2016 ANNUAL REPORT

Cereal Systems Initiative for South Asia Phase III in Bangladesh & Nepal

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Cereal Systems Initiative for South Asia Phase III

Annual Report December 2016

Submitted to:

Biniam Iyob, USAID Washington

Eric Witte, USAID Washington

Submitted by:

International Maize and Wheat Improvement Center (CIMMYT)

Period covered: December 1, 2015 to November 30, 2016

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Grant Summary Information

Project Name: Cereal Systems Initiative for South Asia Phase III, Bangladesh and Nepal
Organization Name: International Maize and Wheat Improvement Center (CIMMYT)
USAID Washington Grant Amount: $15,000,000 over 60 months
Project Duration: December 1, 2015 to November 30, 2020

Report Period: December 1, 2015 to November 30, 2016
Report Due: December 31, 2016
Has this project been granted a no-cost extension? Not yet required.

Principal Investigator/Project Director: Dr. Andrew McDonald
Title: Project Leader, CSISA; Principal Scientist, CIMMYT
Mobile Phone: +977-9808757832
Email: a.mcondald@cgiar.org
Web site: http://csisa.org
Mailing address: CIMMYT International, South Asia Regional Office, P.O. Box 5186, Botany Division, NARC, Khumaltar, Lalitpur, Nepal

Contributors: Mina Devkota, Narayan Khanal, Dilli K C, Gokul Paudel, Anil Khadka, Lokendra Khadka, Salin Acharya, Himalaya Subedi, Surya Dhungana, Bishnu Pandey, Timothy J. Krupnik, Iqbal Ansar Ahammed Siddiquee, Dinabandhu Pandit, Virender Kumar, Sudhanshu Singh, Sreejith Aravindakshan, Humnath Bandari, M. Murshedul Alam, Mohammad Shahidul Haque Khan, Alamgir Khan, Subrata Sarker, Shafiq Islam, Zia Uddin Ahmed, Apurba Roy, Kevin Robbins, Khondker Murshed-E-Jahan, Hera Lal Nath, Md. Mandud-Ul-Haque, Asma Alam, Masud Rana, Farzana Akter, Moktatherul Haque, Ashok Kumar Paul and many others.

With support from Cynthia Mathys and Andrew McDonald

Date Submitted: December 30, 2016
Mobile Phone: +977 9808040992 (Cynthia)
Email: c.mathys@cgiar.org

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Acronyms and Abbreviations

Acronym	Full Name
2WT	Two-wheel tractor
4WT	Four-wheel tractor
AAS	Agricultural Advisory Services
ACCL	Auto Crop Care Ltd
AIRN	Agricultural Input Retailer Network
BADC	Bangladesh Agriculture Development Corporation
BARC	Bangladesh Agricultural Research Council
BARI	Bangladesh Agriculture Research Institute
BRRI	Bangladesh Rice Research Institute
CIMMYT	International Maize and Wheat Improvement Center
CSISA	Cereal Systems Initiative for South Asia
CSISA-BD	Cereal Systems Initiative for South Asia in Bangladesh
CSISA-MI	Cereal Systems Initiative for South Asia-Mechanization and Irrigation
CSRD	Climate Services for Resilient Development
DADO	District Agriculture Development Offices
DAE	Department of Agricultural Extension
DOA	Department of Agriculture
DSR	Direct-seeded rice
EVCOM	Event and Visual Communication Association
FCM	Fuzzy cognitive map
FtF	Feed the Future
iDE	International Development Enterprises
IWM	Integrated weed management
JVA	Joint venture agreements
KISAN	Knowledge-based Integrated Sustainable Agriculture and Nutrition
LLL	Laser land leveling
MOAD	Ministry of Agricultural Development
MTR	Mechanically transplanted rice
NAMEA	Nepal Agricultural Machinery Entrepreneurs' Association
NARC	Nepal Agricultural Research Council
NARES	National Agriculture Research and Extension System
NMRP	Nepal Maize Research Program
PQR	Premium quality rice
RVC	Rice value chain
SEAN	Seed Entrepreneur's Association of Nepal
STARS	Spurring a Transformation in Remote Sensing in Agriculture'
USAID	United States Agency for International Development
VDC	Village development committee
WRC	Wheat Research Center
ZT	Zero tillage

CSISA PHASE III

Context, Approach, and Theory of Change

Following the food price crisis of 2007–8, agricultural research and development efforts in South Asia have received considerable public, private sector, and donor investment, particularly in the relatively impoverished areas of the Eastern Indo-Gangetic Plains. Nevertheless, re-investments in agriculture have been less adept at supporting transformative change than was originally envisaged. While progress has been made in addressing some of the systemic weaknesses that contribute to low rates of rural growth, many persist:

- **Research organizations** narrowly construe their mandates and are only partially oriented towards the clients of research outputs;
- **Extension** primarily focuses on single technologies or generalized 'packages of practices' that are not underpinned by rigorous field evaluations that lead towards better targeting;
- **Livelihoods** initiatives do a commendable job of reaching underserved communities, including women farmers, but rarely have the technical competence to match their reach;
- The **private sector** – although learning quickly – lacks deep experience in the emerging markets in the region along with the types of location intelligence that can steer engagement;
- **Small entrepreneurs** generally lack access to support services, both business development and technical;
- Progressive **policies** ostensibly support farmers, but just as often impede private investment;
- **Cooperation across organizations** in the agricultural research-for-development space is, in most cases, limited.

Layered onto these dynamics are the risks inherent to cropping in areas where weather patterns are erratic, water resources are poorly developed, heat stress is a binding constraint, and timely field operations are often compromised by a diminishing supply of rural labor. Despite these shortcomings and production challenges, there is considerable promise that the many individual strengths within the innovation system[1] in South Asia can be marshaled and coordinated to spur and sustain transformative change.

With support from the Bill & Melinda Gates Foundation and U.S. Agency for International Development, the Cereal Systems Initiative for South Asia (CSISA) has worked as an eco-regional initiative to support agricultural development in South Asia since 2009. **CSISA's aim is to use sustainable intensification technologies and management practices to enhance the productivity of cereal-based cropping systems, increase farm incomes, and reduce agriculture's environmental footprint**[2]. As a science-driven and impacts-oriented initiative, we reside at the intersection of a diverse set of partners in the public and private sectors, occupying the 'messy middle' where research meets development. By engaging with a network of partners,

[1] The World Bank (2012) defines innovation systems as '…. a network of organizations, enterprises, and individuals focused on bringing new products, new processes, and new forms of organization into economic use, together with the institutions and policies that affect their behavior and performance.

[2] Pretty and Bahrucha (2014) define sustainable intensification '….as a process or system where agricultural yields are increased without adverse environmental impact and without the conversion of additional non-agricultural land. The concept does not articulate or privilege any particular vision or method of agricultural production. Rather, it emphasizes ends rather than means…. The combination of the terms 'sustainable' and 'intensification' is an attempt to indicate that desirable out comes around both more food and improved environmental goods and services could be achieved by a variety of means.'

CSISA is built on the premise that transformative development typically requires not one single change, but the orchestration of several.

CSISA's approach has evolved with time as partnerships have strengthened and our understanding of geographically differentiated entry points and scaling logic has matured. In **Phase I** (2009–12), CSISA emphasized the power of example with technological change achieved primarily through direct engagement with farmers. Within the initiative, a diverse set of competencies were present, but were not always synergistic. In **Phase II** (2012–15), CSISA adopted a model of integrated planning around common impact pathways to better coordinate the different dimensions of the initiative and to best complement and incorporate the mandates and activities of our partners towards common goals. Just as importantly, CSISA increasingly focused on strengthening intermediaries like service providers who, in turn, support access to new technology and knowledge among a larger set of famers – i.e. supporting a few to reach many. In **Phase III** (2015–20), CSISA proposes to continue the strong momentum created in Phase II, but with a deliberate emphasis on ensuring that partners in the public and private sectors are better poised to contribute to change on a sustaining basis by addressing areas of systemic weakness (as listed above). By addressing these areas and fostering new connections and collaborative efforts across the innovation system, CSISA will seek to mainstream elements of our approach and to ensure a successful exit at the termination of Phase III.

The overarching goal of CSISA in Phase III remains to support the widespread adoption of sustainable intensification technologies to spur inclusive agricultural growth, both within the time-horizon of investment and beyond. Achieving this goal is predicated on achieving most of USAID/Feed the Future's (FTF) intermediate development outcomes (IDOs), including improving productivity, expanding markets, increasing investment, and enhancing resilience. These IDOs also align with the Gates Foundation's investment strategy for South Asia. CSISA's theory of change in Phase III is structured around four **inter-linked primary outcomes**, and will be coordinated by a fifth that ensures that potential synergies across the project are realized and lessons learnt during implementation (monitoring, learning & evaluation, ML&E) are reflected in periodic strategy adjustments.

The first outcome, **widespread adoption of sustainable intensification technologies and management practices in South Asian cereal systems**, emphasizes the primary scaling pathways embraced by CSISA. Most agriculture development projects focus on direct engagement at the farm scale to achieve impact. Although direct engagement models are often effective at generating impact within targeted communities, their geographic reach is limited, transactions costs very high, and sustainability low. CSISA's model diverges from conventional approaches by **prioritizing support to change agent 'intermediaries'** – i.e. public and private sector partners who in turn support large numbers of farmers. For example, an average zero-tillage service provider in Bihar reaches more than 25 households with capital-intensive technologies that otherwise would be out of reach for most rural households. With this approach, CSISA will continue to support and strengthen four primary **scaling pathways** to accelerate change: (1) the service economy for scale-appropriate mechanization with SME entrepreneurs, (2) input and output markets with private sector companies such as Kellogg's, Bayer, and Syngenta, (3) women-inclusive livelihoods initiatives such as KISAN in Nepal with reach into marginalized communities, and (4) NARES extension partners – e.g., DAE in Bangladesh, State Departments of Agriculture in Bihar, Uttar Pradesh, and Odisha. By embracing government, NGO, and market-led solutions, CSISA's investments are scalable and strengthen systems that will persist long after the termination of the project, thereby enhancing sustainability.

To further enhance sustainability and scale, CSISA's second outcome, **mainstreamed innovation processes,** seeks to extend the most successful elements of the CSISA model into the

programming of national, state, and district-level government institutions in order to improve the impacts achieved with current and future investments in agricultural R&D. Specifically, CSISA will seek to: (I) integrate geo-spatial data and analysis into planning and ML&E, (2) strengthen on-farm participatory evaluations of new technologies to inform investment priorities and management recommendations, (3) foster closer linkages with the private sector including small- and medium-scale enterprises such as mechanized service providers, and (4) develop new insights into farmer decision processes. On the last point, farmer motivations and capacity for innovation rarely inform government programming, often resulting in low returns on investment for public expenditure.

With national research partners (e.g., Indian Council for Agricultural Research in India, Bangladesh Agricultural Research Council, and Nepal Agricultural Research Council in Nepal), CSISA's third outcome focuses on the generation of **critical knowledge and research-based products (R&D)** that will support technology scaling and impact generation. This outcome is organized thematically to address major challenges and opportunities for sustainable intensification in CSISA's priority geographies, often from a systems perspective rather than with single technologies. In the predominantly rainfed areas of the Eastern Indo-Gangetic Plains, farmers are at the mercy of the vagaries of the monsoon rains, which change markedly from year to year with respect to onset, distribution, and recession. The risks associated with excess or deficit rains can cause severe direct damage to the rice crop while also constraining investment in productivity enhancement. CSISA will continue to develop and scale strategies for enhancing yields and reducing risk in a variable monsoon, including water-efficient rice establishment practices and crop diversification options in drought-prone areas.

The second binding constraint affecting yield and yield stability is heat stress affecting winter crops during the reproductive growth phase (March through May). Hot weather during this period can reduce yield potential for crops like wheat by 50% – a scenario that will worsen with progressive climate change. CSISA will continue to seek research-based strategies for building resilience to temperature extremes through system design changes that permit early planting, together with companion management strategies (e.g., genetics, irrigation, conservation agriculture-based management) that buffer against heat extremes.

In South Asia, there is almost no scope for expanding the area under agriculture. As yield gaps close, future advances in production will have to come from systems intensification (i.e., more crops per year). Fortunately, there are many areas where cropping intensity is low, including areas dominated by winter fallows in coastal Odisha and southeastern Bangladesh. Farmers and policy makers, however, typically judge these areas as non-productive, and there are multiple management and market-based factors that need to be addressed before they can be profitably intensified. CSISA will continue to innovate production practices that permit intensification as well as address the enabling factors such as output market linkages that promote investment in intensification. In general, basic knowledge and application of precision approaches to weed, water, and nutrient management are absent from farmers' fields and are the prime contributors to attainable yield gaps[3] of > 50% for rice, wheat, and maize in many areas where CSISA works. CSISA will advance research-based recommendations for cereal agronomy basics, including decision frameworks with proven scaling opportunities as well as 'low risk – low cost' entry points for intensification.

CSISA's fourth outcome, **Improving the policy environment to support sustainable intensification,** prioritizes scaling up work with national partners to address policy constraints and improve the policy environment for realizing sustainable intensification futures in CSISA's

[3] Yield gap = attainable yield – achieved yields / attainable yield

target geographies. Planned activities on **seed systems and markets** will focus on communicating policy reform options for state-led seed market interventions and the tradeoffs between promoting short-term varietal replacement and long-term seed market development. Activities on **scale-appropriate mechanization** will emphasize the design of policy incentives and investment strategies (e.g., better targeted subsidies) that encourage the development of localized commercial markets for the scale-appropriate machinery and equipment required for sustainable intensification. Activities on **soil fertility management and fertilizer markets** will support policy reforms to promote balanced fertilizer use through improved understanding of the costs, benefits, fiscal burden, sustainability, and effectiveness of various public programs. Activities on **agricultural risk management** will develop investment strategies and evidence-based policy options around alternatives to costly crop insurance schemes, including innovative index insurance and credit products specifically designed for risk-prone areas.

FY16 Indicators of Progress

CSISA Phase III surpassed its target by 52% for the number of hectares of land under improved technologies or management practices, reaching 19,711 ha in FY16 in Bangladesh and Nepal. The corresponding number of farmers reported was 52,584, deviating from our target by -10%. In FY16, the technologies and management practices contributing to these indicators included new crop varieties (rice and maize hybrids), healthy rice seedlings, Premium Quality Rice, improved weed management, maize intensification, reaper-based harvesting, irrigation through axial flow pumps, and supplemental irrigation management.

In Phase III, CSISA has emphasized 'trainings of trainers' and service provider mentoring, thereby training fewer individuals but ultimately reaching more farmers by capitalizing on 'one is to many' relationships. In this fiscal year we exceed our target by 200% by training 684 individuals.

CSISA's final indicator monitored the number of micro, small, and medium enterprises (MSMEs) receiving business development services. In Nepal, CSISA achieved its target, but in Bangladesh the team did not report into this indicator, because the business development services activities had not yet been started by CSISA's sub-grantee, International Development Enterprises. Therefore, the combined numbers missed the overall target.

Major Activities and Accomplishments

BANGLADESH

- Over 23,000 farmers have learned about the principles of **healthy rice seedlings** for higher yields through interactive village-based video shows and trainings organized by CSISA and the Agricultural Advisory Society.
- Strategic alignment of the CSISA-MI project with CSISA Phase III resulted in 5,745 and 3,889 hectares of land coming under **fuel-efficient surface water irrigation and mechanical reaping**, respectively, in the FtF zone.
- CSISA continues to leverage governmental, NGO and private sector partners to disseminate information on **best-bet agronomy**. Over 80,000 leaflets and booklets on rice, wheat, maize, and legume management were distributed through these partnerships.
- CSISA entered into partnership with the Agricultural Input Retailer Network, which is currently using experiential learning modules produced jointly by CSISA and Department of Agricultural Extension to increase 800 input dealers' skills and knowledge on **integrated weed management**. Two agro-chemical companies have also begun

commercialization of new highly effective and environmentally sound herbicides in the FtF zone as a result of CSISA's work.

- Farmers in Southern Bangladesh only make profit from rice by growing **premium quality varieties**. In 2016, CSISA distributed over one ton of starter seed-kits to farmers who are now growing highly profitable rice varieties.
- A serious outbreak of **wheat blast disease** threatened 15,000 hectares of wheat in Southern Bangladesh. CSISA has reacted by partnering with agencies under the Ministry of Agriculture to distribute 300,000 government-endorsed leaflets explaining how farmers can prepare to manage blast. Further disease modeling and forecasting efforts continue to be underway at the request of CSISA's NARES partners.
- Prospects for **direct-seeded rice** grow as hundreds of farmers and agricultural machinery farmers are trained in direct seeding techniques in preparation for the 2017 *aus* rice season.
- CSISA has been evaluating several tools for providing **risk management solutions** to smallholder farmers in Bangladesh. In particular, CSISA has analyzed the effectiveness of a novel weather index insurance product to address risks related to deficient rainfall during the summer monsoon season.

NEPAL

- The KISAN project is USAID's flagship FtF investment in Nepal. CSISA has collaborated with KISAN and NARES partners to produce accessible guides for **better bet agronomy for rice and maize** – information that is generally not available to smallholders**.** KISAN has reproduced these guides as the backbone of their technical training programs for staple crop production. In 2016, **60,205 farmers received the rice tips and 69,923 farmers received the maize tips** in the FtF zone. Efforts are ongoing to track the impact generated by these 'tips' across geographies and farm types.
- Nepali rice farmers are particularly vulnerable to monsoon variability because fewer farmers have access to assured irrigation than in any other country or region in South Asia. CSISA has worked to identify and develop markets for short-duration rice hybrids that preserve yield potential but also increase resilience by avoiding late-season stress when the monsoon withdrawal is premature. As a result, more than 40 agro retailers across the Terai districts of the FtF zone sold **20 MT of hybrid rice seed in 2016, enough to preserve yield potential and increase resilience on about 1,000 ha.**
- Direct-seeded rice (DSR) holds tremendous promise for decreasing water requirements for rice establishment and thereby reducing early-season vulnerability to weak or late-arriving monsoon rains. Nevertheless, DSR comes with its own set of production risks that have constrained adoption including vulnerability to early inundation and weed competition. Reducing production risks is the essential first steps towards making DSR viable at scale. CSISA conducted on-farm evaluations of DSR using 'dust mulching', a simple management adjustment that uses pre-sowing irrigation followed by shallow tillage to better control weeds and permit earlier planting by limiting irrigation requirements. Results showed that **dust mulching significantly increased yield (20%) and decreased early weed pressure (25%)** compared to post-sowing irrigation in DSR**.**
- By developing and sharing market intelligence, CSISA is playing a critical role in making the **private sector active players in market development** for new varieties. For example, CSISA data demonstrates that adoption of hybrid maize can increase productivity by 50% with no other changes in management in the hills of Nepal where almost all farmers currently grow open pollinated varieties. By sharing these insights

with private sector input suppliers and ensuring that high-performing hybrids are officially registered with the Government of Nepal in the FtF zone, seed dealers like NIMBUS have been motivated to used their own funds (>$30,000) to implement 100 on-farm demonstrations of new maize hybrids and supply 3 tons of price-discounted seed through agricultural retail networks in the FtF zone.

- Over the last 3 years, stalk rot has emerged serious threat to summer maize for most of the Terai and Inner Terai region of Nepal. In collaboration with the National Maize Research Program, CSISA initiated research on integrated disease management approaches that **reduced the disease infestation by 53% and increased yield by up to 40%** compared to untreated plots. Effectively managing this risk is a pre-condition for intensification, and this research will inform management recommendations for the coming maize season where maize is grown on > 40,000 hectares**,** often as a diversification option away from rice where water resources are limiting.

A. Innovation Toward Impact

A.1 Reducing Risk to Facilitate Uptake of Sustainable Intensification Practices

A.1.1 Directly-sown rice to address labor and energy constraints to precision rice establishment

FARMERS SPOT-WEED AND TEND TO A DIRECTLY SOWN RICE FIELD IN JESSORE DISTRICT DURING THE CROP'S VEGETATIVE DEVELOPMENT STAGE

Transplanting is the most common and popular method of rice crop establishment in Bangladesh. The time-, labor-, water- energy-, and cost-intensive nature of this practice however casts doubt on its long-term potential for the country. Land preparation and transplanting costs in Southern Bangladesh can be as high as US$ 100/ha – a significant cost for resource-constrained and smallholder farmers. Transplanting does however have advantages, including precise crop establishment and weed control. These benefits are however increasingly weighed against other problems with the practice, including steadily rising labor costs and lack of sufficient water for wet land preparation in the *aus* pre-monsoon season or late monsoon season rains that may delay monsoon summer *aman* crop establishment. This can result in yield penalties for the subsequent delayed sowing of the dry *rabi* season crop (detailed in the 'early wheat for high yields' section below). These issues are gradually compelling farmers to experiment with alternatives to transplanting, including dry direct-seeded rice (DSR).

In addition to addressing labor scarcity and costs, DSR has other advantages including reduced input costs by forgoing repetitive wet tilling operations prior to crop establishment. This also reduces energy inefficiency in rice production. Correct implementation of DSR is nonetheless heavily reliant on good crop establishment and sufficient weed control. These can be problematic for farmers to achieve in the monsoon *aman* season in particular, as precipitation and within-field flooding are unpredictable and difficult to control. Appropriate machinery for crop establishment is also crucial to establishing DSR. Machinery scale-out and commercialization efforts in the complementary CSISA-MI project are now resulting in expanded availability of two-wheeled tractor attachable cereal sowing equipment that can be used to prepare fields and directly sow rice in a single operation.

CSISA carefully considered these factors, and following a series of focus group disucssions and simple adaptive research efforts, decided to focus in on strategic use of DSR for *aus* (pre-monsoon season) rice. Compared to the monsoon, the *aus* season hs reduced establishment risk due to failure due to rain or flooding. DSR aso cannot be practiced in the dry winter *boro* season because low temperatures can significantly retard early crop germination and establishment. Deploying DSR during the *aus* season in areas where machines and service providers for sowing are now more

widely commercially available through the CSISA-MI project therefore offers considerably more opportunity. There are over 100,000 ha of *aus* rice cropland in Dinajpur and Jessore hubs – where mechanized sowing equipment is increasingly becoming available – that are estimated as being suitable for DSR.

PREPARING TO REAP SUCCESS FROM DIRECTLY SOWN RICE: FARMERS INSPECT THEIR DSR FIELDS DURING THE EARLY HEADING AND FLOWERING STAGE, IN ANTICIPATION OF HARVESTING A CROP THAT WILL RETURN INCREASED PROFITS THROUGH DRAMATICALLY REDUCED PRODUCTION COSTS.

Because Phase III began in December 2015, DSR activities were limited in the 2016 *aus* season. DSR demonstrations were implemented in Jessore and Faridpur Hubs on 17 ha of *aus* rice. Initial results were encouraging, with farmers obtaining comparable yields to transplanted rice, though with significantly lower production costs through DSR. In Jessore Hub, two farmer field days were organised to raise farmers' awareness of DSR and answer any questions they might have. Seventy-nine farmers attended. An additional 139 farmers were trained in DSR practices using the direct sowing equipment discussed above. Many farmers observed DSR first time and expressed interest in practicing DSR in the coming *aus* rice season, representing a significant opportunity that will be levered in the first half of 2017. Feedback from farmers suggested the need to organise more trainings on DSR. Opportunities for extending these trainings through the Department of Agricultural Extension (DAE) and other development partners are now being explored. Key strategic plans for DSR for 2017 *aus* rice season are as follows.

- Provide trainings to large numbers of government organization and NGO staff, input dealers, and farmers regarding DSR technology and its advantages.
- In-depth trainings of established machinery service providers on DSR techniques in collaboration with BRRI and DAE, in association with CSISA-MI
- Aggregation of farmers' demand for DSR services in specific geographies
- Conduct further on-farm verification trials of innovative DSR production practices (e.g., improved weed management, dust mulching, early irrigation, and modified machinery) to reduce production risk. Trials will be conducted in partnership with local machinery service providers and thus will offer learning opportunities.
- Implement strategic on-farm demonstrations as learning centers on DSR.
- Work with DAE, NGOs, and machinery dealers to raise awareness of DSR technology in association with CSISA-MI.
- Facilitate business development by linking farmers with LSPs and input dealers, particularly herbicide dealers in viable *aus* DSR areas.

A.1.3 Agronomic and variety recommendations to reduce the threat of wheat blast

The first outbreak of wheat blast outside the Americas was recorded in Bangladesh in February of 2016, affecting a large area estimated at 15,000 hectares in seven southwestern and southern districts of Bangladesh that fall within the Feed the Future Zone: Kushtia, Meherpur, Chuadanga, Jessore, Jheneidah, Barisal and also on Bhola. The disease established itself quickly, after which it caused significant crop losses for the region's wheat farmers. The estimated average yield loss in affected fields was 25–30%, but in severely infected fields, total losses could be observed. Bangladesh's Ministry of Agriculture officially announced the presence of the devastating fungal disease on 27 March 2016, in order to alert neighboring nations, including Nepal, India, and Bhutan, where wheat is also grown. With support and partnership from CSISA, a wheat blast action sub-committee was formed under the leadership of Bangladesh Agricultural Research Council (BARC) with representatives from Department of Agricultural Extension (DAE), Bangladesh Agriculture Development Corporation (BADC), Bangladesh Agriculture Research Institute (BARI), Bangladesh Rice Research Institute (BRRI), different Universities, FAO, CIMMYT etc. formulate next steps to mitigate disease spread.

FACT SHEET ON HOW TO MANAGE WHEAT BLAST INFECTIONS. DEVELOPED COLLABORATIVELY WITH NATIONAL PARTNERS AND ENDORSED BY THE MINISTRY OF AGRICULTURE, 300,000 COPIES HAVE PRINTED AND DISTRIBUTED TO FARMERS WITH SUPPORT BY CSISA.

CSISA is working to coordinate many of CIMMYT's blast-oriented response activities is collaboration with concerned organizations. This included co-support to send a senior pathologist from the Bangladesh Agricultural Research Institute's Wheat Research Centre (WRC) to attend an international workshop on blast disease, held in Brazil in April, 2016. This provided new opportunities to network with pathologists working to control the disease internationally, and garnered global research support for Bangladesh. In addition, blast samples collected from affected areas in collaboration with BARI were sent to Kansas State University's wheat blast group (https://www.k-state.edu/wheatblast/), which collaborated with the USDA for genetic analysis of the pathogen. These and other laboratories confirmed the pathogen as *Magnaporthe oryzae* pathotype Triticum (MoT), very close to the South American isolates. This analysis also confirmed that the blast outbreak found in Bangladesh did not evolve from the rice blast pathotype already common in Bangladesh or variants from other local hosts. Following these actions, both CSISA and CSISA-MI funds were used to coordinate and support a regional consultation workshop on "Mitigation of the Threat of Wheat Blast in Bangladesh and beyond" held during 26–27 July 2016 in Kathmandu, Nepal. The workshop was widely attended, including by officials from the Indian Center for Agricultural Research and Nepal Agricultural Research Council (NARC), and a number of American, South American, and European Universities, as well as USAID. These linkages have created new possibilities for cross-regional research, knowledge exchange, and trainings on management of wheat blast (see the 'increasing the capacity of NARES to conduct participatory science and technology evaluations' section for further detail).

SYMPTOMS OF WHEAT BLAST INCLUDE BLEACHING AND INFECTION AT THE WHEAT SPIKE.

In addition to these activities, CSISA has also worked to spread awareness of wheat blast within Bangladesh, and to inform farmers how to manage the disease in the event of its reoccurrence in the 2016/17 winter *rabi* season. Along with BARI's WRC, CSISA has prepared an easy-to-follow Bangla language factsheet with short-term recommendations that farmers can follow to prepare for and manage blast, should its symptoms be detected. Three hundred thousand copies of the leaflet were printed after the factsheet was approved by the wheat blast sub-committee and the Ministry of Agriculture. The factsheet is now being distributed by the Department of Agricultural Extension, BARI, BARC, AIRN, CSISA, and a number of additional local NGOs in the areas in which wheat blast was a problem in the last season. CSISA and other partners identified the following easy-to-implement agronomic and variety recommendations to help farmers better manage the disease:

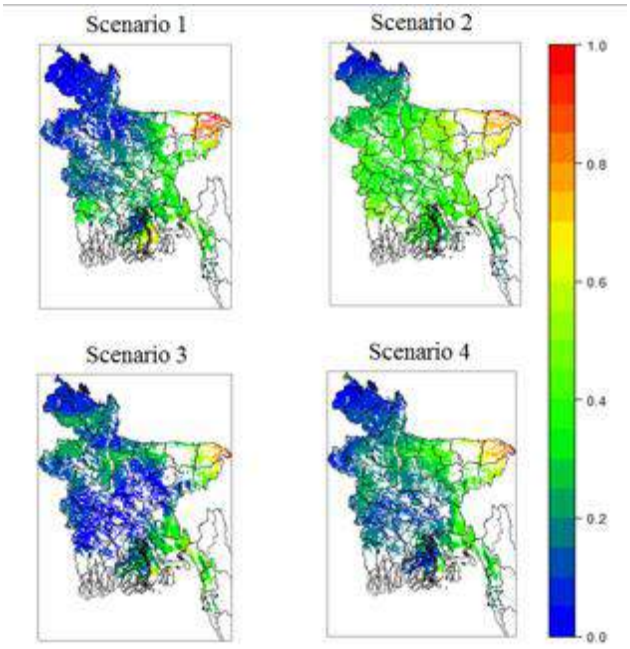
1. Do not save and replant seeds from blast-infected fields.
2. Grow less susceptible wheat varieties, for example BARI Gom 28 and BARI Gom 30.
3. Complete seeding within the recommended planting dates (generally from 15–30 November) to harvest early before high temperatures and rainfall, which are associated with wheat blast outbreaks, might occur in mid- to late-February.
4. Before sowing, treat seeds with acceptable fungicides while following health and environmental protection measures. Seed treatments also suppress other diseases that may affect wheat.
5. Keep wheat fields and field margins free of weeds that might harbor the disease.
6. In areas where wheat blast was found in 2015/16, preventative fungicide sprays at the early reproductive stage may assist in controlling blast. Spraying should only be done by a trained professional following health and environmental protection measures.

Noteworthy partnerships that have emerged in the process of preparing Bangladesh to pro-actively manage the continued threat of wheat blast disease include those with WRC, BARI and the Bangladesh University of Engineering Technology. The latter has focused on research assessing historical climactic data to assess the frequency of weather patterns conducive to blast outbreaks, and to forecast the potential risk of future outbreaks. Research with WRC has conversely included planning (1) comprehensive field surveillance studies of wheat blast, both on wheat and on alternative hosts, in Bangladesh during early 2017, (2) evaluation of wheat cultivars for blast resistance and susceptibility against wheat blast under field conditions, (3) studies examining the efficacy of seed treatment and foliar fungicides in controlling wheat blast, (4) examination of seed to plant transmission of wheat blast fungus, and studies assessing the effect of sowing dates and artificial precipitation simulation on the severity of wheat blast.

Despite intensive research being conducted since the appearance of wheat blast in South America, durable resistant wheat genotype have not yet been identified, although tolerant cultivars have been found in specific areas. Moreover, the complex epidemiology the disease, though not yet fully understood, suggests that eradication will not be entirely possible. In other words, the disease may lie relatively dormant in alternative years, or subsist undetected on alternative host such as the weeds commonly found in rice and wheat fields. This, together with the large potential yield losses within a very short period after the outbreak, will require innovative measures from farmers and researchers to effectively manage it.

In Focus: Preliminary wheat blast risk assessment using historical climactic data

CSISA's scientists analyzed the last 30 years' gridded temperature and precipitation data for the month of February to evaluate the past frequency of occurrence of the climactic conditions similar to those found during February of 2016 when wheat blast was reported in Bangladesh. These conditions, which included spikes in rainfall and high temperatures, are correlated with increasing risk for disease outbreak.



We calculated past occurrence of wetting periods (when the spike that supports wheat grains are sufficiently wet for infection) similar to weather conditions under February 2016 under the four following scenarios: (1) three-hourly precipitation of 1 mm or higher , (2) daily rainfall of 8 mm or higher, (3) three-hourly relative humidity greater than or equal to 90%, and (4) twenty-hour relative humidity greater than or equal to 90%. The results, which are indicated in the maps above and the associated probability scale (0–100%), indicate that the occurrence of climactic conditions favorable for blast incidence as found in February of 2016 were almost absent in wheat growing areas of Bangladesh in the last 30 years. The only environment in which high incidence of these conditions was found is in Sylhet District, where wheat is rarely grown. Conversely, under Scenario 2, which examined the potential effect of daily rainfall > 8 mm, wheat blast has considerable risk for outbreak. These models and the assumptions underlying them require integration of temperature data and further refinement – work that is ongoing in CSISA. Although this preliminary analysis suggests that blast may not be observed every year, this information should be treated with caution as even occasional outbreaks can be severe and devastating for smallholder wheat producers.

Stakeholders at the wheat blast workshop held in Kathmandu in 2016 agreed that the development of a forecasting model that considered the presence of susceptible host, a virulent pathogen and a favorable environment that favors disease spread, is important for providing early-warning to wheat farmers' to combat outbreaks. In growth chamber experiments, the highest blast infection on wheat was observed at 30°C with increased wetting period durations (in other words, for longer time periods during which wheat leaves were kept sufficiently wet). This laboratory environment may however not entirely represent conditions found in farmers' fields. An improved understanding of the effect of temperature and wetting period for wheat blast development and spread in relation to the development of the wheat crop is therefore necessary for developing an early forecasting model for disease management.

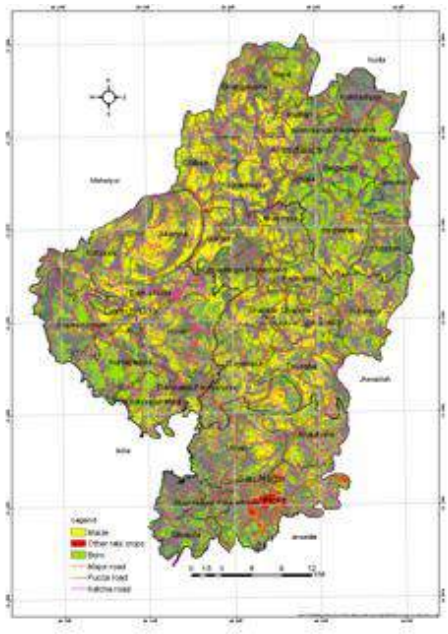
To this end, CSISA has implemented on-station research experiments during the 2016/17 wheat production season. The experiments, which manipulate sowing dates' wetting periods using automatic sprinkler systems, will generate basic information to develop an early-warning system for wheat blast based on a climatic model by evaluating the relationship between sowing dates or temperature, grain wetting periods and disease intensity under field conditions. Results from these experiments and subsequent modeling efforts will be reported after harvest and data analysis in the next CSISA Phase III report.

A.2 Adding value to extension and agro-advisory systems

A.2.2 Building precision nutrient management approaches around scaling pathways

Maize is the third most important cereal crop after rice and wheat in Bangladesh; it is increasingly grown for livestock, poultry, and fish feed, and is important in the generation of household income. However, most farmers' over- or under-apply fertilizers, and frequently in an unbalanced fashion, with low amounts of phosphorous, potassium and micronutrients in comparison to nitrogen. Over time, this can lead to a negative balance for most of the nutrients found in rice–maize cropping systems. Unbalanced application is both an environmental and economic concern, the latter because it increases costs and reduces nutrient efficiency for maize production, the former because of soil degradation and nutrient losses to the environment, including greenhouse gas production and nitrogen leaching.

Because maize is grown in a wide range of climates, soil and land types across Bangladesh, geographic variability in indigenous soil fertility and maize yield response to applied fertilizers can therefore be expected. While site-specific nutrient management based decision support tools that focus on farmers' individual fields might be more logical from the standpoint of fine-tuning locally explicit recommendations, they are also likely to be difficult to scale out to tens of thousands of maize farmers without significant cost and effort.



MAPS GENERATED USING INFORMATION IN THE PRECISION NUTRIENT MANAGEMENT DATABASE DESCRIBING MAJOR LAND USE PATTERNS

At the core CSISA's research activities in Phase III in Bangladesh is the careful development of a spatial database of soils, crop management, and nutrient application as practiced by farmers. The same database will include attainable yield information, characterization of growing environments, soil characteristics, and indigenous nutrient supply capacity of the soil to maize crops grown following rice. Innovative digital soil mapping technology using state-of-the art spectroscopy instrumentation offers potential additional advantages for easing the analytical burden encountered when wet chemistry laboratory methods are used to process soil samples and examine their nutrient status. In combination with available remote sensing data, these data are necessary for developing a more comprehensive precision nutrient management system in rice-maize systems in Bangladesh.

MORE PRECISE AND EASY TO IMPLEMENT NUTRIENT MANAGEMENT TECHNIQUES AIM AT INCREASED PROFITS FOR FARMERS BY RATIONALIZING FERTILIZER INVESTMENTS.

In 2016–17, data from remote sensing were used to create preliminary land use maps using fusion of multi-temporal Landsat 8 and Sentinel-2optical and Sentine-1 SAR imagery. 80 large fields were selected for observation where rice–maize is the dominant cropping system. Nutrient omission plot trials with the sequential omission of fertilizer N, P, and K, and a nutrient sufficiency plot (with all nutrients applied in quantities high enough to obtain high yields) were implemented in another 70 of nearby fields. Soil sample collection, crop-cuts for rice yield and surveys for farmers' management information have already been completed at these sites. In addition, crop cut, field survey and soil sampling have been

completed at four rice–maize sites in each of the original 80 farmers' fields. Information from these fields (that do not contain experiments), are considered as "control" fields, and will be used to predict indigenous soil nutrient supplying capacity using nutrient omission plot trials generated data. Experiments have recently been established at the time of writing. Further information on the results of this work will be forthcoming with the next CSISA Phase III report.

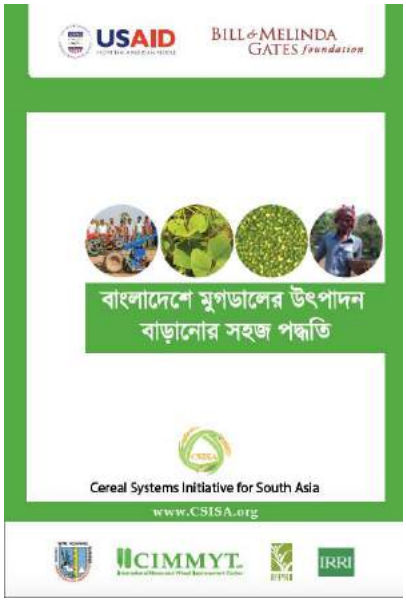
B. Systemic Change Toward Impact

B.1 Partnerships for inclusive growth around commercial pockets and neglected niches

B.1.1 Deployment of better-bet agronomic messaging through input dealer networks and development partners

Scaling-out information on better-bet agronomy

In Bangladesh, CSISA III is working to scale-out better bet agronomic practices through agricultural input dealers, as they are often farmers' first point of contact for technical information on agriculture, and through NGOs and partner development programs. A large part of this work entails the broad-scale distribution of printed extension materials on easy-to-implement improved management practices in agronomy for rice, wheat, maize, lentil and mungbean crops, with the ultimate goal of encouraging 1 million farmers to improve their practices through the use of such messaging by 2020. Targets for this reporting period include 20,000 farmers accessing improved agronomic management information in Jessore, Faridpur, and Barisal hubs. CSISA is currently implementing activities to achieve this target through the distribution of leaflets and other media written as simple but actionable 2-page guides on how to improve cereal and legume crop production while lowering production costs, maintaining or enhancing yields, and minimizing environmental externalities.



DEPARTMENT OF AGRICULTURE-ENDORSED CSISA BOOKLET TO GROWING BETTER MUNGBEAN IN BANGLADESH.

In collaboration with BRRI and BARI, CSISA's scientists and communications and training experts have developed and printed 10,000 leaflets for non-rice crops that have been distributed to farmers. The impact of these leaflets, which are distributed by local NGO partners, the DAE, and AIRN member input dealers, are currently being tracked as the winter crop season commences and farmers have the opportunity to implement these practices. An additional 18,000 leaflets for improved dry season rice production have also been printed and are under distribution. During the winter *boro* rice 2016–17 and summer monsoon *aman* 2017 seasons, a total of 54,000 leaflets on improved rice crop management practices will be distributed to farmers by extension service providers of DAE, NGOs, and input dealers. To ensure the effective distribution and utilization of these printed materials, orientation programs on better-bet agronomy are under way and will reach 700 extension service providers before the end of 2017. As the winter season is now only beginning at the time of writing, the impact of these activities will be presented in full during the next reporting period.

In Focus: Scaling success recognized – CSISA Video Project Wins International Award for Effective Farmer Communication

A collaborative video project designed to raise farmers' awareness of small-scale agricultural machinery and best-bet agronomy in South Asia has won the bronze prize in the Event and Visual Communication Association (EVCOM) 2016 Award for Communication Effectiveness at an event in London on April 28. The EVCOM Screen Awards are among the most prestigious competitions in corporate film and visual communications. The award was jointly accepted by Agro-Insight, the Bangladesh Agricultural Research Institute (BARI), Agricultural Advisory Society (AAS), and the International Maize and Wheat Improvement Center (CIMMYT) for CSISA. Paul Van Mele, director of Agro-Insight, praised the partnership between agricultural research organizations BARI and CIMMYT, and video production company Agro-Insight and video distribution partner AAS formed through CSISA's efforts. "The EVCOM Award for Communication Effectiveness celebrates a unique partnership model whereby quality training videos far exceeded the impact that agricultural development projects usually have," he said. "In population-dense South Asia, the sheer number of farmers makes it difficult to expand reach to raise awareness in rural areas," said CIMMYT systems agronomist Tim Krupnik. "Video is a great medium for extension if you want to make awareness spread like wildfire."

Based on the film "Save more, grow more, earn more," produced in 2012 with support from the Bill and Melinda Gates Foundation and the U.S. Agency for International Development through the Cereal Systems Initiative for South Asia (CSISA), which also featured some field sites shown from ACIAR and U.S. Department of Agriculture–Cornell University funded partner projects, a suite of videos was translated into eight languages for farmers in Bangladesh, China, India, Iran and Nepal. Harun-Ar Rashid, executive director of AAS commented that "our achievement was enormous." Between 2012 and 2014, AAS and CIMMYT jointly organized 482 screenings for over 110,000 farmers in 482 villages in Bangladesh. Dr. Israil Hossain, a leading agricultural engineer at BARI, commented that "now farmers are inspired, seeing the advantages for crop production, and use of machinery is increasing."

Internationally, 1,500 DVD copies were distributed to farmer leaders and others such as two-wheel tractor operators, agricultural equipment and input dealers, community-based organizations, government services centers, NGOs and even tea stalls with televisions. Fifty eight million television viewers were reported in Bangladesh and over 100 million in India. "The videos increased farmers' awareness of the products of BARI's research, which is a huge success," explained Dr. Md. Rafiqul Islam Mondal, director general of BARI.

Healthy rice seedlings for higher yields

SIMPLE MANAGEMENT PRACTICES THAT RESULT IN HEALTHY RICE SEEDLINGS CAN LEAD TO HIGHER YIELDS FOR RICE FARMERS

As a particular sub-set of better-bet agronomy in Bangladesh, one of the primary causes of the low productivity in Bangladesh is the difficulty farmers encounter in transplanting rice grown using healthy seedlings. Additional problems can be encountered in transplanting seedlings when they are of appropriate age. In both cases, the role of tradition and culture that favored the use of older seedlings with traditional varieties continues to predominate. These customs are however poorly suited to the now more widely available high-yielding rice varieties common in Bangladesh. During the winter *boro* season, most farmers grow their nurseries in river banks or near water sources after monsoon season floodwaters recede. BRRI, one of CSISA's core partner research institutes, recommends improved seedbed management practices for healthy seedlings, although farmers' knowledge of these

recommendations remains limited, or farmers are resource constrained and encounter difficulties in their implementation. CSISA is playing a catalytic role in scaling out the technologies to raise healthy rice seedlings by working with a variety of governmental and NGO partners, and other stakeholders including seed companies, nursery entrepreneurs, input dealers, and lead farmers to spread awareness and action to improve the health and management of rice seedbeds.

FIELDS OF GREEN: HEALTHY RICE SEEDLINGS PRODUCED USING APPROPRIATE SEEDBED MANAGEMENT PRACTICES.

CSISA III has targeted extension personnel from the DAE, Rural Reconstruction Foundation — a local NGO – and private nursery entrepreneurs, as potential and immediate extension information service providers and trainers for farmers. Training of trainers were consequently deployed for 80 of these partners on healthy rice seedling practices. CSISA also organized the training of 7 farmers' groups, each of which consists of 20 farmers. CSISA in collaboration with BRRI also developed actionable and farmer-friendly guides for raising healthy rice seedlings in the form of leaflets and booklets. In the monsoon *aman* season of 2016, 650 leaflets on this subject were disseminated to farmers through DAE and development partners including NGOs. An additional 1,500 booklets and 32,000 leaflets were printed at the time of writing, with distribution under way. In order to boost the accessibility of these materials and respond to farmers' questions on healthy rice seedling practices, approximately 700 extension service providers will be trained on healthy rice seedling practices in coming winter *boro* rice season.

While the distribution of leaflets and booklets through partner organizations is a core part of CSISA's activities to support the adoption of more healthy rice seedling practices, seeing is believing. CSISA therefore worked with Bangladesh Television to produce a 12-minute video on the benefits of healthy rice seedlings. The video carries many of the same messages shared in print media, though in graphic and audibly compelling form. Working with the NGO Agricultural Advisory Society, video shows have reached over 23,000 farmers and are creating considerable awareness among farmers and extension workers to stimulate the adoption of better-bet nursery management options.

Number of farmers watching video show at 211 events in seven districts during October November 2016

Hub	District	Total Events (No.)	Farmer audience (No.)
Jessore	Jessore	81	8,447
	Narail	20	2,732
	Jheneidah	12	1,618
Jessore Hub Total		***113***	***12,797***
Faridpur	Faridpur	50	5,235
	Gopalganj	13	1,818
	Madaripur	11	1,400
	Rajbari	24	2,035
Faridpur Hub Total		***98***	***10,488***
Grand Total		**211**	**23,285**

In addition to video production and showing efforts, farmers working with CSISA established eight community managed nurseries in the Feed the Future Zone. An additional 20 nursery entrepreneurs and 300+ individual farmers have begun raising healthy rice seedlings. Three-hundred sixty hectares

were also planted for demonstration and training purposes with healthy rice seedlings in the monsoon *aman* season of 2016, out of which 184 hectares came from community-based nursery groups, 53 hectares from nursery entrepreneurs, and 123 hectares from individual farmers, all of whom began experimenting with healthy rice seedling practices to improve rice productivity.

To further strengthen the concept of healthy seedlings, a set of experiments were conducted in collaboration with BRRI to study the optimum seed rate in the seedbed and raising seedlings in mat nursery for manual transplanting. The crop has just been harvested and the results of this work will be presented in the next report.

FARMERS LEARN ABOUT THE PRINCIPLES OF HEALTHY RICE SEEDLING MANAGEMENT IN VILLAGE AND ROADSIDE VIDEO SHOWINGS. OVER 23,000 FARMERS HAVE NOW SEEN THESE FILMS, WHICH ARE ACCOMPANIED BY PARTICIPATORY QUESTION AND ANSWER SESSIONS, THROUGHOUT FARIDPUR AND JESSORE HUBS.

The supply of rice seedlings at the appropriate time of transplanting also plays a significant role in technology adoption. A business diagnostic study was conducted across three hubs to explore rice seedlings markets and scope for promoting rice nursery enterprises. The main conclusions are that (1) rice seedling buying and selling is widely practiced in the monsoon season, particularly in unfavorable environments with medium to deep field flooding, (2) the seedling market size is gradually increasing over the years, in both *aman* and the *boro* season, but less in the latter, (3) seedling transactions mainly take place in local market bazaars, and (4) seedlings are actively traded for about two months during the planting time. These local markets can be an entry point to develop rice nursery entrepreneurs to scale out the use of healthy rice seedling practices, a subject which is now being pursued and will be reported on in the next reporting period.

B.1.3 Rabi fallows development in coastal Bangladesh

In south central Bangladesh, farmers often fallow their land or grow low-input and rainfed 'opportunity' crops during the dry season. Increasing future food production is nonetheless crucial in Bangladesh's cereal-based farming systems, upon which 161 million people – nearly 32% of whom live below the national poverty line of US$ 2 per day– rely on for food security. Understanding the factors affecting farmers' decisions to fallow land as opposed to cropping it is therefore crucial to assess if and how these lands can be converted to reliably supply food in the coming decades. CSISA is working to address these issues – and supporting Government of Bangladesh policy on irrigation expansion and crop intensification in the south central part of the Feed the Future zone through applied research and by convening stakeholders to discuss policy and development investment alignments in this impoverished but high-potential region.

Research on crop intensification trajectories and options in coastal Bangladesh

In order to assess these issues from an integrated and transdisciplinary standpoint, surveys evaluating farmers' reasons for fallowing and interest in intensification were carried out with 204 farm households in non-polder areas of Barisal district and 298 farmers in polder areas of Patuakhali and Barguna district. This survey was complemented by nine focus group discussions and a survey of 240

farm households to identify farmers' perceptions of the constraints and opportunities associated with surface water irrigation-based crop intensification.

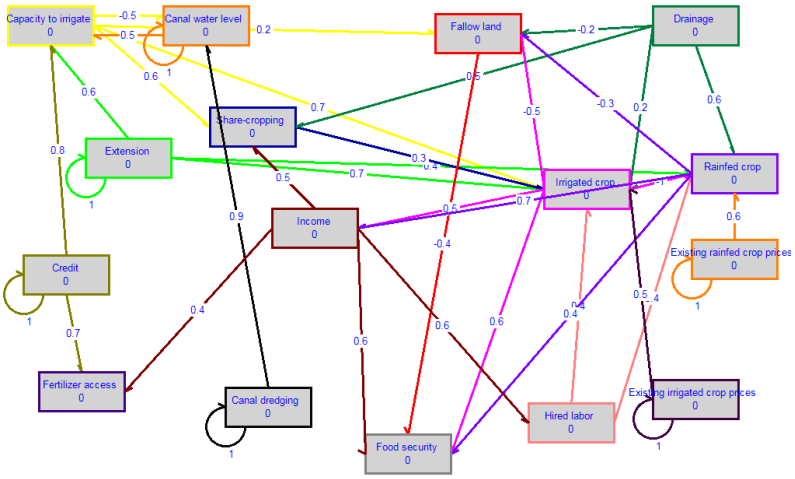
SCALE OF THE PROBLEM AND SIZE OF THE OPPORTUNITY: PERVASIVE DRY SEASON LAND FALLOWING IN BARISAL DIVISION

The resulting data shows continuous decline of cropping intensity over the last 20 years, by 14–15%. One of possible reasons emerging from this study is the lack of labour availability of during peak periods of land preparation and sowing, indicating opportunities for scale-appropriate mechanization, so long as farmers are empowered to invest in machinery. Labour costs have grown approximately 300% over the last two decades, accounting for a 5–14% increase in fallow land since 1995. Survey data also show a positive effect of the share of land under machine tillage on the reduction of fallow land, further supporting the need for mechanization to support intensification. Among farm households in polders, experienced and older farmers tended to have less land under fallow. Most of these farmers choose to grow mungbean or lathyrus under rainfed conditions, and are relatively new to the idea of irrigated agriculture. Approximately 75% of the surveyed households investing in dry *rabi* season crops cultivated mungbean, the cultivation of which has grown 4% during the last 20 years. In addition, farms proximal to main roads had greater access to power tillers and hence the incidences of fallows are lower where road connectivity is found. Crucially, farmers with access to extension were also found to be less frequent fallowers of their land during the dry season.

These preliminary results led to subsequent investigation of potential solutions to land fallowing and lower-productivity legume cultivation in support of higher-income generating and yielding intensification practices. Based on a sub-sample of the survey among 240 farm households, 16 concepts for the farms in the non-polder and 17 concepts for the farms in polders were identified by farmers as important in farmers' conception of their farming systems and land management practices. We selected these important concepts for constructing preliminary baseline fuzzy cognitive maps (FCMs). FCMs are a methodological approach to exploring 'what if' scenarios of inherently complex and difficult-to-represent systems. Originating in psychology and cognitive science, they are increasingly used to explore complex issues pertaining to natural resources management. FCMs have only recently been applied to international agricultural development research, with efforts conducted through CSISA breaking ground in use of this innovative applied research tool.

FCMs represent the 'mental models' of farming system as perceived by farmers using data originating from focus groups and extensive surveys. These mental models show linear relationships between each of the concepts, represented using straight lines. Those lines starting from a concept are assigned to have uniform colour. We measured weights assigned by individual farm household for each of the above relationships using a Likert type scale (-1 to +1). Average weights of similar components were taken to identify the strength of relationship between concepts. Similar concepts were combined as were output market access and output market prices for irrigated and rainfed crops. Additionally, access to credit and access to fertilizers were used as proxies for factors facilitating investment in intensification. External concepts upon which farmers seldom have any control were identified as drivers affecting the farming system. By manipulating the state values of these drivers hypothetical scenarios can be simulated. For farms in the non-polder, simulation of

hypothetical scenarios in FCM using six drivers viz. extension, credit, canal dredging canal water level, and existing output market prices of irrigated and rainfed crops were carried out. Similarly for polder farms, hypothetical scenarios in FCM were simulated using seven drivers viz. extension, credit, canal dredging, canal water level, salinity and existing output market prices of irrigated and rainfed crops.



Example fuzzy cognitive map representing mental model of farming system intensification as perceived by farmers in non-polder areas in Barisal Division.

The results of simulation of alternative scenarios based on mental models of farmers in non-polder areas comparison shows that by provision of extension where it is currently absent, farmers perceive that fallow lands could be reduced the by up to 28%. This is in addition to potentially perceived positive effects on both income and food security, respectively. On the other hand, the mental model indicated that increased access to extension may also result in considerably larger potential for irrigated than rainfed crops. Interestingly, simulations of increasing credit access do not appear to have large potential impacts on land fallowing. Observed reductions in perceived incomes may be attributed to farmers' preference for household consumption of irrigated *boro* rice rather than selling it in the market. The increasing effect of credit access on food security corroborates this finding, and indicates that farmers may prioritize increasing household food access over income generation, which has important implications for the potential re-investment of income earned in crop intensification.

Simulations of increased credit access nonetheless resulted in increasing irrigated cropping and decreasing rainfed and extensive production practices. Turning to the perceived impact of crop output prices, it is nonetheless likely that perceptions of rainfed crop output prices drive both rainfed cropping and irrigated cropping with positive contributions to both perceived income and food security. Farmers tend to believe that irrigated rice crop can increase household food security as most of it produced is for own consumption. This behaviour of household is evident by the slight positive perceived effect of irrigated crop prices on food security.

Siltation of canals in several areas of non-polders was reported by farmers during the focus groups, and canal dredging is often suggested by the attendees as a solution. Simulations of the perceived effect of canal rehabilitation indicated more than a one-fold increase in irrigated cropping with a consequent reduction in fallow. The last scenario simulated the combined effect of all potential development interventions associated with cropping systems intensification. This yielded the most promising results with an increase in income complimented by an increase in food security by halving fallow land. In this scenario irrigated cropping grew over two times while rainfed cropping declined by more than 100%.

What can be learned by simulations using fuzzy cognitive mapping? All results coming from this research should be treated cautiously. As cognitive maps are a generalized depiction of what farmers perceive to be key aspects and relationships of their farming systems, perceptions are not the same as reality. Perceptions do however drive farmers' decision making processes, and have an important influence on the adoption of improved cropping practices and intensive management. By simulating potential development interventions aimed are reducing land fallowing, this research has provided potential evidence for how farmers may perceive different development investments, and hence

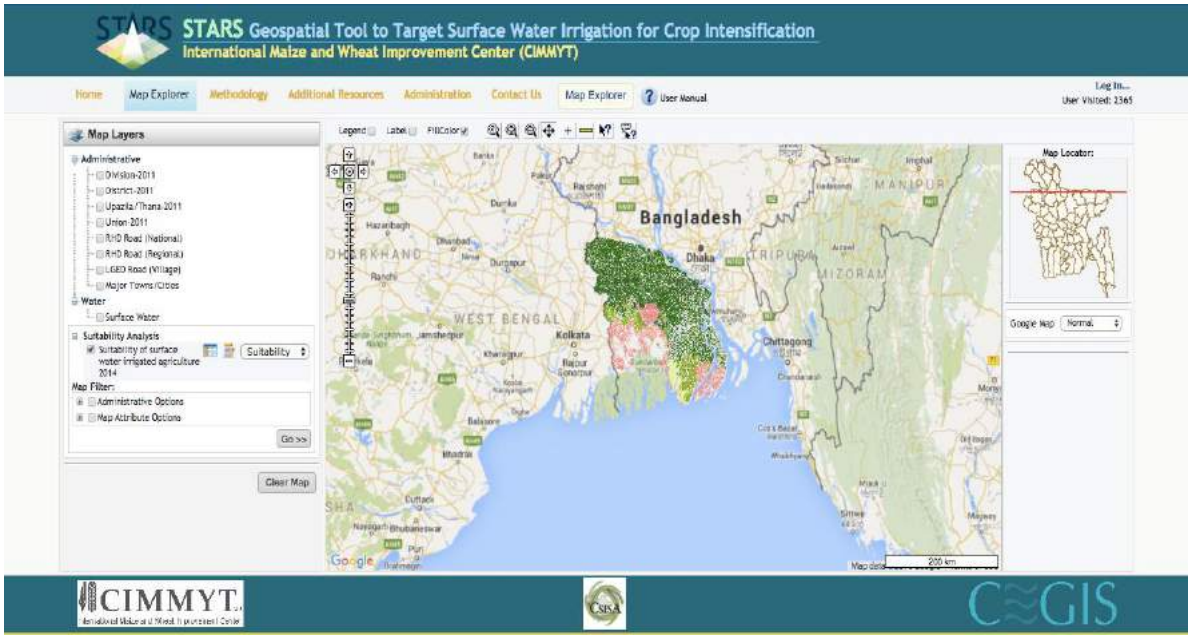
influence their subsequent adoption behaviour. In sum, increased extension, credit, canal dredging, maintenance of canal water supply, and existing output market prices of irrigated and rainfed crops are the major drivers that should be considered and discussed when weighing development investments to intensify cropping in these areas.

Increasing stakeholders' use of science and data to encourage sustainable intensification

NATIONAL SCIENTISTS LEARN HOW TO USE THE GEOSPATIAL TOOL FOR TARGETING SURFACE WATER IRRIGATION FOR CROP INTENSIFICATION IN DAY-LONG, HANDS ON TRAININGS.

In partnership with the Bill & Melinda Gates Foundation-funded 'Spurring a Transformation in Remote Sensing in Agriculture' (STARS) project, CSISA scientists collaborated with the Center for Environmental and Geographic Information Services to develop a decision support tool for geographically targeting surface water irrigation for crop intensification in Bangladesh's Feed the Future zone. The decision support tool is housed on a website and provides a practical, and easy to use tool that allows users to explore, query, and download maps, data, and graphical analyses regarding the potential to use surface water resources to sustainably intensify land in southern Bangladesh that is either currently fallow or rainfed, but which could be transformed into high-productivity cropping in the dry season.

By integrating satellite analysis of crop groundcover, soil and water salinity in canals and rivers, and by examining the duration of the presence of water availability into the dry season, this website provides a practical tool allowing policy makers and planners, researchers, the private sector, and even irrigation service providers to identify tracts of land that are most suited for irrigation. Ultimately, this tool can be used to target and plan where to place small-scale irrigation schemes, and to decide where irrigation pumps and pumping can be most efficiently placed to make use of available water resources to boost cropping intensity in Southern Bangladesh. This research and decision support tool responds to Bangladesh's Country Investment Plan and Governmental mandate to sustainably boost the intensity of cropping in the south of the country, and to alleviate pressures on groundwater in the north of the country, by emphasizing the use of available surface water for irrigation.



THE ONLINE GEOSPATIAL TOOL DEVELOPED BY CSISA AND THE BMGF STARS PROJECT ALLOWS USERS TO ASSESS THE EXTENT OF FALLOW AND RAINFED CROPLAND SUITABLE FOR SURFACE WATER IRRIGATION AND INTENSIFIED DRY SEASON CROPPING IN

BANGLADESH'S FEED THE FUTURE ZONE. THIS ONLINE VERSION OF THIS DECISION SUPPORT RESOURCE CAN BE FOUND HERE: HTTP://202.53.173.179/CIMMYT/HOME.ASPX.[4].

Both CSISA and STARS supported efforts to train stakeholders on the use of this decision support tool. Trainings were conducted in Dhaka and in Barisal Division. Participants included Bangladesh Agricultural Development Corporation staff (a parastatal, BADC leads efforts in small-scale irrigation in Bangladesh), BARI, DAE, IRRI, and the Soil Resource Development Institute, among others. Further trainings and efforts to institutionalize use of the tool in irrigation and land use planning will continue in 2017.

Future activities in rabi fallows development in coastal Bangladesh

Moving forward, CSISA will convene several fora in 2017 with relevant policy makers, donors, and development planners to examine the results of the survey work described above, and to discuss potential avenues for future investments in sustainable crop intensification in southern Bangladesh. Further efforts will also focus on expanding trainings in decision support tool use. These efforts will be complemented by increasing interest among research and development organizations to bring science to bear in improving land and water management in Bangladesh's coastal region. Information on the outcomes of learning exchanges and policy discussions on this topic will be reported in the subsequent semi-annual report.

B.1.4 High-value, premium quality rice expansion Bangladesh

Higher income from rice farming is an important consideration in efforts to improve rural livelihoods in Bangladesh. Nearly all farmers grow rice for home consumption. In some areas, farmers are also increasingly interested in sales of rice produced to generate additional income. The USAID Mission in Bangladesh developed and supported these initiatives, which include the CSISA Expansion in Bangladesh and Rice Value Chain project. These efforts have demonstrated that the cultivation of premium quality rice can be a viable means to increase farmers' income in the Feed the Future Zone. These projects are however now completed, while demand for PQR continues to grow growing at a pace of 5% per year, a result of rising per capita income and preference for fine-grain rice, increasing PQR export by private players, and improved milling facilities.

PQR however currently accounts for only 10% of the total rice area in the FtF Zone. This relatively small area results from insufficient milling facilities or a mill's lack of assured quantity deliveries of PQR for processing, lack of farmers' knowledge about available PQR varieties and associated market linkages with rice buyers, and the need for new stress tolerant varieties with grain quality similar to existing PQR varieties.

In collaboration with DAE, BRRI, NGOs, development partners, agro-input dealers, nursery entrepreneurs, and farmer groups, CSISA has implemented strategic activities to expand the PQR area, increase yield, and enhance farmers' production capacity. Major efforts focus on (1) technology targeting – identification of locations for PQR expansion using biophysical information to assess what varieties are agronomically appropriate, and associated market information including distance to mills and potential for farmer sales of rice, (2) diagnosis of adoption constraints and investment opportunities for PQR, (3) development of training information and extension materials on PQR for partners, (4) training of trainers and extension service providers from DAE and NGOs to increase their knowledge and skills on best management practices for PQR with the ultimate aim of disseminating the technology to farmers, (6) conducting mass media campaigns to increase knowledge and awareness on PQR, (7) facilitating PQR seeds supply to farmers, (8) organizing adaptive trials to verify

[4] Krupnik, T.J., Schulthess, U., Ahmed, Z.U., McDonald, A.J. 2017. Sustainable crop intensification through surface water irrigation in Bangladesh? A geospatial assessment of landscape-scale production potential. Land Use Policy. 60: 206–222. Available online: http://www.sciencedirect.com/science/article/pii/S0264837716302940.

technological and economic performance of different management options for new PQR varieties, and (9) improving farmers' access to market by linking them to traders, millers, and seed suppliers.

Farmers respond to assured PQR markets. A premium crop of BRRI Dhan 34 pictured here.

Through CSISA and previous RVC efforts, demand among millers for PQR is expanding in the Feed the Future Zone.

These actions lead to increased sales of PQR to consumers and income generation for rice farmers in Southern Bangladesh

A PQR diagnostic study showed that the popular PQR variety (BRRI Dhan34) had an average yield of 3.6 tons per hectare and fetched a farm-gate price of USD 0.32 per kg, resulting in a gross return of USD 1,150 per hectare. After deducting the production cost of USD 580 per hectare, farmers earned a net profit of USD 570 per hectare from PQR cultivation. This profit is about 55% higher than that of the popular non-PQR variety (Swarna), despite higher yields with the latter. This difference in profitability shows the potential to earn higher income from PQR cultivation.

Comparatively low yields, a risk to blast damage, unavailability of seeds, and poor knowledge of production practices nonetheless remain major problems with PQR expansion. More than 4,100 husking, semi-auto, and auto rice mills are operating in the FtF Zone. These mills are underutilized half of the year because of short supply of premium quality rice. Hence, enhance in the production of PQR helps better capacity utilization of rice mills and contributes to employment and rural economic growth. Traders and millers further indicated that the demand for PQR was growing and they were willing to be linked to farmers selling these varieties, especially in view of a substantial gap in supply. Millers also showed interest to visit PQR field sites where new varieties are being grown.

In Focus: Growing the potential for premium quality rice in Bangladesh

Securing a high and stable income from farming despite rising cultivation costs is a common challenge for smallholder farmers. This is certainly true in Bangladesh's Feed the Future zone, where rapidly increasing labor wages and input costs are making rice cultivation less profitable and less attractive for farmers. Bangladesh rice farmers currently grow more than 70 premium quality rice varieties, which are characterized by long, slender and fine grains; may or may not have an aroma; and command a higher price than other, popular rice varieties. PQR varieties have a 20–60% price advantage and 50% higher profit over other rice varieties, indicating that there could be significant interest in expanded production.

A farmer (center) receives seeds of BRRI dhan34 in Jessore District.

Demand for PQR is growing at 5% per year because of rising per capita income, leading to increased consumption of PQR, urbanization, growth of modern food supply chains (supermarkets), and growing investment of private companies in the rice value chains. diagnostic study conducted by CSISA found that the popular PQR variety, BRRI dhan34, could be up to two times more profitable

than commonly grown rice varieties. Higher profitability and growth in demand demonstrates considerable potential for expansion in the FtF zone, where PQR currently accounts for a mere 10% of the total rice area. Increased PQR cultivation is also likely to create additional employment for the more than 4,000 rice mills operating in the FtF zone. The study identified that due to a shortage in supply of PQR, these mills remain underutilized for the better part of the year. Initial discussions with millers and traders has revealed a strong willingness to be linked directly with farmers growing these varieties. CSISA is responding by seizing the opportunity to encourage expanded cultivation of PQR by supplying kick-starter seed packages to farmers and working to link them to rice buyers and millers. These efforts are supported by applied research evaluate the yield performance of PQR varieties to identify the varieties that fit best in specific locations, and those with the highest yields.

CSISA focuses on developing pathways for out-scaling. The project has consequently established a partnership with DAE, NGOs, and AIRN to distribute information on PQR market potential. A TOT module and leaflet on better-bet agronomy for PQR cultivation have been developed. Eighty-eight people from the DAE, NGOs, and CSISA also participated in training-of-trainers programs on PQR. Moreover, in the monsoon *aman* rice season of 2016, guides to better bet PQR agronomy were distributed to 850 farmers. CSISA is also currently in the process of distributing 65,000 copies of material on PQR targeting the upcoming winter *boro* season, through DAE, NGO, and AIRN.

One ton of seeds of PQR varieties (BRRI dhan34, BRRI dhan75 and BINA dhan17) were also distributed to 375 farmers (new adopters) at 50% of the retail price to kick-start PQR cultivation in new locations during 2016. The total new area of PQR covered by the project distributed seeds and farmer's purchased seeds was 60 ha, producing 220 tons of PQR, although a total of 273 hectares came under PQR cultivation in neighboring farmers' fields. Further efforts to support PQR expansion in the *aman* season were hampered by reduced staff movement following terrorist attacks in the early summer.

The distribution of PQR seeds at discounted prices to new locations is in the long-run expected to not only increase awareness and knowledge of PQR to farmers in new locations, but also increase the availability of seeds for farmer-to-farmer dissemination to help expand PQR production in the coming year. An additional 6 tons of PQR seeds are currently being distributed to new farmers using a similar approach to encourage expansion of PQR in the *boro* season. CSISA is also working to hire an agricultural value chain coordinator to help link new PQR farmers to assured and viable market buyers, in turn linked to millers. In collaboration with BRRI, CSISA also conduced 36 adaptive trials across three hubs to evaluate the yield performance of eight new PQR varieties. The trials will help identify best PQR varieties for a specific location with high yield. As the crop was recently harvested, production data are still being analyzed and the results will be included in the next report.

B.2 Bringing participatory science and technology evaluations to the landscape and back again

B.2.1 Increasing the capacity of NARES to conduct participatory science and technology evaluations

CGIAR institutes working within South Asia are not expected solely to produce knowledge and technologies through research. They are also expected to leave a lasting impact on national agricultural research and extension systems (NARES) by training and transferring advanced research skills to national scientists. CSISA remains committed to this ideal by aiming to generate clear evidence by year three of Phase III that BARI begins to implement new methods by including them in their annual research work plans.

Last year, NARES scientists were directly involved in research work under several CSISA work streams, including fallows intensification, wheat blast, and precision nutrient management. In the latter category, BARI is implementing on-farm research trials in Jessore Hub (see earlier section on precision

nutrient management). These activities provide hands-on and on-the-job learning opportunities for NARES scientists. While CSISA had planned to conduct additional formal classroom-based trainings in association with these partners, following requests by NARES colleagues to conduct trainings after the dry *rabi* winter cropping season commenced, trainings have been shifted to early 2017. Trainings on R statistical computing, multi-variate data analysis, and on-farm participatory research design will be conducted in the first half of 2017.

At least 20 young scientists from BARI will also gain detailed hands-on training on wheat blast disease surveillance through a residential training program CSISA is holding on 3-22 February in association with BARI's WRC, Cornell and Kansas State University. Funding for these efforts will be supplied both in-kind and directly by these organizations, in addition to support from CSISA and through the USAID/Bangladesh Mission. This intensive training will involve classroom and laboratory sessions on the following topics:

- Pathogen and disease identification
- Laboratory inoculation
- Use of moisture chambers
- Epidemiology and ecology
- Spatial considerations and design
- Sample georeferencing with GPS and data management
- Host resistance
- Blast forecasting and modeling efforts in Bangladesh
- Wheat blast pathogen identification
- Alternate host identification
- Single spore Isolation
- PCR extraction and analysis
- Sample collection, labeling and curation, and storage and media preparation

In addition, participants will take part in a week of field reconnaissance and sampling for wheat blast (both on wheat and on alternative host species) across 15 of Bangladesh's largest wheat growing districts. The resulting georeferenced data will be used to provide up-to-date information to the Ministry of Agriculture regarding the level of intensity and threat of wheat blast. Subsequent annual surveillance studies will also be planned as part of this training effort, resulting in the successful institutionalization of highly relevant disease surveillance methods in Bangladesh.

C. Achieving Impact at Scale

C.1 Growing the input and service economy for sustainable intensification technologies

C.1.1 Commercial expansion of two-wheel tractor based machinery and associated service provision models for reapers and seeders

CSISA III scales-up integrated weed management options through the DAE, the Agricultural Retailer Input Network, and NGO partners. A hands-on, experiential training module detailing the principles of IWM been developed by CSISA and BARI scientists, and endorsed by the Director General of the DAE[5]. It is now being used by AIRN and NGOs.

[5] Krupnik, T.J., Naher, K. Islam, S., Hoque, M.A., Roy, A., Kumar, V., Hossain, I., Hossain, K., Shahrin, S., Gathala, M.K., Shrestha, A., Uddin, S.M.N. 2016. Integrated weed management: Experiential learning modules – Book 2. Mexico, D.F.: CIMMYT. Available Online: http://csisa.org/wp-content/uploads/sites/2/2014/06/Integrated-Weed-Management-Book-2.pdf.

Working with AIRN, 25 lead input dealers were trained on how to implement IWM learning modules.

AGRICULTURAL INPUT DEALERS LEARN HOW TO COMPARE AND IDENTIFY AND CLASSIFY MAJOR WEED SPECIES OF RICE CROPS IN BANGLADESH THROUGH CSISA SUPPORTED TRAINING EFFORTS IN PARTNERSHIP WITH THE AGRICULTURAL INPUTS RETAILER NETWORK (AIRN).

These individuals are now working as master trainers and are in the process of training an additional 800 retailers in 17 districts in FtF zone on IWM principles. These activities result from a sub-grant collaboration and agreement with AIRN which is supported by CNFA's Agricultural Inputs Project. Farmers are expected to widely benefit from increased access to IWM information, as input dealers tend to be their first point of contact for technical information on crop management practices and on weed control in particular. Trainings using the same experiential modules on IWM was were also arranged for 88 persons from DAE and NGOs. The scaling outcomes of information dissemination through this promising and indirect pathway will be detailed in the next report, as trainings will be completed in February of 2017, immediately prior to the winter *boro* season.

In addition, CSISA has reached an additional 850 farmers during the monsoon *aman* rice season of 2016 season by providing information on improved weed management practices through village-level discussions during which farmers have the opportunity to talk with CSISA and DAE technical staff. The project has planned to train an additional 700 extension service providers from DAE and NGO partners during the winter *boro* rice season, and will disseminate IWM guides to 27,000 farmers through trained DAE and NGO staff and to 40,000 farmers through trained input dealers and retailers.

AGRICULTURAL INPUT DEALERS GAIN FIRST-HAND EXPERIENCE OF HOW TO CORRECTLY USE AND APPLY LOW-ENVIRONMENTAL IMPACT HERBICIDES. 800 DEALERS WILL BE TRAINED BY MID-FEBRUARY, ENABLING THEM TO PASS ON INFORMATION ON INTEGRATED WEED MANAGEMENT PRINCIPLES AND PRACTICES TO FARMERS AT SCALE.

To evaluate and identify cost effective IWM options integrating new classes of safe herbicides and manual or mechanical weeding, an additional 30 on-farm adaptive trials were conducted across three hubs. This research was conducted in collaboration with BRRI and private sector partners representing herbicide companies. Because the experimental crops are only now being harvested, the results from these trials will be presented in next report.

CSISA also endeavors to work through value chains to increase the availability of safe and effective

herbicides in Bangladesh. Consultation meetings were therefore organized with private sector players including Auto Crop Care Ltd (ACCL), Dow Agro, Syngenta, and ACI (through the USAID-RVC project with which CSISA partners) to support initial market development of new weed control products for increasing the availability of and access to new classes of safe herbicides approved by USAID but not

available in the FtF zone. Some of these promising new products include bispyribac-sodium and penoxsulam. Discussions are ongoing to implement market tests of these products through dealer networks and for joint evaluation and in adaptive demonstration trials.

As a result of these efforts, ACI conducted on-farm demonstrations in Jessore and Faridpur Hubs on the performance of bispyribac-sodium. ACI has expressed interest to establish markets for this product during the upcoming winter *boro* rice season. The scaling outcomes from these efforts will be detailed in the next CSISA report. In addition, ACCL introduced Penoxsulam for the first time in CSISA's working area and sold 30 liters during the 2016 summer *aman* season. ACCL has continued to request technical support from CSISA, and has expressed an interest in continuing to market this herbicide in the future.

Lastly, CSISA conducted a weed transect study across Jessore and Faridpur hubs to refine weed management recommendations as per dominant weed flora in each region. One hundred twenty farmers' fields were sampled in the monsoon *aman* season during 2016 for weed community diversity and composition. Multi-variate analysis is used to understand how weed community composition is influenced by the landscape, crop management, and cropping systems. Based on these results, simple posters will be developed for input dealers to guide them to make accurate weed management recommendations to farmers.

C.1.3 Commercial expansion of two-wheel tractor based machinery and associated service provision models for reapers and seeders

This intervention focuses on expanding the impact generated in CSISA's complementary investment made by the USAID/Bangladesh Mission in mechanization and irrigation commercialization for smallholder farmers. As an FtF investment, CSISA-MI is constrained to working in the FtF zone exclusively. CSISA III's Dinajpur hub conversely offers considerable opportunities for multi-crop reaper and two-wheel tractor-based direct seeders. As such, this intervention aims to integrate CIMMYT's core partner in CSISA-MI, International Development Enterprises, to work with established CSISA staff in the north to develop value chains and an enabling environment to expand the affordable commercial availability of machinery appropriate for smallholder cereal farmers in northern Bangladesh.

Working with iDE, CSISA will focus on (1) engagement with lead firms and finance partners through a market facilitation approach, (2) intervention design and delivery to develop effective supporting services and an enabling environment in the market for the target machineries, and (3) advisory on monitoring and results measurement approaches to inform activity improvements in scaling-out machinery availability. CIMMYT and iDE have signed a sub-agreement to formally initiate activities, although iDE has already begun work in Dinajpur in anticipation of developing agricultural machinery value chains. Key goals of the upcoming sub-grant, which will result in at least 900 hectares of land under scale-appropriate machinery in Dinajpur in 2017/18, include:

- The creation and monitoring of joint venture agreements (JVAs) – or modification of existing JVAs – with key private sector partners who already sell two-wheel tractor-based seeders and reapers in the FtF zone, but do not yet sell these machines in Dinajpur and surrounding districts.
- The creation and monitoring of a JVA with key financial sector partner(s) who lend to two-wheel tractor-based seeder and reaper customers in the South, but do not yet make such loans in Dinajpur and surrounding districts.
- Linkage creation between key market actors in Dinajpur and other districts in Dinajpur hub where machinery sales and local service provision aligned with CSISA III's goals are possible, as agreed by CIMMYT and iDE. Such actors might include dealers, sales representatives, lenders, mechanics, and spare parts shops.

In the interim period during which appropriate business models and intervention activities are being planned in Dinajpur, CSISA Phase III made complementary investments through staff time and strategic support activities associated with the CSISA-MI project in the FtF zone itself[6]. CSISA III's technical backstopping and training and coordination with CSISA-MI resulted in 5,745 hectares of land coming under fuel-efficient surface water irrigation technologies in the FtF zone (a 66% positive deviation above irrigation coverage targets for CSISA III), and additional hectares of rice and wheat being mechanically harvested and threshed by service providers trained and supported by CSISA. Moving forward, CSISA will continue to leverage synergies with complementary CSISA-MI project investment that is strategically aligned with the broader CSISA program, to expand farmers' access to scale-appropriate machinery services in the FtF zone. These efforts will come in addition to machinery expansion in Dinajpur hub, which are in the long run hoped to spur further independent private sector investments in agricultural machinery markets in other parts of the country.

C.2 Managing risk by coping with climate extremes

C.2.2 Early wheat for combatting heat stress

Wheat is commonly grown in South Asia's rice–wheat cropping systems during the dry winter *rabi* season from November through April. It is the region's second most important food security crop after rice, including in Bangladesh. Average yields in Bangladesh are 67 kg per hectare below the regional mean of 2.75 tons per hectare. Currently, per capita wheat demand is 17.3 kg per year, approximately 20% of rice consumption. With 3% more protein than rice, wheat makes an important contribution to protein intake at 4.3 grams per day. While Bangladesh's wheat production decreased by 34% in the last decade, aggregate demand jumped by 13% in the same period. Bangladesh's wheat imports are currently ~3.12 million tons a year, costing US$ 0.67 billion in foreign currency reserves in 2013.

Wheat is however a temperature-sensitive crop in Bangladesh. The winter *rabi* season duration and intensity of Bangladesh is less than ideal for non-stressed production. Wheat in particular is sensitive to heat stress. Exposure to temperatures above 30°C can reduce photosynthesis and increase the rate at which the crop matures, resulting in reduced grain filling. At very high temperatures above 32°C near crop maturity, the loss of photosynthesis is more severe, resulting in reduced grain size and number. Where farmers are unable to establish wheat within recommended planting windows or cannot access stress-tolerant or early-maturing cultivars, research in Bangladesh has shown that large productivity declines are possible, in agreement with crop modeling efforts that indicate a 3–17% yield loss for each 1°C of rising temperatures in South Asia.

In this situation seeding time plays a very important role in determining yield. In the mid-1980s, BARI's WRC suggested that the optimum time for wheat seeding is 15–30 November, though recommendations were made for the whole of Bangladesh. More recent information indicates that farmers in the northwestern districts can sow wheat slightly later as winters in the north are comparatively longer than in the south, thereby resulting in less temperature stress, particularly at the crop's reproductive stage, though the extremely high global temperatures found in 2015 and 2016 – which are at least partly a result of climate change – still cause problems for the maintenance of acceptable yield. Late sown crops are also susceptible to violent early storms that are common in March and that can cause the crop to lodge, which has a serious negative impacts on productivity. This is of special concern for wheat grown in the southern districts of Bangladesh. Available evidence

[6] Through co-investment and shared CIMMYT staff during FY 2015-16 by the broader CSISA-MI, a portion of mechanization activity achievements in Bangladesh have also been reported alongside interventions pursued jointly in CSISA-MI. Co-investments in mechanization activities between the sub-projects under the wider CSISA program umbrella offers opportunities to leverage synergies among public and private sector partners and to achieve enhanced on-the-ground impact in the FtF zone.

also suggests that late sown wheat is also more susceptible to diseases spread by high temperature and humidity conditions including leaf blight, leaf rust, and wheat blast (see section 'agronomic and variety recommendations to reduce the threat of wheat blast'). As such, the simple act of sowing wheat as early as possible can have considerable yield and risk reducing impacts in Bangladesh. For this reason, CSISA focuses on collaborations with partners and research institutes to spread awareness and action encouraging early sown wheat to combat heat stress and prepare farmers to adapt to climate change.

CSISA's strategy in Bangladesh is centered on solving key problems that reduce farmers' ability to sow wheat on time. Hence, rather than develop generic extension campaigns on the benefits of early wheat sowing, CSISA works to target the most formidable constraints to early wheat sowing – several of which are not agronomic – and accordingly develop intervention plans that farmers can rapidly act upon. To identify the causes of late seeding, CSISA conducted 20 focus groups with wheat farmers in Dinajpur, Jessore, Faridpur and Bhola districts. Three hundred wheat farmers and respective Sub-assistant Agriculture Officers (SAAOs) from the DAE attended these meetings.

EARLY WHEAT SOWING HELPS FARMERS COPE WITH THE RISKS OF YIELD REDUCING EXTREME HEAT AT THE END OF THE SEASON, AND PROVIDES A SIMPLE AND ACTIONABLE BEST MANAGEMENT PRACTICE THAT FARMERS CAN IMPLEMENT TO INCREASE PRODUCTIVITY WHILE HEDGING AGAINST CLIMACTIC RISKS.

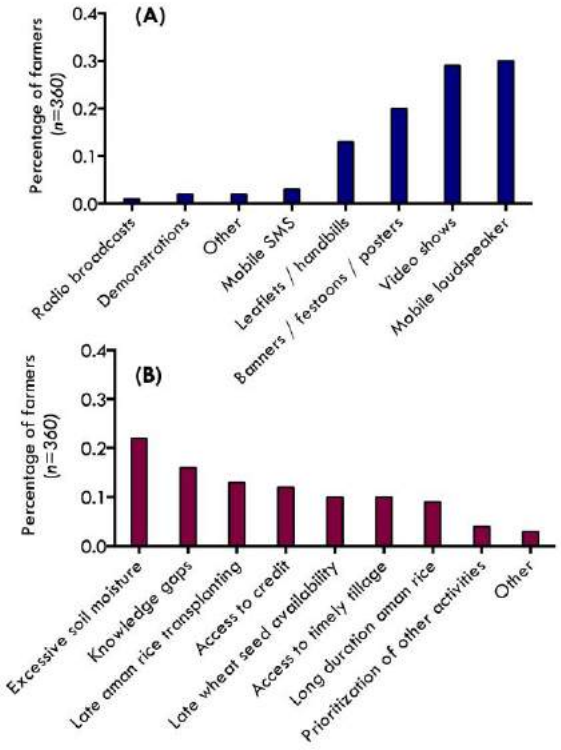
Resulting data revealed that high soil moisture at wheat seeding time was the number one cause of late seeding, followed by knowledge gaps on the benefits of early seeding, late planting and long duration of the prior *aman* rice crop, poor access to credit facilities, late availability of seeds, and poor access to machinery (reapers, tillers, seeders). Excessive soil moisture is a function of an agricultural field's landscape position, and is not actionable in terms of shifting wheat sowing dates earlier. The other constraints to early wheat sowing are actionable, and CSISA has subsequently implemented a strategy that avoids poorly drained soils while targeting farmer groups to raise awareness of early sowing through partnerships with SAAOs. DAE data were also used to target Upazilas where wheat tends to be sown much after recommended planting dates, but where landscape elevation is not a constraining factor. In addition, CSISA has also worked to aggregate wheat farmers who wish to sow earlier into large blocks, so that rice reaping and tillage service providers can service them as clients in a more timely manner. Combined with farmers' new enthusiasm for early sowing, these actions help to create a favorable environment in which farmers can more easily establish their wheat crop on time. Longer-term interventions considering options to increase farmers' access to credit and timely availability of seed are also under development.

Farmers were also asked questions as to what ways they could be motivated to adopt early wheat seeding. Their resulting answers provided insight into what they perceive as the most valuable and effective form of mass media communication to spread awareness on early wheat sowing. Farmers also added that video shows early wheat sowing in public gatherings can be an effective method of rapid information dissemination, followed by hanging banners/festoons, posters in public places, leaflet distribution, etc.

As per farmers' advice, tailored activities for the 2016/17 wheat season are being implemented at the time of writing. Audio clips have been prepared and broadcast using loudspeakers at strategic locations (e.g., high volume village markets) in three hubs. A total of one hundred sixty five person days of mobile loudspeaker communication has been completed using small three-wheeler vehicles that travel from village to village to spread awareness on early wheat sowing. Three hundred thousand Bangla language leaflets on early wheat seeding have been printed, of which 174,000 have

been handed over to the government, NGOs, and private sector partners for distributing to farmers. Three hundred eighty five banners and festoons were printed and hung in public places where farmers frequently visit, for example in the vicinity of markets and input supply retailers. And in order to build partner organizations' awareness of these issues, 22 orientation meetings were organized with 660 SAAOs in 22 working Upazilas of three hubs. Eighty-four thousands leaflets were handed over in these meetings to distribute to farmers. Input dealers associated with AIRN have also distributed 54,000 leaflets. Ninety local NGO staff from SDC, JCF and RDRS, were also oriented on early wheat seeding technologies, with 36,000 leaflets distributed through them.

In addition, 18 consultative meetings were organized with farmers, machinery tillage service providers, input dealers, and SAAOs to tackle the issue of aggregating wheat farmers to better access machine harvesting, tillage and sowing, and input services. Farmers agreed to begin growing the same early maturing *aman* rice variety in large blocks, so that rice could be rapidly harvested at the same time, thereby enabling a tillage service provider to prepare many fields for timely wheat sowing in the same area, thereby lowering their transactions costs and making wheat field preparation financially attractive. Dealers were requested to collect seeds early, so that farmers can purchase and sow wheat early. In these meetings, rice reaping and seeding wheat by two-wheel tractor-drawn direct seeder was demonstrated. Machine use can clearly reduce the turn-around time between rice harvest and wheat seeding. Twenty-three farmers' participatory strategic demonstrations were installed in different hubs as learning centers. Demonstrations included in two seeding dates (early and late) sown in large blocks. Field days will be organized with farmers, concerned government, NGO and private sector partners to show the crop performance in early 2017. From these field days many farmers will adopt early seeding and other participants will be motivated and will convince other farmers to adopt it. Because wheat sowing is completed in mid-December, the results of these efforts will be reported in the next CSISA report.



RESULTS FROM FARMER SURVEYS ON EARLY WHEAT SOWING. (A) PREFERENCES FOR DIFFERENT TYPES OF MEDIA TO BE USED FOR EXTENSION AND AWARENESS BUILDING ON EARLY WHEAT SOWING, (B) KEY CONSTRAINTS TO EARLY WHEAT SOWING IDENTIFIED BY FARMERS.

Challenges faced during the reporting period

The primary challenges encountered in the first half of year 1 of CSISA Phase III in Bangladesh have their origins in the beginning of the project, which began field activities on December 1, 2015. The winter *rabi* crop season in Bangladesh is sown from October through early December, and as such we were unable to implement planned activities during this season.

Additional challenges were encountered with respect to field staff's ability to travel and conduct field work given the heightened security precautions in Bangladesh following terrorist attacks on foreigners in late 2015 and mid-2016. Most USAID-funded projects suspended or interrupted activities for at least part of the year following the massacre of over 20 people – predominantly foreign workers in Bangladesh – at a café in Dhaka in the middle of 2016. Following that event, the Government of Bangladesh launched counter-terrorist operations that appear to have reduced the current threat of attacks, although these events still took a significant toll on CSISA's ability to fully

implement work plans.

Despite these setbacks, the project was at least partially able to utilize the 2015/16 winter season to sensitize new and continuing staff members with respect to the CSISA III intervention plan, and to prepare for *aman* 2016 rice activities, although these too were not fully implemented due to the reoccurring terrorist threat. Additional setbacks included miscommunication between Governmental agricultural offices that resulted in the Department of Agricultural Extension' sudden decision to actively campaigning against wheat cultivation in Jessore hub given their perceived threat of wheat blast disease. This hampered the project's ability to fully promote early wheat sowing practices. The current reporting period falls at the beginning of the 2016/2017 winter dry season, meaning that most of the performance indicator information for the project will be collected in early 2017, and reported in the next semi-annual report.

A. Innovation Toward Impact

A.1 Reducing Risk to Facilitate Uptake of Sustainable Intensification Practices

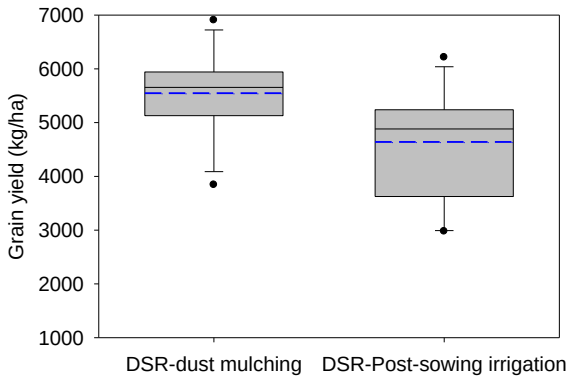
A.1.1 Directly-sown rice (DSR) to address labor and energy constraints to precision rice establishment

Due to outmigration and an aging rural workforce, seasonal scarcity of agricultural labor is one of the biggest challenges to the viability and profitability of Nepalese agriculture. Traditional rice establishment practices of manually transplanting seedlings into puddled fields cost farmers time, labor, energy, and money. Machine-sown dry direct-seeded rice (DSR) is a cost-effective technology that allows the direct line sowing of rice seeds into non-puddled fields and avoids the cost of raising rice nurseries and transplanting seedlings. In this context, DSR can be a suitable alternative to conventional transplanted puddled rice.

In 2016, DSR area expanded to > 350 ha, 60% more than in 2015.

DSR can also be riskier, though, than transplanted puddled rice due to higher weed pressure and the possibility of stand mortality with early rains. The selection of suitable land, deployment of trained service providers, timely crop establishment and utilization of integrated weed management practices are pivotal for reliably obtaining good yields with DSR. Innovation also plays a role, with the 'dust mulching' approach to stand establishment along with investment in early irrigation now being evaluated across landscape gradients in Nepal from the perspectives of risk-reduction, yield stability, and yield potential. CSISA III's DSR-related activities function synergistically with the machinery focus of the CSISA-Nepal Mechanization and Irrigation program, and also expand beyond the FtF zone into areas where machinery value chains are the strongest (e.g. Nawalparasi and Rupandehi Districts). For a technology that is a radical departure from conventional practices, it is essential to help create a critical mass of first adopters.

Reducing production risks is the essential first steps towards making DSR viable at scale. CSISA conducted on-farm evaluations of DSR using 'dust mulching', a simple management adjustment that uses pre-sowing irrigation followed by shallow tillage to better control weeds and limit evaporative losses, thereby reducing early irrigation requirements. Paired experiments comparing dust mulching to post-establishment irrigation were conducted on 16 farmers' fields in Banke, Bardiya, Kailali and Kanchanpur Districts. Results showed that dust mulching significantly **increased yield (20% higher) and decreased early weed pressure (25% less)** compared to post-sowing irrigation DSR (see inset)**.** The outcome of this applied research which promises to significantly reduce the production risks associated with DSR will be broadly disseminated before the next rice season through radio jingles, new and existing service providers, seed producers' groups and other private partners.



To scale DSR and to create a critical mass of first adopters, CSISA organized a coordination meeting with service providers, key farmers, the District Agriculture Development Office (DADO), and machinery traders. To help famers cope with shrinking labor availability and water limitations to rice establish, DSR has now been adopted as a priority technology for the Terai by the Department of Agriculture as a direct result of CSISA's efforts. In Rupandehi District, the DADO conducted block demonstrations of DSR in 25 new areas with backstopping support from CSISA. In all demonstrations, DSR produced similar or higher yields to conventionally transplanted rice while significantly reducing production costs and early water requirements for crop establishment. **In aggregate, more than 350 ha were planted to DSR through service providers in 2016 – an increase of more than 60% over 2015.**

B. Systemic Change Towards Impact

B.1 Partnerships for inclusive growth around commercial pockets and neglected niches

B.1.1 Deployment of better-bet agronomic messaging through input dealer networks and development partners

Despite growth in the private sector and recent re-investments in extension, many poor communities in the Eastern Indo-Gangetic Plains are not connected to these sources of agricultural knowledge. On the other hand, considerable investments have been made in South Asia through rural livelihoods projects (e.g. the Knowledge-based Integrated Sustainable Agriculture and Nutrition (KISAN) project in Nepal). These initiatives have tremendous connectivity with marginalized groups, including women farmers, and can be leveraged to extend better-bet management information to communities that otherwise are disconnected from most formal and informal knowledge sources.

In collaboration with the Nepal Agricultural Research Council (NARC), CSISA has developed better-bet agronomy 'tips' for rice and maize (see inset). In very simple terms, the factsheets explain low-risk options for improving management practices from seeding to harvesting and storage. They have been deployed through KISAN, state extension, and agricultural retailer networks across the FtF zone. Factsheets were distributed in the beginning of April, before the growing season started. CSISA also organized 'training of trainers' (ToT) events around these factsheets so that they can be effectively deployed as part of the hands-on training programs of extension and development partners as well as serving as a stand-alone resource. The reach attained through these channels is extensive, with the **KISAN network in the FtF zone alone reaching 60,205 rice farmers and 69,923 maize farmers**.

Ex post evaluations of the new practice adoption by farmers who have received the tips is in process with our development partners and will be included in the semi-annual report.

B.1.2 Income-generating maize production in neglected hill and plateau ecologies

Maize is the major summer crop grown in upper valley of Dang, Surkhet and foothills of Banke districts covering > 60,000 hectares. Most farmers rely on maize production for basic food security, although productivity is low at less than 2 t/ha. Nevertheless, maize is a potentially remunerative crop in areas where feed mills and value chains are emerging to support the poultry and dairy industries. The incentives for local product sourcing is strong, as feed is currently procured from

considerable distances (mostly from Bihar and Andhra Pradesh in India), eroding profitability by increasing transportation costs. Further, political disturbances at the Nepal–India boarder in 2015 severely disrupted imports, forcing many feed mills to temporarily close. Nevertheless, concerted and coordinated efforts are required to take advantage of these market opportunities since the consolidated supply chains from India benefit from economies of scale and, boarder closings aside, provide a virtually unlimited supply of high-quality product that can be procured through established brokers through a single phone call to arrange shipment directly to the factory gate.

INTERNAL DEMAND AND FEED MILL PROCESSING CAPACITY FOR MAIZE IS INCREASING IN NEPAL, PROVIDING NEW INCENTIVES ('PULL FACTORS') FOR INTENSIFIED PRODUCTION

In Phase II, CSISA conducted research and worked with farmers in Nepal's hill region to demonstrate basic agronomic methods and promising varieties that could substantially increase maize yields to 6 to 8 t/ha. Based in part on these efforts to demonstrate the yield potential in these long-neglected production environments, a host of new public and private sector-led initiatives are taking form. In collaboration with the National Maize Research Program, four maize hybrids (Rajkumar, Bioseed 9220, Nutan and TX 369) were formally registered and approved for cultivation in the Mid and Far-West Development Districts. Prior to these efforts in 2016, there were no hybrids registered in the FtF zone which made private sector partners unwilling to actively stock and market these elite seeds. Even more importantly, the Ministry of Agricultural Development has started an agricultural commercialization project ('super zone' concept) for maize in Dang District, which is one of three locations where CSISA focuses maize intensification efforts. As part of CSISA's efforts to mainstream science-based innovation with partners to accelerate and sustain change, the project will assist the Government of Nepal with technical priority setting across the maize super zone based on the results of applied research and also survey-based insights into how farmers are actually managing their crops in different production domains.

During the reporting period, CSISA developed an inclusive model for strengthening the maize value chain with an initial thrust centered around increasing input availability (e.g. hybrid seed) and providing technical training for dealers and feed mill staff who in turn will potentially reach large numbers of farmers. A total of 20 agricultural technicians from private sectors partners (Rapti Feed Mill, NIMBUS Feed Mill, and associated agricultural cooperatives) were trained on maize production technologies as well as methods for conducting effective demonstrations and communicating the value of new innovations to farmers. In turn, these **mills established 700 community demonstrations** as part of their initial efforts to procure maize locally in association with farmer groups and cooperatives. To jumpstart market development activities for new inputs, CSISA organized joint monitoring visits in farmers' fields with public and private sector partners. As part of this initiative, regional input dealers like NIMBUS were introduced to local retailers to form business alliances and distribution networks where they were previously absent. **NIMBUS then invested about US$ 30,000 to pre-finance stocks of hybrid seed at the retailer level, to support 'introductory' pricing schemes for those hybrids, and to bear the costs of associated field demonstrations**. To our knowledge, this development represents the first time that the private sector has invested its own resources in maize production in the FtF zone.

Drawing on the lessons learned from 2016, CSISA intends to expand such partnerships in Banke and Kailali in 2017. We will work with Karnali Feed Mill in Banke and Bardiya, and Far-Western Feed Mill in Kailali and Kanchanpur. In this process, CSISA will facilitate contractual agreement between farmer's groups and cooperatives and feed mills and their traders for output marketing. CSISA will also provide technical support to farmers for sustainably intensified maize production through trainings, visits, strategic guidance in collaboration with MoAD's Maize Super Zone project and District Agricultural Development Offices. Similarly, technical support will be given for organizing demonstrations under NIMBUS's leadership and protocol development for such demonstrations. Over all, this model aims to achieve the following outcomes in 2017:

- 3,100 ha additional land planted with hybrid maize
- 1000 demonstrations of hybrid maize organized in private sector leadership
- 200 contracts signed between feed mills and maize growers
- 50 traders engaged in the maize marketing

As a complement to market development activities, CSISA continues to embrace science-led innovation where needed to address key knowledge gaps. Maize is the dominant food security crop in the upper valley of Dang and Surkhet Districts. In the last 3 years, production was severely affected due to stalk rot disease, which in cases caused complete crop failure. Very little research has been conducted on how to control this disease in Nepal. In response to this threat, CSISA organized a consultation meeting with the Department of Agriculture and the National Maize Research Program (NMRP) to identify possible entry points to overcoming the problem and joint priorities for new field research. The disease has been widely observed in the low hill ecologies of the FtF zone and appears to be exacerbated by imbalanced use of fertilizer (e.g. only applying urea). This year was favorable for the disease infestation with 65% of the maize field in Dang and Surkhet being affected by this disease, with estimated yield losses ranging from 60–100%.

STALK-ROT AFFECTED MAIZE FIELD IN DANG DISTRICT

To disentangle the interactions between disease severity and fertility management practices, CSISA established on-farm experiments in Surkhet and Dang Districts. Similarly, in collaboration with NMRP and Agriculture Research Station (ARS) Surkhet, CSISA initiated research on integrated disease management that builds on the fertility management component to include varietal screening for resistant genotypes in combination with the judicious use of fungicide and insecticide.

Preliminary results suggest that spraying of the insecticide (Cypermethrin) and bactericide (Streptocyclin) twice **(**i.e. knee height stage combined with a subsequent spraying after 15 days) **reduced the disease infestation by 53% and increased yields up to 40%**. Similarly, disease severity was reduced under balanced fertilization compared to farmers' practice. As this disease is localized and severity changes with weather conditions**,** this evaluation needs to be repeated in order to see the treatment effect across the years. Outcomes of this evaluation will be endorsed by DADOs and the government agriculture modernization program (Maize Super Zone), and will be deployed using social media campaigns in disease-prone areas during the upcoming 2017 season.

Mechanical maize seeding: A new initiative in Dang

In the mid-hills of Nepal, almost all farmers sow maize by dropping seed behind a bullock-drawn plough. Not only does this result in imprecise crop establishment, bullocks numbers are declining

significantly and crop establishment is often delayed as farmers wait; this reduces maize productivity and also compromises the performance of the second crop in the annual rotation**.**

CSISA has introduced the first seed drills for maize into the hills of Nepal for both the two and four-wheel tractor platforms. Potential service providers have been offered technical training and several have purchased their own drills. Prem Kandel purchased a drill and immediately started to provide mechanical maize seeding services to other farmers, reaching more than 10 ha in the summer 2016. He stated, "From a single seed drill I could not provide service according to all of the farmers who demanded it." He now plans to buy another seed drill for the forthcoming maize season in order to keep up with farmers' maize-sowing needs. A client, Gima Kanta Sapkota, a member of Ananta Memorial Agriculture Cooperatives, observed that due to line seeding, **intercultural operations had become simpler and faster, including weeding and fertilizer application. The labor (female) needed for weeding in particular was reduced by 20%.**

CSISA's focus on new mechanized technology introduction thorough service providers is permitting maize farmers in the hills of Nepal to reduce drudgery and enhance profitability through costs savings and yield enhancement from precision management.

FIELD PREPARATION WITH BULLOCKS

WEED MANAGEMENT IN A MAIZE FIELD WITH RANDOM PLANT GEOMETRY

DRILL DEMONSTRATION AND SERVICE PROVIDER TRAINING

REGULAR ROW GEOMETRY AND UNIFORM STAND

C. Achieving Impact at Scale

C.1 Growing the input and service economy for sustainable intensification technologies

C.1.1 Integrated weed management to facilitate SI transitions in rice

Poorly controlled weeds can result in complete crop failure for rice, and routinely cost farmers between 15 and 30% of their yield potential in Nepal. In some of the Terai districts, farmers have recently started using herbicides for rice and wheat, often relying on recommendations from local input dealers. However, most of the time there is little association between the nature of the weed problem in the field and control recommendations that are made by dealers or extension.

To address this disconnect, CSISA conducted a baseline survey to document problematic weed species and current control strategies. Detailed survey information was collected across six Terai districts (Nawalparasi, Rupandehi, Banke, Bardiya, Kailali and Kanchanpur) and included information on which herbicides are being used, where they are obtained, and what types of recommendations are being provided by input retailers. Findings include:

WEED INFESTATION IN A TRANSPLANTED RICE FIELD, KANCHANPUR DISTRICT

- 22 different weed species are present in rice fields, and among them grassy weeds are the most problematic both in uplands and lowlands.
- About 60% of farmers apply herbicide to control weeds as post and pre-emergence application, mainly in an effort to minimizing the costs involve for weed management and also due to scarcity in farm labor.
- More than 85% of farmers purchased herbicide from input dealers and many requested herbicides based on the suggestion of a neighbor, based on the bottle color and form of herbicide, i.e., granular, liquid or powder.

The input retailer survey suggest that most are unaware of proper rates recommendations, safe spraying techniques, or the importance of linking herbicide selection to the actual nature of weed problems as they exist in farmer's fields. Based on this information, CSISA is designing a training program for retailers (to be implemented in 2017) and also cultivating backward linkages in the herbicide value chain to develop markets for modern and safe products that are well matched to the weed flora in the Nepal Terai.

C.2.1 Coping with a weak and variable monsoon and avoiding kharif fallows

Healthy rice seedlings for higher yields: better nursery management for transplanted rice

n Nepal, rice nursery establishment and transplanting are highly dependent on the monsoon, as more than 80% of rice is grown under rainfed conditions. Poor crop establishment is one of the major constraints to rice productivity, especially early incidences of abiotic stresses, such as drought and flood. Uncertainty around monsoon onset and erratic rainfall patterns also affect the timing of nursery establishment and transplanting. The use of healthy seedlings grown in properly managed nurseries to ensure good crop stand following transplanting is one of the major adaptive strategies in response to this threat.

TIPS FOR RICE NURSERY MANAGEMENT FOR TRANSPLANTED RICE

CSISA developed a factsheet on better nursery management for healthy seedlings and provided training to the technicians from DADOs, KISAN, and seed companies. As a result, 800 farmers in the FtF zone transplanted 240 ha using healthy seedlings.

Deployment of the tips on healthy seedling was delayed in 2016 as it could not be printed in a timely manner due to a shortage of printing material in the market – residual effects from the 2015–16

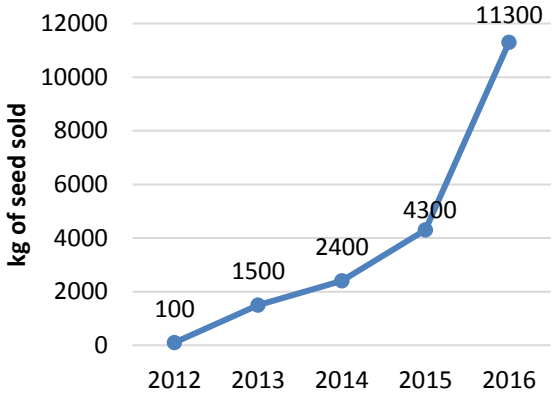
border blockade with India. We anticipate that the area under healthy seedlings will be significantly increased in the coming season by getting out timely messages through DADOs, seed companies and farmer co-operative groups.

Adoption of high-yielding and shorter duration rice hybrids

In Nepal's Mid and Far West Terai, rice is grown on 246,976 ha, with a total annual production of 838,028 MT. Average productivity is around 3.4 t/ha, much below the area's achievable yields. Some farmers are growing improved varieties, but many of these varieties do not have resilience traits that are advantageous for maintaining high yield potential in the rainfed and partially-irrigated systems that predominate in Nepal.

MR. NATHU RAM CHAUDHARY IN HIS DY 69 FIELD

In 2012, CSISA began participatory field evaluations of rice hybrids that were registered in Nepal but not commonly available in the market in the FtF zone. These evaluations found that DY 69, a short-duration rice hybrid that matures in 120 days, to be consistently high yielding (nearly 10 t/ha). As a short-duration hybrid, DY 69 avoids late season water stress in years when monsoon rains end prematurely and allows farmers to capture residual moisture and sow winter crops early, which can increase the yield of wheat by up to 50%. CSISA distributed limited quantities of DY 69 seed through District Agriculture Development Offices in Kailali, Kanchanpur, Banke and Bardiya, and evaluated DY 69 in large plots and strategic demonstrations. CSISA also organized monitoring visits for DADOs and CSISA advisory committee members to show the performance of DY 69.



Many farmers who have observed DY 69's high yield and resilience to stress began cultivating it. Due to rapidly increasing demand for DY 69, Kisan Agrovet, one of the leading dealers of DY 69 based in Dhangadhi, reported that his sales of this hybrid have increased significantly each year and reached 11 MT (see inset). **In 2016 more than 40 retailers in the FtF zone sold a total of 20 MT, enough to plant over 1,000 ha.** Farmers reported yields of between 8 and 10 t/ha this year, and demand out-stripped supply – an envious position that the retailers will capitalize on in 2017 by stocking more seed.

Transitioning to maize in drought-prone areas

The productivity of rainfed rice in the well-drained soils that predominate in pockets of the Terai is unstable and very low in years when monsoon rainfall is weak. To reliably grow high-yielding rice in these soils requires frequent rainfall or irrigation. In these areas, crop diversification away from rice by substituting crops like maize or soybean may be the best options for mitigating drought and increasing stability and average productivity.

MAIZE GROWN IN THE MONSOON SEASON IN THE TERAI

In the Mid and Far West there are large areas with light textured soil that may be more suitable for maize than rice. CSISA introduced maize to several of these areas in 2016, comparing it with rice cultivation in adjacent fields. **Even in a relatively 'normal' monsoon year like 2016, the profitability**

of maize was approximately $250 per hectare higher than for rice. In a drier year, we anticipate that this difference will be even higher. The output of CSISA's research will be shared and deployed through DADOs, farmers' groups, feed industries, and the government agriculture modernization project (i.e. maize 'super zone' chosen to make the country self-reliant in maize production) and for coping with a weak and variable monsoon. We estimate that there are approximately 10,000 hectares of excessively drained land in the Nepal Terai within the FtF zone where farmers can profitably transition to maize. The same market development approaches used to accelerate the expansion of commercial maize in the hills will be deployed in these ecologies.

C.1.1 Commercial expansion of two-wheel tractor based machinery and associated service provision models for reapers and seeders

In Nepal, Rupandehi and Nawalparasi Districts fall outside the FtF zone of influence but are instrumental in strengthening the value chains for **scale-appropriate mechanization** at a national level. Working with public and private sector partners (including the CSISA-support NAMEA private sector trade group), we have facilitated linkages between District Agriculture Development Offices, local machinery suppliers, and 32 new and existing 2WT reaper service providers who were supported by the project in Phase I to address machinery-related constraints to reaper harvesting, including availability of reapers, spare parts, and advanced practical training on operation. The unavailability of machinery spare parts has been identified by our stakeholders as a core constraint that impedes the spread of sustainable intensification technologies in Nepal and our private sector partners have agreed to aggressively resolve this weakness in the value chain with support from the DADOs. With this support and network area under use of reaper for harvesting rice and wheat will increase significantly in the coming season.

Opportunity for expansion of farm mechanization in Nuwakot and Makwanpur

Building on knowledge and networks gained under CSISA's Earthquake Recovery Support Program (2015–16), CSISA III, in September this year, took the opportunity to establish an office in Nuwakot District. CSISA collaborated with traders, DADOs and farmers' groups for the demonstration of the 2WT-operated reaper and thresher during the 2016 rice-harvesting season. This was the first introduction of this technology in the district. Farmers and DADOs were impressed with CSISA's efforts and the introduction of the technology was a major highlight for the news. In collaboration with traders, CSISA also organized an operators' training on reapers.

In the same season, following the training, Prem Kandel, a service provider with a two-wheel tractor, immediately started to provide reaper services for rice to other farmers. Demand for his services further increased after farmers saw the benefit. **Mr. Kandel has since provided reaper services on more than 15 ha of rice in 2016.** After seeing the benefits, 2–3 other 2WT service providers are planning to purchase reapers for the coming wheat season. There is huge potential for the expansion of reaper technology as there are already more than 400 2WT service providers in the region.

Challenges faced during the reporting period:

- Early onset of the monsoon restricted the sowing window for DSR, so the area under DSR was not as large as expected.
- Nepal suffered a five-month trade and energy blockade starting in the third week of September, 2015. While Nepal normally receives over 300 fuel tankers per day, for much of the blockade newspapers reported tankers crossing in single digits spurning a massive growth in smuggling

and black-marketed fuel. CSISA field staff were greatly hindered from getting to the fields due to lack of fuel and violence that affected the Mid and Far West Regions. Fertilizer and seed for trials were difficult to obtain and finding fuel for project vehicles and tractors was challenging. The private sector was not able to supply key machinery on time as their trucks and containers were stuck for 3–5 weeks at the border. Fuel shortages for tractors and irrigation pumps obviously had a significant effect on farmers and overall production as well.

D. Policy Reform

D.1 Seed Systems

Bangladesh

CSISA continues to work closely with partners in Bangladesh to promote seed sector reforms. Key to this are efforts to encourage the development of a private seed industry, define a more appropriate role for the Bangladesh Agricultural Development Corporation (BADC), reduce regulatory barriers, and improve private sector access to foundation seed developed through the public research system. One of CSISA's priorities going forward is to explore opportunities for regional harmonization in varietal registration procedures beyond rice.

A challenge in effecting sustained change in Bangladesh's seed system is that varietal turnover rates are very low. Much of the required supply of quality seeds for different crops comes from farmer-saved seeds. This, in turn, limits farmers' access to genetic improvements that are embodied in new varieties. Furthermore, a challenge to the expansion of a private seed industry is the existence of a large parastatal (BADC) with vested interests. Its existence increases the barriers to private sector entry, and hinders improvements to the regulatory environment.

CSISA continues to work closely with several partners on the seed systems front, including IFPRI's Bangladesh Policy Research and Strategy Support Program, the main CGIAR centers, programs, and projects that are active in Bangladesh, the national research system, and the donor community.

Nepal

CSISA is working with the Seed Entrepreneur's Association of Nepal (SEAN) to field a seed market survey to better understand how farmers source seed, what quality of seed they source, and where there are supply bottlenecks and quality issues that occur throughout the seed supply chain. While this work is still ongoing, it will allow CSISA to have a better understanding of ground-level issues, and will provide a basis of evidence on which to advise the Government of Nepal on policy and regulatory options under the Nepal Seed Vision 2020. While CSISA's initial work is being pursued in collaboration with USAID's Policy Reform Initiative Project in Nepal and focuses on a pilot survey related to the horticulture seed market, there are plans to expand this activity under CSISA III to include analysis of the sources of cereal seed as well as supply bottlenecks that constrain the distribution of new, high quality seeds.

In general, a major challenge to effecting policy reform within Nepal's seed sector is the lack of sensible rules and regulations in an increasingly decentralized governance structure and contention public positions on international and regional trade. Nevertheless, CSISA is supportive of Nepal's efforts to manage its co-existing regulatory regimes for seed quality set forth under the 1998 Seed Act while encouraging greater openness to the international and regional exchange of both genetic resources and commercial seed.

D.2 Scale-appropriate mechanization

Bangladesh

CSISA is engaged in determining the potential impact and tradeoffs associated with the Government of Bangladesh's various policies to support domestic agricultural equipment manufacturers, such as duty/tariff exemptions, credit facilities, and other support mechanisms. In particular, CSISA is exploring policy reforms to rationalize import duties on raw materials used in the manufacture of agricultural equipment, and is considering exploring policy reforms to reduce import duties on machines themselves and the potential for additional investments in agricultural engineering to support the customization of these machines. To date, activities have focused on policy reform solutions to address the supply of agricultural machines in Bangladesh, but plans are also being

formulated to consider policy reforms to stimulate demand for mechanization, primarily through the design of appropriate incentive mechanisms targeted toward resource-poor smallholder farmers.

Nepal

CSISA has exploring the Government of Nepal's various policies respect to the promotion of scale-appropriate mechanization in Nepal. The expansion of mechanical equipment is particularly important in Nepal, where there has been considerable migration (often of male members in the household) that has resulted in declining supplies of manual farm power. The Government of Nepal has prioritized the promotion of small-scale equipment, such as power tillers, 2-wheel tractors, multifunctional tilling implements, and irrigation equipment that are more appropriate for the small farms that dominate the agricultural sector in Nepal. The domestic supply of such machines and implements is insufficient to meet the growing demand, so the government is currently exploring various schemes involving tariff exemptions, subsidies, and increased credit to increase the utilization of agricultural machines, with complementary capacity building programs to support local service provision.

D.3 Soil fertility management and fertilizer markets

Bangladesh

CSISA continues to evaluate the Government of Bangladesh's efforts to increase fertilizer consumption and to promote balanced use of chemical fertilizers. The Government is keenly interested in ensuring the timely supply of fertilizers to satisfy the growing demand, yet at the same time ensure that the fertilizers that are on the market are of the desired quality and not prone to adulteration.

As is the case with Nepal, there are legitimate concerns about fertilizers being smuggled across the border from India, where they are sold at a considerable discount as a result of heavy subsidies. To date, the Government of Bangladesh has not expressed much concern over these cross-border leakages, so any policy reforms aimed at reducing the movement of fertilizer from India to Bangladesh will most likely have to be effected within India.

Nepal

CSISA has been working on exploring policy solutions to address Nepal's fertilizer market, which is currently bolstered by the informal/illegal inflow of subsidized fertilizers from India. Domestic production is insufficient to meet the growing demand, which has the potential to lead to supply bottlenecks and prohibitively high prices. Nepal's policy solutions to date have included ad-hoc border closings and proposals to increase domestic fertilizer production capacity, though the latter proposals have been viewed as unrealistic due to insufficient and/or unreliable natural endowments of feedstock. Current and future policy reforms in India attempting to reduce the cross-border leakages of fertilizers into Nepal will likely contribute to supply shortages and higher prices, which could potentially have significant impacts on crop production in Nepal.

To date, CSISA has not contributed to any direct reforms with respect to Nepal's fertilizer policies. One challenge to effecting any fertilizer policy reforms in Nepal is that it is a small country whose fertilizer policies are largely influenced by its much larger neighbor. Nevertheless, CSISA's role in this regard is to bring evidence and rational thinking to this debate to identify potential policy solutions.

D.4 Agricultural risk management

Bangladesh

CSISA has been evaluating several tools for providing risk management solutions to smallholder farmers in Bangladesh. In particular, CSISA has been analyzing the effectiveness of a novel weather index insurance product to address risks related to deficient rainfall during the summer monsoon

season. Early results from a pilot study suggest that having insurance has positive effects during both the monsoon season, as well as during the dry winter season. While the former effect is a pure risk mitigation effect, the latter effect may be principally due to increased liquidity following the receipt of an insurance payout. CSISA will be organizing a convening on agricultural risk management with BRAC, the Asian Development Bank, and other development partners who have existing investments in agricultural risk management, as well as other members of the development community in Bangladesh. In this convening, CSISA will present findings from its pilot program, hear from other researchers and development agencies active in this area, and discuss targeting and implementation strategies to increase the scale of insurance uptake in the country.

A challenge with respect to agricultural risk management is that most forms of crop insurance have proven to be incredibly tricky to take to scale, especially in the absence of direct government support in the form of subsidies. Bangladesh is somewhat unique in this regard, since there is a large existing network of nongovernmental organizations and microfinance service providers. There is a continued need to work on improving the design of insurance products, and we view this as a potentially fruitful area for continued investments.

Nepal

CSISA plans to explore ways to improve smallholder resilience to various sources of risk. This is a challenge in Nepal, since, to date, existing programs for providing agricultural risk management in Nepal (e.g., agricultural insurance) remain very limited, and private sector engagement in providing insurance is almost non-existent. The government of Nepal has committed to exploring new and novel ways of improving agricultural risk management, particularly with the aims of enhancing farmers' resilience to climate change, disasters, price volatility, and other shocks, including through the development of agricultural insurance. We are closely monitoring these developments, and will attempt to bring evidence to bear on the relative success of these approaches.

Engagement with Missions, FTF partners and project sub-contractors

USAID Missions

In Bangladesh, the CSISA Phase III Bangladesh country coordinator regularly updates the USAID/Bangladesh Mission staff under the Office of Economic Growth with regards to ongoing activities. CSISA is also regularly consulted by the Mission for information on cereal based cropping systems, agricultural mechanization, and appropriate agricultural development investments. Notable consultations include requests for information and ideas on improving gender mainstreaming in agricultural development, in addition to solicitation of ideas for future investments. Most recently and at the Mission's request CSISA Phase III participated in a field visit to Bangladesh and project sharing program for Dr. Gary Lindon, the Acting Deputy Assistant to the USAID Administrator.

In Nepal, CSISA has engaged with the Nepal mission in the following core areas in FY16:

- Formulated the *Earthquake Recovery Support Program*, which was implemented under the banner of CSISA with funding from USAID-Nepal ($1 m, June 2015 – September 2016). This program leveraged ongoing CSISA work on mechanization value chains to bring scale-appropriate small tractors and attachments to hill communities that lost draft animals and agricultural labor in the devastating earthquakes that affected Nepal in April and May of 2015.
- Convened the first National Seed Summit with USAID-Nepal and the Ministry of Agricultural Development, which informed the design and created political momentum for the recently started *Nepal Seed and Fertilizer* project (US$ 15 m investment). This project was awarded to CIMMYT and is functionally aligned and support by CSISA.
- Provided technical advice and support to the KISAN project (USAID-Nepal's flagship FtF program) on staple crop management.
- Shared technical insights into challenges and opportunities confronting the sustainable intensification of staple crop systems in Nepal that (we believe) have informed the development of the forthcoming KISAN II project solicitation.

FTF partners

CSISA Phase III also directly collaborates with the following FtF projects in Bangladesh:

- **Agricultural Inputs Project (AIP):** This CNFA led project works to improve the knowledge of and access to quality agricultural inputs for farmers in the Feed the Future (FTF) zone of Bangladesh. Phase III collaborates with AIP and the Agricultural Input Retailer Network (AIRN) to scale-up farmers' access to information on better-bet agronomy and integrated weed management. Details on AIP can be found here: https://www.cnfa.org/program/agro-inputs-project/
- **Rice Value Chain (RVC) Project:** The IRRI-led RVC project is a 15 month activity starting on 1st October 2015 and ending on the 31st December 2016. It builds on the lessons learned from the, Cereal Systems Initiative for Southeast Asia in Bangladesh (CSISA-BD), and supports the private sector improve the efficiency of the rice value chain. The project will work out of hubs based in Jessore, Khulna, Barisal and Faridpur. Because of RVC's closure at the end of 2016, CSISA Phase-III will build on the project's activities and inherit staff and partnerships to continue to scale-out farmers' use of premium quality rice varieties in the FtF zone.

- **Cereal Systems Initiative for South Asia – Mechanization and Irrigation (CSISA-MI) project**: CSISA-MI emerged out of CSISA's ongoing efforts in the USAID/Bangladesh Mission-funded CSISA expansion project (2010–15), and during CSISA Phase II. It continues to be strategically aligned with the broader CSISA Phase III program in Bangladesh, and is led by CIMMYT in partnership with International Development Enterprises (iDE). CSISA-MI is a five- year project (July 2013 – September 2018) that focuses on unlocking agricultural productivity through increased adoption of agricultural mechanization technologies and services. The CSISA-MI Project Leader has a position on the CSISA Phase III technical coordination committee. The Phase III Bangladesh Country Coordinator also maintains a position on the leadership committee of CSISA-MI.

  Although it does not fall under the FtF program, CSISA wheat blast research activities on disease forecasting and modeling are also strategically aligned with the USAID-Washington funded **Climate Services for Resilient Development (CSRD) project**, which falls under the Global Climate Change Office Bureau for Economic Growth - Education and Environment. Strategic alignment with CSISA is assured as the CSRD Project Leader is also the CSISA Phase III Bangladesh Country Coordinator.

  In Nepal, the KISAN project, part of USAID's global Feed the Future initiative, is a US$ 20 million five-year program working to advance food security objectives by increasing agricultural productivity. KISAN works collaboratively with CSISA by utilizing technical and extension materials and advice to improve the uptake of better-bet sustainable agriculture production and post-harvest practices and technologies for targeted cereals. KISAN has a reach of hundreds of thousands of farmers, who have been exposed to CSISA information, materials, and technologies through this partnership.

  During the reporting period, CSISA and KISAN have:

  - Produced accessible guides for **better bet agronomy for rice and maize** – information that is generally not available to smallholders**.** KISAN has reproduced these guides with their own resources and they provide the backbone of their technical training programs for maize and rice, the two core staple crop value chains for the project. In 2016, 60,205 **farmers have received the rice tips and 69,923 farmers has received the maize tips in the 20 FtF districts** through the KISAN network.
  - Developed a factsheet on better nursery management for healthy seedlings and provided training to technicians from DADOs, KISAN, seed companies and some key farmers in different districts with the objective to disseminate the information to additional farmers.
  - Established block demonstrations of maize under best management practices (variety, planting method, and proper plant population and fertilizer and weed management) in different areas while comparing the farmers' practices to increase farmers' motivation. With the adoption of best management practices maize yield can increase by 3 times. Through DADOs, KISAN, farmers' co-operatives, and NIMBUS, CSISA distributed tips on best management practices for maize before the season. **With support from DADOs and NIMBUS, in 2016 farmers in Surkhet and Dang adopted best management practices on 70 ha of maize.**

Project Sub-Contractors

CSISA Phase III maintains three sub-contractual partners in Bangladesh that are essential in scaling-out CSISA supported technologies and for reaching farmers at large. This is particularly important as CSISA is coordinated through a partnership of three research institutions. It is only by working with development partners that the knowledge products produced through

the CGIAR's research can be effectively deployed in farmers' fields. CSISA therefore strategically vets and selects partners based on their philosophical alignment with the CSISA approach and ability to generate impact at scale. Current partnerships include the following:

- International Development Enterprises (iDE): This sub-contract extends through 2018. The purpose of iDE's involvement in CSISA-III is to leverage iDE's existing work in CSISA-MI to contribute to the agricultural machinery commercialization objectives of CSISA-III. Specifically, iDE will build upon its current relationships with private sector and financial sector partners to support the commercialization of target technologies – power tiller operated seeder and reaper– first in Dinajpur District and then in other districts of Rangpur Division. The sub-grant value is USD 400,000. More about iDE can be found here: http://www.ide-bangladesh.org/
- Agricultural Advisory Society (AAS): This sub-contract extends into February of 2017. The purpose of the sub-agreement is to increase knowledge, skills, and Practice of farmers on the quality rice seedlings production through video shows and training on healthy rice seedlings production in seven FTF districts within two CSISA hubs (Jessore and Faridpur) in the south western region. The sub-grant's target output is the development of awareness and motivation on healthy rice seedlings production of 24,000 interested farmers through video shows and training on the healthy rice seedlings production at 240 communities in seven FTF districts within Jessore and Faridpur hubs. This sub-grant's value is USD 17,875 More about AAS can be found here: http://aas-bd.org/
- Agricultural Input Retailers' Network (AIRN): This sub-contract extends into March of 2017. AIRN formed as a result of CNFA led efforts in the above-described Agricultural Inputs Project. Partnering with CSISA, AIRN is training 800 inputs dealers on the principles and practices of integrated weed management in Faridpur and Jessore Hubs. This sub-contract has a value of USD 18,461. More about AIRN can be found here: http://www.aipbd.org/airn/airn/
- The Bangladesh Research Institute (BRRI): This sub-agreement extends until June of 2017. Under this agreement, BRRI assists with (1) implementation of on-farm trials of new Premium Quality Rice (PQR) varieties in 6 Upazilas within 3 hubs of CSISA to identify best-bet premium quality varieties in terms of yield and farers', millers', and traders' preferences, (2) on-farm performance evaluations of integrated weed management (IWM) options to increase yield and profit in farmers' fields, (3) on-station trials to develop/ fine tune mat nursery method of raising rice seedlings for manual transplanting, and (4) Organize additional on-farm trials and collect necessary crop cut data as required. The total sub-grant value is USD 17,000. More information is available online about BRRI can be found here: http://www.brri.gov.bd/index.php?lang=en

Appendix 1 – Key Staff

Name	Role	Institution	Address	Phone	Email
Andrew McDonald	Systems Agronomist & Project Leader	CIMMYT	Kathmandu, Nepal	+977 9808757832	a.mcdonald@cgiar.org
Cynthia Mathys	Project Manager	CIMMYT	Kathmandu, Nepal	+977 9808040992	c.mathys@cgiar.org
Sudhanshu Singh	Rainfed Lowland Agronomist & IRRI Coordinator	IRRI	New Delhi, India	+91 9654543301	Sud.singh@irri.org
David Spielman	Senior Research Fellow & IFPRI Coordinator	IFPRI	Washington, DC, USA	+1 202-862-8137	d.spielman@cgiar.org
BANGLADESH					
Timothy Krupnik	Systems Agronomist & Country Coordinator	CIMMYT	Dhaka, Bangladesh	+88-0175-556-8938	t.krupnik@cgiar.org
Ansar A. Siddiquee	Project Manager and acting M&E Lead	CIMMYT	Dhaka, Bangladesh	+88-0171-304-4764	a.siddiquee@cgiar.org
Zia Uddin Ahmed	GIS & Remote Sensing Scientist	CIMMYT	Dhaka, Bangladesh	+88-0176-666-7416	z.ahmed@cgiar.org
Murshed-E-Jahan	Applied Socio-economist	CIMMYT	Dhaka, Bangladesh	+88-0171-203-1926	k.jahan@cgiar.org
Dinabandhu Pandit	Technical Coordinator	CIMMYT	Dhaka, Bangladesh	+88-0171-213-0599	d.pandit@cgiar.org
Vacant	Lead M&E Specialist	CIMMYT	Dhaka, Bangladesh		
Murshedul Alam	Senior Associate Scientist II	IRRI	Dhaka, Bangladesh	+88-0171-507-7894	m.alam@iiri.org
Humnath Bhandari	Scientist (Agricultural Economist)	IRRI	Dhaka, Bangladesh	+88-0173-070-0018	h.bhandari@irri.org
NEPAL					
Mina Devkota	Systems Agronomist	CIMMYT	Kathmandu, Nepal	+977 9851197994	m.devkota@cgiar.org
Scott Justice	Mechanization Specialist	CIMMYT	Kathmandu, Nepal	+977 9851027678	s.justice@cgiar.org
Dilli KC	M&E Specialist	CIMMYT	Kathmandu, Nepal	+977 9851131004	d.kc@cgiar.org
Narayan Khanal	Value Chain Specialist	CIMMYT	Kathmandu, Nepal	+977 9851183024	n.khanal@cgiar.org
Gokul Paudel	Socioeconomist	CIMMYT	Kathmandu, Nepal	+977 9845089438	g.paudel@cgiar.org
Ashok Rai	Data Specialist	CIMMYT	Kathmandu, Nepal	+977 9808939798	a.rai@cgiar.org

Appendix 2 – Project subcontractors and key partners

BANGLADESH				
PARTNER	**PARTNERSHIP OBJECTIVE**	**ALIGNMENT WITH THEMES**	**LEVERAGING OPPORTUNITY**	**STATUS OF PARTNERSHIP**
Government of Bangladesh				
Bangladesh Agricultural Research Institute (BARI)	Development, validation, and refinement of technologies and new research methods, boosting scaling capacity	Innovation towards impact	With a network of regional research stations and strong input into the development of extension materials, approaches, and policy, and with integration in the Ministry of Agriculture, BARI provides leveraging opportunities to mainstream sustainable intensification innovations into the Government of Bangladesh NARES system.	CIMMYT maintains a formal partnership MoU; BARI has collaborated with CSISA in Phase II and will continue into Phase III
Bangladesh Rice Research Institute (BRRI)	Development, validation, and refinement of technologies and new research methods, boosting scaling capacity	Innovation towards impact	With a network of regional research stations and strong input into the development of extension materials, approaches, and policy, and with integration in the Ministry of Agriculture, BRRI also provides leveraging opportunities to mainstream sustainable intensification innovations in the Government of Bangladesh NARES system.	IRRI maintains a formal partnership MoU; BRRI has collaborated with CSISA in Phase II and will continue into Phase III
Department of Agricultural Extension (DAE)	Extension and scaling	Achieving impact at scale	DAE boasts over 5,000 field extension agents throughout Bangladesh. In CSISA Phase II and CSISA-BD, DAE collaborated with activities within Bangladesh's Feed the Future zone, and in Dinajpur hub. By sensitizing DAE agents to sustainable intensification technologies and approaches, large opportunities for improved reach and awareness-raising among farmers are possible, with sustainability	CIMMYT maintains a formal partnership MoU with the DAE, collaboration in CSISA III has been initiated and is ongoing

			aims for messaging after Phase III is completed.	
Agricultural Information Services (AIS)	Production of extension materials for DAE use	Achieving impact at scale	AIS produces extension materials and media that are used by DAE. Strategic partnerships with AIS facilitate the integration of sustainable intensification principles into extension materials and messaging.	CSISA III has initiated informal collaboration with AIS, with activities ongoing
Bangladesh Television (BTV)	Large-scale public showings of training videos and materials on national television	Achieving impact at scale	In CSISA Phase II, and CSISA-BD, work with BTV resulted in millions of television viewers being exposed to messaging on improved crop management and scale-appropriate machinery on the weekly farm-oriented program Mati-o-Manush (MoM)	Informal partnership with MoM to produce and show training videos. Sub-contracts developed on an as-need basis
Bangladesh Private Sector				
Janata Engineering	Development and sales of scale-appropriate machinery	Achieving impact at scale	Domestic production and import of sustainable intensification scale-appropriate machinery and sales through the private sector	Established relationship with commercial Joint Venture Agreement
Metal Pvt Ltd	Development and sales of scale-appropriate machinery	Achieving impact at scale	Domestic production and import of sustainable intensification scale-appropriate machineries and sales through the private sector	Established relationship with commercial Joint Venture Agreement
Rangpur Foundry Limited (RFL)	Development and sales of scale-appropriate machinery	Achieving impact at scale	Import of sustainable intensification scale-appropriate machineries and sales through the private sector	Established relationship with commercial Joint Venture Agreement
Advanced Chemical Industries	Sales of scale-appropriate machinery, fungicides, weed control products and seed. IRRI is working with ACI to produce a range of hybrid and open-pollinated rice seeds	Achieving impact at scale	Import of sustainable intensification scale-appropriate machineries and sales through the private sector. Along with a range of chemical and cereal seed products.	Established relationship with commercial Joint Venture Agreement
Bangladesh projects				

Agricultural inputs project (AIP)	Facilitation of linkages to input dealers, outlet for extension messaging and value chain work to extend weed control products to farmers	Achieving impact at scale	This USAID-funded project works with 3,000 agricultural input dealers in the Feed the Future zone. Coordination with AIP permits the broad extension of SI information to dealers, including recommendations, chemicals, seeds, fertilizer and other materials, and an avenue for increasing the availability of critical weed control products and precision nutrient management recommendations.	Established and ongoing working arrangement, though without formal agreement
Agricultural Extension Project (AEP)	Coordination assistance for interactions with DAE/AIS, capacity development of DAE Extension Agents in scaling and new extension methods	Achieving impact at scale	AEP works closely with DAE and AIS and assists in coordination of both bodies to align to CSISA's objectives. In addition AEP is working with 6,000 farmer groups in the areas where CSISA III is operating.	Established and ongoing working arrangement, though without formal agreement
Women's Empowerment Project (WEP)	WEP identifies and facilitates linkages to women entrepreneurs	Systemic change towards impact	WEP works with both the Women's Ministry and DAE and will identify women who interested in adopting CSISA technologies. WEP will serve an important role in healthy rice seedling enterprises.	In the process of establishing relationship and working modality
NGOs				
iDE Co-implementer and project subcontractor	Development of business models, facilitation of private sector partners in scale-appropriate machinery scaling	Achieving impact at scale; Innovation towards impact	Value chain and market development NGO responsible for business modeling and joint venture agreements with the private sector partners listed above	Formal CSISA-MI and CSISA Phase III partner. Sub-contracts under CSISA-MI and CSISA III formalized. CSISA III subcontract for $400,000.
Agricultural Advisory Society (AAS) Project subcontractor	Facilitates village screenings of training films and conducts follow-up studies	Achieving impact at scale	Working with AAS in Phase II and CSISA-BD, we were successful in reaching 110,000 farmers in village training video screenings accompanied by question and answer sessions to raise awareness among farmers on scale-appropriate machinery and	Subcontract for CSISA III currently in place for $17,634.

			associated crop management practices.	
Agro-Input Retailers Network (AIRN) Project subcontractor	Trains input dealers & retailers	Achieving impact at scale	Will train 800 advanced retailers in integrated weed management in Southern Bangladesh by Feb 2017.	Subcontract for CSISA III currently in place for $18,461.
Universities				
Wageningen University	Strategic research on farmer decision making processes and fallows intensification	Innovation towards impact	Strategic high-end research capacity to assist in the analysis of farmer decision-making processes with respect to intensification decisions	Formal established working relationship with CIMMYT; this relationship entails research deliverables in support of CSISA Phase III
Georgia Tech University	Technical support for the development of scale appropriate machinery	Innovation towards impact	Laboratory facilities for rapid prototyping of machinery innovations and technical support on testing in collaboration with BARI	Established yet informal relationship in co-support of CSISA III, with ongoing collaboration
Bangladesh Agriculture University	Bangladesh's largest and first agricultural university	Innovation towards impact	Bangladesh's largest agricultural university, with influence over the next generation of young scientists, many of whom go on to work in BARI, BRRI, and the DAE	Relationship with Phase III in process of establishment. Relationship is envisioned to be informal
Bangabandu Sheik Mujibur Rahman Agriculture University (BSMRAU)	Strategic partnership in wheat blast research, and in advancing methods of crop cut surveys	Innovation towards impact	BSMRAU scientists have formally collaborated with CSISA-BD and CSISA Phase II on the basis of individual sub-contracts to co-support research efforts in crop cuts and accompanying diagnostic surveys. Additional informal collaboration in geospatial analysis and remote sensing in support of wheat blast development and spread is ongoing.	Formal relationship with sub-contracts for specific work packages; on-going informal collaboration with professors and students to assist in analysis of wheat blast risks.

NEPAL				
PARTNER	**PARTNERSHIP OBJECTIVE**	**ALIGNMENT WITH THEMES**	**LEVERAGING OPPORTUNITY**	**STATUS OF PARTNERSHIP**
Government of Nepal				
Ministry of Agricultural Development	Technical guidance for GoN investments in agricultural development	All	New Agriculture Development Strategy approved by GoN in Fall of 2015. CSISA acts as a technical partner to shape the loan and investment programs associated with ADS, which may exceed $100 m USD.	Active and sanctioned by CIMMYT's host country agreement
Nepal Agricultural Research Council (NARC)	Strategic and applied research on SI technologies	Innovation towards impact	NARC is responsible for providing the science basis of all state recommendations; their endorsement and ownership of emerging sustainable intensification technologies is essential.	Active and long-standing
Department of Agriculture (DoA)	Front line extension and support to farmers, service providers, and private sector	Achieving impact at scale	DoA has staff at the district level across Nepal and considerable budgets to support programming; CSISA assist in improving the quality of extension messaging and works to deepen linkages to private sector.	Active and long-standing
Nepali private sector				
Machinery importers (BTL, SK Traders, Dhahal, etc.)	Introduction and market development for scale-appropriate machinery	Achieving impact at scale	Rapid expansion of investment in scale-appropriate machinery and support for emerging service provision markets.	Active and long-standing
NIMBUS	Introduction and market development for new crop varieties and hybrids	Achieving impact at scale	Registration and market development for hybrids in the Feed the Future zone from a base of zero in 2015.	Active since 2015
NGO				
NAMEA	Trade association formed with the help of CIMMYT to create an enabling environment and policy	Systemic change towards	Important voice for private sector with GoN as the Agriculture Development Strategy support programs take shape.	Active since 2014

	dialogue for scale-appropriate mechanization in Nepal	impact		
SEAN	Trade association strengthened with the help of CSISA to create an enabling environment and policy dialogue for seed system strengthening / SMEs in Nepal	Systemic change towards impact	Important voice for private sector with GoN as the ADS support programs take shape.	Active and long-standing
Universities				
University of Illinois	Strategic research and landscape diagnostics to uncover patterns of spatial variability in crop performance and the contributing factors for yields gaps in Nepal cereal crops	Innovation towards impact	Collaboration with advanced research institution increases the quality of science conducted in Nepal; national partners learn new research methods and contribute to the formulation of new research questions.	Active
University of Nebraska	Opportunities for agronomic practices to conserve water, reduce risk, and enhance yields in maize-based systems in the hills of Nepal	Innovation towards impact	Collaboration with advanced research institution increases the quality of science conducted in Nepal; national partners learn new research methods and contribute to the formulation of new research questions.	Active
Wageningen University	Role of livestock and value chains in farmer willingness to invest in maize intensification	Innovation towards impact	Collaboration with advanced research institution increases the quality of science conducted in Nepal; national partners learn new research methods and contribute to the formulation of new research questions.	Active

Projects				
Knowledge-based Integrated Sustainable Agriculture and Nutrition (KISAN)	Strategic partnership to co-support on the large scale deployment of extension information and technologies	Achieving impact at scale	The KISAN project, part of USAID's global Feed the Future (FTF) initiative, is a US$ 20 million five-year program working to advance food security objectives by increasing agricultural productivity. KISAN works collaboratively with CSISA by utilizing technical and extension materials, and advice, to Improve the uptake of better-bet sustainable agriculture production and post-harvest practices and technologies for targeted cereals. KISAN has a reach of hundreds of thousands of farmers, who have been exposed to CSISA information, materials, and technologies through this partnership.	Active for 3+
High-value Agriculture Project (HVAP) - IFAD	Opportunistic partnership to take advantage of value chains and entrepreneurial skills created by HVAP, including among women farmers	Achieving impact at scale	HVAP has worked on literacy, numeracy, and value chain strengthening for high value commodities like vegetables. CSISA is taking advantage of the social and market capital created by HVAP to introduce and expand commercial maize production in the mid-hills.	New

Appendix 3. Indicator Numbers Covering October 2015 through September 2016

Indicator / Disaggregation	2016 Comment	2016 Deviation Narrative	2016	
			Target	Actual
EG.3.2-18: (4.5.2-2) Number of hectares of land under improved technologies or management practices with USG assistance (RAA) (WOG)				
Technology type			12,909	19,711
crop genetics	This category captures CSISA's work with improved crop varieties and hybrids of rice and maize, and Premium Quality Rice in Bangladesh.	The overall target was missed because in Bangladesh, during the first year of CSISA III, the program was not able to launch the use of improved varieties and hybrids in Bangladesh during the rice season because of security reasons. We will launch this activity during the 2017 rice season. Also, the project started too late to capture the 2015-16 wheat season, and the 2016-17 wheat season has not yet begun.	3,520	1,446
cultural practices	This category captures CSISA's work on weed management, better-bet crop management, bed planters, power-tiller operated seeders, hand crank spreaders, zero till seed drills and rice transplanters.	We exceeded the target because of the success that programming in Bangladesh has had in scaling out technologies such as bed planters, power-tiller operated seeders, hand crank spreaders, zero till seed drills and rice transplanters through service providers.	7,023	9,625
pest management				
disease management				
soil-related fertility and conservation				

irrigation	This category captures CSISA's work with irrigation management practices for rice and wheat and axial flow pumps.	We exceeded this target because of the success of irrigation management and irrigation technologies in both Nepal and Bangladesh. In Nepal, the overachievement is driven by the adoption of irrigation technologies in wheat and rice. CSISA aired radio jingles on local FM radio promoting irrigation at certain strategic times of the cropping cycle, resulting in increased awareness and uptake. The jingles were particularly effective because Nepal experienced drought during the wheat and rice growing season. In Bangladesh, the use of surface water irrigation is a mandate of the current Government of Bangladesh. The introduction of the axial flow pump for irrigation by CSISA has proven very effective in the south/southwestern region, which has enabled us to exceed our target. Due to the Government mandate, even the Department of Agricultural Extension and Bangladesh Agricultural Development Corporation officials play a catalytic role in increasing the use of axial flow pumps.	2,254	7,191
water management (non-irrigation)				
climate mitigation or adaptation				
other	This category captures CSISA's work with zero tillage wheat, reapers, threshers, healthy rice seedlings, and integrated weed management.	We exceeded this target in part because of the relatively low target, but also because of the success of mechanized wheat and rice harvesting in Bangladesh.	112	1,449
total w/one or more improved technology			12,909	19,711
Disaggregates Not Available				
Sex			12,909	19,711
Male		The overachievement in this category is mostly driven by our success in popularizing irrigation by axial flow pump and mechanized harvesting/post-harvesting services in Bangladesh, which mostly involved men.	10,207	17,796

Female		This target was missed largely because of the dominance in male-controlled hectares reported for Bangladesh.	2,582	1,606
Joint		This target was missed largely because in Bangladesh most of the hectares are controlled by males, and land is not usually classified as being under joint management.	80	55
Association-applied		This target was exceeded because in Nepal, CSISA has worked with a large number of cooperatives and farmers groups in the past year, which has caused the number of hectares to exceed its target for this category.	40	254
Disaggregates Not Available				
Commodity **NEW**			0	19,711
Maize grain				463
Rice				5,743
Wheat				5,581
Mung Bean				190
Lentil				171
Disaggregates Not Available				7,563

Indicator / Disaggregation	2016 Comment	2016 Deviation Narrative	2016	
			Target	Actual
EG.3.2-17: (4.5.2-5) Number of farmers and others who have applied improved technologies or management practices with USG assistance (RAA) (WOG)				
Producers				
Sex			58,860	52,584
Male			46,727	47,276
Female		This target was missed largely because In Bangladesh, smallholdings are usually controlled by men and very little land is controlled by women.Therefore, it is significantly more difficult to reach women with sustainable intensification technologies and management practices. Still, CSISA will strive to increase its number of women beneficaries going forward.	11,772	5,107
Disaggregates Not Available		We 'missed' this target mostly because in Bangladesh we were able to identify land ownership as either male or female, and therefore did not require the disaggregates not available category.	361	201
Technology type			58,860	52,585
crop genetics	This number counts the farmers who have cultivated improved varieties and hybrids, especially for rice and maize. It includes our work on premium quality rice.	This target was missed mostly because Bangladesh was not able to start programming in this area during Year 1. In Nepal, the success of improved rice hybrids actually caused us to exceed the target.	11,791	5,959
cultural practices	This number counts farmers adopting technologies and management practices such as healthy rice seedlings, weed management, maize intensification, bed planters, power-tiller operated seeders, hand crank spreaders, zero till seed drills and rice transplanters.		22,447	23,596
livestock management				

	wild fishing technique/gear				
	aquaculture management				
	pest management				
	disease management				
	soil-related fertility and conservation				
	irrigation	This number captures farmers who have adopted improved irrigation management practices, including supplemental irrigation for rice and wheat, and those who have begun using the axial flow pump.	This target has been exceeded because the use of surface water irrigation is a mandate of the current Government of Bangladesh. The introduction of the axial flow pump for irrigation by CSISA has proven very effective in the south/southwestern region, which has enabled us to exceed our target. Due to the Government mandate, even the Department of Agricultural Extension and Bangladesh Agricultural Development Corporation officials play a catalytic role in increasing the use of axial flow pumps.	6,936	8,953
	water management (non-irrigation)				
	climate mitigation or adaptation				
	marketing and distribution				
	post-harvest - handling and storage	This category captures our use of reapers and threshers.	The success in mechanized harvesting and threshing of rice and wheat enabled us to log numbers in the post-harvest category.		3,889
	value-added processing				

other	This number captures farmers in Nepal who received advice on irrigation and weed management practices for wheat, rice and maize and changed their behavior as a result, and those in Bangladesh involved in CSISA's work on healthy rice seedlings and integrated weed management.	This target was missed primarily because in Bangladesh, since CSISA III started in December 2015, the project was unable to capture the dry 'rabi' cropping season, which begins in November. Activities this year have therefore focused predominantly on preparation for the upcoming rabi season, although field work was curtailed following security advisories by the USAID Mission in Bangladesh after a series of high-profile and deadly terrorist incidents in Bangladesh. Social media efforts to create mass awareness among project stakeholders went ahead, although even these efforts had to be reduced due to the threat of terrorism.	17,686	10,188
total w/one or more improved technology			58,860	52,585
Disaggregates Not Available				
Commodity **NEW**				52,584
Maize				3,359
Rice				23,484
Wheat				7,987
Mung Bean				623
Lentil				876
Disaggregates Not Available				16,255

Indicator / Disaggregation	2016 Comment	2016 Deviation Narrative	2016	
			Target	Actual
EG.3.2-1: (4.5.2-7) Number of individuals who have received USG-supported short-term agricultural sector productivity or food security training (RAA) (WOG)				
Type of individual			217	684
Producers	This number counts producer trainees who attended trainings on better-bet crop management practices in Nepal, and those who attended trainings on premium quality rice, healthy rice seedlings, and early wheat sowing in Bangladesh.	We exceeded this target because of the high number of trainees in Nepal for better-bet crop management practices and in Bangladesh because of the large number of farmers who received training on premium quality rice, healthy rice seedlings and early wheat sowing. The inclusion of trainees who received agronomic training after participating in key informant interviews or focus group discussions also caused this number to be high.	74	500
People in government	This number counts training participants representing government offices, mainly District Agriculture Development Offices, and staff of Agricultural Service Centers in Nepal, as well as Upazila Agricultural Officers and Sub-Asst. Agricultural Officers in Bangladesh.	In Nepal, exceeding the target in this category is driven by our move into Dang District, where training was provided to the District Agriculture Devevelopment Office staff. In Bangladesh, trainings were conducted on early wheat sowing for Department of Agricultural Extension Officials (i.e. Sub Assistant Agriculture Officers). Dept of Agricultural Extension officials also participated in training on rice interventions.	29	78
People in private sector firms	This number counts training participants from private seed companies, agricultural input suppliers (agrovets) and cooperatives, as well as local service providers providing agro machinery services.	This target was missed because in Bangladesh, since the project started in December, the winter rice season (Boro rice) could not be fully implemented for CSISA III, which meant that CSISA was not able to train as many service providers this year as anticipated.	74	48

People in civil society	This number counts training participants representing local level non-governmental organizations and community-based organizations.	The relatively high number of trainees is largely related to the number of community-based organizations that participated in trainings for a government-sponsored project on 'improved seed for farmers' in Nepal, and in Bangladesh the number of training participants attending from NGOs and other civil society groups was also higher than anticipated.	29	49
Disaggregates Not Available	This number counts training participants representing local citizen forums and clubs in Nepal.	This 'target' appears to have been missed, but that is only because Bangladesh did not log any trainees in this category, since all trainees were otherwise categorized.	11	9
Sex			217	684
Male		In Nepal, we exceeded the target mainly because we conducted additional trainings in the new CSISA district (Dang) and for a new collaboration with a government-sponsored program on 'improved seed for farmers'. In Bangladesh, CSISA's trainings in the field often prove popular and can frequently attract unexpected participants. This trend has resulted in a significant positive deviation from the target. Participants of key informant interviews and focus group discussions who subsequently received training on early wheat sowing have also contributed to the positive deviation against the target this year.	174	563

Female		In Nepal, we exceeded the target mainly because we conducted additional trainings in the new CSISA district (Dang) and for a new collaboration with a government-sponsored program on 'improved seed for farmers'. In Bangladesh, CSISA's trainings in the field often prove popular and can frequently attract unexpected participants. This trend has resulted in a significant positive deviation from the target. Participants of key informant interviews and focus group discussions who subsequently received training on early wheat sowing have also contributed to the positive deviation against the target this year.	43	121
Disaggregates Not Available				

Indicator / Disaggregation	2016 Comment	2016 Deviation Narrative	2016	
			Target	Actual
4.5.2(37) Number of Micro, Small, Medium Enterprises (MSMEs), including farmers, receiving business development services from USG assisted sources				
MSME Size			832	167
Micro		This target was missed because Bangladesh did not report into this indicator this year.	749	148
Small		This target was missed because Bangladesh did not report into this indicator this year.	83	19
Medium				
MSME Type			832	167
Agricultural producer		This target was missed because Bangladesh did not report into this indicator this year.	204	51
Input supplier		This target was missed because Bangladesh did not report into this indicator this year.	7	1
Trader		This target was missed because Bangladesh did not report into this indicator this year.	87	16
Output processor				
Non-agriculture				
Other			534	99
Sex of producer			832	167
Male		This target was missed because Bangladesh did not report into this indicator this year.	582	106
Female		This target was missed because Bangladesh did not report into this indicator this year.	84	26

Joint		This target was missed because Bangladesh did not report into this indicator this year.	166	35
Disaggregation not available				