put into practice and thus the machines are widely used.



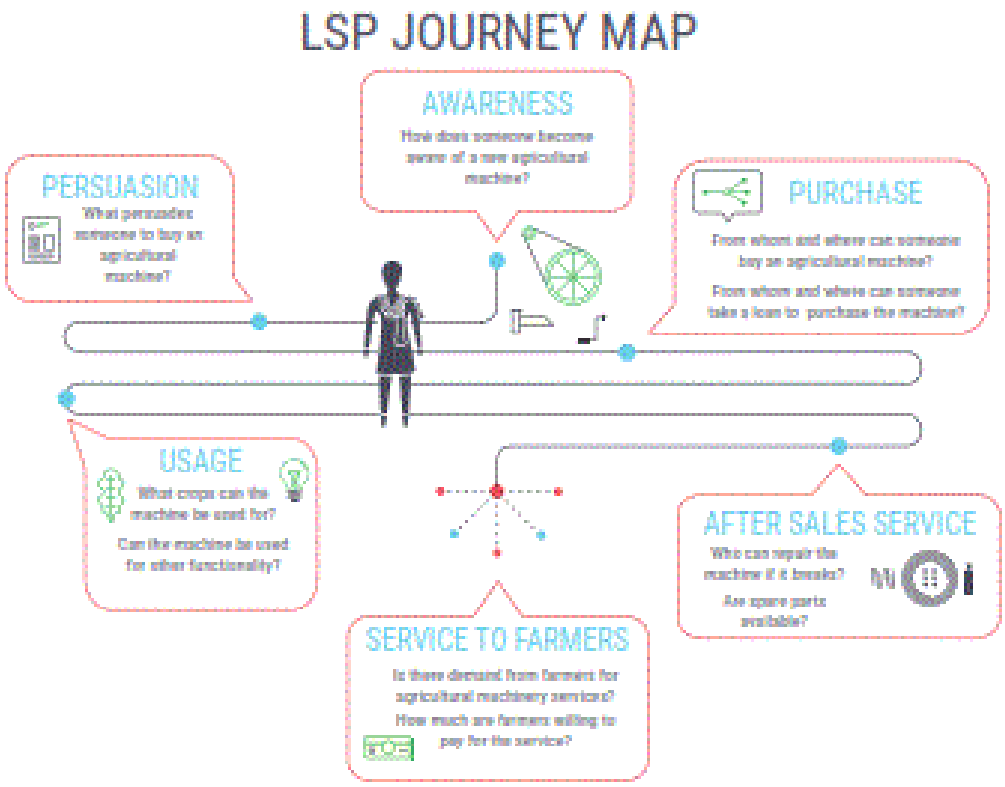
Start with People

Each HCD process is specific to the context in which it is applied, regardless of the size or duration of the project. The HDC process redesigned the machines and the services to fit the changing context of the CSISA-MI. With the goal of introducing and increasing the adoption of technology among small farmers, during the course of its implementation, the project realized that technology commercialization is more than just an engineering problem. One of the keys to HCD use by the project was through the 'Deep dive' tool'. The Deep dive tool is used by starting to ask the desirability questions and to listen to the farmers to better understand their needs and demands in order to make the machines more popular, user-friendly and desirable to the them

"From the beginning, CSISA-MI was intended to be market based, using feedback from the potential adopters to improve the machine design, drop or add machines based on the needs and demands of the LSPs and farmers over time."

The change of practice or change in behavior from the LSPs meant that they have enough incentives to adopt the new practice. The project team used a tool called the 'Empathy Map' to record the feedback of the LSPs and smallholders farmers to learn more about their behaviour pattern.The team further organized this behavior into different categories that could tell them what really motivated LSPs' use of the machines. What really did LSPs say, do, think, or feel about the machines and machinery services that convinced them to turn this into a sustainable business model.

Since CSISA-MI replaced existing machines hence it replaced existing practices. This gave the project insight into the value propositions that incentivized farmers to try something new. The HCD approach allowed the project to empathize to learn about their problems, behaviors, attitudes and aspirations. This empathetic learning moved the project team towards underlying value propositions through which the team could connect the solutions promoted to the farmers. In CSISA-MI, machines that meet both LSPs and farmers' concerns and priorities ensure scale and sustainability.



CASE STUDIES

POWER TILLER OPERATED SEEDER

AXIAL FLOW PUMP

BED PLANTER

Power Tiller Operated Seeder (PTOS)

Prior to the introduction of the PTOS, seeding and fertilizing were usually done by hand, which was very time consuming for farmers. In spite of being in the market for almost as long as ten years, PTOS was never really used widespreadly in the region. Previous HCD research had verified the agronomic utility of the PTOS. The new PTOS have four functions: tilling, land leveling, seeding, and fertilizer application. It prepares soil more quickly and at lower cost than a power tiller, because it requires fewer passes across the field. Farmers could till and seed their land simultaneously – which saved them time and money.

"The PTOS decreases the need for hired labor during the land preparation and planting season."

Tilling
Land Leveling
Seeding
Fertilizer Application

Even though, the price range, while significantly more expensive than the AFP, the PTOS is still relatively affordable for LSPs who can repay their loans within one or two seasons. PTOS has several other advantages. PTOS allows farmers to adopt line sowing and even strip tillage, both of which are relatively new in South West Bangladesh. It turns out that when farmers tried the PTOS, its greatest appeal was to use it as a rotavator to produce a finer and deeper till which is particularly suitable for production of onion and garlic. Furthermore, HCD helped us better understand the user experience. For example, LSPs didn't like the way dust flew up into their faces while they used the machine, and the majority of LSPs longed for a seat to reduce physical stress of standing. These two features were adjusted in the machines to make it more user friendly for farmers. In addition to the machine specific benefits and advantages, a guaranty and warranty, access to quality after sales service, and especially spare parts were all necessary incentives for the LSPs. Most power tiller owners were already serving as LSPs, farmers buying PTOS have almost universally adopted the LSP model. When it came to purchasing the machines,

Axial Flow Pump (AFP)

AFPs replaced the old machine Low Lift centrifugal Pump (LLP), which has been a used as a popular technology for irrigation in Bangladesh for many years. However, CSISA-MI's HCD field research team interacting with the LSPs and farmers helped them to identify few new key features of AFP that would improve its performance and make it a even more popular choice among the farmers.

AFP needed to be perfectly customised to what the farmers wanted exactly like the gloves fit the hands. The project team realized that since the new AFPs require less fuel and works much faster and pumps more water in a very short time it would save farmers both time and money, so it seemed like a winning value proposition for them. Furthermore, the improved AFPs needed very little maintenance and were not tied up to one season or one crop, instead they could be used multiple times throughout the year on multiple crops which again was another big motivating factor and more attractive for farmer to switch their use to the new model of AFP. Moreover AFPs were more relevant to the two most important crops for farmers in Bangladesh i.e. rice and onion, hence very soon they became quite popular. When CSISA-MI first introduced AFP, the private partner selected for producing the machine had imported 4"diameter pumps from Thailand. These pumps had a lighter gauge steel than the existing LLP in use. The 'Deep Dives' tool of IDE helped the team to understand that although LSPs were excited about the greater water pumping and the fuel savings, they were deeply nervous about a pump they perceived as flimsy and unreliable compared to the LLPs which they had been using for so many years. Hence, CSISA-MI team re-modelled the AFPs by replacing the existing rubber bush with Teflon and adding several more bearings in place of just one. This re-modelling made the AFPs more suitable for the Bangladesh farmers' need and made the machines more durable so that they can be used by the local farmers over many years unlike Thai farmers who only used it for one season. Another final feature of the AFPs was that in contrast to the LLPs, the AFPs did not need to be primed by pouring water through them during the cold winter months which often involved farmers getting into the water and required at least two people to start the machine. The adoption of AFP came rather quickly in the project during year 1 and 2.

CSISA-MI is in its fourth year and scaling up of the machines is still in progress. Scaling up has been largely in the form of new LSPs buying machines than existing LSPs buying additional machines. The crops and purposes for which the machines are actually being used ended up being rather different than what was intended by the project i.e from maize and wheat to rice and fish. And with finer tilling function, the PTOS were more appropriate for onion and garlic. In some cases modifications in machine design and manufacture were required to make it more appropriate for the SW Bangladesh market. Most recently in the project, some of the private partners have built on HCD-generated insights to influence design choices in the PTOS that they import. Additionally, three companies have started domestically producing AFP and continue to iterate in design. As the project nears its final year, the project team will be working with its partners to support their ability to generate HCD-style insights independently without the support of the project. HCD is not prescriptive and does not make any assumptions about the potential solutions. Instead it engages the end users to understand their specific needs and constraints around the issue and then identifies solutions that are desirable, feasible and viable by the users and the system within which they operate. Desirability means designing products that are desirable by the intended users. It is ensured through in-depth interviews and informal conversations with the target group and other market players, which leads to important information and valuable

Bed Planter

Bed planters form fields into alternating beds and furrows for more efficient dry season irrigation. They are particularly beneficial for corn and maize by requiring fewer seeds, less land preparation, and lower sowing costs while increasing yields. However they were heavy and expensive machines and also very difficult to maneuver. Additionally, planting in raised beds is not commonly practiced in SW Bangladesh. Therefore, adoption would have required a substantial change in Good Agricultural Practices. Ultimately the project decided to drop the bed planter.

costs

ANNEX 7: Pump Protocol Publication cover