Cereal Systems Initiative for South Asia Phase III

Annual Report December 2017

Submitted to:

Biniam Iyob, USAID Washington

Eric Witte, USAID Washington

Submitted by:

International Maize and Wheat Improvement Center (CIMMYT)

Period covered: October 1, 2016 to September 30, 2017

Funded by

USAID FROM THE AMERICAN PEOPLE

BILL & MELINDA GATES foundation

Partners

CIMMYT International Maize and Wheat Improvement Center

IFPRI

IRRI

Table of Contents

Acronyms and Abbreviations

Acronym	Full Name
AAS	Agricultural Advisory Services
ADS	Agriculture Development Strategy
AIRN	Agriculture Inputs Retailers' Network
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 Office
DAE	Department of Agricultural Extension
DFTQC	Department of Food Technology and Quality Control
DSR	Direct-seeded rice
ESAP	Enhancing the effectiveness of systems analysis' project
FtF	Feed the Future
HRS	Healthy rice seedlings
iDE	International Development Enterprises
IFPRI	International Food Policy Research Institute
IRRI	International Rice Research Institute
IWM	Integrated weed management
KISAN	Knowledge-based Integrated Sustainable Agriculture and Nutrition
MoA	Ministry of Agriculture
MIR	Mid-infrared
NARC	Nepal Agricultural Research Council
NARES	National Agriculture Research and Extension System
NGLRP	National Grain Legume Research Program
NGO	Non-governmental organization
NMRP	Nepal Maize Research Program
NSAF	Nepal Seed and Fertilizer project
PERSUAP	Pesticide evaluation report and safer use action plan
PMAMP	Prime Minister's Agriculture Modernization Project
PNM	Precision nutrient management
PQR	Premium quality rice
RVC	Rice value chain
ToT	Training of trainers
USAID	United States Agency for International Development
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 in 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.

In **Phase III** (2015–20), CSISA places 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.

CSISA Phase III pursues four **inter-linked primary outcomes**:

1. Widespread adoption of sustainable intensification technologies and management practices in South Asian cereal systems

2. Mainstreaming innovation processes into the programming of national, state, and district-level government institutions in order to improve the impacts achieved with current and future investments in agricultural R&D

3. Generating critical knowledge and research-based products that will support technology scaling and impact generation

4. Improving the policy environment to support sustainable intensification, prioritizing scaling up work with national partners to address policy constraints and improve the policy environment for realizing sustainable intensification futures in CSISA's target geographies.

FY17 Indicators of Progress

CSISA Phase III surpassed its target by 33% for the number of hectares of land under improved technologies or management practices, reaching 26,819 ha in FY17 in Bangladesh and Nepal. The corresponding number of farmers reported was 81,078, exceeding our target by 32%. In FY17, 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, and maize intensification. The main drivers were healthy rice seedlings, directly sown rice, premium quality rice, zero tillage and fertilizer management practices.

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 143% by training 3,096 individuals.

CSISA's final indicator monitored the number of firms receiving USG-funded technical assistance for improving business performance. In Nepal, CSISA came within 10% of its target, but in Bangladesh the team fell short of the target by 43%, largely because this indicator is focused on commercial expansion of agricultural machinery in Dinajpur hub. Although substantial progress was made in expanding farmers' access to machinery and several joint venture agreements were established with partners, uptake was not as rapid as had been expected. CSISA III focused this year mainly on building an enabling environment for scaling machinery, by working to train farmers and service providers and mechanics, and to spread awareness of machinery options. It is expected that further private sector pushing will result from these activities to build stronger market uptake in the future.

Major Activities and Accomplishments

BANGLADESH

- Farmers in the Feed the Future zone of Bangladesh tried out labor- and energy-saving directly sown rice (DSR) on a large scale for the first time. CSISA's partnership with the Department of Agricultural Extension (DAE) resulted in 200 hectares of DSR being sown by farm machinery service providers in four districts. Farmers who sowed DSR averaged profits over US$ 100 per hectare more than with transplanted rice. These activities generated considerable interest and CSISA was honored to host a visit by the Director General of the Bangladesh Rice Research Institute, who lauded the progress made in increasing farmers' awareness and appreciation of DSR.
- With support from CSISA, the Bangladesh Agricultural Research Institute (BARI) was able to fast-track the release of the breeding line BAW 1260 in late 2017 as 'BARI Gom 33.' BARI Gom 33 is derived from a CIMMYT cross and is resistant to wheat blast. It is also bio-fortified high Zn content (50–55 ppm) in comparison to other wheat varieties (averaging 40 ppm). BARI Gom 33 can therefore address critical zinc deficiency concerns for pregnant women and children in Bangladesh, as well as mitigate wheat blast risks.
- In addition to the release of BARI Gom 33, CSISA continued to support wheat blast surveillance and monitoring efforts in Bangladesh, printing and distributing 300,000 wheat blast awareness-raising leaflets that reached farmers in disease-affected zones. Young BARI and CIMMYT scientists collaborating with CSISA also received advanced wheat blast pathology training at the USDA-ARS laboratory in Fort Detrick, Maryland, in addition to CIMMYT-Mexico and disease screening locations in Bolivia. Research supported by CSISA through BARI also identified two low-toxicity and PERSUAP-approved fungicides that can be used to control light infections of blast in wheat.
- 54,853 registered farmers (viewers) in the Faridpur and Jessore hubs observed a video on healthy rice seedlings. Responding to CSISA's mass media and awareness-raising campaigns, 27,000 farmers on 6,553 hectares established rice using healthier rice seedlings, grown with simple but improved agronomic practices.
- CIMMYT led efforts to improve the production of pulses in the Feed the Future Zone in Bangladesh. By distributing guidelines on better-bet management of mungbean to development partners, DAE and the private sector, 3,592 farmers (37% women) on 611 hectares have begun using BARI-recommended management practices.
- CSISA continued to boost the capacities of national research and extension partners in Bangladesh by facilitating a widely attended workshop on the use of systems analysis tools and methods to identify pathways towards sustainable intensification in the central coastal environments of the FtF zone.
- 14,202 farmers scored dividends averaging US$ 40 per hectare more than conventional rice varieties by growing fine-grain and aromatic 'premium quality rice' (PQR) varieties on 3,902 hectares in the Feed the Future zone. These farmers achieved higher profits by using CSISA's advice on how to most efficiently cultivate PQR, as well as through project efforts to ensure that farmers could sell rice at profits to mills with high demand and fair pricing structures. This was achieved by setting up 25 collection points for mills to directly source rice from farmers throughout the Feed the Future zone.
- CSISA is the only research and development project in Bangladesh actively encouraging farmers to sow their wheat earlier, thereby avoiding risk of yield-reducing heat stress. Based on this work, and partnerships with DAE, crop monitoring statistics showed that

wheat sowing advanced by 10 days on 10%, 9% and 6% of all wheat area in Dinajpur, Jessore, and Faridpur hubs, respectively, in comparison to the previous year. Triangulating these data with farmers in a series of 30 focus group discussions to reliably estimate CSISA's contribution to this achievement, we determined that sowing was advanced on a total of 4,576 hectares by nearly 14,000 farmers.

NEPAL

- 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. According to our data, dust mulching increased yields by 20% and decreased early weed pressure by 25% compared to post-sowing irrigation in DSR**.** When implemented through CSISA-trained service providers, farmers gained US$ 150–200/ha in profits with DSR and more than 450 ha were planted in 2017 – an annual increase of more than 28%.
- CSISA continues to collaborate with NARES partners, NGOs and private partners to develop and disseminate information on better-bet agronomy. Government partners and NGOs have reproduced these guides as the backbone of their technical training programs for staple crop production. In 2017, over 17,500 tips documents on rice, wheat and maize management were distributed through these partnerships with around 12,000 households implementing new practices.
- CSISA provided hands-on 'training of trainers' for the 130 freshly recruited village-level government technicians on better-bet agronomy, providing an essential practical element to the capacity of these extension staff to diagnose problems and advise farmers.
- Technology targeting rarely considers the investment willingness of farmers, and choice experiments around rice intensification options provides a first effort to rank technologies while also accounting for differences between farm types and geographies. Results will be presented to the Ministry of Agriculture along with key partners such as the USAID-funded KISAN II project so that the findings can inform agricultural development priorities in Nepal.
- Strengthening of input and output markets is a pre-condition for maize intensification and income generation. With facilitation from CSISA, more than 300 contracts were signed between feed mills and producer groups to supply maize in Dang and Banke Districts. With respect to the provision of critical inputs, seed dealers like NIMBUS have supplied more than 200 tons of hybrid maize seed, enough to plant over 9,000 hectares, through retailers' networks in the FtF zone from a base near zero prior to CSISA's efforts.
- Key knowledge gaps for maize intensification were addressed during the reporting period:
    - *Managing the stalk rot menace***:** In collaboration with National Maize Research Program, CSISA identified integrated solutions for disease management that reduced disease severity by approximately 50%.
    - *Integrated weed management:* Due to the combined effects of yield reduction and the high costs of manual weed control, the net profitability in maize systems with prevailing farmer weed control was only US$ 38/ha. In contrast, improved control practices increased grain yields by 30–35% with marked gains in profitability with either the use of herbicides (US$ 582/ha) or mechanical control

(US$ 438/ha), turning maize from a (near) loss-making proposition to an enterprise with attractive returns.

- *Characterization of aflatoxin contamination in maize*: In collaboration with the Nepal government, CSISA is tracing contamination of this dangerous mycotoxin across growing seasons, production ecologies, and steps along the value chain to determine where mitigation measures are best implemented to reduce population-level exposure.
- *Crop-livestock integration*: For farms with moderately acute feed scarcity, simulations suggest that the application of higher rates of fertilizer for maize leads to significant increases in milk production and farm profitability. With an investment of US$ 50, an increase in net revenues from milks sales of US$ 150 can be achieved. Higher fertilizer rates also reduce labour requirements for fodder collection, a daily burden placed almost exclusively on women, by 50%.

- Nepali rice farmers are particularly vulnerable to monsoon variability because few farmers have access to assured irrigation. CSISA 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 FtF Terai districts sold 38 tons of hybrid rice seed in 2017, enough to preserve yield potential and increase resilience on about 2,000 ha.
- Production of healthy rice seedlings was promoted through social marketing and simple extension messages in collaboration with the Department of Agriculture and private partners. 3,733 farmers adopted healthy rice seedling practices on 977 hectares in the 2017 rice season.
- Market development efforts for zero-till seed drills have generated private sector sales of more than 200 drills that are used by CSISA-trained service providers for wheat and, in many cases, for other crops including rice.
- CSISA conceptualized and helped organize the first national commodity forums for maize, rice, and wheat to assist the Government of Nepal unite research, extension and the private sector to meet the ambitious agricultural development goals established by the Prime Minister Agricultural Modernization Program (PMAMP).

POLICY

- CSISA research on agricultural risk management has demonstrated how providing farmers with a relatively simple, transparent index insurance product can yield both *ex ante* risk management effects as well as *ex post* income effects. Specifically, insured farmers increase investments in irrigation and fertilizers by 30 and 24 percent, respectively, during the monsoon period for which the insurance product provided coverage, arising solely due to the transferal of production risk from the insured to the insurer. In the subsequent dry season, not covered by insurance, insured farmers who received an insurance payout during the monsoon season increased investments in fertilizer and new seeds by 10 and 28 percent, respectively.
- In collaboration with the USAID-supported Nepal Seed and Fertilizer Project, CSISA contributed to a successful capacity building workshop in August. Researchers from CSISA led a one-day session focusing on two competing—though complementary—methods for non-market valuation, including discrete choice analysis and experimental auctions. The capacity building workshop was conducted with 15 participants from various segments of the public and private sectors, as well as members of civil society organizations, including representatives form the Ministry of Agricultural and Development, the Department of

Agriculture, the Seed Entrepreneurs Association of Nepal, the Fertilizer Association of Nepal, and members of the formal financial sector.

- A book titled “Rural Mechanization – A Driver in Agricultural Change and Rural Development” was launched on 16 April 2017 in Dhaka. The book was launched jointly by Honorable Minister of Agriculture, Dr. Matia Choudhury, and witnessed the attendance of senior officials from within the Ministry of Agriculture, development practitioners, and members of the media.

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

Dry direct-seeded rice (DSR) is an innovative approach to establishing a rice crop that can overcome labor scarcity, reduce production cost, and save precious water resources. It therefore fits in well with efforts to sustainably intensify rice production in South Asia. Mechanized DSR has the additional advantage that it can reduce the time required for manual transplanting, and as such can help farmers establish their crop on time. DSR is a potential 'win-win' scenario: It addresses mounting rural labor constraints for transplanting rice while also creating rural employment opportunities for young entrepreneurial machine operators who can be hired to prepare and sow farmers' fields on an affordable fee-for-service basis. Because DSR does not involve continuously flooding the field, it also offers opportunities for crop diversification and intercropping.

A directly sown rice (DSR) field in Jhenaidah Sadar Upazila, Bangladesh. Photo by Sudhir Yadav.

The adoption of DSR has however been negligible so far in Bangladesh, until recently. This is due to risks encountered in establishing a uniform crop and associated water management difficulties where rural mechanized service providers or farmers are unfamiliar with how to manage a new DSR crop. Weed pressure can also be a concern where safe and effective herbicides are not easily available. DSR may also not be appropriate in all rice production seasons in Bangladesh. This is due to risks of cold-induced injury of seedlings in the winter *boro* season, and problems of excess water in the summer monsoon *aman* season. That said, manual transplanting, which has long been practiced in South Asia, is also a progressively less viable option for cash-strapped farmers who are unable to afford hiring migrant labor gangs that typically hand transplant rice.

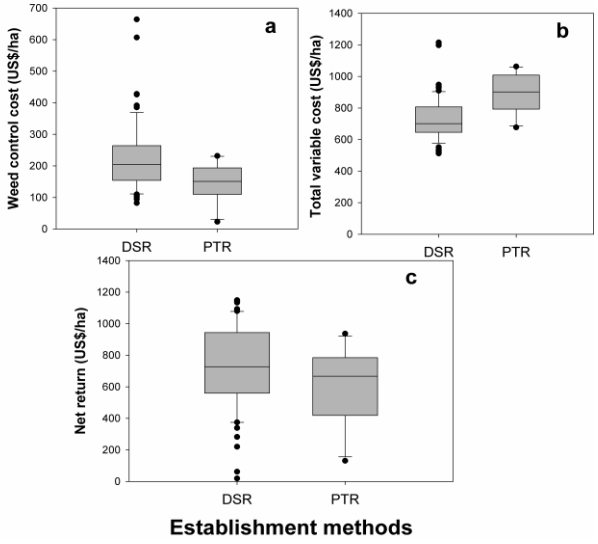
DSR requires careful weed management. In the front, patchy establishment due to late weed control. In the back, well established DSR with weed management administered at the right time and place. Note the innovative intercropping of mango tree saplings in this DSR field in Jessore, Bangladesh. Photo by Sudhir Yadav.

CSISA is therefore targeting the '*aus*' pre-monsoon season for DSR. This choice also aligns with the Ministry of Agriculture (MoA) policy to expand *aus* rice production, including DSR crop establishment. Efforts to expand farmers' use of DSR however depends on combining risk-reducing agronomic practices with technology targeting in environments with less weed pressure, where machinery is available, and where water control can be reliably achieved. Partnering with Bangladesh's Department of Agricultural Extension, which has been working to popularize the MoA policy favoring *aus* cultivation, CSISA's accomplishments in 2017 include the following:

The Director General of the Bangladesh Rice Research Institute visits DSR farmers as part of a CSISA sponsored field visit. Photo by Khairul Islam Rony

- Convening an interactive meeting and training session with 70 young agricultural machinery service providers and rural entrepreneurs to explore and establish interest in expanding their business services to include DSR. This event, conducted collaboratively with DAE and Bangladesh Rice Research Institute (BRRI), successfully identified a core group of young entrepreneurs primed to offer DSR services to farmers.

- Thirty-three 'lead' rural machinery entrepreneurs were subsequently trained on advanced machine operation for DSR establishment, in addition to refresher trainings in repair and maintenance. With assistance from DAE and BRRI, they were also sensitized to better-bet agronomy for DSR. These service providers went on to establish DSR crops in 284 farmers' fields in five separate districts on approximately 43 hectares. This afforded opportunity to hold several cross-locational field visits for farmers and machinery service providers, during which the business logic of DSR was discussed.



(a) Weed control costs, (b) total variable costs, and (c) net return in directly sown rice (DSR) compared to transplanted rice (TPR) during the 2017 aus season. The horizontal line within the box represents the median, while the box boundaries represent the 25th and 75th percentile, respectively.

- CSISA's collaboration with DAE resulted in farmers establishing 200 hectares of DSR during the 2018 *aus* season in Sailakupa and Jhenaidah Saddar Upazilas of Jhenaidah District, and in Sreepur Upazila of Magura District. At harvest time, CSISA conducted crop cuts in 65 farmers' fields to study DSR's performance under farmer-controlled management conditions. Mean grain yields were 5.0 t/ha in DSR compared to 5.2 t/ha with transplanted rice, although they were statistically indistinguishable. Farmers also expressed considerable interest in the cost-saving potential afforded by DSR. Average production costs for DSR were US$ 701 per hectare. Transplanted rice production costs averaged US$ 200 per hectare more. This resulted in higher total profits after costs were repaid from DSR, averaging more than US$ 100 dollars more per hectare.

- Prior to harvest, CSISA also organized field visits for policymakers, scientists, machinery entrepreneurs and lead farmers. Key guests included the Director General of BRRI, Additional Director of the DAE, Jessore District, the Deputy Director of DAE from Jhenaidah District and other high officials. This event created awareness and interest in DSR among policy makers and farmers, and positioned the project to further engage MoA support in 2018, pending funding availability to pursue field activities.
- CSISA also conducted a number of focus group discussions with machinery service providers who sowed DSR in 2017. Preliminary results showed that the area shown ranged from 5–40 hectares, depending upon the demand for DSR services from farmers and the capacity of rural machinery entrepreneurs. Data indicated that the current service area for machinery operators providing DSR services is far lower than their capacity, indicating the potential to expand their businesses if more farmers are sensitized to DSR. On average, service providers earned US$ 19.5 per hectare. Depending on the scale of their operation and service providers' abilities to line up clients for DSR sowing, seasonal earnings ranged between US$ 97–732 per season.

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

Wheat blast (*Magnaporthe oryzae* pathotype *triticum*) is a devastating fungal disease that until recently was found only in South America. Grain sterility caused by wheat blast can significantly reduce yield. The disease appeared in Bangladesh unexpectedly in 2016, and re-emerged in 2017. Wheat area consequently dropped from 62,763 hectares in 2016 to just 14,238 hectares over one year, with reports of spread to India (news here and here). Suitable climatic conditions in South Asia indicate that wheat blast will most likely continue to be a problem in the future. Three hundred million people in South Asia consume over 100 million tons of wheat annually. Wheat therefore presents a significant threat to food security. CSISA has responded to this emergency issue by supporting agronomy and pathology research to mitigate the threat posed by wheat blast, and by contributing to efforts to monitor the spread of the disease. Highlights of CSISA's work in this area in 2017 include the following:

Fast-tracking the release of Bangladesh's first wheat blast resistant variety: The breeding line BAW 1260 was approved by the National Technical Committee of National Seed Board for fast-track release in late 2017 as 'BARI Gom 33'. This was achieved through collaboration between BARI and CIMMYT, including CSISA. BARI Gom 33 was confirmed for wheat blast resistance in trials conducted in Bolivia and Bangladesh, and in greenhouse screening at the USDA-ARS laboratory in Fort Detrick, Maryland. BARI Gom 33 seed availability is, however, very limited at present. Without concerted efforts and emergency funds to multiply seed year-round in locations without a summer monsoon, only 10 tons of BARI Gom 33 (which could cover just 83 hectares) can be produced in Bangladesh before the 2018/19 wheat season. Only small gains could be made in subsequent years. Efforts are needed to support 'shuttle multiplication,' whereby seed grown in Bangladesh in the winter is sent to CIMMYT Mexico for summer multiplication, can seed availability be rapidly expanded. Scientists involved in CSISA are investigating options to technically and logistically support such shuttle multiplication efforts.

Left: Wheat blast infection on an older variety, BARI Gom 26 in Jessore, Bangladesh. Infections are visible as white, bleached spikes. Right: BARI Gom 33, resistant to wheat blast, shows little bleaching and blast infection. Photos were taken from CSISA supported screening and agronomy trials at the BARI Jessore research station, within the FtF zone of Bangladesh. Photo NCD Barma

Monitoring, surveillance, and mapping of wheat blast in Bangladesh: In collaboration with the Wheat Research Center, BARI, CIMMYT and BARI organized the two-week surveillance and training program, 'Taking action to mitigate the threat of wheat blast in South Asia: Disease surveillance and monitoring skills training' on wheat blast. The program received USAID support through CSISA and CSISA-MI, as well as the Australian Center for International Agriculture Research. Forty young wheat pathologists, breeders and agronomists from Bangladesh, India and Nepal participated. Following a week of laboratory work and training, the group of scientists monitored wheat fields in 24 wheat-growing districts across Bangladesh. One thousand six hundred eighty-eight (1,688) wheat leaf and spike samples were collected from 856 fields.

Wheat spike and leaf sample collection in surveillance program. Photo in Jhenaidah by M. Shahidul H. Khan

Progress of wheat blast samples processing, confirmation and preservation 2016-17

Type of field	Field No.	Sample type	Sample type	Samples (No.)	Blotter test completed	Isolates prepared	Status
Symptomatic (Wheat)	77	Symptomatic	Spike	154	154	151	● 38-MoT confirmed ● 60-MoT confirmation in progress ● 53-Isolates ready for MoT confirmation
			Leaf	154	154	-	*Pyricularia* found on 20 samples, but isolation was not possible due to contamination or association of the target fungus with other fungi[3]
		Asymptomatic	Spike	154	154	1	*Pyricularia* found on only one spike
			Leaf	154	154	-	No *Pyricularia*
Asymptomatic (Wheat)	335	Asymptomatic	Spike	1340	1340	-	No *Pyricularia*
			Leaf	1340	1340	-	
Alternate Host (grass weed samples)	35	Symptomatic & Asymptomatic	Leaf	35	35	7	Rice-1, Foxtail millet-2, Triticale-1, *Digitaria* sp. 1, *Panicum repens*-1, *Eleucine indica*-1 (Completed, No *Pyricularia*)

[3] *Pyricularia* is a fungal genus that includes *Magnaporthe oryzae* pathotype *triticum* (wheat blast).

Seventy-seven fields with visible wheat blast symptoms were found in nine of the 24 sampled districts, indicative of relatively lighter infections in 2017 compared to 2016. Over 1,000 samples of grassy weed species from wheat and rice field borders were also collected to check whether weeds can harbor the disease during the monsoon, providing a biological 'bridge' for continued infection of the wheat crop. Sample analysis is under way, although progress has been slow due to laboratory complications and mixed fungal contamination. Initial results are however clear, and indicate that wheat blast can be found on asymptomatic plants (though at extremely low levels). Symptomatic plants remain the main vehicle for disease transmission. Analysis of weed samples is still under way (see table below).

CSISA support to Government of Bangladesh partners to beat back wheat blast: CSISA was invited to participate in the Bangladesh National Blast Action Committee, convened by the Ministry of Agriculture in 2016, and technically assisted in the development of a farmer-friendly wheat blast fact sheet that detailed actionable management approaches farmers could use to reduce or mitigate wheat blast infection. CSISA supported the printing of 300,000 of these factsheets, distributed across key wheat growing regions of Bangladesh by the Department of Agricultural Extension and other development partners.

Confirming the performance of low-toxicity but effective fungicides: CSISA also partnered with BARI to assess the efficiency and toxicity of fungicides in on-station research trials carried out by trained experts. The goal of the trials is to identify low-toxicity and safe fungicides that can be used to combat wheat blast, and that are approved according to USAID PERSUAP standards.

Year 1 results of foliar applied fungicides on wheat blast control in southern Bangladesh.

Trade name	Common name	% Disease Severity	Yield increase from fungicide (kg/ha)	Cost of spray (USD/ha)	Profit (USD/ha)	USAID PERSUAP[4]
Nativo 75 WG	Tebuconazole 50%+Trifloxystrobin 25%	1.3	1,235	$80	$342	Restricted + Approved
Trooper 75 WP	Tricyclazole 75%	1.9	840	$71	$216	Banned
Folicur 250 EC	Tebuconazole 25%	0.8	500	$52	$119	Restricted
Tilt 250 EC	Propiconazole 25%	2.6	985	$49	$287	Restricted
Amistar Top 325 SC	Azoxystrobin 20% + Difenoconazole	1.1	360	$66	$57	Approved + Approved
Control	Unsprayed	14.6	--	--	--	--

Results from five fungicides tested by BARI to mitigate wheat blast indicated that all chemicals effectively controlled blast disease at low environmental infection levels. Two fungicides (Natovo 75 WG and Tilt 250 EC) gave significantly higher profits than others based on controlled station trial data. Amistar Top 325 SC gave less profit due to high market costs, although blast disease control by this fungicide was high. Amistar Top 325 SC is USAID PERSUAP approved. These trials are being replicated in the 2017–18 wheat production season in order to confirm these results. If Amistar Top 325 SC again proves to be effective in control, CSISA will work with partners in the private sector to

[4] CSISA in Bangladesh follows the country-wide Programmatic Pesticide Evaluation Report and Safer Use Action Plan (PERSUAP) for all non-research and on-farm activities. All fungicides applications were sprayed on research station land only by trained professionals following phytosanitary precautions.

identify specialized business models whereby the product can be sold at affordable prices to farmers in wheat blast affected areas while still generating significant company profits.

CSISA support for laboratory tests of seed treating fungicides. Partnering with BARI, CSISA supported initial laboratory experiments that showed that Provax 200 WP (Carboxin 37.5% + Thiram 37.5%), Vitaflo 200 FF (Carboxin 17.5% + Thiram 17.5%) and Rovral 50 WP (Iprodione 50%) can be effective in controlling seed wheat blast infection. All of these products are PERSUAP approved, and were therefore recommended by the wheat blast national technical committee and included in the 2017–18 version of the CSISA-supported and Ministry of Agriculture-approved blast factsheet, which is being distributed to partners and farmers at the time of writing.

Awareness raising workshop on wheat blast: BARI in collaboration with CSISA organized a regional workshop at Faridpur Hub to build awareness of methods to mitigate wheat blast on November 22, 2017. All district and Upazila-level officials of the DAE, officials of concerned research organizations, related government and NGO representatives participated in the workshop. Dr. Naresh Chandra Deb Barma, Director of BARI's wheat research center presented the updates of wheat blast research findings, future research plans and wheat blast mitigation strategies. He explained the advantages of newly released blast resistant wheat variety BARI Gom 33 and distributed the 2nd version of the factsheet on wheat blast to all participants. Factsheets were also supplied to all DAE offices in Faridpur District, as well as the Bangladesh Agricultural Development Corporation for subsequent distribution to farmers.

BARI and CSISA organized a regional workshop for the Department of Agricultural Extension in Faridpur, Bangladesh on Nov 22, 2017. Photo by Ansar A Siddiquee

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

A.2.2 Building precision nutrient management approaches around scaling pathways

Precision nutrient management (PNM) has been a core component of CSISA for many years. PNM aims to provide actionable recommendations to farmers for better nutrient management to move towards attainable yield levels, while using communication and recommendation deployment strategies that do not overwhelm extension services by having to reach each individual farmer. As a high-yielding and profitable crop in Bangladesh, maize requires precise and cost-efficient management approaches. PNM guidelines need to be fine-tuned for the different types of fields and environments, and backed with precise field data and analysis.

To this end, research conducted in 2016–17 in CSISA in southern Bangladesh has continued towards the development of PNM systems in rice–maize crop rotations in Bangladesh. Nutrient omission trials were conducted with the participation of 80 farmers in Jessore Hub within the FtF zone. The goal of the experiments was to predict spatial heterogeneity of the soil's indigenous nutrient supply capacity – information that is crucial for finetuning precise fertilizer management, and for bridging yield gaps. Soils were also sampled from 400 fields. Prior to budget disruptions that arose in mind 2017, CSISA had intended to use these soils for mid-infrared (MIR) spectroscopy analysis in partnership with Bangabandhu Sheikh Mujibur Rahman Agricultural University. MIR can be used as an alternative to costly and time-consuming wet chemistry methods, and has been widely used in sub-Saharan Africa to produce 'digital' soil maps that can assist with PNM recommendations. With CSISA's leadership, would have been the first time that MIR spectroscopy has been used for agricultural research in Bangladesh, although PNM research has been temporarily placed on hold pending clarity in fund flow in 2017–18.

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 response to requests by partners and farmers, CSISA develops accessible guides that farmers can use to grow more productive maize, rice and wheat crops, in addition to legumes and intercrops. Partnering with governmental institutes and the private sector, CSISA works deploy science-vetted agronomic recommendations for simple-to-implement, inexpensive (and hence inclusive) agronomic management practices for smallholder farmers. Key activities in the 2016–17 winter *rabi* cropping season in Bangladesh focused on raising farmers' awareness of how to grow healthier and more productive rice seedlings. This is crucial as rice is Bangladesh's primary staple crop, although productivity levels tend to be lower than what they can be with relatively simple adjustments to seedling and transplant management.

Better-bet agronomy efforts have also focused on mungbean cultivation. Although research has demonstrated that it is possible to achieve yields of over 1.2 tons per hectare, farmers average just 0.7 t/ha in CSISA's Barisal Hub. Mungbean is nonetheless Bangladesh's leading legume in terms of market price and profit potential. Farmers are therefore increasingly interested in growing mungbean as a moneymaking enterprise.

Sown in January/February, after post-monsoon season waterlogging subsides, mungbean fits well into the cropping pattern of many of the coastal districts' polders. Time-series data of mungbean production costs and benefits in Patuakhali collected by CSISA indicates that farmers can fetch between US$ 413–649 per hectare. This renders mungbean as one the most profitable agricultural options for the dry season in Barisal Hub. Markets are also rapidly developing, with large purchasing firms emerging – some even exporting mungbean abroad to Japan – in addition to local traders. Mungbean also contains up to 23% protein. It can therefore can address crucial household nutritional needs when a portion of the crop is consumed in addition to being sold, and help reduce stunting. Despite these encouraging developments, farmers still lack sufficient agronomic knowledge on how to best manage mungbean in the face of climactic risks for high yields and profits.

Healthy Rice Seedlings

Most farmers in Bangladesh who are able to locate and afford hired labor, transplant rice seedlings into flooded fields. The quality of seedlings used for transplanting however varies considerably among farmers. Use of young and healthy rice seedlings (HRS) tends to result in reduced transplanting shock, better crop establishment, early vigorous growth, and can fetch yields 7–10% compared to poorer quality seedlings. Remarkably, most farmers are unaware of the simple methods that can be used to raise more healthy seedlings. They therefore transplant poor quality seedlings, which are tall and thin with less vigor, that are older than their optimum age for transplanting, and often have damaged root systems due to late removal from rice seedbeds. Responding to these problems – and turning them into an opportunity for boosting rice productivity – CSISA completed the following activities successfully in 2017:

Awareness of healthy rice seedlings increased through mass media: A short 10-minute farmer-friendly instructional video on techniques to raise HRS in the winter *boro* and summer monsoon *aman* seasons was developed in Bangla. The instructional video features farmers using a series of 10 recommended practices to produce seedlings of high vigor and quality. Partnering with the NGO Agricultural Advisory Society (AAS), CSISA arranged video showings for farmers in villages in open-air public gathering places, community centers and markets across Jessore and Faridpur Hubs.

The video was shown to 37,117 registered viewers in 498 video-showing events the winter of 2016–17. Each showing was followed by extended question and answer sessions during which farmers were invited to ask technical questions on HRS practices. A trained AAS or CSISA staff member carefully responded to each question and assured that farmers clearly understood the technical advice given in the video. The following summer, an additional 17,736 registered viewers saw the videos in 265 showings implemented using the same protocols.

Taking into account unregistered audience members, the total number of farmer viewers is estimated at approximately 89,000 people in the winter, and another 23,950 people in the summer. Follow-up telephone surveys conducted after transplanting in the winter indicated that 62% of the registered viewers adopted at least one of the recommended HRS practices on their own rice fields. Adoption of HRS practices was lower in the summer aman season; 8,638 (49%) farmers on 3,113 ha land reported that they practiced at least one method. The lower rate of adoption was most likely due to the difficulty of managing water levels in the seedbed during the heavy rainfall monsoon season that can cause localized field waterlogging, and the generally less management-intensive practices used by farmers for the *aman* crop. But when combining the both *boro* and *aman* seasons, 31% of the registered farmers who saw the video adopted three or more HRS practices. The total seedbed area that used three or more recommended HRS practices across two seasons was estimated at 5,883 hectares. Following transplanting, this figure indicates that healthy rice seedlings were used on at least 60,000 hectares because of CSISA's awareness-raising efforts.

Farmer informational leaflet on how to grow healthy rice seedlings published by CSISA in 2017

Hands-on training-of-trainers in healthy rice seedling production methods: CSISA provided training-of-trainers in the first half of 2017. In the second half of the year during the summer *aman* season, the training was suspended because of funding uncertainty. In total, 612 block/village level Department of Agricultural Extension staff and 80 NGO field workers were trained on better bet agronomy management practices of rice cultivation, with a strong emphasis on HRS raising methods. Subsequent farmer trainings conducted by this group reached 8,419 farmers (10% women). Of these, HRS practices were adopted on 2,778 hectares of seedbed area, resulting in 28,300 hectares of rice grown using HRS techniques.

A trader sells his rice seedlings at a 'haat bazaar' or open air-market in Bangladesh. In Faridpur District, approximately 10 such markets are convened in the aman season where 15–20 traders, coming from different locations, buy and sell seedlings. Photo: Humnath Bhandari

Healthy rice seedling booklets reach development partners at scale: CSISA also developed and distributed informational HRS booklets to all of the Department of Agricultural Extension's 1,500 field master trainers. An additional 33,000 HRS leaflets were delivered through the Agricultural Inputs Retailer Network, and NGO that was developed by the USAID/Bangladesh-funded Agricultural Inputs Project, which maintains a network of over 3,000 input dealers in the FtF zone. These leaflets were subsequently distributed to farmers throughout the zone of influence who purchased rice-related inputs from these dealers. AIRN distributed 25,858 leaflets to farmers in the winter *boro* season, while the rest were sent out for the summer *aman* season. During this season, the printing of additional leaflets was not continued due to funding uncertainties.

Building up youth entrepreneurs in healthy rice seedling businesses: Farmers in Bangladesh frequently purchase rice seedlings. This is especially the case in locations where flooding or cold weather damages seedlings. CSISA trained farmers, especially youth, interested in becoming seedling entrepreneurs or expanding existing businesses. Forty-one entrepreneurs who had been running a seedling business and six new entrepreneurs under the age of 40 were trained on advanced HRS agronomy and business management skills. Several months after the interactive and hands-on trainings, focus group discussions indicated that the trained farmers began to prepare seedbeds within recommended planting calendar windows and using the proper seed rate. They also began treating seeds to produce fungal disease transmission, and using better water and nutrient management to improve seedling quality. On average, the HRS entrepreneurs earned a net profit of up to US$ 500 per season by producing and selling seedlings. They therefore all showed considerable interest to increase their business in coming seasons. These activities were conducted in early 2017, but were however discontinued later in the year due to funding uncertainties.

Scaling-out HRS practices through development partner networks: One of CSISA and the CGIAR's advantages is our long-standing presence in the countries in which we work. This had led to a number of durable and mutually beneficial partnerships with government and NGOs working in rural development, thereby providing pathways to scale-out research findings and information rapidly and effectively. These partnerships were used to benefit work on HRS in 2016–17. Working with the DAE and NGO partners, 1,092 farmers established 95 community-managed seedbeds in Jessore (62), Faridpur (14) and Barisal (19) hubs. An alternative to purchasing seedlings, community seedbeds not only gave farmers access to sufficient area to raise seedlings, but also reduce seedling costs of resource-poor farmers while spreading risk across a mutually supportive community. Community approaches to seedbeds are likely to be more appropriate for farmers engaged in pre-existing farmer clubs or groups that are frequently and independently convened by the DAE and NGOs. Community seedbeds increase the ease of precise seedbed management and appear to also lead to generally higher yields. Community seedbed activities

A rice community seedbed in Chowgaccha of Jessore district of southern Bangladesh. Photo by Jahangir Ali

were however suspended following the advice of USAID leadership in the third quarter of 2017 due to funding uncertainties.

Better-bet management of mungbean

CSISA has long delivered in turning research results into real-world impact. Building on the strong foundation of research into improved agronomy for mungbean production conducted by the Bangladesh Agricultural Research Institute, CSISA partnered with BARI in 2016 and developed farmer-friendly guidelines on mungbean agronomy and pest management in Bangladesh. Over 20,000 of these booklets were used to support farmer trainings deployed through CSISA's partners in DAE and USAID/Bangladesh Agricultural Extension Support Activity. A new private sector partnership was also formed with Grameen Euglena Ltd., a social business joint venture between Grameen Krishi Foundation and Euglena of Japan, to use the booklet to train mungbean farmers from whom the company would purchase after harvest. As a result, 3,592 farmers (37% women) on 611 hectares have begun using BARI-recommended management practices that were extended through the availability of the CSISA mungbean manual to boost yield and profits.

Farmers in Patuakhali, Bangladesh, harvesting mungbean grown with agronomic management advice from CSISA and BARI. Photo by Hera Lal Nath

B.1.3 Rabi fallows development in coastal Bangladesh

Estimates are that, rather than being cropped twice a year, up to 120,000 hectares in the FtF zone of Bangladesh are regularly fallowed after the monsoon season rice crop, or are under rainfed production during the winter dry season. Encouraging crop intensification in coastal Bangladesh however is not straightforward. Myriad biophysical limitations, including soil and water salinity, poor drainage and waterlogging, present consistent challenges. Poor transport systems, weakly developed markets, outmigration, shareholder cropping, and overall production risk pose additional barriers to intensified *rabi* season cropping in this region. In addition, not all farmers are the same – different farmers and farm types have differing capacities and interests in intensification, which must be accounted for. These problems call for new methods and approaches to study how and where development investments and initiatives might target and sequence their interventions.

In support of the Ministry of Agriculture's policy initiatives aimed at boosting cropping intensity and irrigation in the coastal south of Bangladesh, CSISA has been conducting interdisciplinary and policy-relevant research to identify pathways for the sustainable intensification of these otherwise marginal lands. Much of this research makes use of new frameworks and methods in agricultural systems analysis. Systems analysis is the study of complex problems such as those described above by breaking study system components into parts, and analyzing how they work together. Systems analysis, which increasingly incorporates biophysical and socioecological systems, often uses mathematical and simulation modeling to investigate the ways in which an outcome can be achieved with the greatest efficiency. Use of systems analysis tools can bring together a diversity of development stakeholders and opinions, incorporating them into a framework for unified analysis.

Ultimately, systems analysis tools can be used to support policy discussion and decisions, for example the ways in which development investments in the FtF zone of Bangladesh could be used to support intensified cropping while assuring equitable development for a diversity of farmer types.

Since 2015, CSISA has worked with tools from the 'enhancing the effectiveness of systems analysis' project (ESAP) to support learning and innovation in multi-stakeholder platforms. ESAP is a partnership between the Farming Systems Ecology group at Wageningen University, and the Royal Tropical Institute, both in the Netherlands. Funded by the MAIZE CGIAR research program, ESAP aims to identify research tools for systems analysis that can be applied effectively in multi-stakeholder settings to strengthen actors' interactions and a common understanding of the system in which they operate. On October 7, 2017, CSISA and ESAP co-supported a workshop with 31 participants working on issues related to sustainable intensification and surface water irrigation in the FtF zone of Bangladesh. The workshop goal was to highlight research results and to stimulate discussion among policy makers, development practitioners, agricultural scientists, and other stakeholders working in the region as to how to address and overcome these 'wicked' problems. Participants ranged from those involved in writing and passing Ministry of Agriculture policy supporting surface water irrigation initiatives, cereal systems scientists at cooperating national agricultural research and extension Institutes, water management specialists, and NGO and private sector partners from 17 different organizations.

Outcomes from the workshop included the following:

- Most workshop participants appreciated the use of new and novel tools to tackle the complex problems encountered in designing appropriate development pathways for sustainable intensification in southern Bangladesh.
- Workshop participants appreciated the use of cognitive mapping tools that facilitated rich discussion on types of interventions in which farmers and development experts prioritize for development initiatives aimed at cropping systems intensification. Gaps between farmers' and experts' perceptions of appropriate interventions were identified and discussed, allowing policy makers in the audience to refocus their attention on ways in which development investments can better serve farming communities.
- Participants broadly appreciated CSISA's work to develop online and publically accessible decision support systems to target where surface water irrigation might be most biophysically and hydrologically feasible, while accounting for ways in which fallow land can be intensified during the dry season. CSISA is engaged in discussions with Bangladesh Agriculture Development Corporation as to how this tool can be sustained for use over a longer time, and used on an institutional basis by governmental partners to assist in irrigation development planning.

New systems analysis tools help boost the sustainable intensification of agriculture in Bangladesh

In the northwestern Indo-Gangetic Plains, farmers use groundwater to irrigate their fields. This allows them to grow two or three crops on the same piece of land each year, generating a reliable source of food and income for farming families. But in the food-insecure lower Eastern Indo-Gangetic Plains in Bangladesh, farmers have lower investment capacities and are highly risk averse, resulting in low cropping intensity.

Could the use of available surface water for irrigation provide part of the solution to these problems? The government of Bangladesh has recently promoted the use of surface water irrigation for crop intensification. The concept is simple: by utilizing the country's network of largely underutilized natural canals, farmers can theoretically establish at least two well-irrigated and higher-yielding crops per year. The potential for this approach to intensifying agriculture however has limitations. High soil and water salinity, poor drainage and waterlogging threaten crop productivity. In addition, weakly developed markets, rural to urban out-migration, tenancy issues and overall risk limit productivity. The systematic nature of these problems calls for new approaches to study how development investments can best be leveraged to overcome these complex challenges to increase cropping intensity.

Policy makers, development practitioners and agricultural scientists recently gathered to respond to these challenges at a workshop in Dhaka. They reviewed research results and discussed potential solutions to common limitations. Representatives from more than ten national research, extension, development and policy institutes participated. The workshop however differed from conventional approaches to research by focusing explicitly on systems analysis approaches to addressing these complex problems. This workshop focused on these approaches and highlighted new advances in mathematical modeling, geospatial systems analysis, and the use of systems approaches to farmer behavioral science.

Timothy J. Krupnik, Systems Agronomist at CIMMYT and CSISA Bangladesh country coordinator, gave an overview of a geospatial assessment of landscape-scale irrigated production potential in coastal Bangladesh to start the talks. For the first time in Bangladesh, research using cognitive mapping, a technique developed in cognitive and behavioral science that can be used to model farmers' perceptions of their farming systems, and opportunities for development interventions to overcome constraints to intensified cropping, was described. This work was conducted by Jacqueline Halbrendt and presented by Lenora Ditzler, both with Wageningen University.

"This research and policy dialogue workshop brought new ideas of farming systems and research, and has shown new and valuable tools to analyze complex problems and give insights into how to prioritize development options," said Executive Director of the Krishi Gobeshona Foundation, Wais Kabir.

Workshop participants also discussed how to prioritize future development interventions, including how to apply a new online tool that can be used to target irrigation scheme planning, which arose from the work presented by Krupnik. Based on the results of these integrated agronomic and socioeconomic systems analyses, participants also learned how canal dredging, drainage, micro-finance, extension and market development must be integrated to achieve increases in cropping intensity in southern Bangladesh.

Mohammad Saidur Rahman, Assistant Professor, Seed Science and Technology department at Bangladesh Agriculture University, also said he appreciated the meeting's focus on new methods. He indicated that systems analysis can be applied not only to questions on cropping intensification in Bangladesh, but to other crucial problems in agricultural development across South Asia.

- CSISA is now also engaged in discussions with the Krishi Gobeshona Foundation, under the Government of Bangladesh, which works to promote partnerships and collaborations among the NARES institutes, technology dissemination departments, farmers' organizations, private sector entities, and the international research centers/universities dealing with activities related to agricultural research, development and extension. CSISA is working to investigate the potential for small but complementary investments to support NARES scientists in the use of systems analysis tools as a regular part of their research and policy formulation work. This could result in additional activities under 'CSISA Intervention B.2.1 Increasing the capacity of NARES to conduct participatory science and technology evaluations' in the future, pending fund availability on both a complementary basis and from USAID.

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

Premium quality rice pays dividends in Bangladesh. Photo: Soikat Majumder

Rice is the core staple food in Bangladesh. It is likely to remain the 'backbone' of most rural income-generating activities throughout the country for the foreseeable future. Farmers' ability to profit from rice cultivation is however generally decreasing. Much of this problem stems from large increases in input prices – particularly for labor and irrigation water – in relation to comparatively smaller increases in rice prices in the market. Market prices are however on the rise for aromatic and slender-grain premium quality rice (PQR) varieties in Bangladesh, which are increasingly favored by consumers in both rural and urban areas.

Research conducted by CIMMYT indicates that farmers growing PQR using better-bet agronomy can seize incomes up to US$ 200 per hectare as compared to conventional high yielding varieties. CSISA is harnessing this opportunity by playing a catalytic role to expand PQR production through an assortment of strategic public and private sector partners involved in rice seed procurement and grain trade. Key partners include the Department of Agricultural Extension, which partners with CSISA to spread awareness of PQR varieties and how to grow them, the Bangladesh Agricultural Development Corporation, which distributes several PQR varieties, private seed companies entering the PRQ market, lead local NGOs who can spread awareness of PQR opportunities, and rice traders and millers involved in the post-harvest value chain.

CSISA's PQR interventions include creating awareness about PQR varieties among farmers, aligning private and governmental partners to assure the timely availability PQR seeds, training farmers through NGO and DAE partnerships on better-bet agronomy for PQR varieties, organizing farmers into groups for collective marketing, and linking farmers to traders and markets.

Major accomplishments in 2017 include:

Creating awareness of PQR opportunities: CSISA trained 894 DAE field-level 'sub-assistant agricultural officers' and 80 NGO partner staff in Jessore Hub on better-bet agronomy of PQR. Trainees in turn used this knowledge during their daily interaction with rice farmers, and assisted PQR farmers with any production related difficulties encountered. This resulted in better crop management, control of diseases and generally higher yield.

Assuring seed supply to new PQR farmers: Much of CSISA's work in Bangladesh is facilitated

through strategic linkages to Government of Bangladesh partners with the potential to scale-out impact among farmers. To this end, CSISA's partnership with the DAE resulted in the timely distribution of 6.6 tons of early-generation, quality PQR seed (varieties included BRRI Dhan 50 and BRRI Dhan 63) in the winter *boro* 2016–17 season, and 6.3 tons of BRRI Dhan 34 and BRRI Dhan 75 in the summer *aman* season in 2017. These open-pollinated seeds can be saved by farmers after each harvest and traded in farmer-to-farmer seed sharing networks, thereby expanding availability of these PQR varieties.

A total of 3,902 ha was planted with PQR varieties in these seasons by 14,202 farmers. We conservatively estimate that about 11,706 tones of unhusked PQR rice produced in 2016–17 as a result of CSISA's activities and strategic partnerships. The aggregate additional benefit of PQR was estimated to be around US$ 0.6 million, or roughly US$ 42 more per hectare than farmers who grew conventional rice varieties. This indicates a very high return on investment in PQR that is likely to expand to more farmers as use of the seed distributed in 2016–17 takes root. Market research indicates that the demand for PQR is extremely high relative to domestic supply; as such, PQR farmers' profit margins are likely to be stable for some time to come.

Farmers can earn dividends in Bangladesh by cultivating premium quality rice varieties with high market demand. Photo: TJ Krupnik

Linking PQR farmers to profitable output markets: CSISA works to align value chains to assure the delivery of dividends from PQR to smallholder farmers and cereal procurers and millers alike. Farmers often face difficulties selling PQR to mills, which typically require large volumes to lower purchasing transactions costs. In response, CSISA organized 25 collection points in strategically located villages in 25 locations within the FTF zone. Farmers growing rice in these areas were able to sell into these collection zones from which PQR was rapidly transferred to 12 automatic rice mills and 23 semi-auto rice mills for processing. The project also began an inventory of all mills within the FtF zone with the capacity to process PQR, accompanied by an assessment of their demand and regular monitoring of rice price elasticities. This information was intended to better match farmers supplying to collection points with more capable and profitable mills, although this activity has been temporarily suspended due to fund uncertainties.

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

In early 2017 CSISA worked closely with BARI to co-organize an intensive two-week training program for scientists from India, Bangladesh and Nepal entitled "Taking action to mitigate the threat of wheat blast in South Asia: Disease surveillance and monitoring skills training." The training was the first of its kind in South Asia and was co-funded by USAID/Bangladesh, the WHEAT CRP, and ACIAR. Forty wheat pathologists, breeders and agronomists from Bangladesh, India and Nepal participated in the training. With further technical support from CIMMYT, Mexico, Kansas State University and Cornell University's Delivering Genetic Gains in Wheat project, participants learned about wheat blast epidemiology and ecology, and participated in surveillance exercises in farmers' fields. The training also involved intensive sampling of wheat blast disease to surveil its presence in over 800 fields across all major wheat growing districts in Bangladesh. Although follow-up NARES participatory science and technology evaluations were planned for the second half of 2017 – with emphasis on trainings to orient scientists in the use of systems analysis tools (see report section 'B.1.3 Rabi

fallows development in coastal Bangladesh'), these activities were suspended following advice from USAID to minimize budget expenditures given funding uncertainties in 2017–18.

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 sustainable intensification transitions in rice

Studies have shown that poorly controlled weeds can result in rice yield losses ranging from 15 to 90 percent in Bangladesh. The high costs of manual weeding that accompany mounting labor scarcity underscore the need for sensible and cost-effective integrated weed management (IWM) programs, which may require use of herbicides for increased weed control. Farmers' knowledge of how to properly utilize herbicides is however often lacking. This presents an important challenge for efforts to increase the productivity and efficiency of rice cultivation in Bangladesh. Farmers for example frequently get advice from agricultural input dealers, who also have poor practical knowledge of how to identify and select the right product for specific weeds, how to safely apply herbicides, and often are motivated to sell chemical products to farmers regardless of product efficiency and appropriateness. This presents a moral hazard that must be carefully navigated when scaling-out IWM programs in Bangladesh. If herbicides are also not used with care, they can also cause environmental damage, in addition to agronomic management challenges. For example, continuous use of the same mode of action for long periods may result in the evolution of herbicide-resistant weeds that render herbicides ineffective. In response, CSISA approaches weed management – which is crucial for assuring higher productivity and returns from rice based farming systems – using systematic approach in Bangladesh, by extending the principles of integrated weed management, which may require use of herbicides, to farmers and agricultural input dealers alike. Highlights of CSISA's efforts in the reporting period include the below activities.

Establishing the scientific evidence for new weed control products and practices: CSISA conducted a number of on-farm IWM trials across the Jessore and Faridpur Hubs in collaboration with Bangladesh Rice Research Institute (BRRI). The IWM trials included a combination of new classes of herbicides (pre-emergence (Mefenacet+ bensulfuron methyl), post-emergence (bispyribac sodium or penoxsulam)) and hand or mechanical weeding compared to farmers' typical weed management practices in transplanted rice. All herbicides were applied by BRRI's trained and approved field technicians with the requisite phytosanitary precautions.

Across different weed control options, the pre-emergence herbicides Mefenacet + Bensulfuron methyl followed by the post-emergence herbicide Bispyribac sodium followed by 1 hand weeding required the lowest number of laborers in both Faridpur and Jessore (3 person-days per hectare in Faridpur and 16 person-days per hectare in Jessore) to control weeds. In both locations, the second lowest number of laborers are required in the option having Mefenacet + Bensulfuron followed by Penoxsulam followed by 1 hand weeding. Similarly, the total cost of weeding was considerably less with these in these two options in both hubs. Weeding cost for either option compared to farmers' practices 74 – 75% in lower in Faridpur Hub and 85 – 105% in lower in Jessore Hub. These results suggest that Mefenacet + Bensulfuron methyl followed by either Bispyribac sodium or Penoxsulam followed by 1 hand weeding can effectively control weeds and reduce labor requirements and weeding costs. These new classes are however not commercially available at this time in Bangladesh, and require further vetting to assure their consistent performance across years, in addition to analysis of environmental safety criteria. Further vetting of these criteria has however been placed on hold following advice from USAID following news of budget uncertainties.

Characterizing weed species diversity to better advise farmers and input dealers on how to control problematic flora: Surveys of weed species diversity were carried out in 120 farmers' field in aman 2016 in two CSISA Hubs (Jessore and Faridpur). Detailed information was collected to characterize the distribution of major problematic weeds in rice, current weed control methods practices used by

farmers, as well as information on where farmers most frequently receive herbicide information. A total 23 different weed species were recorded across all fields surveyed. Among these, grassy weeds were found to be the most problematic followed by sedges and broadleaved weeds. Farmers generally only use pre-emergent herbicides and application time varies from 4 to 15 days after transplanting (DAT). The most widely used pre-emergent herbicide is Pretilachlor but with widely variable doses. All farmers surveyed get weed control information exclusively from agricultural input dealers. These results will be used in the future to re-focus CSISA's efforts on the prevention of problematic grassy weed species, and through continued targeting of IWM information for agricultural input dealers, coupled with awareness rising of the importance of providing farmers appropriate weed management advice as part of smart business practices to avoid moral hazards.

Top 10 weed species, their relative intensity and percent occurrence in rice-rice and rice-wheat-jute cropping systems in two CSISA hubs in 2017:

TOP 10 WEED SPECIES RECORDED	RICE–RICE SYSTEMS		TOP 10 WEED SPECIES RECORDED	RICE-WHEAT-JUTE SYSTEMS	
	Relative intensity	Percent occurrence across fields		Relative intensity	Percent occurrence across fields
PASPALUM SP	26.2	80	*Cyperus rotundus*	36.3	69.0
CYPERUS DIFFORMIS	23.1	80	*Cyperus difformis*	22.0	87.9
AMMANIA SP	16.7	45	*Cynodon dactylon*	14.9	84.5
SCRIPUS MARITIMUS	16.2	47	*Alternanthera sessilis*	8.3	69.0
MONOCHORIA VAGINALIS	10.5	50	*Paspalum sp*	7.7	55.2
CYPERUS ROTUNDUS	9.5	45	*Scripus maritimus*	7.5	37.9
CYNODON DACTYLON	5.3	58	*E. colona*	6.0	65.5
LEERSIA HEXANDRA	5.2	55	*Ammania sp*	4.4	46.6
ALTERNANTHERA SESSILIS	5.1	55	*Ludwigia sp.*	4.2	34.5
ECHINOCHLOA CRUS-GALLI	4.5	52	*Monochoria vaginalis*	2.8	44.8

Continued collaboration with the Agricultural Input Retailers' Network (AIRN) to sensitize input dealers on the principles of integrated weed management. CSISA continued its partnership with AIRN in 2017. By providing training of trainers to AIRN leadership, AIRN in turn trained over half the dealers in their network – a total of 1,182 people – on IWM principles and the business logic of providing farmers appropriate information on IWM options, including safe herbicide use. By partnering with AIRN, CSISA's impact in IWM has been significant: 5,872 farmers applied what they had learned from dealers by using IWM practices on their own fields and farms.

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

Increasing labor scarcity and costs are a prime driver of farmers' interest in agricultural mechanization in Bangladesh, with emphasis on crop sowing and harvesting equipment. USAID/Bangladesh guidelines unfortunately constrain CSISA-MI to working in the southern FtF zone. CSISA Phase III's northwestern Dinajpur hub conversely offers large market commercial opportunities to expand the availability of multi-crop reapers and two-wheel tractor mechanized seeders to smallholder farmers. Availability of machinery can also have knock-on income generating benefits for seeder and reaper owners. Many new machine purchasers use machinery not only for their own fields; they also rent out machinery for use on an affordable fee-for-service (or service

provision) arrangement. Many of these new rural entrepreneurs are also young, and excited that machinery can offer viable employment and income status raising activities in rural areas.

CSISA's work on the commercial expansion of two-wheel tractor-based machinery and associated service provision models for reapers and seeders aligns with work done by CSISA-MI's partner, International Development Enterprises (iDE), to develop value chains and to expand the commercial availability of affordable and efficient machinery in northern Bangladesh. Through this arrangement, joint venture agreements were established with two of Bangladesh's leading agricultural machinery importers and manufacturers: ACI and the Metal (Pvt.) Ltd. Supporting agreements have been reached with the NGO partner, TMSS, to provide financial services and credit to farmers interested purchasing machinery. A database of machinery mechanics and spare parts sellers was also developed following detailed field surveys. In addition, CSISA worked with BARI to train 364 potential machinery entrepreneurs in Dinajpur. The majority of these activities however had to be suspended in mid-2017 before they had time to fully take root. Suspension was a result of advice given by USAID following increasing uncertainty about longer-term fund flow, and unfortunately also resulted in the temporary suspension of the above joint venture agreements. Initial study during this reporting period indicates that approximately 474 farmers on 207 hectares received services from initial reaper and seeder purchasers. Continuation of these activities will be determined following clarity on fund availability in early 2018.

C.2 Managing risk by coping with climate extremes

C.2.2 Early wheat for combatting heat stress

Three hundred thousand people in South Asia eat wheat daily. Sustaining this demand is a challenge given climatic variability and climate change – largely because wheat is a temperature-sensitive crop. When temperatures exceed 30°C, grain sterility and reduced yields can result. Temperatures above 32°C during flowering are even more damaging, and often coincide with drought stress. Farmers who sow wheat after the recommended calendar date in Bangladesh often face these constraints as their crops mature in a hotter climate than in fields where farmers sow earlier. Research also indicates that late-seeded wheat is also more susceptible to major diseases like leaf blight, rusts and blast. For these reasons, wheat is most productive when the crop is sown during November.

CSISA works widely with farmers to increase their adaptive capacity in the face of climate change and climate variability. In Bangladesh, project activities focus on widely increasing farmers' awareness of the benefits of timely sowing. This is achieved through the use of carefully designed mass media campaigns (including radio, videos and leaflets), and through advisories deployed at scale through development and governmental partners. In total, 208,000 leaflets developed collaboratively with BARI were distributed through DAE and NGOs. An additional 33,000 leaflets were distributed by 1,182 input dealers associated with the Agricultural Input Retailer Network. 385 awareness-raising banners were also located in public markets and community centers. CSISA engaged mobile loudspeakers that broadcast early wheat sowing 'jingles' in marketplaces and in sub-districts known for excessive sowing delays. In total, over 1,000 hours of these broadcasts were aired.

Early wheat to beat the heat in Jessore District, Bangladesh. Photo: Ranak Martin

Finally, training and orientation on how to communicate the importance of early sowing to farmers was given to 660 DAE field agents and 80 NGO partner staff. This strategy is particularly important as partner staff were

leveraged to scale out advisory messaging on early sowing. At the end of 2017, CSISA continues to be the only project actively promoting earlier sowing for increased resilience of wheat farmers anywhere in Bangladesh.

CSISA's focus on early wheat sowing has borne considerable results. Crop monitoring statistics provided by DAE clearly showed that wheat sowing advanced by 10 days on 10%, 9% and 6% of all wheat area in Dinajpur, Jessore, and Faridpur hubs, respectively, in comparison to the previous year. We triangulated these data with farmers in a series of 30 focus group discussions to reliably estimate CSISA's contribution to this achievement[5], sowing was advanced on a total of 4,576 hectares by nearly 14,000 farmers. This was, however, only 76% of the targeted area. The reduction resulted from unseasonable rains in November 2016. These rains resulted in considerable soil moisture that prevented tractors from preparing land for sowing, thereby delaying sowing, in addition to farmers' reluctance to grow wheat in a year following a wheat blast outbreak.

In addition to the work described above, CSISA is also supporting BARI to test varietal responses to earlier sowing dates in Bangladesh. An additional focus of this work is to identify the degree to which different varieties are infected with wheat blast disease as a function of sowing dates. Six varieties were tested in blast hotspots in Jessore on five seeding dates at 10-day intervals starting from Nov 10. The results indicated that wheat sown during the optimum planting dates (Nov 10 and Nov 20), either escaped infection or had low disease severity (0–7%) compared to late sowing dates (Dec 10 and Dec 20) where infection was 11–60% across the varieties included. This study will continue for further confirmation next year, with experiments conducted at two additional research sites.

Challenges faced during the reporting period

The only major challenge faced in the 2016–17 reporting period has been the uncertainty in 2017–18 funding. Based on this uncertainty, CSISA received guidance from USAID that activities in the second half of 2017 should be suspended to save budgets given expectations of both a shortfall and delay in budget transfer for the 2017–18 year. For this reason, most activities were severely curtailed or stopped after July of 2017. CSISA has nonetheless been successful in achieving the majority of its targets and activities in the 2016–17 reporting period.

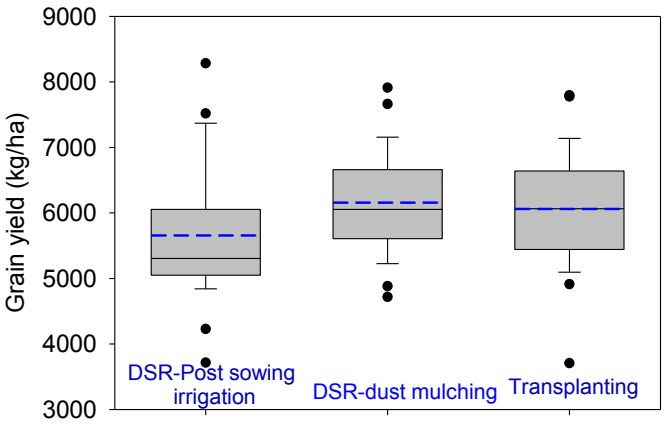
[5] Attribution to CSISA's media campaign was approximately 40% in Dinajpur and Faridpur and 80% in Jessore hubs.

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 rice seedlings into puddled fields cost farmers time, labor, energy and money. Machine-sown direct seeded rice (DSR) is a cost-effective technology that avoids the costs of raising rice nurseries and transplanting seedlings in the main field. In this context, DSR can be a suitable alternative to conventional transplanted puddled rice.



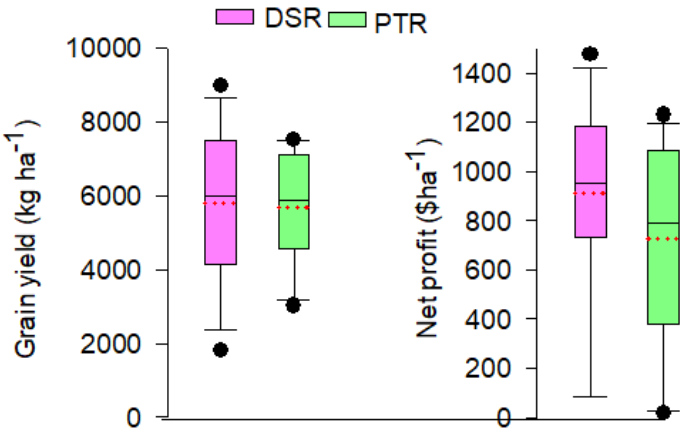
Agronomic innovations for DSR like 'dust mulching' significantly reduce production risks associated with the and produce yield equal to transplanted rice

Despite these benefits, DSR can be riskier 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, along with the 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. Dust mulching is a simple management adjustment that uses pre-sowing irrigation followed by shallow tillage to control weeds and limit evaporative losses, thereby reducing early irrigation requirements.

Reducing production risks is the essential first step towards making DSR viable at scale. In 2017, on-farm experiments compared two methods of DSR establishment (dust mulching vs. post-sowing irrigation) with conventional rice transplanting into puddled soils. Evaluations were conducted across 31 locations in six Terai districts and repeated the design used in 2016 to begin to assess if growing season weather has a large bearing on performance stability and yield outcomes. Dust mulching significantly increased yield (10% higher) and decreased early weed pressure (20% lower) compared to DSR with post-sowing irrigation. Also, there is no yield penalty under DSR-dust mulching compared to puddled-transplanted rice ('PTR'). These results are very similar to those from 2016, adding confidence to the stability of the results across years.

To scale DSR and create a critical mass of first adopters, CSISA organized a coordination meetings with service providers, the District Agriculture Development Offices (DADO), staff from the Prime Minister Agriculture Modernization Project (PMAMP), and machinery traders. 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 and Bardiya Districts, the DADO conducted block demonstrations of DSR in 35 new areas with technical backstopping from CSISA. In all demonstrations, DSR produced similar or higher yields than conventionally transplanted rice while significantly higher net profit (US$ 150–200/ha) (see inset) mainly due to reduction in production costs and early water requirements for crop establishment. In aggregate, more than 450 ha were planted to DSR through service providers in 2017 – an increase of more than 28% over 2016. The expansion of area reflects a convergence of the efforts of public and private sector partners.



Grain yield and net profit under DSR & transplanted rice under farmers' management conditions

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

1. Extending agronomy basics

In Nepal, government and development partners often focus on new technology introductions without retaining a focus on the basics of sound management that provide the foundation for sustainable intensification. Consequently, many farmers report a low-level of knowledge of research-based management recommendations and achieve low yield levels and profitability accordingly. To close this gap, CSISA collaborated with the commodity programs of the National Agriculture Research Council (NARC), including the National Rice Research Program, the National Maize Research Program and the National Wheat Research Program, to develop better-bet agronomy 'tips' covering production practices for rice (including healthy seedlings), maize and wheat. In very simple terms and with an emphasis on actionable advice, the factsheets explain low-risk options for improving management practices from seeding to harvest and storage. CSISA is deploying better-bet agronomic messaging through a range of public and private sector partners, with a companion focus on the development of master trainers so that better-bet agronomy is effectively mainstreamed and fully owned by these partners. Progress in the reporting year by crop was as follows:

	TIPS DISTRIBUTED	REPRINTED BY PARTNERS?	TOT TO PARTNERS (#)	HH APPLYING NEW TECHNOLOGY*	AREA UNDER NEW TECHNOLOGY (HA)*
RICE	10,000	Yes	400	8,177	1,501
WHEAT	2,500	Yes	247	2,138	948
MAIZE	5,000	Yes	212	1,436	400

** Note: Household and area estimates for technology adoption do not capture farmers reached through the efforts of partners to reprint CSISA's outreach materials or otherwise incorporate CSISA's materials in their programs. Those figures are pending.*

2. Strengthening the foundation of state extension:

Village technicians learning to operate precision spreaders with the District Agriculture Development Office in Rupandehi

The Government of Nepal has recently recruited 20–30 village-level agricultural technicians for each district – a first and very promising step towards providing advice to farmers at scale. However, the education systems for agricultural graduates in Nepal is not strong at practical, field-oriented skills development. CSISA is helping address this gap by providing principles-based field training on agronomy basics. Full-day trainings were organized in seven districts in coordination with the Department of Agriculture with 130 new agricultural technicians trained in better-bet agronomy for rice and maize. In turn, back-stopping support is now being provided by CSISA staff as these technicians implement demonstrations and their own training events for farmers.

3. Targeting messages and development efforts by assessing investment propensity towards different technologies

Rice is the staple crop for the majority of the Nepalese, but the country is not self-sufficient in rice production, and yields are among the lowest in the region as are adoption rates of new technologies that boost productivity. With little possibility of expanding the cultivated area of rice, increasing rice productivity is of prime importance in Nepal. While the reasons for low adoption rates are diverse, farmer perceptions of new technologies and willingness to invest in different intensification options for rice remains largely uncharacterized with attendant implications for the efficiency and effectiveness of development programming. In collaboration with Wageningen University (*graduate student Pragya Shrestha*), CSISA is using *ex ante* assessment techniques to explore the likely adoption propensity for a range of technological and management innovations for rice intensification.

The study was carried out in six rice-growing districts of the Terai, namely Rupandehi, Kapilvastu, Banke, Bardiya, Kailali and Kanchanpur. A sub-sample of 121 households (HHs) was drawn from a larger pool of survey respondents (n= 1,052) whose rice production practices and yield outcomes were surveyed by CSISA in 2016. Hierarchical Cluster Analysis (HCA) using five likely functional indicators of incentives and capacity to intensify rice production were used to classify and characterize farms. Choice experiments were used to study adoption propensity and perception of rice farmers regarding different intensification technologies. The technologies evaluated included better nursery management, direct seeded rice (DSR), use of urea at a recommended rate, hybrid seed, improved weed control, supplemental irrigation, mechanical harvesting, and cultivation of new rice varieties and hybrids.

Farmers' propensity towards adoption of rice intensification technologies varied by technology, with some 'no regrets' options such as improved nursery management having broad appeal and others, particularly those requiring more investment of labor, not strongly favored by farmers. Responses were also influenced by farm type with, for example, households that are less market-oriented with respect to sales of staple crops less willing to invest in inputs like fertilizer, particularly at un-subsided prices. Even more than farm type, geographic differences between districts explained a significant amount of the response variation in the survey. This was especially the case for technologies that were largely unfamiliar to farmers, although in several cases the results appear to be a reflection of true preference differences. For example, farmers in the western Terai districts are less inclined towards the combine harvester because it makes residue collection for livestock feeding less tenable. Integrated crop-livestock systems are more common in that part of Nepal.

Technology targeting rarely considers the investment willingness of farmers, and this study provides a first effort to rank technologies accordingly while accounting for differences in functional farm types and geographies. Full results are in the final stages of compilation and will be presented to the Ministry of Agriculture along with key partners such as the USAID-funded KISAN II project so that the findings can begin to inform development priorities in Nepal.

Propensity scores estimated on a Likert Scale (+3 highly likely <---- > -3 highly unlikely) towards adoption of rice intensification technologies categorized by district.

	DISTRICTS (MEAN VALUES)						MEAN (SD)
	Rupa n=22	Kapil n=18	Ban n=29	Bar n=16	Kai n=7	Kan n=12	
IMPLEMENT BETTER NURSERY MANAGEMENT	2.7	2.3	2.6	2.5	2.0	2.4	2.5 (0.7)
IRRIGATE TWO ADDITIONAL TIMES	1.5 ^{ab}	1.6 ^{ab}	1.6 ^{ab}	0.9 ^{b}	2.1 ^{a}	2.0 ^{ab}	1.5(1.2)
CULTIVATE SHORT DURATION RICE* **	2.3 ^{a}	2.2 ^{a}	1.8 ^{ab}	-0.7 ^{ab}	0.7 ^{b}	1.6 ^{c}	1.5(1.5)
PURCHASE HYBRID RICE*	1.3 ^{ab}	1.7 ^{ab}	2.0 ^{a}	0.7 ^{ab}	0.7 ^{ab}	0.4 ^{b}	1.3(1.7)
APPLY UREA WITH SUBSIDY* **	2.6 ^{a}	2.2 ^{a}	0.0 ^{c}	-0.2 ^{c}	1.8 ^{ab}	1.3 ^{b}	1.2(1.2)
PURCHASE HERBICIDE **	1.9 ^{ab}	2.2 ^{a}	0.5 ^{bc}	0.37 ^{bc}	1.1 ^{abc}	1.3 ^{c}	1.1(1.9)
USE REAPER* **	-0.3 ^{c}	-0.5 ^{c}	1.6 ^{a}	1.3 ^{ab}	0.3 ^{bc}	1.3 ^{ab}	0.7(1.4)
IMPLEMENT DSR*	0.0 ^{bc}	0.5 ^{bc}	0.8 ^{abc}	-0.6 ^{c}	2.1 ^{a}	1.5 ^{ab}	0.5(1.9)
ADDITIONAL HAND WEEDING* **	0.7 ^{ab}	1.1 ^{a}	-0.5 ^{c}	-0.2 ^{bc}	1.6 ^{a}	1.1 ^{a}	0.4(1.5)
USE COMBINE HARVESTER* **	1.6 ^{a}	1.2 ^{a}	-0.8 ^{a}	-1.1 ^{a}	0.7 ^{a}	0.3 ^{ab}	0.2(1.9)
APPLY UREA AT WORLD MARKET PRICE* **	2.0 ^{a}	1.1 ^{a}	-1.3 ^{b}	-2.0 ^{b}	-2.0 ^{b}	-1.3 ^{b}	-0.3(1.6)

*NOTE: SD: STANDARD DEVIATION. N = 104. DATA FOLLOWED BY LETTERS DIFFER SIGNIFICANTLY (DUNCAN '.05'), WITHIN ROW COMPARISON. LIKERT SCALE FOR THIS ASSESSMENT IS (-3: STRONGLY DISAGREE, -2: MODERATELY DISAGREE, -1: SLIGHTLY DISAGREE, 0: NEUTRAL, 1: SLIGHTLY AGREE, 2: MODERATELY AGREE, 3: STRONGLY AGREE). (KAPIL = KAPILVASTU, RUPA = RUPANDEHI, BAN = BANKE, BAR = BARDIYA, KAI = KAILALI, KAN = KANCHANPR). (SIGNIF. CODES: 0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1)*

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

1. Market facilitation to drive expansion of spring and summer maize cultivation

Despite the considerable cultivated area (2nd only to rice in extent), Nepal imports about 400,000 tons of maize grain per year, primarily to supply feed mills that support the rapidly growing poultry industry. Not only is this a missed income opportunity for Nepali staple crop farmers, it also erodes the potential profitability of feed mills since grain sourcing is currently secured from considerable distances (mostly from Bihar and Andhra Pradesh in India). 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 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.

Against this backdrop, CSISA has worked to build coalitions in order to facilitate the emergence of markets for maize grain in the FtF zone. Without the 'pull' factors provided by strengthened markets, farmers have fewer incentives to intensify production.

Spring maize: In the Terai districts of the FtF zone the area under spring maize is increasing where irrigation facilities are available. However, spring maize is a relatively new crop for this area and, consequently, best management practices are not well known and the input and output markets to support intensified production are still developing. CSISA organized market development events that united feed mills, farmer groups, government partners (e.g., extension officers from the Department of Agriculture), and input dealers. As a result**,** 61 farmers signed contracts with Rapti Feed Mill to supply maize produced on 350 ha during the 2017 spring season. The agreements with Rapti represents one of the first times that maize grain has been produced under contract in the FtF zone, representing an important step forward in the commercialization of maize production and the creation of new income-generating opportunities among staple crop farmers.

CSISA also used the market development events to canvass stakeholders about perceived priority areas for capacity development. Thereafter, trainings were organized for 130 resource persons from the public and private sectors on better-bet crop management practices including mechanization and post-harvest management. Quality factors, including aflatoxin contamination, remain a primary bottleneck and pressing concern for expansion of commercial maize production (see below).

Summer maize: Maize is the dominant monsoon (*kharif*) season crop in the hills of Nepal and is also commonly cultivated in the rolling plain region where the Terai meets the hills. Nevertheless, familiarity has not equated to productivity as most farmers achieve less than 2 t/ha in grain yields.

CSISA continued to support maize value chain strengthening focused on 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 in the hills. A total of 40 agricultural technicians from private sector partners (Rapti Feed Mill, NIMBUS Feed Mill, village development committee technicians and those 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. Building on the momentum created in the spring crop from the Terai, CSISA again facilitated contractual arrangements between Rapti Feed and maize growers for the production and marketing of maize grain. As a result, an additional 250 contracts were signed during the 2017 summer season.

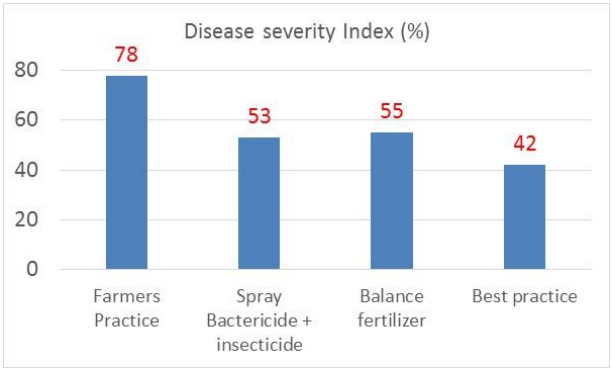
Availability of quality inputs is also an important constraint to intensification in the hills. To strengthen the supply of hybrid seed, CSISA organized six market development meetings where agro-dealers in the hills were introduced to a broad set of input suppliers. Input chains were strengthened on the basis of these interactions with a company like NIMBUS supplying 200 tons of hybrid seed through the dealer network in *kharif* 2017.

2. Managing the menace of stalk rot

Over the last 4 years, maize production in the low hill ecologies of the FtF zone such as Dang and Surkhet Districts has been severely affected by stalk rot disease, which in some cases caused complete crop failure. Very little research has been conducted into how to control this disease in Nepal. In 2016, CSISA organized meetings with the Department of Agriculture and the National Maize Research Program (NMRP) to identify possible entry points for overcoming the problem and to determine joint priorities for new field research.

Stalk rot appears to be exacerbated by imbalanced use of fertilizer (e.g. only applying urea). To disentangle the interactions between disease severity and fertility management practices, CSISA established on-farm experiments in Dang District in the 2017 *kharif* season. Similarly, in collaboration with NMRP and NARC (ARS-Surkhet), research station trials explored integrated methods for stalk rot management including fertilizer, varietal selection, and judicious use of fungicides and insecticides.

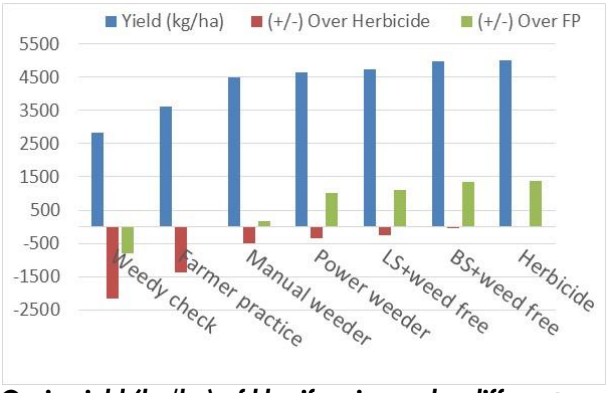
Preliminary results suggest that spraying of an insecticide (Cypermethrin) and bactericide (Streptocyclin) twice (i.e., knee height stage combined with a subsequent spraying after 15 days) reduced disease severity by 32% compared to farmers' practice. Similarly, disease severity was reduced by 30% under balanced fertilization compared to farmers' practice. With an integrated approach (spraying of the insecticide and bactericide, better weed management and balanced fertilizer application) disease severity was reduced by 46% compared to farmers' practice and constitutes 'best practice' from the perspective of control. Outcomes of these evaluations were shared with the Department of Agriculture and will be disseminated in disease-prone areas during the upcoming season. Additional research is required to identify options for further reducing disease severity as well as identifying economically optimal control strategies. CSISA will expand collaborative work with the Nepal Seed and Fertilizer (NSAF) team to screen a wider set of maize hybrids for resistance traits in 2018.



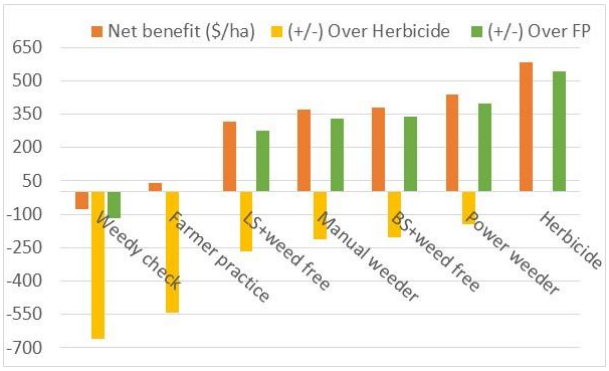
Stalk rot disease severity index as affected by different management practices.

3. Weed competition, labor, and economic returns in maize

Weed management is one of the most significant production challenges to *kharif* maize. Manual weeding, mostly by women, is labor intensive and challenging to complete in a timely manner since weeding operations conflict with rice transplanting when demand for rural labor is at its peak. It is crucial to identify less labor-intensive weed management methods for maize that can be scaled in the hills. To date, very little R&D investment has been made in mechanical or chemical weed management options in Nepal; only a single herbicide has been registered for maize.



Grain yield (kg/ha) of kharif maize under different weed management practices. LS: line seeding; BS: broadcast seeding.



Net benefit ($/ha) associated under different weed management practices in maize.

In this context, CSISA has partnered with agriculture universities and the Prime Minister Agriculture Modernization Project to evaluate different weed management options, including mechanical and herbicide-based weed management technologies. Results from on-farm trials research trials revealed the true costs associated with existing weed control methods: due to the combined effects of yield reduction and the high costs of manual weed control, the net return in these systems was only US$ 38/ha. In contrast, all improved control practices increased grain yields by 30–35% compared to current farmers' practice (see inset). Gains in economic performance were more impressive. The use of herbicides increased net returns to US$ 582/ha, with the best mechanical option increasing

returns to US$ 438/ha. These results demonstrate the transformative gains in profitability that can turn maize from a (near) loss-making proposition to an enterprise with attractive returns.

As a result of emerging experimental results, public and private sectors partners have started initiatives to promote mechanical weed control and markets for equipment. Similarly, CSISA is assisting the Department of Agriculture's Plant Protection Directorate to register safe and effective herbicide options for maize.

4. ***Characterizing maize quality with respect to aflatoxin contamination across production ecologies and growing seasons***

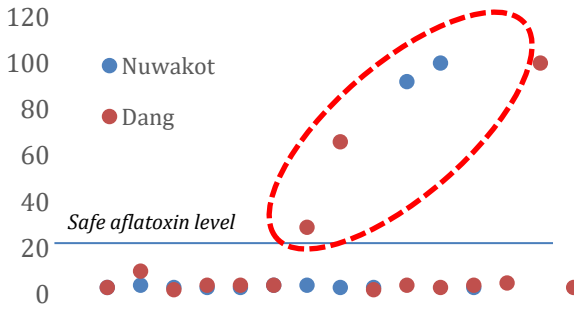
Aflatoxins are carcinogenic mycotoxins produced mainly by two types of mold – *Aspergillus flavus* and *A. parasiticus.* When ingested for sustained periods they can be acutely toxic to livestock and humans based on causal associations with diseases such as liver cancer. Moreover, even shorter-term exposure can be hazardous with childhood growth stunting also associated with aflatoxin consumption.

Aflatoxin contamination in maize grain

Aflatoxin has been found in grain and feed samples in Nepal. The Department of Food Technology and Quality Control (DFTQC), a governmental body, documents that about 20% of the maize samples assessed contained aflatoxin at levels greater than the safety limit of 20 ppb.

The USAID-funded Nutrition Innovation Lab (Tufts University) has started to document aflatoxin levels in pregnant women and children. Preliminary results document that 95% of the sampled individuals in the Nepali Terai had a detectable aflatoxin levels.[6] Global research shows that the risk of aflatoxin contamination is highest during the rainy season under hot and humid conditions. Maize is the crop grown under the most diverse production environments in Nepal, but there is little documentation of how aflatoxin contamination varies according to environment and management practices. Accordingly, CSISA collaborated with DFTQC and the Post-Harvest Directorate to:

- assess the level of aflatoxin contamination in maize grown during different seasons and in different production ecologies
- understand how pre-and post-harvest management practices affect aflatoxin contamination



Aflatoxin level in spring maize in Nuwakot and Dang Districts.

Sample collection and analysis from the field and across the post-harvest maize values chain (i.e., on-farm storage to feed mill and dealers) are ongoing. Aflatoxin levels from freshly harvested spring maize from Nuwakot (*n=12*) and Dang (*n=15*) Districts have been analyzed. Preliminary results showed that all samples had detectable aflatoxin levels and that approximately 19% had aflatoxin levels that exceeded the safety standard of 20 ppb (see inset).

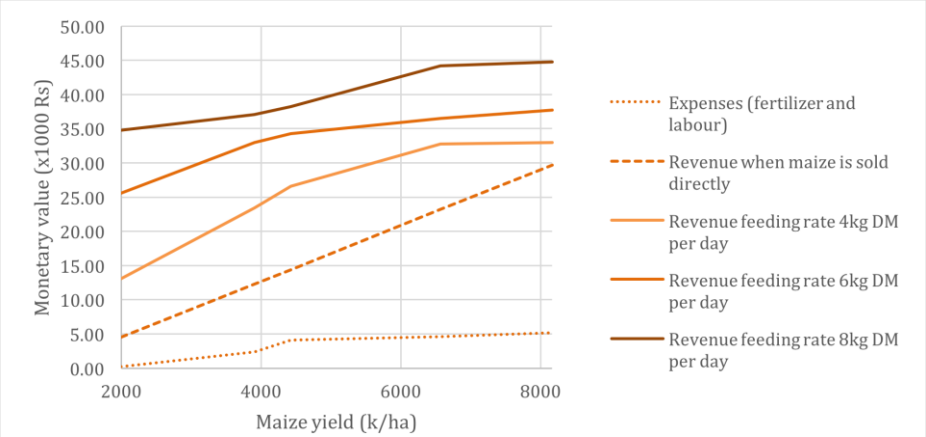
With the full survey results in hand by Q3 of 2018, we expect to be able to guide the government, private sector, and farmers towards management practices that will reduce aflatoxin contamination in production environments and storage conditions that are particularly vulnerable.

[6] CSISA supported the development of the agriculture module for the Nutrition Innovation Lab survey on aflatoxin: http://www.fasebj.org/content/31/1_Supplement/639.42.

5. *Crop-livestock integration: Is it profitable to invest in fertilizer to enhance maize production in order to drive increased milk sales?*

In the mid-hills of Nepal, dairy livestock are common as part of mixed maize-livestock enterprises, but milk production is still low with seasonal feed deficits identified as a prime reason. Two additional factors help frame the intensification challenge. First, labour inputs for fodder collection are extremely high and fall disproportionality on women. Few households have the capacity to invest more labour into dairy feeding. Second, maize productivity is low and several technical and management options have been identified that can dramatically increase maize productivity. In this collaborative research study conducted jointly with Wageningen University (*graduate student Jori Bremmer*) and Heifer International, we ask if it is profitable to invest in fertilizer to boost maize production in order to increase livestock feed and milk production. Farm surveys were conducted in Palpa and Dang Districts to assess farm and livestock management characteristics. A farm-level simulation model (LivSim) was then used to explore the impact of increasing maize yields on milk production.

There are two main differences between Palpa and Dang affecting the profitability of integrated crop-livestock enterprise: milk prices are higher in Palpa and more maize is used as feed, increasing milk production and milk revenues. In both regions, it is worthwhile investing in fertilizer; under all tested feeding regimes the costs for fertilizer do not represent more than 15% of the revenues generated when selling the milk. However, an intensification limit is reached as there is a maximum amount that livestock can eat before higher stocking rates would be required to make use of additional feed resources.



Revenues generated through milk sales under different maize productivity scenarios achieved through increased soil fertilization.

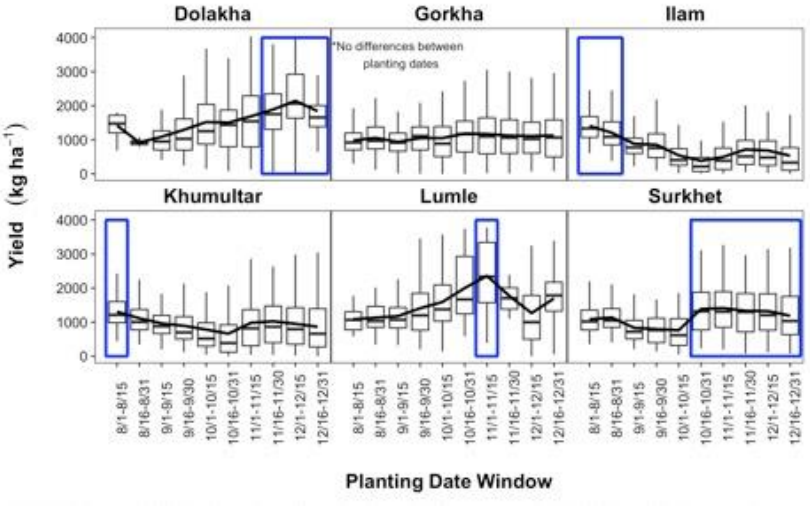
For farms with moderately acute feed scarcity (feeding rate of 4 kg dry matter per day), the application of fertilizer leads to significant increases in milk production and farm profitability: with an investment of around US$ 22 in fertilizer, an increase in net revenues from milks sales of US$ 80 can be achieved. With an investment of US$ 50, this increases to approximately US$ 150. The application of fertilizer for increasing the maize yields can lead to a lower requirement for labour for cut and carry when part of the fodder in the diet is replaced by maize (e.g. under a high feeding regime labour requirement can decrease from 38 days/year to 24 days/year). Although this leads to a decrease in labour, in some circumstances it may also decreases overall feed quality. The implication of this trade-off merits further study.

Although increasing maize production for feed purposes is found to be a good option to decrease feed shortage and increase milk production, the results cannot be overly generalized. They vary depending on household labour availability, characteristics of fodder quality and quantity, livestock stocking rate and the financial resources available for purchasing fertilizer.

6. *Ex ante* assessment of opportunities for closing system-level crop yield gaps in cereal systems in the mid-hills of Nepal

Yield gap assessments are essential for establishing agricultural development priorities and assessing threats to food security. Recently, Devkota et al. (2015) characterized different options for the sustainable intensification of maize production in the mid-hills of Nepal, including: 1) timely planting, 2) cultivation of longer-duration maize hybrids, and 3) adoption of conservation agriculture (CA) based practices. In this collaborative study conducted with the University of Nebraska (*graduate student and Borlaug Fellow John Laborde*), we place these options in the context of the prevalent maize-wheat cropping pattern of the mid-hills to characterize productivity tradeoffs and synergies at the cropping systems level and extend the analysis to explore behavior across the principal elevation and precipitation gradients in the mid-hills.

The DSSAT model was used to simulate potential productivity of maize and wheat under CA and conventional (CP) management, contrasting N application rates, and a continuous range of wheat planting dates binned into 15-day windows from September 1st to December 15th with 30 years of historic weather data at six locations within the mid-hills. Cultivating longer duration maize hybrids increases total biological productivity by up to two-fold, but also increased the risk of delaying wheat planting by up to 71% for regions with mean seasonal temperatures below 14.0°C. Also, optimal wheat planting date occurred in August for hot and dry locations, and between October 16th and December 31st for cool and wet locations. Furthermore, we found that increasing N rates above current recommendations significantly increased wheat productivity regardless of location, but wheat response to N was greatest at cool and wet locations. Lastly, CA was more productive than conventional tillage only at locations where seasonal rainfall exceeded 400mm, ostensibly because sufficient soil water was present to promote rapid breakdown and nutrient cycling of surface residues on CA soils.



Wheat yields simulated at six locations in the mid-hills of Nepal. Planting dates in blue represent the highest average yielding 15-day planting date window.

7. Partnership with the Prime Minister Agricultural Modernization Project (PMAMP) for commercialization of maize production

With a planned commitment of more than US$ 100 m and a 10-year performance period, the Prime Minister Agriculture Modernization Project is the centerpiece of the Nepal Government's efforts to implement the *Agriculture Development Strategy* (ADS) that was passed by parliament in 2016. The ADS provides a roadmap for investment and aims to make the country self-reliant in agriculture production through targeted science-led innovation, progressive policies, and support to the

emerging private sector. The PMAMP is organized around 'super zones' (commercial areas of more than 1,000 ha), zones (> 500 ha), blocks (> 50 ha) and pockets (> 10 ha). After consultation with the PMAMP leadership and by invitation, CSISA has initiated deep collaborations with the commodity programs for wheat, maize and rice that extend into the FtF zone. For example, the Maize Super Zone program has included CSISA in its technical and advisory committees and joint work plans were developed for the 2017 spring and summer maize seasons. Key activities include:

- Demonstrating mechanized maize establishment in new areas by mobilizing CSISA service providers;
- Contributing to the development of five new commercial maize pocket areas (> 10 ha each) by linking input and output value chain actors with producer groups;
- Organizing technical trainings on sustainable intensification production technology for key intermediaries from the PMAMP, Department of Agriculture, and private sector;
- Sharing extension publications in the forms tips, posters, booklets and videos that draw from CSISA applied research programming.

Under this partnership, the first national Maize Forum was organized on October 9–10, 2017 and included 35 key public and private stakeholders. To frame the discussion, CSISA scientists presented a synthesis of findings from production practice surveys as well as on-farm experiments conducted in different seasons and geographies. Discussion at the forum then emphasized the identification of proven best practices for sustainable intensification, consideration of scaling pathways for knowledge and technological innovations, areas for future research, and joint work plan development for the 2017–18 maize season. Similar events were also held for wheat (Q3 2017) and rice (Q4 2017).

Participants at the first national Maize Forum

Going forward, CSISA sees the PMAMP as the core mechanism for scaling sustainable intensification technologies for cereals in Nepal. As such, CSISA will continue to make contributions to the PMAMP at the strategic and operational levels.

C. Achieving Impact at Scale

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

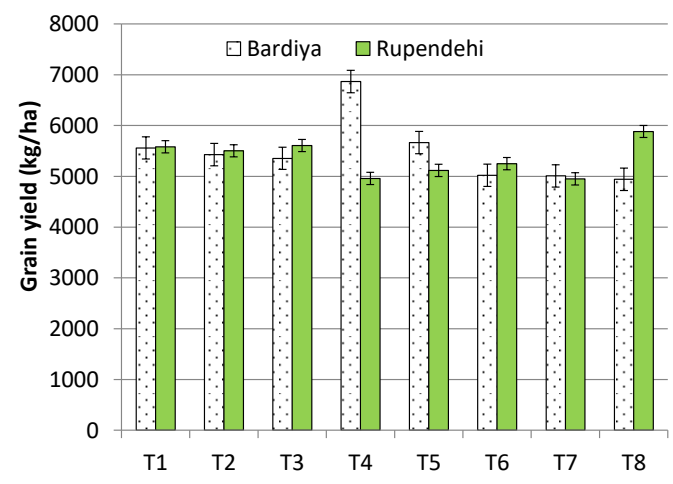
C.1.1 Integrated weed management to facilitate SI transitions in rice

In Nepal, manual hand weeding is the most common method of weed control in rice. Because of the scarcity of labor and consequently increase in labor wages, manual weed control is becoming expensive and laborers are often not available at critical weeding times, leading to late weeding and more yield losses (sometimes even up to 40%).

Recently, a proportion of farmers have started using herbicides for achieving timely and economical weed control, but there is almost no data available on the types of weeds that are most common, or on the contemporary control strategies implemented by farmers and supported by the private sector. To address these gaps and best target integrated weed management (IWM) interventions, CSISA conducted a field survey of current weed management practices and began gathering spatial information on problematic weeds across the landscape to inform NARES and private companies so they can deploy appropriate management solutions.

Surveys covered >350 households across six Terai districts in the FtF zone. Forty weed species belonging to >15 families including annual and perennial grassy weeds, broadleafs, and sedges were documented. A companion survey of input dealers revealed that almost all stock herbicides but only one or two products, mostly Butachlor for rice and 2, 4-D for wheat. Because weed flora is complex in these environments, the same herbicide may not control all weeds in all locations. Selecting economically and environmentally efficient herbicides and linking these herbicides to value chain actors could greatly benefit rice farmers.

Based on 2016 weed survey results, and to generate actionable information for the private sector, CSISA collaborated with the Nepal Agricultural Research Council (NARC) to identify the most effective and economical weed management options for transplanted rice through on-farm research. Eight different weed management treatments using new and safe herbicide molecules combined with hand weeding were evaluated at nine farmers' fields in Bardiya and Rupendehi Districts. Results showed that a combination of two herbicide molecules (Bispyribac + pyrazosulfuron or Fenoxaprop + Carfentrazone) was better able to control the diverse weed spectrum common in rice. Similarly, rice yields in herbicide-based weed management treatments were either higher or at par with farmers' practice (T8) but have a better economic return through labor savings (see inset). Based on this finding, CSISA will work with herbicide importers and the Plant Protection Directorate for the registration and market availability of those herbicides.



C.1.2 Zero-till wheat to tackle energy and economic constraints and to enhance crop production

1. Apparent savings, hidden costs: documenting the impact of high-speed rotovator use in the wheat systems of Nepal

The rotovator is a tractor-operated approach to soil tillage that uses rotating 'L' or 'J'-shaped blades to create fine tilth while efficiently incorporating crop residues, often with a single tractor pass if 'high speed' equipment. Rotovator tillage has spread rapidly in many parts of South Asia, perhaps because fewer field operations are required and the physical appearance of the soil is uniform. Nevertheless, some farmers and researchers have raised concerns about impact of this technology on soil quality. Conventional research methods such as long-term trials on research stations have a role in documenting immediate and progressive impacts on soil characteristics and crop yields with time, but are expensive to conduct and do not sufficiently capture technology interactions with the range of soil types and management factors that characterize the staple crop production systems of South Asia. This study overcomes these methodological constraints to technology assessment by combining farm level data (i.e. production practice and crop-cut surveys) and a non-parametric propensity score matching estimator to derive insights from the landscape scale on wheat yields in the Terai plain of Nepal. When we compared the mean yield and profit levels between rotovator adopters and non-adopters, we found that adoption clearly leads to inferior outcomes. Due to rotovator use, farmers lost about 284–309 kg of wheat grain yield and US$ 93–101 of profits per hectare on average. Adoption of the rotovator was apparently driven by the cost-savings (US$ 11–15; 15–20% per hectare) at the time of land preparation, along with lack of awareness among farmers about the yield penalties incurred.

By sharing these results with research and development partners in Nepal, we expect to generate more demand for zero-tillage as a timesaving alternative to conventional crop establishment that raises yields and economic returns.

2. Scaling zero tillage for wheat through service providers

In Nepal, the national average wheat productivity is far below other Asian countries with similar production ecologies. A CSISA survey conducted across the Terai's wheat growing districts in 2016 showed that >25% of the wheat farmers suffer net financial losses, mainly due to high production costs and low productivity. Zero tillage significantly reduces the cost of sowing wheat and helps facilitate early seeding, especially in lowland areas, thereby reducing production costs and increasing productivity while significantly reducing risk and boosting resilience by helping farmers avoid terminal heat stress. CSISA is facilitating ZT wheat technology by facilitating the emergence of well-trained ZT service providers. This collaborative effort in 2016–17 facilitated 1,145 farmers to adopt ZT wheat on 537 hectares. Most encouragingly, ZT adoption has been achieved through the increased private sector provision of seed drills. ZT drills were not commercially available in Nepal before CSISA intensified its market facilitation efforts in 2014. Around 50 drills were sold during the current reporting period, and the 'leading edge' indicator strongly suggests that this technology and the service arrangements to support it are primed to quickly expand in Nepal.

2. Priorities for wheat intensification beyond zero tillage: decomposing yield gaps

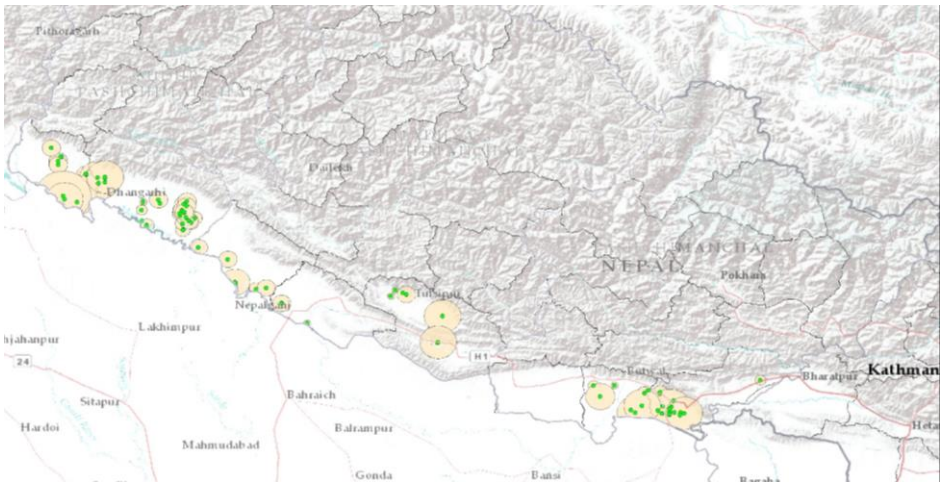
Despite very similar potential yield levels, wheat productivity in the Terai region of Nepal is roughly half of what is achieved in the Indian breadbasket states of Punjab and Haryana. This collaborative research with the University of Illinois (*graduate student and Borlaug Fellow Alex Park*), conducted an assessment of the causes of wheat yield gaps with an emphasis on the Terai and Bihar State in India. Underpinning this work were the recurrent crop-cut and production practice surveys conducted annually by CSISA. An analytical framework using classification and regression tree analysis (CART), in combination with linear mixed effects models (LMEs), was used to assess the importance of management practices to close yield gaps at nested spatial scales.

Average wheat yield of surveyed farmers in Bihar was 72% of yield potential, whereas in Nepal that value was only 36% - a remarkably low level. Among farmers who use adequate levels of inputs, the most powerful combination of practices used by farmers to reduce yield gaps was pairing timely planting with longer-duration wheat cultivars. For every day increase in maturity rating at the earliest planting date (November 9th) yield gaps were reduced by 243 kg ha^{-1}. At the most foundational level of good management, farmers in Bihar used approximately double the inputs of nitrogen, phosphorous, and irrigation than those in Nepal. Famers in Bihar also achieve higher use efficiencies of use for every unit of fertilizer and irrigation applied. Potassium unexpectedly emerged as a critically limiting factor across the study region. Only 48% of farmers from Bihar, and 30% of Nepali farmers applied any K whatsoever.

C.1.3 Commercial expansion of scale-appropriate machinery and associated service provision models for reapers and seeders

1. Developing markets for seeders

Service providers are key to increasing access to capital-intensive mechanization technologies by making them available for a fee to small- and medium-scale farmers do not have the financial resource to purchase their own machinery. With technical and market development support from CSISA, more than 200 service providers have purchased seed drills in the Terai region. CSISA conducted a survey of 85 service providers in six Terai districts to help develop a 'service provider profile'. On average, each provider operates within a 20-km area and charges on average US$ 12–15 per hour. The figure below shows the distribution of service providers located in CSISA working districts and the circle indicates the maximum distance that each service provider reached to provide the services to the farmers.



Distribution of seed drill service providers located in CSISA working districts. The circle indicates the maximum distance travelled to reach farmers.

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**.**

In early 2016, CSISA introduced the first four-wheel tractor-drawn seed drill for seeding maize in Dang. Use of this drill reduces the costs of crop establishment by 60% and the cost of the first weeding by 20% due to the operational efficiencies created by row planting. Besides providing technical training for potential service providers, CSISA facilitated market linkages for the availability of the machinery at the local level. With this effort, seven new service providers purchased seed drills at their own cost and provided service for more than 300 farmers on around 200 ha of land for seeding *kharif* maize in 2017. This number was significantly higher than last year, when only one service provider existed and only 30 farmers adopted mechanized seeding on 10 ha.

New seed drills roll off the lot and into the hands of service providers in Dang.

2. CSISA's relationships across the machinery value chain

In the first days of CSISA, the project focused almost exclusively on new technology introductions. Recognizing that introduction alone will not drive technological change, CSISA began to emphasize marketing campaigns, backward linkages with machinery manufacturers, and government cost-share programs that serve to stimulate private sector investments.

The table below highlights the partnerships for market-based mechanization that CSISA has successfully facilitated. CSISA's involvement included providing introductions, facilitating tours to launch linkages, providing advice, and strategically nudging both parties along the way to move partnerships towards fruition.

CSISA's facilitation efforts across the machinery value chain in the FtF zone of Nepal

Exporter / Location	Importer	Partnership Established	Product(s)
Khedut India	SKT (initially) BTL and Global Trading (currently)	March 2016 January 2017	Lower-cost seed drills for minitiller Lower-cost seed drills for two-wheel tractor (2WT) Lower-cost seed drill four-wheel tractor (4WT) Lower-cost manual planters, jab planters and pull planter
National Agro India	The Habi Kubir and Sons	December 2015 Apr – Dec 2016	Premium four-wheel tractor seeders and planters
KGBK, Jharkhand	Kubir and Sons	March 2016	Hand tools (weeders, etc)
Durga Engineering India	SKT	May 2016	Open drum thresher
Dharti India	Kubir and Sons	December 2016	Lower cost minitiller, 2WT, & 4WT seeders
Various Chinese suppliers	BTL SKT Kubir and Sons Tikapur	Before project 2014 2014 2016	2WT reapers
Various Chinese suppliers	BTL	July 2016	Premium vertical plate maize planter
Various Chinese suppliers	SKT and AMC	2016	Hand cranked seed and fertilizer spreader
Various Chinese suppliers	Shrestha Agro, SKT, BTL, AMC	2015 (via CSISA Earthquake Recovery Support Program)	Irrigation-water pumps for mini-tillers

3. Mechanization in the Earthquake Zone

The powerful earthquakes that struck Nepal in the spring of 2015 exacerbated the labor shortages that the most badly affected districts were already confronting due to intense out-migration. Building on knowledge gained and networks established under CSISA's Earthquake Recovery Support Program (2015–16), funded by USAID Nepal, CSISA continues to support the introduction of farm machinery into the earthquake-affected districts of Nuwakot and Makwanpur to address the issues of declining agricultural labor availability and the need to create businesses to keep small farms viable. After reapers were introduced into Nuwakot in September 2016, 66 households were able to harvest more than 20 ha of rice and wheat in 2017. CSISA then collaborated with DADOs, traders and farmers' groups for the introduction of the push row seeder and seed drill for mechanically seeding maize for first time in the district.

CSISA's efforts to demonstrate and introduce new scale-appropriate machinery and improved agronomy has caught the eye of other development partners like USAID's SABAL project, which has incorporated machinery demonstrations and trainings for farmers, especially women, into their programming in Nuwakot and beyond, with technical backstopping from CSISA.

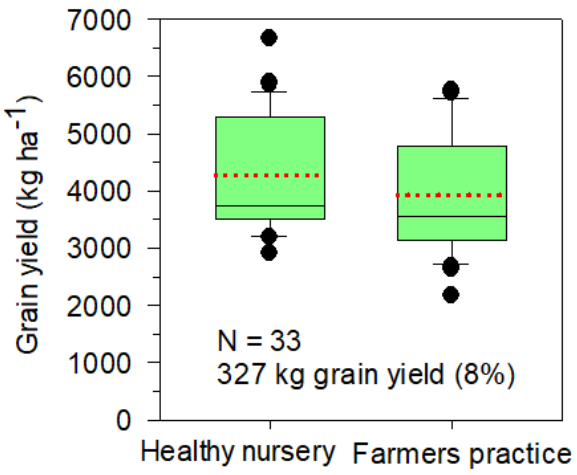
C.2 Managing risk by coping with climate extremes

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

1. Healthy rice seedlings for higher yields

In Nepal, rice nursery establishment and transplanting depend heavily 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. Cropping system productivity will suffer if crop establishment is delayed and if poor quality seedlings are used. Often, farmers lose their nursery seedlings and then face the unavailability of seedlings in the market. Increasing the supply of healthy nursery through entrepreneurs is one a significant adaptive strategy.

As a first step, CSISA has developed a factsheet on better nursery management for healthy seedlings and has provided training to technicians from the Department of Agriculture, the USAID-funded KISAN project, and seed companies. Also, to further raise awareness about the importance of healthy rice seedlings in Nepal, CSISA collaborated with the Department of Agriculture to produce and broadcast radio jingles through local and national stations. As a result, preliminary estimates suggest that 3,733 farmers adopted healthy rice seedling practices on 977 hectares during the reporting period. CSISA also conducted paired comparisons of 'heathy' versus normal seedlings across the Terai belt of the of FtF zone. This simple step increased rice yield by 8% compared to farmers' practice.

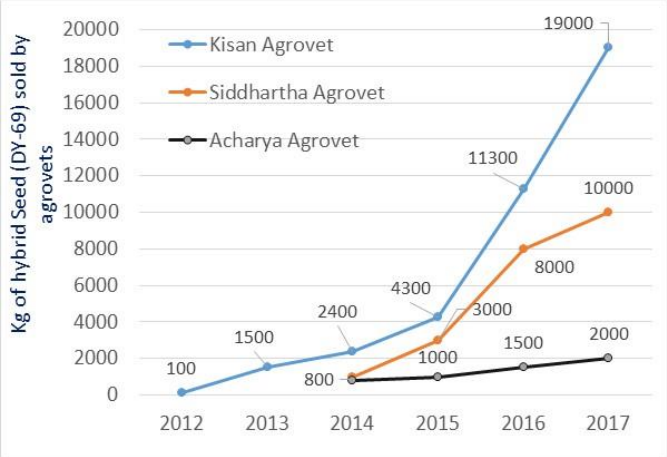


Yield advantage with adoption of healthy rice seedlings in the Nepali Terai

2. Facilitating adoption of high-yielding and shorter duration rice hybrids

In Nepal's Mid and Far West Terai region, rice is grown on 246,976 ha, with an average productivity of 3.4 t/ha – much lower than achievable yields. Though many farmers are growing improved varieties in the region, monsoon variability keeps yields relatively low, particularly in the rainfed and partially irrigated systems that predominate in Nepal. In 2012, CSISA began participatory field evaluations of rice hybrids that were registered in Nepal but which were not commonly available in the market in the FtF zone. These assessments found that DY 69, a short-duration rice hybrid that matures in 120 days to be consistently high yielding. 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 six FtF districts 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 each year significantly and have reached 19 MT in 2017 (see inset). Similarly, Siddhartha Agrovet in Banke and Acharya Agrovet in Dang reported that the sales of DY 69 have considerably increased. In 2017, more than 40 retailers in the FtF zone sold a total of 38 MT of hybrid seed, enough to plant over 2,000 ha. Farmers reported yields of between 8 to 10 t/ha this year, and demand out-stripped supply – an envious position that the retailers will capitalize in 2018 by stocking more seed.



Rapidly increasing sales of rice hybrids helps Nepali farmers reduce risk in low rainfall years, while boosting production in all years.

3. Crop transitions away from rice 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.

In the Mid and Far West there are large areas with light textured soil that may be more suitable for maize than rice. 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. CSISA introduced maize to several of these areas since 2016, comparing it with rice cultivation in adjacent fields. Even in a relatively 'normal' monsoon year, the profitability of maize was approximately US$ 250/ha higher than for rice. The output of the research was shared and deployed through the Department of Agriculture, feed industries, and the maize super zone program. With this effort, 457 farmers adopted maize as an alternative to rice on 128 ha area during the 2017 *kharif* season.

For maize sector development, CSISA worked to increase input availability (e.g., hybrid seed) while providing technical training for dealers and feed mill staff. Most importantly, CSISA has facilitated contractual agreements between farmers' groups, cooperatives, feed mills and their traders for output market strengthening.

Diversification with pulses is also an option to build resilience to monsoon variability. Nepal is importing large quantities of soybeans to fulfill national demand, especially from the feed industry. CSISA has collaborated with National Grain Legume Research Program (NGLRP) and Rapti Feed Mill to evaluate three new higher-yielding soybean varieties. Pigeon pea is also an option, but there are only two varieties available, both released in the 1990s. CSISA has also collaborated with the NGLRP and ICRISAT to evaluate 20 new genotypes for yield potential and how then fit into prevailing cropping patterns in the Terai.

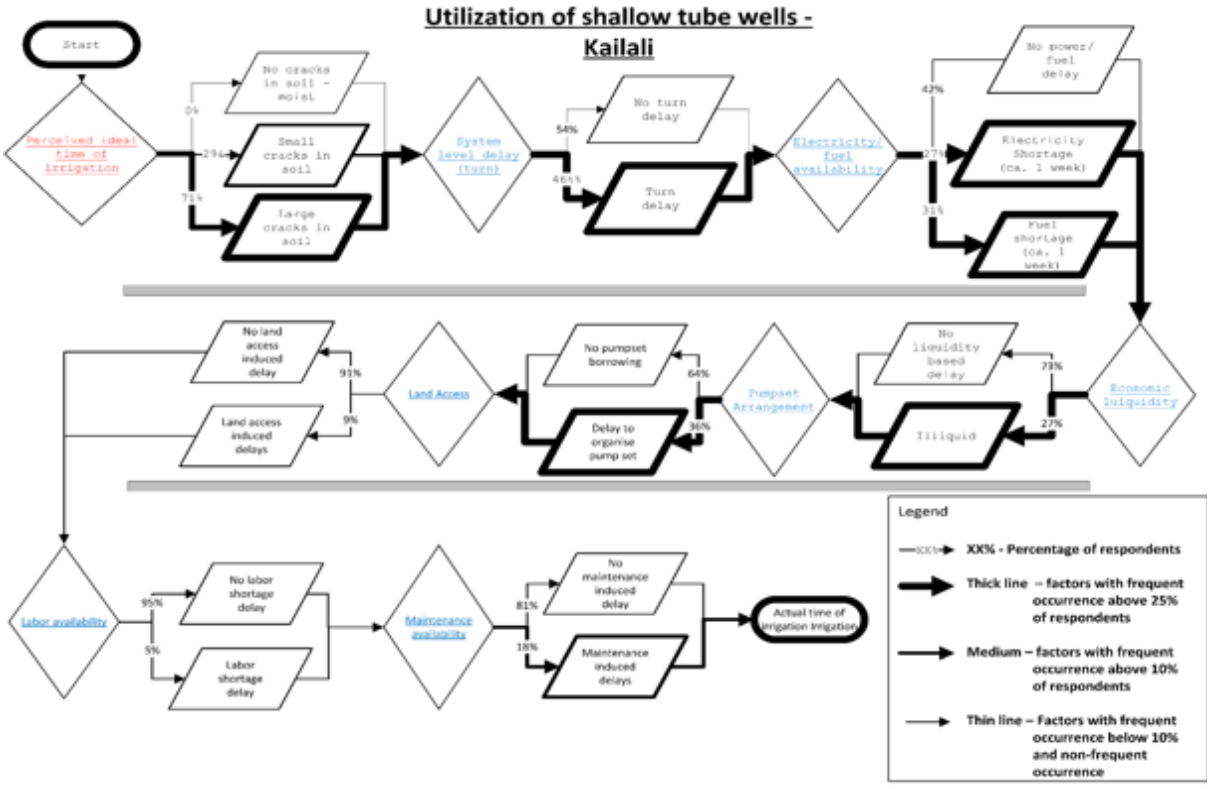
4. Water resources utilization for resilience and higher yields

CSISA's yield and production practices survey for the 2016 rice crop confirms the importance of supplemental irrigation for reducing risks and achieving high and stable crop yields. Across the Terai districts where the survey was implemented (total of more than > 1,050 households), farmers who irrigated three or four times had rice yields that averaged approximately 4.5 t/ha, whereas farmers

who did not irrigate achieved yields of 3.0 t/ha, indicating that water stress in even a 'good' monsoon year reduces rice yield potential by 33%.

Past and on-going efforts to expand the use of irrigation in Nepal for staple crop production have focused primary on assuring supply by supporting the expansion of infrastructure such as tube wells for groundwater pumping. Through CSISA's surveys and stakeholder engagement, it has become clear that many farmers who insufficiently irrigate rice do, in fact, have access to irrigation water but choose not to use it. To change this scenario and to increase systems resilience, food security, and profitability, CSISA has partnered with the Water Resources Management Group at Wageningen University (*graduate student Anton Urfels*) to characterize farmer decision process around irrigation use in rice. Case studies were developed for Banke, Rupandehi and Kailali Districts using semi-structured interviews, household surveys, and ethnographic decision-tree models.

Fields with un-used irrigation capacity in drought-hit Banke in July 2017. Loss-aversion associated with the high price of diesel fuel makes many farmers reluctant to irrigate, even when the need is acute.



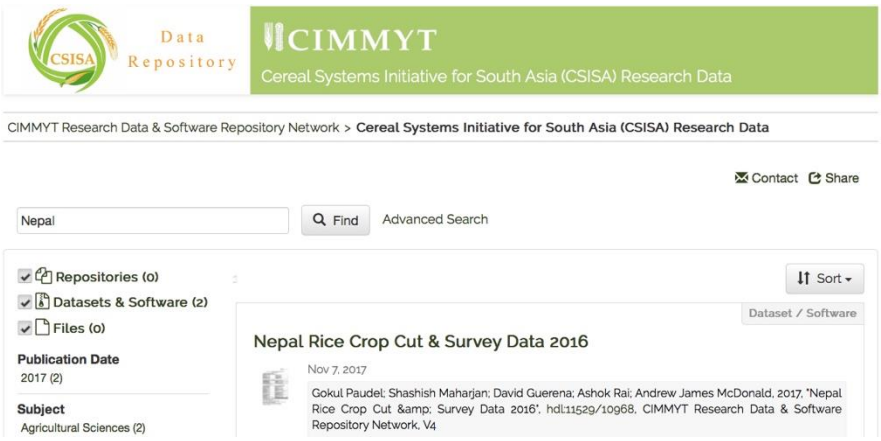
Example ethnographic decision tree for shallow tubewell irrigation in Kailali District, Nepal

Our results indicate that irrigation is constrained by many of the same factors across the entire area, but with varying degrees of importance. The most influential factors associated with lower irrigation application rates in rice include: 1) 'loss aversion'-induced delays (e.g. concern that rains will eventually come, eroding the value of applied irrigation – a core issue in all districts), 2) lack of reliable electricity (Banke), 3) shortages of pumpsets (all), 4) turn-taking for shared tubewells (Rupandehi), 5) financial constraints (Kailali), and 6) pump maintenance-induced delays (Rupandehi, Kailali).

Efforts to encourage more optimal use of irrigation infrastructure will fundamentally require improvements in decision support tools for irrigation scheduling to address loss aversion. In Rupandehi, increasing tube well density is likely to stimulate informal water markets to provide more benefits by driving down rental delays. In Banke, the large number of existing agricultural electricity connections and shallow tubewells renders a reliable electricity supply a worthy focus point for improving irrigation utilization in the driest of the three districts. In Kailali, cash constraints are of larger importance. Bringing down water prices through improved pump system design and provision of credit are promising entry-points.

Extra: CSISA Open Data Repository

CSISA has created open data repository for its research trials and survey data on Dataverse – an open source web application developed at Harvard University to share, preserve, cite, explore and analyze research data. These research data are being uploaded after curation to make them compliant with USAID & BMGF open data policies. The repository includes datasets from on-station, on-farm trial sites, socioeconomic and project baseline surveys on cereal based cropping systems from CSISA Nepal, India and Bangladesh sites. The raw datasets available on Dataverse are expected to cater to the research interests of diverse audience of researchers, policymakers and the public. The URL of the CSISA Dataverse page has also been interlinked with CSISA webpage and USAID's Development Data Library.



Challenges faced during the reporting period

- Local elections were held on June 28, 2017 in most Terai districts – the first local elections in 20 years. The vote campaign coincided with DSR establishment and nursery raising for rice. Most of the service providers were highly involved in election campaigns and were not able to provide services on time as per demand, so the area under DSR was not as large as expected. The campaign period also affected rice nursery establishment, so the area under healthy rice seedlings was also below expectations.
- Evolving process of political devolution: Nepal remains in the midst of a complicated effort of building a federated structure with more regional autonomy. One result is that the agricultural budget that used to be with the District Agriculture Development Offices has been diverted to new, local administrative units. As there is no clear-cut breakdown of local budget by sector, many agricultural development support programs have been deferred or otherwise delayed.
- Nepal suffered massive floods in most of the Terai districts in August, after rice transplanting (see photo). Reports from the Nepal Government indicated that floods and landslides claimed 141 lives, injured 117 persons, displaced 460,900 people, and left 24 missing. This situation affected farmers' ability to make decisions on the adoption of best management practices, mainly for fertilizer and weed management, so the adoption of best management practices for rice was suppressed. A large area under summer maize was also damaged by flooding.

D. Policy Reform

D.1 Seed Systems

Bangladesh

CSISA continues to work closely with partners on the seed systems front in Bangladesh, including IFPRI's Bangladesh Policy Research and Strategy Support Program and Agricultural Policy Support Unit, the main CGIAR centers with offices in Dhaka, the national research system, and the donor community. A vital component of these partnerships is to define a more appropriate role for the Bangladesh Agricultural Development Corporation and to encourage the continued development of the private seed industry. One of CSISA's priorities since the inception of Phase III was to explore opportunities for regional harmonization in varietal registration procedures beyond rice, and this remains an important objective.

Nepal

CSISA has entered into a collaboration with the USAID-supported Nepal Seed and Fertilizer Project, led by CIMMYT, to determine the demand and supply gaps required to bring about a systemic policy change in varietal turnover. To assess farmers' demand for quality and timely availability of seed, CSISA is planning to field a discrete choice experiment among farmers in Nepal to better assess the specific varietal traits that farmers desire in cereals seeds. While this work is still in the initial scoping and discussion stage, 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. The field experiment and activities thereupon will closely associate with the Nepal government's intention to reduce the subsidy burden on the exchequer by replacing universal subsidies with a targeted voucher system.

In general, a major challenge to effecting policy reform within Nepal's seed sector is the lack of sensible rules and regulations in the now 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 and the ambitious Agriculture Development Strategy 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 and protect domestic agricultural equipment manufacturers, such as customs duties and tariffs, credit facilities, and other support mechanisms. In particular, CSISA is exploring policy reforms to rationalize import barriers 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 characterizing the current status of the agricultural machine industry and the dispersion of agricultural machines throughout Bangladesh, understanding the structure of the aforementioned trade barriers on agricultural equipment, attempting to understand the sensitivity of supply and demand to price changes, and characterizing changes in government revenue as a result of changes to trade policies. There are several important data gaps that exist, such as national, administrative data on specific machines and data on supply and demand elasticities for agricultural machines.

The activities to date are presently synthesized in the form of an analytical piece that reviews trade and tariff policies that either fostered or discouraged the development of local machinery markets and the supportive policy framework in the form of tax and trade policies required to ease regulation

for machinery import and sale. 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. In the light of the aforementioned data gaps, this will likely necessitate a series of assumptions, but should provide the opportunity for the identification of appropriate trade policies to optimize the dual objectives of increasing the diffusion of agricultural equipment (through reduced traded barriers) while also not adversely affecting government revenues (by collecting duties on a larger number of imported machines).

CSISA also supported the development of a book titled "**Rural Mechanization – A Driver in Agricultural Change and Rural Development"** that was launched on April 16, 2017 in Dhaka. The book was launched jointly by Honorable Minister of Agriculture, Matia Chowdhury (Chief guest); Dr. Atiur Rahman, former Governor of Bangladesh Bank (special guest); Dr. QK Ahmad, Chairman of Institute of Inclusive Finance and Development (InM) (chair); Dr. Mustafa K Mujeri, Executive Director, InM; Dr. M.A. Sattar Mandal, Former Vice-Chancellor, Bangladesh Agricultural University; Dr. Akhter Ahmed, Chief of Party, IFPRI Bangladesh; Dr. Wais Kabir, Former Chairman, BARC and Dr. Timothy J. Krupnik, Systems Agronomist, CIMMYT. The book launch was well attended by participants from different organizations including government bodies, NGOs, research organizations, private sector and the media.

Nepal

CSISA is exploring the Government of Nepal's various policies with 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

In both Bangladesh and Nepal, there are legitimate concerns about fertilizers being smuggled across the border from India and subsequently sold on the black or grey markets. These leakages arise because of the considerable arbitrage opportunities that exist (primarily because of the sizeable subsidies on chemical fertilizers in India) and porous borders into these neighboring countries. To date, the Government of Bangladesh has not expressed much concern over these cross-border leakages, but that is likely to soon change due to fertilizer policy reforms that have begun in India aimed at reducing these cross-border leakages. In particular, the government of India has introduced a fertilizer monitoring system that is meant to track fertilizer supplies from the manufacturer to the retailer, which has the expressed intent of eliminating diversions to Bangladesh and Nepal. CSISA is closely following the policy landscape on both sides of the border to determine the impact of such a policy on the availability of fertilizer in Bangladesh, particularly in the border areas. The delayed implementation of India's Aadhar-enabled fertilizer management system has impeded efforts to qualitatively assess the impacts on fertilizer supplies in Bangladesh, but even with this slow implementation, there is anecdotal evidence that leakages have reduced. There are some data gaps that preclude a rigorous quantification of these impacts, but CSISA is investigating other data sources that might shed light on this phenomenon.

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.

Nepal

Similar to what was referred to above with respect to Bangladesh, CSISA is monitoring developments and exploring policy solutions to address Nepal's fertilizer market, which is currently bolstered by the informal/illegal inflow of subsidized fertilizers from India. Officially, the Government of Nepal will not acknowledge that its farmers have benefitted from these informal flows, but there is much evidence to suggest that domestic production is insufficient to meet the growing demand, which has the potential to lead to supply bottlenecks and prohibitively high prices. The Government of Nepal has repeatedly expressed an interest in increasing its domestic fertilizer production capacity through the construction of fertilizer manufacturing facilities, though the latter proposals have been viewed as unrealistic due to insufficient and/or unreliable natural endowments of feedstock. As mentioned above with respect to Bangladesh, 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. Recently compiled data from the Nepal Seed and Fertilizer project's baseline survey may provide some insights into this phenomenon, though because the data have only recently become available, and because there are still data cleaning efforts underway, a detailed analysis of these potential impacts has not yet been possible.

To date, CSISA has established close contact with senior officials within the Ministry of Agricultural Development in Nepal, including the Secretary (Dr. Suroj Pokhrel) to understand the changing policy environment and strategies with regards the implementation of ADS. CSISA is also coordinating with the USAID-supported Nepal Seed and Fertilizer (NSAF) project staff at CIMMYT to collaborate on research that aims to understand the demand for quality and timely availability of fertilizers using modern experimental valuation techniques. These experiments are expected to be initiated during the *rabi* season of 2017-18 to generate results and estimates that can be used to study farmer behavior with respect to key input usage in their *kharif* 2018 cultivation. Given the Nepali government's focus on reducing fertilizer dependence on India and other countries by encouraging organic fertilizer usage, it is imperative to fill the current knowledge gap around demand side requirements of key agricultural inputs that impede yield maximization of smallholder farmers and our study is aimed to address the same.

In collaboration with NSAF, CSISA contributed to a capacity building workshop that took place in Godavari, Nepal on August 8–10, 2017. The goal of the workshop was to discuss and gather consensus on the various challenges facing the seed, fertilizer, and rural credit sectors in Nepal, as well as to build participants' competencies on advanced methods for non-market valuation and improve the overall quality of agricultural research undertaken by the national agricultural research system. In particular, researchers from CSISA led a one-day session focusing on two competing—though complementary—methods for non-market valuation, including discrete choice analysis and experimental auctions. The methods were discussed in detail, with an emphasis on their comparative strengths and weaknesses and relevance for addressing policy-related research questions. The particular value of these methods is that they enable researchers to uncover farmers' underlying willingness to pay for agricultural inputs, which has direct implications for government interventions and policies to promote the expanded use of these inputs. The capacity building workshop was conducted with 15 participants from various segments of the public and private sectors, as well as members of civil society organizations, including representatives from the Ministry of Agricultural

and Development, the Department of Agriculture, the Seed Entrepreneurs Association of Nepal, the Fertilizer Association of Nepal, and members of the formal financial sector.

D.4 Agricultural risk management

Bangladesh

CSISA has been evaluating several tools for providing risk management solutions to smallholder farmers in Bangladesh, specifically stress-tolerant rice cultivars developed under the Stress-Tolerant Rice for Africa and South Asia project and index insurance. Work evaluating the effectiveness BRRI dhan 56 (a drought-tolerant rice variety) is ongoing, but CSISA has completed analyzing the demand for and effectiveness of a novel hybrid index insurance product to address risks related to deficient rainfall during the summer monsoon season. Since index insurance is generally less expensive to administer, is less prone to informational asymmetries such as adverse selection and moral hazard, and typically entails lower reinsurance costs, it is often considerably less expensive than conventional crop insurance. Yet despite this, the results from this pilot study suggest that, consistent with experiences from many other developed and developing countries around the world, farmers' demand for insurance is very sensitive to price, with virtually no farmers willing to pay an actuarially-fair price for insurance.

Reducing the cost of insurance to encourage uptake will likely have to involve government interventions such as subsidies, at least in the short-run. The study evaluated two such interventions: an upfront discount or a rebate returned to the farmer at a later date. While most farmers would prefer the discount, there is evidence that some farmers prefer the assurances of a subsequent payment (the rebate) even if the insurance does not pay out. The results also suggest that insurance has positive effects on agricultural production during both the monsoon season—which is the period covered by the insurance product—as well as during the dry winter season. While the former effect is a pure risk mitigation effect (i.e., having insurance encouraged insured farmers to invest in risker—but higher returning—inputs), the latter effect may be principally due to increased liquidity following the receipt of an insurance payout. Specifically, during the *aman* season, insured farmers increased investments in irrigation and fertilizers by 24 and 30 percent, respectively. During the subsequent *boro* season, after receiving an insurance payout, insured farmers increased expenditures on fertilizers and seeds by 10 and 28 percent, respectively.

CSISA is helping to organize a regional dialogue on agricultural risk management to be hosted in Dhaka in December. The goal of the dialogue is to provide a platform whereby experiences and ideas can be shared among various stakeholders and across disciplinary and geographic boundaries, all for the enhancement of rural livelihoods in South Asia. This convening will be attended by policymakers, development practitioners and researchers alike and is expected to result in continuing conversations that shed light on the policy reforms and knowledge creation required to fulfill CSISA's objectives.

Nepal

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. The aforementioned regional dialogue hosted in Dhaka in December 2017 will provide CSISA researchers an opportunity to learn from policymakers and practitioners in Nepal about the specific challenges that have been encountered in their efforts to introduce agricultural insurance in Nepal, while also sharing examples from the experiences of other countries in the region and providing evidence-based policy solutions based on small-scale pilot programs.

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.

CSISA engaged with the Nepal mission in the following core areas in FY17:

- Suggested the formation of the 'M&E Working Group of Agriculture Partners,' which was subsequently convened by USAID Nepal. CSISA participates in group meetings and provides feedback on various M&E and FTFMS Indicator issues. CSISA also presented a technical session on 'incremental sales analysis' during the working group meeting on Feb 23, 2017.
- Aided the USAID Integrating Gender and Nutrition within Agricultural Extension Services (INGENEAS) project in investigating the gendered impacts of scale-appropriate mechanization in the mid-hills.
- Helped conceptualize, evaluate, and (through support to partners) implement the Feed the Future *Data-Driven Farming Prize*.
- Participated in an 'ICT 4 Ag' roundtable with Dr. Gary Linden and USAID-Nepal SEED office team.

FTF partners

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

- **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 zone of Bangladesh. Phase III collaborates with AIP and the Agricultural Input Retailer Network 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 October 1, 2015 and ending on the December 31, 2016. It builds on the lessons learned from the, Cereal Systems Initiative for Southeast Asia in Bangladesh, 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.
- The **Nepal Seed and Fertilizer (NSAF)** project, a $15 m USAID-Nepal initiative, was a direct outshoot of progress made by CSISA on seed systems and integration soil fertility management. CSISA staff deeply collaborate with NSAF on scientific and operational matters. The lead of CSISA, Andrew McDonald, acts as the senior advisor for NSAF.
- **The KISAN project**, part of USAID's global Feed the Future initiative, is a US$ 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 core staple crop value chains for the project. In 2016, 60,205 **farmers received the rice tips and 69,923 farmers have received the maize tips in the 20 FtF districts** through the KISAN network.
- ✓ Developed a factsheet on *Stemphylium* management for lentil 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.

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 extended through 2018 but was cut when USAID FY18 funding became uncertain. The purpose of iDE's involvement in CSISA-III was to leverage iDE's existing work in CSISA-MI to contribute to the agricultural machinery commercialization objectives of CSISA-III. Specifically, iDE built upon its 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. More about iDE can be found here: http://www.ide-bangladesh.org/
- Agricultural Advisory Society (AAS): 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 southwestern 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. More about AAS can be found here: http://aas-bd.org/
- Agricultural Input Retailers' Network (AIRN): 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. More about AIRN can be found here: http://www.aipbd.org/airn/airn/
- The Bangladesh Research Institute (BRRI): 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. 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
Patrick S. Ward	Research Fellow & IFPRI Coordinator	IFPRI	Washington, DC, USA	+1 202-862-4608	p.ward@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	CIMMYT	Dhaka, Bangladesh	+88-0171-304-4764	a.siddiquee@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
Md. Syed-Ur-Rahman	Lead M&E Specialist	CIMMYT	Dhaka, Bangladesh	+88-171-1584808	syedvet@gmail.com
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 aims for messaging after Phase III is completed.	CIMMYT maintains a formal partnership MoU with the DAE, collaboration in CSISA III has been initiated and is ongoing
Agricultural	Production of extension	Achieving	AIS produces extension materials and media that are	CSISA III has initiated

Information Services (AIS)	materials for DAE use	impact at scale	used by DAE. Strategic partnerships with AIS facilitate the integration of sustainable intensification principles into extension materials and messaging.	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	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	Established and ongoing working arrangement, though without formal

	value chain work to extend weed control products to farmers		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.	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 associated crop management practices.	Subcontract for CSISA III currently in place for $17,634.
Agro-Input Retailers Network (AIRN)	Trains input dealers & retailers	Achieving impact at	Will train 800 advanced retailers in integrated weed management in Southern Bangladesh by Feb 2017.	Subcontract for CSISA III currently in place for

Project subcontractor		scale		$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 dialogue for scale-appropriate mechanization in Nepal	Systemic change towards impact	Important voice for private sector with GoN as the Agriculture Development Strategy support programs take shape.	Active since 2014

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	Strategic partnership to co-support on the large scale	Achieving impact at	The KISAN project, part of USAID's global Feed the Future (FTF) initiative, is a US$ 20 million five-year	Active for 3+

Agriculture and Nutrition (KISAN)	deployment of extension information and technologies	scale	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.	
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 2016 through September 2017

Indicator / Disaggregation	Total 2017		2017	2017
	Target	Actual	Comment	Deviation narrative
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)	**1,272**	**3,096**	This number counts individual received short term training (mostly 1 to 3 days) in various better-bet agronomic practices, healthy rice seedlings, premium quality rice and integrated weed management. Note about 2018-2020 targets: Due to funding cuts and a reorienting of the program towards research and away from scaling, the targets have been significantly reduced.	The overachievement on this indicator was most strongly driven by the number of individuals trained in Bangladesh, largely through trainings given to people in government and in the private sector. CSISA III works with the Department of Agricultural Extension staff to orient them on better-bet agronomic practices for healthy rice seedlings and premium quality rice. Reported data is based on the scaling activities in Barisal, Faridpur and Jessore, representing the out-scaling effect of training. Moreover, agro input dealers from the Agricultural Input Retailers' Network (AIRN), formed through the Agricultural Inputs Project (USAID supported) were provided training on integrated weed management in two tranches. These synergistic efforts resulted in a large positive deviation on achievement as our partners enthusiastically embraced the training outcomes; the consecutive results will also be reflected in other related indicators too.
Type of Individual	**1,272**	**3,096**		
Producers	**433**	**220**	Producers were mostly trained on agricultural best management practices.	In the producers category, the Nepal program overachieved their target due to the number of producers reached through trainings to producers on agricultural best management practices. In Bangladesh, however, trainings were oriented towards the public and private sector actors, not at individual producers. In this model, procuers receive trainings from government and private sector partners, not directly from the project, and they did not register any individuals in this category. Cumulatively, the overall actuals for both countries fell below the target.
Male		152		*Note that in 2016 when USAID's indicator system was revised, the FTFMS shifted all of our targets to "disaggregates not available" automatically. To understand our deviation, please look at the cumulative numbers.*
Female		68		
Disaggregates Not Available	433			

People in government	**188**	**898**	District Agriculture Development Offices, Agricultural Service Centers, NARS and agricultural extension officers were trained on topics such as premium quality rice.	In Nepal, the actuals were within 10% of the target, but in Bangladesh Trainings of Trainers were provided to the agriculture extension officers of Faridpur, Barisal and Jessore. This was done mostly in the first semester to orient all extension staff on and Premium Quality Rice. The large number of government extension personnel trained caused this category to far surpass the original target.
Male		769		*Note that in 2016 when USAID's indicator system was revised, the FTFMS shifted all of our targets to "disaggregates not available" automatically. To understand our deviation, please look at the cumulative numbers.*
Female		129		
Disaggregates Not Available	188			
People in private sector firms	**434**	**1,782**	Private seed companies, agricultural inputs suppliers (agrovets), and cooperatives were trained on seed value chain-related issues, integrated weed management and other topics.	In Nepal, the the actuals were within 10% of the target, but in Bangladesh agriculture input dealer-members of the Agriculture Input Retailers' Network (AIRN) were provided training on integrated weed management so that they could advise farmers on weed management during the monsoon rice season. Using AIRN as a partner allowed CSISA to surpass the overall target.
Male		1,660		*Note that in 2016 when USAID's indicator system was revised, the FTFMS shifted all of our targets to "disaggregates not available" automatically. To understand our deviation, please look at the cumulative numbers.*
Female		122		
Disaggregates Not Available	434			
People in civil society	**188**	**182**	NGOs received trainings related to scale-appropriate sustainable intensification technologies and agricultural management practices.	N/A
Male		162		*Note that in 2016 when USAID's indicator system was revised, the FTFMS shifted all of our targets to "disaggregates not available" automatically. To understand our deviation, please look at the*

Female		20		*cumulative numbers.*
Disaggregates Not Available	188			
Disaggregates Not Available	**29**	**14**		The target in Nepal was suprassed slightly because of the number of organizations provided training which did not provide sex disaggregation. In Bangladesh, they did not need to use "disaggregates not available" as a category, as they categorized all participants by sex.
Male		5		*Note that in 2016 when USAID's indicator system was revised, the FTFMS shifted all of our targets to "disaggregates not available" automatically. To understand our deviation, please look at the cumulative numbers.*
Female		9		
Disaggregates Not Available	29			

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)	**61,239**	**81,078**	This indicator counts the number of farmers who have applied improved agricultural technologies such as better-bet agronomy, healthy rice seedlings, premium quality rice, and soil fertility management. Note about 2018-2020 targets: Due to funding cuts and a reorienting of the program towards research and away from scaling, the targets have been significantly reduced.	Overachievement on this indicator is mostly driven by the actuals registered by our Bangladesh team, since on average our Nepal program came within 10% of their target. For Bangladesh overall, CSISA III works with extension agents and other key players (i.e. Agriculture Input Dealers etc.) to disseminate information on better-bet agronomic practices on healthy rice seedling and Premium Quality Rice. CSISA III also partnered with the NGO Agricultural Advisory Society to deploy rural video showings on healthy rice seedlings.
Producers	**61,239**	**81,078**		
Sex	**61,239**	**81,078**		
Male	55,115	72,154		The Nepal actuals fell within 10% of the target, but Bangladesh exceeded their targets. As a scaling project, CSISA III works with extension agents and other key players (i.e. Agriculture Input Dealers etc.) to disseminate information on better-bet agronomic practices on healthy rice seedling and Premium Quality Rice. CSISA III also partnered with the NGO Agricultural Advisory Society to deploy rural video showings on healthy rice seedlings. Over 54,000 farmers viewed the videos and the results reported here reflect results from follow-up surveys that measured adoption of healthy rice seedlings practices.
Female	6,124	8,924		Both Nepal and Bangladesh exceeded their targets. Due to the increase in female-headed household among Nepali farming households, the number of women who adopted new technologies was relatlively high.In Bangladesh, as a scaling project, CSISA III works with extension agents and other key players (i.e. Agriculture Input Dealers etc.) to disseminate information on better-bet agronomic practices on healthy rice seedling and Premium Quality Rice. CSISA III also partnered with the NGO Agricultural Advisory Society to deploy rural video showings on healthy rice seedlings. A large number of women farmers were reached through this intervention.
Disaggregates Not Available				
Technology type	**61,239**	**81,078**		
crop genetics	6,060	14,202		Exceeding of the target was driven by activities in Bangladesh, where the acceptance of premium quality rice was high and thus increased the number of farmers recorded.

cultural practices	30,937	40,260	This number counts farmers adopting various types of cultural practices such as healthy rice seedling mgmt., better-bet agronomy on rice, maize, and wheat, directly sown rice, scale appropriate mechanization,and commercial maize (winter and summer) cultivation.	Targets were exceeded in both Nepal and Bangladesh. In Nepal, many farmers adopted scale appropriate technologies associated with better-bet agronomic tips on rice, maize and wheat and healthy rice seedlings production. In Bangladesh, CSISA has expanded the adoption of commercially-oriented healthy rice seedlings and directly sown rice.
livestock management				
wild fishing technique/gear				
aquaculture management				
pest management		5,872		The Bangladesh program launched some interventions related to integrated weed management through the agro inputs dealers, resulting in us reporting against this category.
disease management				
soil-related fertility and conservation	1,515	1,708	This number counts farmers adopting soil fertility management activities primarily ZT-wheat cultivation and fertilizer mgt on rice and maize.	The Nepal program reported into this category and we exceeded the target because of the success in facilitating the adoption of zero tillage wheat technology and fertilizer management practices.
irrigation				
water management (non-irrigation)				
climate mitigation				
climate adaptation	22,727	19,036	This number counts farmers adopting climate adaptation coping technologies by cultivating hybrid rice and summer maize.	Nepal slightly exceeded their target, and Bangladesh slightly missed their target. In Nepal, a large number of farmers adopted short/medium duration rice hybrids (e.g., DY-69) due to early season drought, as well as choosing to plant maize in upland areas to cope with the climatic variability. In Bangladesh, Wheat blast has reduced achievement on modifying wheat cultivation to adapt to climate change, resulting in the actuals being lower than expected.
marketing and distribution				
post-harvest - handling and storage				
value-added processing				
other				
Disaggregates Not Available				
Commodity		**81,078**		
Maize		5,649		

Rice		52,523		
Wheat		19,310		
Disaggregates Not Available or Other		3,596		

EG.3.2-18: (4.5.2-2) Number of hectares of land under improved technologies or management practices with USG assistance (RAA) (WOG)	**20,209**	**26,819**	This indicator counts number of hectares under applied improved agricultural technologies such as better-bet agronomy, healthy rice seedlings, premium quality rice, and soil fertility management. Note about 2018-2020 targets: Due to funding cuts and a reorienting of the program towards research and away from scaling, the targets have been significantly reduced.	Overachievement on this indicator is mostly driven by the actuals registered by our Bangladesh team, since on average our Nepal program came within 10% of their target. For Bangladesh overall, CSISA III works with extension agents and other key players (i.e. Agriculture Input Dealers etc.) to disseminate information on better-bet agronomic practices on healthy rice seedling and Premium Quality Rice. CSISA III also partnered with the NGO Agricultural Advisory Society to deploy rural video showings on healthy rice seedlings.
Technology type	**20,209**	**26,819**		
crop genetics	2,000	3,902		Exceeding of the target was driven by activities in Bangladesh, where the acceptance of premium quality rice was high and thus increased the number of farmers recorded.
cultural practices	10,209	12,925	This number counts the area (ha) under various cultural practices such as healthy spring rice seedling mgmt., direct seeded rice, adoption of better-bet agronomy on rice, maize wheat, use of scale appropriate mechanization, commercial maize (winter and summer) cultivation.	Targets were exceeded in both Nepal and Bangladesh. In Nepal, many farmers adopted scale appropriate technologies associated with better-bet agronomic tips on rice, maize and wheat and healthy rice seedlings production. In Bangladesh, CSISA has expanded the adoption of commercially-oriented healthy rice seedlings and directly sown rice.
pest management		3,200		The Bangladesh program launched some interventions related to integrated weed management through the agro inputs dealers, resulting in us reporting against this category.
disease management				
soil-related fertility and conservation	500	561	This number counts the area (ha) under soil fertility management activities specifically ZT-wheat cultivation and fertilizer mgt on rice and maize.	The Nepal program reported into this category and we exceeded the target because of the success in facilitating the adoption of zero tillage wheat technology and fertilizer management practices.
irrigation				
water management (non-irrigation)				
climate mitigation				
climate adaptation	7,500	6,231	This number counts the area (ha) by adopting climate resilient hybrid rice variety (DY 69) and summer maize.	Nepal slightly exceeded their target, and Bangladesh slightly missed their target. In Nepal, a large number of farmers adopted short/medium duration rice hybrids (e.g., DY-69) due to early season drought, as well as choosing to plant maize in upland areas to cope with the climatic variability. In Bangladesh, Wheat blast has reduced achievement on modifying wheat cultivation to adapt to climate change, resulting in the actuals being lower than expected.
other				

Disaggregates Not Available				
Sex	**20,209**	**26,819**		
Male	18,188	24,144		Nepal came within 10% of their target, but Bangladesh exceeded their target. In Bangladesh majority of the agricultural land is owned by male, so this target was exceeded.
Female	2,021	2,675		Exceeding the target for this category was driven by the Nepal program, where the large number of women-headed farming households have driven our success in this category.
Joint				
Association-applied				
Disaggregates Not Available				
Commodity		**26,818**		
Maize grain		2,748		
Rice		16,813		
Wheat		6,644		
Disaggregates Not Available or Other		613		

EG.5.2-1: Number of firms receiving USG-funded technical assistance for improving business performance (O)	**320**	**243**	This indicator counts the agricultural firms have received technical assistance to improve their business performance. Assistance included business plan development and expansions of agricultural machinery markets and value chains. Note about 2018-2020 targets: Due to funding cuts and a reorienting of the program towards research and away from scaling, the targets have been significantly reduced.	The target for this indicator was missed largely because of the numbers registered by the Bangladesh program, as the Nepal program came within 10% of their target. In Bangladesh, this indicator is focused mainly on commercial expansion of agricultural machinery in Dinajpur hub. Although substantial progress was made in expanding farmers' access to machinery, and several joint venture agreements were established with partners, uptake was not as rapid as had been expected. CSISA III focused in this year mainly on building an enabling environment for scaling machinery, by working to train farmers and service providers, mechanics, and to spread awareness of machinery options. It is expected that further private sector pushing will result from these activities to build stronger market uptake in the future.
Type of Firm	**320**	**243**		
Formal		47		This achievement was registered by the Nepal team, which was able to provide technical performance to formal firms such as seed companies and agro-vets.
Informal	320	196		In Nepal, CSISA provided technical assistance to informal firms such as service providers, but focused more on formal companies at this point in the project, thereby missing the target for this category. In Bangladesh, this indicator is focused mainly on commercial expansion of agricultural machinery in the Dinajpur hub. Although substantial progress was made in expanding access by farmers (aka, informal firms) to machinery, and several joint venture agreements were established with partners, uptake was not as rapid as had been expected. CSISA III focused in this year mainly on building an enabling environment for scaling machinery, by working to train farmers and service providers, mechanics, and to spread awareness of machinery options. It is expected that further private sector pushing will result from these activities to build stronger market uptake in the future.
Disaggregates Not Available				
Duration	**320**	**243**		

New	320	243		The target for this category was missed mostly because of the numbers achieved by the Bangladesh program. This indicator is focused mainly on commercial expansion of agricultural machinery in Dinajpur hub. Although substantial progress was made in expanding farmers' access to machinery, and several joint venture agreements were established with partners, uptake was not as rapid as had been expected. CSISA III focused in this year mainly on building an enabling environment for scaling machinery, by working to train farmers and service providers, mechanics, and to spread awareness of machinery options. It is expected that further private sector pushing will result from these activities to build stronger market uptake in the future.
Continuing				
Disaggregates Not Available				