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ANNUAL REPORT

2015

THE CEREAL SYSTEMS INITIATIVE FOR SOUTH ASIA PHASE II

CIMMYT
International Maize and Wheat Improvement Center

IFPRI

ILRI
INTERNATIONAL LIVESTOCK RESEARCH INSTITUTE

IRRI

WorldFish

Annual Report #3

October 1, 2014 to September 30, 2015

CEREAL SYSTEMS INITIATIVE FOR SOUTH ASIA (CSISA) PHASE II

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Cereal Systems Initiative for South Asia Phase II

International Maize and Wheat Improvement Center (CIMMYT)

Date: December 18, 2015

Grant Summary Information

Project Name: Cereal Systems Initiative for South Asia (CSISA) Phase II
Organization Name: International Maize and Wheat Improvement Center (CIMMYT)
Grant ID# (Gates Foundation): OPP1052535
Grant ID# (USAID): BFS-G-11-00002
Program Officer (Gates Foundation): Dr. Tony Cavalieri, Dr. Christian Witt
Program Officer (USAID Washington): Dr. Biniam Iyob
Program Officer (USAID India): Dr. Bahiru Duguma, Dr. Srivalli Krishnan
Date Grant was Awarded: September 12, 2012 (BMGF)
Project End Date: November 30, 2015
Grant Amount (Gates Foundation): $18,600,314
Grant Amount (USAID): $15,000,000
Project Duration (in months): 38 months
Report Period: October 1, 2014 to September 30, 2015
Report Due: November 30, 2015
Has this project been granted a no-cost extension? Yes, covering October 1, 2015 through November 30, 2015

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The Cereal Systems Initiative for South Asia (CSISA) is a research-for-development partnership implemented jointly by CGIAR members—the International Maize and Wheat Improvement Center (CIMMYT), the International Food Policy Research Institute (IFPRI), the International Livestock Research Institute (ILRI), the International Rice Research Institute (IRRI), and World Fish, in close partnership with public and private sector organizations across South Asia. CSISA is funded by the United States Agency for International Development (USAID) and the Bill and Melinda Gates Foundation. CSISA is an integral part of several CGIAR Research Programs (CRPs), connecting and integrating their work in South Asia. These CRPs include: CRP 2: Policies and markets; CRP 3.1: WHEAT; CRP 3.2: MAIZE; CRP 3.3: GRiSP; and CRP 3.7: Livestock and fish. CSISA also has interactions in South Asia with CRPs 1.1: Dryland systems; 1.3: Coastal and aquatic systems; 4: Nutrition and health; 5: Water and land; and 7: Climate change.

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Acronyms and Abbreviations

Acronym	Full Name of Acronym
ACI	Advanced Chemical Industries
AFP	Axial flow pump
AFT	Axial flow thresher
AIC	Advisory and investment committee
AWD	Alternate wetting and drying
BAMETI	Bihar Agricultural Management & Extension Training Institute
BAU	Bihar Agricultural University
BHU	Banaras Hindu University
CA	Conservation agriculture
CCAFS	Climate Change Agriculture and Food Security
CGIAR, CG	Consultative Group on International Agricultural Research
CIMMYT	International Maize and Wheat Improvement Center
CSISA	Cereal Systems Initiative for South Asia
CSISA-BD	CSISA-Bangladesh
CSISA-MI	CSISA Mechanization and Irrigation project
CSISA-NP	CSISA-Nepal
CT	Conventional tillage
DAS	Days after sowing
DOA	Department of Agriculture
DSR	Direct-seeded rice
EC	Executive committee
EIGP	Eastern Indo-Gangetic Plains
EUP	Eastern Uttar Pradesh
FB	Followed by
FBD	Flat bed dryer
FTF	Feed the Future
GIS	Geographic information services
IARI	Indian Agricultural Research Institute
ICAR	Indian Council of Agricultural Research
ICT	Information communication technology
iDE	International Development Enterprises
IFPRI	International Food Policy Research Institute
IGP	Indo-Gangetic Plains
ILRI	International Livestock Research Institute
IRRI	International Rice Research Institute
IWM	Integrated weed management
KVK	Krishi Vigyan Kendra
LCAT	Landscape-scale crop assessment
LLL	Laser land leveling
LSP	Local service provider
M&E	Monitoring & evaluation
MCM	Maize Crop Manager
MGNREGA	Mahatma Gandhi National Rural Employment Guarantee Act
MT	Management team
MTNPR	Machine-transplanted non-puddled rice
MTPR	Machine-transplanted puddled rice
NARC	Nepal Agricultural Research Council
NARES	National agriculture research and extension systems

NGO	Non-governmental organization
NILs	Near isogenic lines
NM	Nutrient Manager
NMR	Nutrient Manager for Rice
NOPT	Nutrient omission plot technique
ODK	Open Data Kit
OMFED	Orissa State Co-operative Milk Producers' Federation
OUAT	Orissa University of Agriculture and Technology
PAU	Punjab Agricultural University
PTR	Puddled transplanted rice
PVS	Participatory varietal selection
RCM	Rice Crop Manager
RFL	Rangpur Foundry Limited
RP	Research platform
RWCM	Rice–Wheat Crop Manager
QTL	Quantity trait locus
SAU	State agriculture university
SHG	Self-help group
SI	Sustainable intensification
SP	Service provider
SRI	System of Rice Intensification
SSNM	Site-specific nutrient management
STRASA	Stress Tolerant Rice for Africa and South Asia
ToT	Training of trainer
TNAU	Tamil Nadu Agricultural University
USAID	United States Agency for International Development
WYCYT	Wheat Yield Consortium Trait Yield Nursery
ZT	Zero tillage

Executive Summary

In recent years, gains in cereal productivity in South Asia have slowed markedly and, simultaneously, issues of resource degradation, declining labor availability, and climate variability pose steep challenges for achieving sustainably intensified cereal-based systems that meet the dual goals of improving food security and rural livelihoods. To address these challenges, the Cereal Systems Initiative for South Asia (CSISA) was established in 2009 to pursue an interlinked set of research and innovation system interventions to catalyze durable change at scale in South Asia's cereal systems through accelerated adoption of sustainable intensification technologies (SI)[1].

Operating in rural innovation hubs in Bangladesh, India, and Nepal, CSISA involves partnerships with the public, civil society and private sectors for the development and inclusive deployment of improved cropping systems, resource-conserving management technologies, new cereal varieties and hybrids, livestock feeding strategies and feed value chains, aquaculture systems, progressive policies and strengthened markets. The project is composed of six linked objectives: (1) Catalyzing widespread dissemination of production and post-harvest technologies to increase cereal productivity, resource use efficiency and income; (2) Process-based research into crop and resource management practices for future cereal-based systems; (3) High-yielding, heat- and water-stress-tolerant rice varieties for current and future cereal and mixed crop-livestock systems; (4) High-yielding, heat- and water-stress-tolerant, and disease-resistant wheat varieties for current and future cereal and mixed crop-livestock systems; (5) Improved policies and institutions for inclusive agricultural growth; and (6) project management, data management, M&E and communications.

In the past year, CSISA has made strong progress towards achieving the goals set out in its results framework (see Appendix C and *Key Accomplishments and Developments* detailed below) and towards the over-arching 10-year vision of success for the initiative. In addition to implementing regular programming, CSISA was externally reviewed and development a new vision for CSISA ('Phase III') that was approved by BMGF and USAID in the Fall of 2015.

As a science-driven and impacts-oriented initiative, CSISA resides at the intersection of a diverse set of partners in the public and private sector – occupying the 'messy middle' where research meets development. By engaging with a network of partners, 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 will to continue the strong momentum created in Phase II, but with a deliberate emphasis on ensuring that partners in the public and private sector are better poised to contribute to change on a sustaining basis by addressing areas of systemic weakness. 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.

Progress for the last year of CSISA Phase II (2014 – 2015) is detailed in this report, with the proviso that the final report for the CSISA-BD sub-project funded by USAID-Bangladesh is still being compiled and results from Bangladesh not fully contained herein.

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[1] 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.'

OBJECTIVE 1 AND 2

- **Building a service economy for SI:** CSISA has supported the emergence of a nascent but robust service economy for SI technologies with over 1,900 SPs now active in Bihar and EUP alone.
- **Accelerating spread of mechanized SI technologies**: As a result of CSISA's collaboration with the national agriculture research and extension systems (NARES) and private sector entrepreneurs, more than 37,000 hectares zero tillage wheat in 2014–15 across CSISA's working districts in Bihar and EUP through low-cost access to capital-intensive machinery through service providers. Area under ZT increased by more than 68% over 2013-14.
- **Achieving productivity and profitability gains at scale:** CSISA's on-farm surveys document average yield gains of 498 kg ha^{-1} and net revenue increases of \$110 ha^{-1} with ZT wheat. In aggregate, this translates to an estimated gain of 18,445 t of additional wheat production and an on-farm profitability increase of more than \$4.07 m USD on an annual basis.
- **Increasing resilience to climate extremes:** Timely planting of winter crops ensures that high temperatures in the Spring do not reduce yields. In partnership with the Bihar State Department of Agriculture, the area under early sowing of wheat in 2014–15 increased by an estimated 37% to exceed 62,000 hectares.
- **Strengthening input systems**: With support from CSISA, sales of hybrid rice in Bihar increased by 500 t in 2015, with an estimated area expansion of 33,000 hectares.
- **Reaching a critical mass of 'first innovators' in new regions:** Awareness and utilization of SI technologies was extremely low in Odisha when CSISA started activities in 2012. The spread of MTR, DSR, line sowing and diversification has resulted in an areas of 4,460 ha transitioning to SI technologies in last year of Phase II.
- **Compelling private sector investment:** CSISA's approach to achieving and sustaining impact with farmers through markets and public-private partnerships is paying off. From a base of zero, private sector reaper sales for the 2-wheel tractor exceeded 100 units in Nepal during the reporting period with importers adding new stocks of more than 400 units in advance of 2015-16 Rabi season. In Bangladesh through the CSISA-MI project, Rangpur Foundry Ltd. imported 446 seed and fertilizer drills with technical and market development assistance from CSISA.
- **Meeting our goals:** As the USAID-Bangladesh funded 'CSISA-BD' (2010 – 2015) investment draws to a close, more than 215,000 farmers have benefited from core programming on sustainable intensification technologies with a further million farmers receiving new stress tolerant rice varieties.
- **Sustaining a legacy of impact**: In CSISA's transition hubs in NW and Southern India, government partners and entrepreneurs continue the good work that CSISA and predecessor investments such as the Rice-Wheat Consortium initiated. For example, service providers in Haryana have laser levelled an estimated 162,000 ha and there are approximately 2,850 levelling machines deployed by service providers across the state. In Thirvarur District, Tamil Nadu, more than 27,000 acres of directly sown rice (DSR) was planted using seed drill sowing in last *samba* season.
- **Generating new innovations**: Most of the pressing challenges confronting agriculture in South Asia cannot be addressed with single technologies, and often require integrated approaches and systems-level interventions. CSISA's work on combining crop genetic advances with conservation agriculture and improved water management in the stress-prone eastern IGP shows significant promise for stabilizing wheat yields under a shrinking window of opportunity for winter cropping due to climate change. Moreover, variable rainfall patterns and monsoon

failures have become the norm in South Asia. Field and simulation studies demonstrate the importance of planting short and medium duration rice cultivars to maintain systems productivity, especially when rice planting is delayed due to late onset of the monsoon rains.

Objective 3

- **Rice breeding for new agronomy:** During the wet season 2014, 36 entries in early, 40 entries each in medium early and medium duration were evaluated under machine sown dry DSR conditions at seven locations in India. The mean grain yield advantage of the top five entries over the best check in respective maturity groups ranged from 10–20% over Sahabhagidhan (4.9 t ha^{-1}) for early, 14-19% over MTU1010 (5.6 t ha^{-1}) for medium, and 10-15% over NDR 359 (5.4 t ha^{-1}) for long-duration cultivars.

Objective 4

- **Release and scaling of new wheat varieties**: made significant progress by releasing 17 new wheat varieties that have superior yield potential and are well-buffered against the vagaries of climate change, have greater resistance to biotic stresses, are fully adaptable to the CA practices and have consumer preferred end-use qualities. These varieties showed yield advantage of 5–14% and two-thirds of the varieties were shorter in duration than prevalent cultivars enabling their higher suitability for intensive cropping systems. Formal sector seed production figures indicated that CSISA-bred wheat lines account for 18% of sales in India, 24% in Nepal and 34% in Bangladesh

Objective 5

- **Reforming extension**: CIMMYT and IFPRI organized a learning event on "Strengthening Agricultural Research, Extension, and Input Markets in South Asia: Evidence from Regional and Global Practice," in Washington, DC, June 8-9, 2015. Key partners from the agricultural research and extension systems of Bangladesh, India, and Nepal participated in this event as an add-on to their participation in the global MEAS symposium held during the prior week. The event was an opportunity for participants to explore extension system reforms in a new and critical light, and have established the foundation for more strategic and action-oriented partnerships with CSISA in Phase III.
- **Reaching consensus on investment priorities**: CIMMYT and IFPRI helped coordinate and intellectually contributed to the National Seed Summit convened by the Nepal Ministry of Agricultural Development, Kathmandu, September 14-15. The event was an important pan-stakeholder event designed to translate Nepal's new Seed Vision 2020 into implementation, with emphasis placed on reforms to regulations governing variety registration, quality control, and private sector investment. This event has set the stage for a forthcoming investment in Nepal's seed systems by USAID that will be lead by CIMMYT and functionally linked to CSISA.

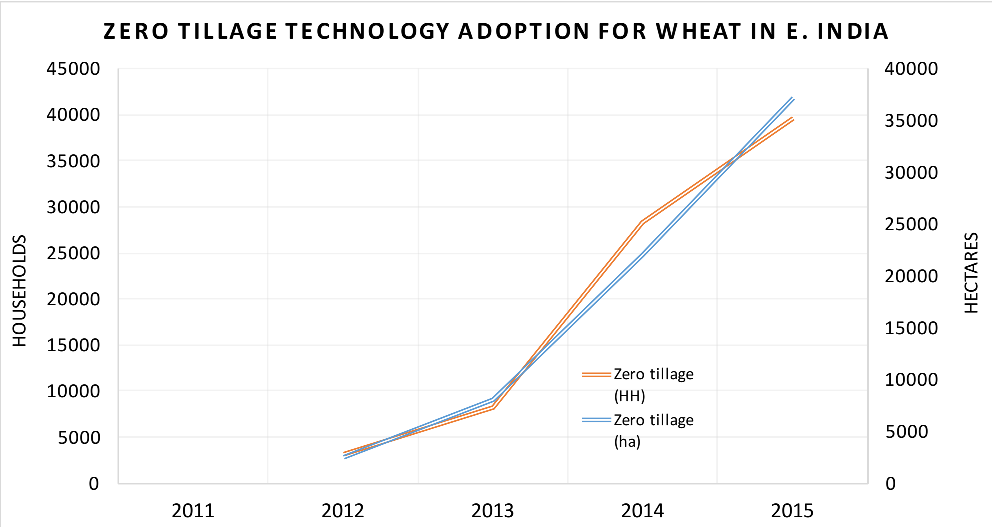
India

Objective 1 focuses on achieving short- and long-term impact on sustained cereal production growth by accelerating the adoption of innovative sustainable intensification technologies, forming private- and public-sector partnerships, identifying sustainable business models and information systems, and undertaking additional activities such as social marketing campaigns that foster impact at scale. Outputs of Objective 1 include participatory testing and technology refinement; translating research into actionable products and insights; mobilizing partnerships for catalyzing impact at scale; and strategic capacity development to support key agents of change.

The **Bihar and Eastern Uttar Pradesh (EUP) Hubs** focus on scalable and sustainable technologies that can have a huge impact on system productivity (such as early sowing of wheat), on change agents who can carry them forward past the life of the project (such as service providers), and on cropping system optimization interventions that can increase overall productivity and profitability (such as following long-duration wheat by short-duration rice).

In 2014–15, CSISA's impact has accelerated at its fastest pace since the beginning of Phase II, albeit with varying rates of progress for different technologies. The number of service providers (SPs) in Bihar and EUP have increased between 22 and 87%, depending on the technology and location. In total, CSISA has supported the emergence of a nascent but robust service economy for SI technologies:

SERVICE PROVIDERS FOR:	Bihar	EUP
Zero tillage	1,290	370
Laser land leveling	18	22
Mechanized rice transplanting	60	49
Paddy threshing	18	86

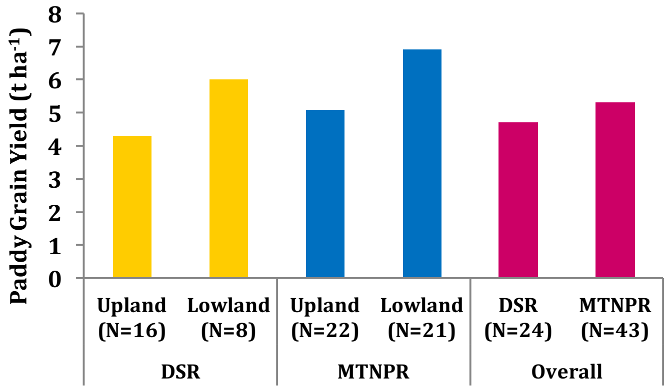


As a result of CSISA's collaboration with the national agriculture research and extension systems (NARES) and private sector entrepreneurs, more than 36,000 farmers planted zero tillage wheat in 2014–15 across CSISA's working districts in Bihar and EUP through low-cost access to capital- intensive machinery through service providers. CSISA's on-farm surveys document average yield gains of 498 kg ha^{-1} and net revenue gains of \$110 ha^{-1} with ZT wheat. In aggregate, this translates to an estimated gain of 18,445 t of wheat production and a profitability increase of more than \$4.07 m USD on an annual basis with a single technology intervention. Generating this magnitude of sustained impact at scale requires comprehensive approaches that combine technology innovation, public-private partnerships, and strengthened market-based systems. Following the success of early wheat sowing (EWS) and ZT, CSISA has expanded efforts with similar integrative approaches to refining and scaling other technologies as detailed below.

Except where noted, results refer to the 2014 *kharif* (monsoon) season and 2014-15 *rabi* (winter) season.

Bihar Innovation Hub

Rice Establishment Methods



Labor constraints and variable weather patterns continue to provide strong incentives for farmers to seek alternatives to the conventional practice of transplanting rice into puddled (i.e. wet tillage) soil. Directly sown rice (DSR) is a proven method for dramatically reducing establishment costs, but it performs better in years with relatively good early rains, especially in lowland landscape positions where weed pressure is less intense. In 2014, rainfall deficits in the month of June adversely affected area expansion in direct seeded rice. The effect of this deficit was more pronounced in upland ecologies of Patna, Vaishali, Samastipur, and Muzaffarpur with typical rice yields from 3.9 to 4.9 t ha^{-1} compared to lowland ecologies of Arra and Buxar, where paddy yields with DSR ranged from 5.8 and 6.5 t ha^{-1}. For the upcoming rice season, CSISA is targeting areas in Arra and Buxar has prime candidates for DSR expansion.

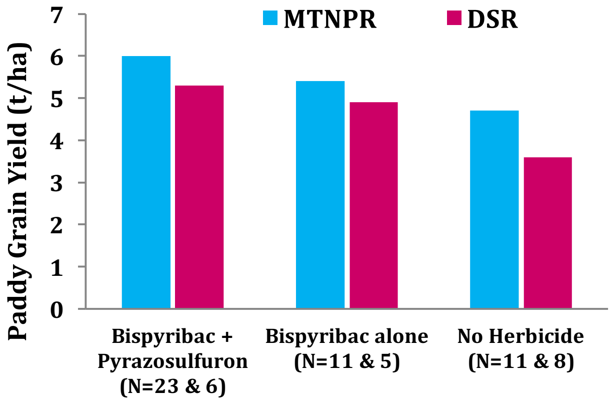
A less risky innovation in rice establishment is mechanical transplanting. In collaboration with the Department of Agriculture (DOA), CSISA facilitated the emergence of 33 new service providers for machine transplanting under non-puddled conditions (MTNPR). Based on 67 side-by-side comparisons, yield advantages of 0.6 t ha^{-1} over DSR were observed and these advantages were consistent across landscape elevation gradients.

As a companion initiative, CSISA is now focusing on the establishment of nursery enterprises so that rice can be transplanted immediately after the onset of rains with appropriately aged seedlings.

Rice Hybrids

CSISA addressed the related issues of late rice transplanting and complex weed flora through the promotion of short- to medium-duration hybrids and efficient weed management. Both interventions have picked up momentum, and were critical to improving the performance of MTNPR as well as facilitating timely establishment of winter crops. Despite bad weather, the use of hybrids alone improved rice productivity from 5.6 to 5.8 t ha^{-1} and weed management along with hybrids further improved it to 5.9 t ha^{-1}. Nevertheless, yield performance of different hybrids varies considerably, with Arize 6444 out-performing competitors like PRH 10 and generating higher profitability ($200 - $400 ha^{-1}, depending o crop establishment method). Market development efforts for rice hybrids have laid the foundation for systems intensification in the form of shorter-duration rice (SDR) followed by long-duration wheat (LDW) without compromising rice yields.

Seed sale of hybrid rice in Bihar increased from 5,500 t to 6,000 t in 2015, which at a seed rate of 15 kg ha^{-1} translates to an estimated gain of 33,000 hectares under hybrid rice in the reporting period, reflecting the joint efforts of private sector partners (e.g. Bayer Crop Science) and CSISA to bring this technology to scale through coordinated demand generate and market development activities.



Weed Management in Rice

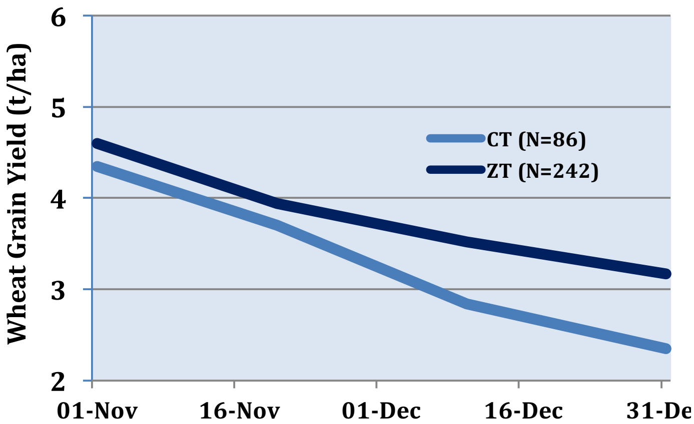
Based on results from 24 evaluation trials, it is clear that DSR expansion depends on adequate weed management. Since DSR is dominated by the emergence of complex weed flora, the use of bispyribac and pyrazosulfuron together used as post emergence was the best way forward with an average paddy yield of 5.4 t ha^{-1} as compared to 4.9 t ha^{-1} with bispyribac applied alone.

According to information gathered from our partner, Bayer Crop Science, sales of safe and effective rice herbicides like bispyribac are now growing at more than 15% per annum thanks in part to CSISA's efforts.

Kharif Crop Diversification

Due to drought-like conditions experienced during 6 out of the last 7 monsoon seasons, CSISA and its partners focused on increasing the area under *kharif* soybean and maize as a coping mechanism to build resilience to low rainfall. In 2014, the area under soybean increased by 2,500 ha and the area under ZT soybean increased to 219 ha. All maize hybrids showed good performance when planted on beds compared to zero tillage and conventional tillage across 57 on-farm evaluation trials. Double Dekalb and NK 6240 were the best performing hybrids with more than a 1 t advantage over poorer performing hybrids.

Early Sowing (EWS) and Zero Tillage (ZT) Wheat



The very significant yield and economic benefits of early wheat sowing and zero tillage were again observed across varieties and CSISA's geographies in the 2014-15 *rabi* season (see inset).

In partnership and coordination with the Bihar State Department of Agriculture, the area under EWS in 2014–15 increased from 45,769 ha to 62,889 ha – a gain of 37%. The main driver of productivity growth in high-yielding districts such as Begusarai (3.8 t ha^{-1} versus 2.7 in adjacent areas) is early planting. The area under ZT wheat attributed to CSISA-support service provider in Bihar and EUP has expanded from 21,973 ha in 2013-14 to 37,102 ha in 2014-15, with approximately 40,000 adopting households in 2014–15.

Wheat Varieties

Long-duration wheat varieties are universally acknowledged as having superior performance under timely sowing conditions, but are perceived as a poor choice for later sowing. In contrast to that perception, CSISA's on-farm research data suggests that long duration varieties with high yield potential provide similar yield to that of short duration varieties when sown late in the season. To further test that supposition, CSISA ran a replicated trial at ICAR-RCER, Patna. Results show that even under late- to very late-sown conditions on 15th December and 1st January, long duration varieties like HD 2967, HD 2733, HD 2824, PBW 550, Super 172 gave an average grain yield of 0.2 t ha^{-1} higher than short duration varieties like PBW 154, Lok 1 and HUW 234.

Recent surveys of selected seed dealers show that long duration wheat varieties are finding favor with farmers with sales volume increasing from 2,393 t in 2013-14 to 2,854 t in 2014-15 with seed sales for the lower-yielding short duration varieties commensurately declining.

Weed Management in Wheat

Labor shortages are driving farmers to seek alternatives to expensive manual weeding, and to look for effective measures against complex weed flora dominated by *Phalaris minor*. In Bihar, 241 farmer's field trials showed that the performance of sulfosulfuron + metsulfuron had superior control efficacy, which increased yields and profits over the use of single herbicides and manual control. The area in herbicide mixtures expanded from 12,395 ha to 31,043 ha in 2014-15.

Women's Empowerment through Technological Change and Yield Enhancement

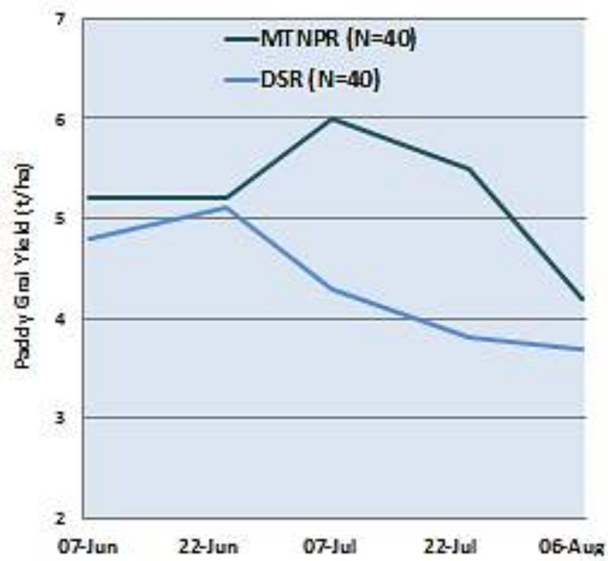
Focus group discussion were conducted with 100 women farmers to analyze the effects of technological change that has been supported by CSISA. Indicative results suggest that the grain yield of *kharif* maize increased from 3.9 t ha^{-1} in 2012 to 5.5 t ha^{-1} in 2014. The corresponding yield of potato in intercrop systems increased from 11.0 t ha^{-1} to 16.0 t ha^{-1} in the same period. These results demonstrate that women farmer's in India can benefit from targeted training on staple crop management just as much as their male counterparts – many are ready to innovate if the messages are right and support systems in place. CSISA is now in the process of refining its strategy for maximizing the effectiveness of programming to support women farmers based on progress and lessons learnt in Phase II.

Eastern Uttar Pradesh (EUP) Innovation Hub

[*Technology performance and production challenges in EUP and Bihar are very similar. We highlight here results that complement what is presented above for Bihar*]

Rice Establishment Methods

In general, early planted DSR yields are on par with mechanical transplanting. However, in the rainfed production systems of Bihar and EUP, DSR yield potential sharply declines with later planting while MTNPR increases (see inset). Based on these results, CSISA is now advising farmers, service providers, and government partners to only plant DSR before the third week of June.

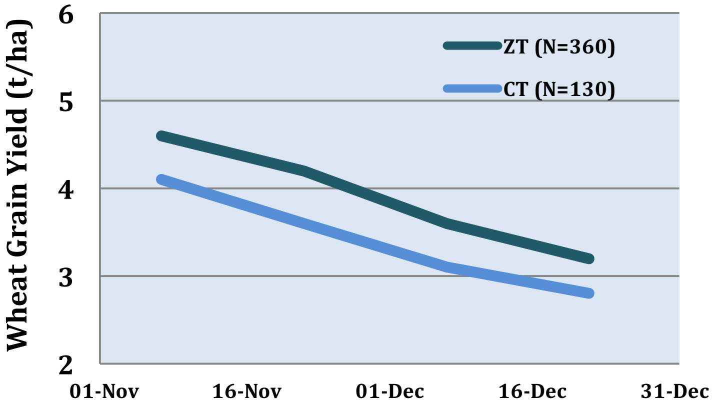


Weed Management in Rice

CSISA's on-farm agronomic trials assessed the value of creating 'dust mulches' by irrigating and then ploughing prior to crop establishment in order to reduce early competition from weeds and to promote soil moisture conservation. Dust mulches decreased weed populations compared when irrigation was given after seeding rice in a well-prepared field. The weed population in the scenario where soil mulch was created was 84 weeds m^{-2} compared to 232 weeds m^{-2} where post sowing irrigation was given, reducing the labor requirement for weeding (29 fewer labor hours ha^{-1}) and eliminating the need for post-sowing irrigation for 2 to 3 weeks. This is because soil mulch did not allow the loss of moisture from the root zone or the emergence of weeds due to dry surface soil. This new approach to DSR devised by CSISA has shown great promise for reducing risk and expanding the areas where DSR can successfully be cultivated. On-farm trials of this new approach to DSR management are continuing across landscape and soil gradients as well as planting dates.

Early Wheat Sowing and Zero Tillage

As in Bihar, early planting and ZT had significant and consistent advantages across evaluation sites in EUP (see inset). These advantages are driving adoption with the most recent annual gain in estimated area under EWS increased from 80,170 ha to 116,392 ha in 2014-15 and from 10,018 ha to 21,973 ha for ZT.



One example of the power of these interventions to change productivity at scale is in the Maharajganj district of EUP. Before the start of CSISA, average wheat yields across the district were stagnant at 2.8 t ha^{-1}. Through CSISA efforts and those of our partners, they increased a half ton per hectare to 3.3 t ha^{-1} in 2013-14.

Wheat Varieties

As was the case in Bihar, long-duration wheat varieties had superior yields to their short and medium duration counterparts. A growing recognizition of the value of long-duration varieties is reflected in seed sales data, with 1,536 t in 2013–14 increasing to 2,018 t in 2014–15 among surveyed dealers.

Weed Management in Wheat

CSISA addressed the problem of weed competition in wheat through a series of on-farm evaluations of new classes of safe and effective herbicides, often deployed in tandem through tank mixtures to better control complex weed flora. Carfentrazone was introduced to EUP with the help of CSISA in 2011 and now is used on more than 5,300 ha, increasing from 3,174 ha in 2013–14. The area under herbicide mixtures has exceeded 15,800 ha in 2014–15 against 9,644 ha in 2013–14.

Rice Wheat Crop Manager (RWCM)

Since the same evaluation protocol was followed for EUP and Bihar for the RWCM decision framework for precision nutrient management, data were combined from both hubs and presented here. From a base of 3.5 t ha^{-1} with prevailing farmer-managed fertility practices, wheat yields of 4.1 t ha^{-1} were achieved with RWCM recommendations when additional potash was applied. Without additional potash, grain yields increased by 0.41 t h^{-1} with the RWCM recommendation. Insights derived from these experiments are three-fold: 1) farmers are over-applying N and P, but under-applying K; 2) current state recommendations under-apply N and K; 3) yield responses to K are evident in most field, and more work on economically-optimal rates is warranted. Additional tool verification exercises are on-going for the 2015-16 wheat season with university collaborators with the ambition to secure sanction from the state departments of agriculture for tool deployment as part of the 'official' system of extension recommendations.

In Focus: Machine rice transplanting reaches critical mass

Numerous factors can impede the successful adoption of new technology, even when expected benefits are significant and locally proven. In order to employ mechanical transplanting, special rice nursery 'mats' are needed that require specialized knowledge and equipment and many would-be service providers for this technology have been reluctant to commit to producing their own seedling mats. Based on feedback collected directly from farmers, CSISA and the national agriculture research and extension system (NARES) came up with an enterprise-based nursery approach, wherein one farmer raises the mat-type nursery for selling to machine owners who provide transplanting services to farmers. This 'community nursery enterprise' is a low-risk investment since seedlings can also be sold to farmers practicing manual transplanting.

With university and ICAR partners, CSISA has also conducted applied research on options to further reduce the production costs of mechanical transplanting, specifically on practices that permit transplanting into non-puddled soil ('MTNPR'). Not only does this technology 'tweak' improve economics, but it also improves seedling anchorage and contributes to long-term enhancement of soil quality.

In 2015, CSISA conducted a cost-benefit analysis of MTNPR, DSR and manual transplanting covering 210 farmers. Results showed that rice yields per hectare were 5.3 t for MTNPR in contrast to 4.4 t for both DSR and manual transplanting. The corresponding net returns were US$ 524, US$ 388 and US$ 266 per hectare, respectively. In addition, MTNPR also helped service providers earn an average net income of US$ 513 per season.

Until 2014, the Bihar Department of Agriculture (DoA) advocated the System of Rice Intensification (SRI) as a pathway for farmer to produce and earn more. In part due to CSISA's efforts to quantify the real yield and economic benefits achievable with different rice establishment alternatives, the Bihar DoA now promotes machine transplanting as it's 'best bet' option for sustainable rice intensification.

In Focus: Service provision more profitable than farming

Jai Prakash Verma in his field

Significant value can be gained from connecting farmers with innovative technologies, and service providers can serve as effective facilitators of this technology dissemination. A focus on incentivizing the purchase of machines by service providers, can uniformly spread the benefits of mechanization across large ecologies and a variety of types of farmers.

Service Providers (SPs) are a cost-effective mechanism for extending capital-intensive sustainable intensification technologies to smallholder farmers. To strengthen networks of service providers and the farmers they serve, CSISA has helped facilitate more than 1,900 progressive farmers across Bihar, eastern Uttar Pradesh and Odisha to become SPs over the past three years.

Service provision is especially profitable in India's eastern ecologies because of increasing labor scarcity and relatively low competition among service providers. For example, farmer-turned-entrepreneur Jai Parkash Verma and his family from Kurkuri village in Ara district of Bihar increased their annual income of US$ 538 from service provision in 2010 to US$ 3,344 in 2015.

In 2010, Verma's family farmed on 2 acres of the land they owned and only offered zero tillage as a custom hire service. In 2012, Verma attended various training sessions jointly organized by the local *krishi vigyan kendra* (farm science center) and CSISA on better-bet agronomic practices. Armed with this knowledge and income generated from ZT, he decided to expand his service provision portfolio.

By 2015, Verma had expanded his own farm operations by renting an additional 40 acres. Even after paying the land rent, he was able to make a profit of US$ 1,000 and US$ 2,400 from the improved cultivation of wheat and rice, respectively. He was able to nearly double this amount with his income from service provision – US$ 1,464 from the axial flow thresher, US$ 799 from zero tillage wheat, US$ 409 from machine transplanting of rice, US$ 266 from direct seeded rice, US$ 218 from the wheat thresher and US$ 188 from selling rice nursery – a total of US$ 3,344.

Verma's is only one of many SP success stories and, seeing his profits, other farmers from the village are already keen to take up service provision themselves. This growing interest and the steady increase in SP numbers is a strong indicator of the effectiveness of this mechanism to promote sustainable intensification in the region.

In Focus: Factors affecting the adoption of ZT wheat in Bihar

As highlighted in the Annual Report 2014, the use of zero-tillage (ZT) in wheat entails substantial economic benefits from yield increases and cost savings (p. 20). The assessment of the technology's performance in farmers' fields was based on data collected in a random sample of 1,000 farm households in 2013, comprising both ZT users and non-users, who were spread across 40 randomly selected villages in six districts of Bihar. After further refining the analysis presented in last year's report, a yield increase of 498 kg ha^{-1} (19%) was estimated for ZT wheat as compared to conventional-tillage wheat, and a total economic gain from yield increase and cost savings of 110 USD ha^{-1}, which is equivalent to a 6% increase in total annual income for the average wheat farming household (Keil et al. 2015). If, for illustrative purposes, one assumed full ZT wheat adoption in Bihar, the associated yield increase would be able to offset total wheat imports into Bihar, suggesting that broad-scale adoption of ZT technology could play a major role in making Bihar self-sufficient in wheat (ibid.).

However, the adoption of agricultural innovations is contingent on a multitude of household- and higher-level factors, which will ultimately determine the overall adoption rate. To gain insights in adoption constraints, the same sample used for the performance assessment of ZT was also used to identify factors influencing the adoption of the technology. We find that only 44.3% of the sample households were aware of the ZT technology at the time of the survey in 2013. Since unaware households, by definition, have no chance to adopt ZT, the identification of adoption determinants was broken down into two stages: (1) factors influencing the awareness of ZT and (2) factors influencing the adoption of ZT, conditional on being aware of the technology. Hereby, the modeling approach applied corrects for selection bias, i.e., the fact that the stage (2) analysis is based on a non-random sample.

We find that there is a substantial scale bias both with respect to awareness of ZT and adoption of the technology among the aware farmers, with larger and better educated farmers being more likely to be aware and adopt. The positive influence of farm size diminishes at the margin, i.e., its effect is largest among relatively small farmers and does not play a role beyond a farm size of approx. 20 acres.

In villages with no ZT service provider in a 5 km radius, the probability of using ZT (conditional on awareness) drops by 27 percentage points, highlighting the importance of a relatively dense network of ZT service providers (cf. Semi-annual Report 2015, p. 32). The experience of delayed monsoon rains in the past 10 years increases the likelihood of ZT adoption by 13 percentage points; after a delayed rice harvest, ZT allows farmers to establish their wheat crop faster than with time-consuming conventional tillage operations, especially under conditions of high residual soil moisture. The importance of timely wheat sowing has been highlighted in previous project reports. The possession of a radio increases the likelihood of being aware of ZT by 13 percentage points, and also access to agricultural extension enhances awareness. Both with respect to awareness and adoption, the ZT adoption behavior of farmers' individual social networks appears to play an important role.

For CSISA, these findings imply that (1) activities aimed at raising farmers' awareness of the ZT technology continue to be of great relevance; hereby, care must be taken to reach also the smaller and less educated farmers with appropriate messaging; (2) the social inclusiveness of access to the technology should be enhanced; to this end, the network of ZT service providers needs to be further expanded, and the transaction costs of servicing smaller farmers need to be reduced through appropriate business models involving demand aggregation and service coordination; (3) the time-saving potential of ZT in wheat establishment appears to be valued by farmers, especially under conditions of increasing variability of monsoon rains; this potential should be further highlighted in awareness raising and training activities, in conjunction with CSISA's goal to advance wheat sowing times.

Reference

Keil, A., D'souza, A., McDonald, A. J., 2015. Zero-tillage as a pathway for sustainable wheat intensification in the Eastern Indo-Gangetic Plains: does it work in farmers' fields? *Food Security* 7 (5), 983-1001.

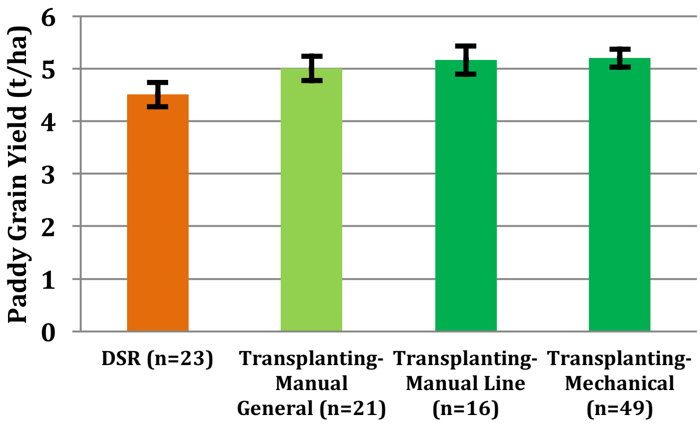
Odisha Innovation Hub

Since 2012, the Odisha hub has taken up cropping system intensification activities in three districts. Predominantly, the rice–fallow cropping system is being intensified through the introduction of pulse and oil seeds with improved planting methods, management practices and appropriate mechanization. As in Bihar and EUP, farm mechanization through local service providers (SPs) has been at the center of CSISA's technology adoption efforts, with 207 service providers now trained by CSISA. Additional efforts were employed to support maize growers by establishing linkages with remunerative markets. Rice Crop Manager (RCM), a decision support tool that provides field specific management guidelines for rice has been released in local language (Odia) and endorsed by Odisha University of Agriculture & Technology (OUAT), Bhubaneswar. During the period under report CSISA helped to scale-out machine transplanting of rice (MTR), direct seeded rice (DSR) by seed drill machine, line sowing of maize, and intensification of rice–fallow in 2,657,1,158, 273, and 265 ha, respectively.

Rice Establishment

Agricultural labor availability in Odisha is decreasing at 14% per year, making rice transplanting very costly. Machine transplanting of rice (MTR) and direct seeded rice (DSR) reduce demand for labor. To make these technologies more widely available, CSISA helped increase the number of service providers from 19 in 2012–13 to 152 in 2014–15. As a result, the adoption of MTR increased to 2,657 ha in 2014–15 compared to 1,747 ha the previous year. A study conducted by CSISA showed that MTR has driven down the cost of transplanting by \$50 ha^{-1} against manual transplanting. DSR was even better, with an establishment cost savings of \$59 against manual broadcasting (Fig. 16). As such, MTR has generated a regular stream of cash flow through custom services with an average profit of \$922 for SPs.

Crop-cut data of *rabi* 2014–15 across varieties and districts showed that MTR yields are on par with manual transplanting but with lower costs. The average grain yield recorded in *kharif* 2014 (n=40) under MTR varied from 4.9 to 6.5 t ha^{-1}. The paddy yield recorded under DSR was the lower compared to other methods. But, the performance of DSR in terms of profitability remained at par with transplanting methods due to lower cost of production by \$119 ha^{-1} and \$69 ha^{-1} compared to manual and mechanical transplanting, respectively.



CSISA's strategic alignment with ongoing programs like "Bringing the Green Revolution to Eastern India (BGREI)" of DOA for scaling-out DSR gathered momentum in *kharif* 2015.The increase in the number of SPs for DSR from 18 to 49 was the key growth driver in area expansion, resulting in 1,133 ha covered during *kharif* 2015, against 49 ha during *kharif* 2014, generating a critical mass of new technology adopters. In DSR, farmers often find it hard to control complex weed flora but in Odisha weed flora is relatively simple and CSISA coordinated with agri-input distributors and dealers to make safe and effective herbicides available at field level.

Water Management

To address the issue of excess irrigation water application in rice during *rabi*, CSISA helped farmers practice alternate wetting and drying (AWD) in collaboration with two NGOs (LWSIT and WISDOM) in Puri. Staff of the selected NGOs were trained on AWD by CSISA and then organized follow-up AWD awareness-raising meetings for farmer's groups, with technical backstopping by CSISA. In *rabi* 2014–15, these two NGOs installed 265 '*pani* pipes' in 115 farmers' fields, covering 180 acres across three blocks in Puri district. Participating farmers confirmed there was no yield penalty compared to the previous year's yield or neighboring farmers' fields, while still saving 3–5 irrigations.

Rice Crop Manager (RCM)

CSISA, in partnership with Orissa University of Agriculture &Technology (OUAT), continued evaluating Rice Crop Manager (RCM) decision support framework. Based on successful evaluations in farmer's fields, OUAT recently endorsed the RCM Odisha app and jointly planned its dissemination with DOA. CSISA, in collaboration with KVKs of OUAT and DOA, started disseminating RCM-based recommendations in 8 districts.

Maize in the Tribal-dominated Plateau Region

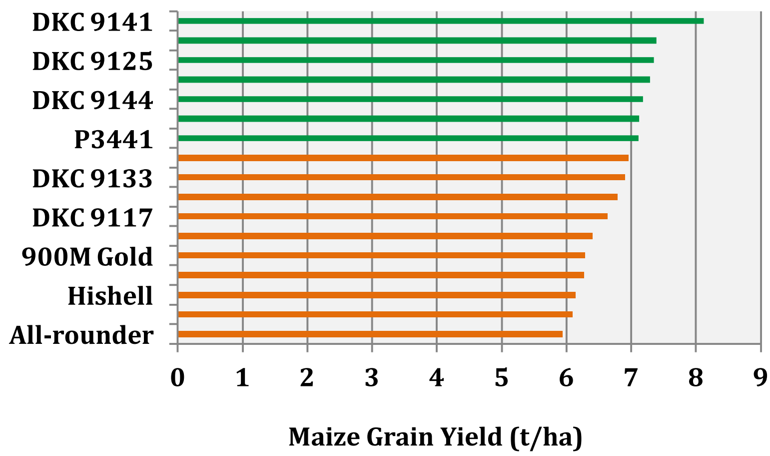
Nearly half (43%) of the total cultivable area of Mayurbhanj District (the largest in Odisha) is considered moisture-limited 'upland', which is not suitable for growing *kharif* rice. Furthermore, the 2015 monsoon season had rainfall deficit of 26.7% which significantly suppressed rice yields – a scenario that has become more common in the past decade. To build resilience to low rainfall years and to take advantage of , CSISA increased its focus on increasing maize cultivation in Mayurbhanj as a means of stabilizing and increasing agricultural productivity. CSISA targeted low-yielding maize areas as well as fallow lands and promoted the adoption of better-bet agronomic practices, including the selection of the best performing maize hybrids from different maturity classes, line sowing with maintenance of optimum plant population of 65,000-75,000 ha^{-1}, soil-type specific nutrient management practices with adequate phosphorous nutrition (e.g. $N:P_2O_5:K_2O$ @ 150:100:80 kg ha^{-1}), and integrated weed management practices, including mechanical control. Farmers who opted for these agronomic practices reported the grain yield of more than 5 t ha^{-1} in contrast to 1.5 t ha^{-1} with prevailing farmer practices. These results were achieved under rainfed conditions on the nutrient-depleted lateritic and acidic soil that dominates Odisha's plateau – areas that are commonly dismissed by policy makers as intractably unproductive and unworthy of investment. CSISA continued to create demand for these interventions by awareness through trainings and demonstrations and distributed a brochure called "Tips to Increase Maize Yields in Plateau of Odisha" for farmers in the local language (Odia) and for other stakeholders in English.

Maize line sowing using the multi-crop ZT planter gained momentum through the engagement of local SPs. Eight new SPs were created who were trained to deliver custom hiring services for planting maize in lines using the multi-crop ZT planter. Awareness-raising program involving officials of DoA and other local partners helped create demand for the technology. These steps strengthened our efforts to further enhance the area under intensified maize from 118 ha in 2013–14 to 240 ha in 2014–15.

Women farmers too have now become an integral part of this change. In the current year, 395 women farmers linked to 42 self-help groups (SHGs) of PRADAN, an NGO, adopted line sowing of maize and better-bet agronomic practices. To reduce the cost of maize cultivation and the drudgery of women farmers, CSISA introduced the power weeder, which can increase the efficiency of weeding. Four women service providers provided power weeding services, and each earned an average of $300 in one season.

To avoid distress sales of maize as green cobs, CSISA has helped enhance the negotiating power of maize farmers by facilitating their linkages with potential markets (e.g., private organizations and poultry feed mills). CSISA trained 56 farmers on practices pertaining to harvesting time, drying procedures and efficient shelling methods, which were the pre-requisites to produce quality maize grains for the market. CSISA convinced concerned stakeholders about the importance of mechanical shelling of maize, which resulted in the introduction of two big (shelling of 3 t hr^{-1}) and 8 small (shelling of 0.15 t hr^{-1}) maize shellers into the system. This new system enabled farmers to sell their maize in the current season at \$21-23 q^{-1} against \$15-17 q^{-1} from last season due to improved quality. Around 50% of the maize produced in *kharif* 2015 has been sold as dry grain.

CSISA has initiated a dialogue with the district level authorities to form maize producers groups (PGs). Odisha Livelihood Mission (OLM) has shown interest in supporting these PGs for easy credit access and market linkages. CSISA has also organized two field days to showcase the scope for change for government officials, private seed companies & market players.

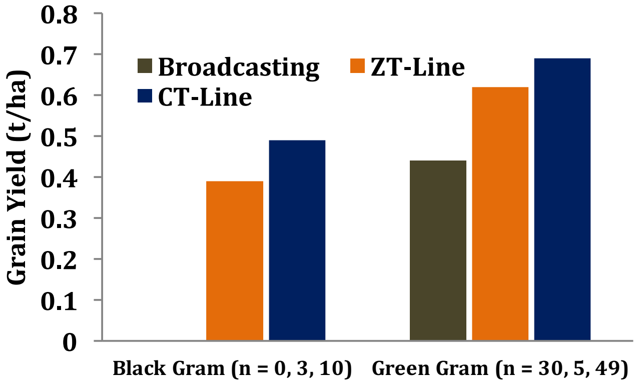


A maize crop 'cafeteria' was set up in Mayurbhanj so farmers could select the best performing maize hybrids. Out of the 17 promising hybrids from 3 private seed companies tested, 7 hybrids achieved a yield of more than 7 t ha^{-1}. DKC 9141 of Monsanto yielded the highest (8 t ha^{-1}), followed by P 3501 of Pioneer. Three Monsanto hybrids (DKC 9125, 9126 & 9144) and two Pioneer hybrids (P 3401 & 3441) yielded above 7 t ha^{-1}.

Developing Rice–fallow Cropping Systems

The rice–fallow cropping system of Odisha has considerable potential for system intensification, both through better management of rainfed crop options (e.g. pulses, oilseeds) as well as through the expansion of irrigated area (e.g. to support the cultivation of more water-demanding crops such as maize, wheat, vegetables, or rice).

During the winter cropping season, rainfed areas in Odisha are currently either fallowed or cultivated with 'low input–low output' pulse systems. Since winter rainfall is very low, conservation and productive use of soil moisture coming out of the *kharif* season is the linchpin for higher productivity. Our work now shows that mungbean (aka 'green gram') has the potential to create significant value due to better yield and higher market price. Performance of black gram and green gram was analyzed under broadcasting, ZT line sowing and CT line sowing. Results demonstrate that line sowing and the resulting uniformity of stand establishment improve crop performance with both ZT and CT. Surprising, CT systems performed better for both mungbean and black gram. We speculate that the dust mulch created by CT conserved soil moisture, thereby increasing availability of water for crop uptake . CSISA brought 258 ha under double cropping during *rabi* 2014–15, out of which green gram in lines accounted for 174 ha. At the farm level, CSISA surveys document profitability increases of \$380 ha^{-1} with adoption of line sowing for mungbean.



CSISA is also exploring opportunities for supporting intensification with small investments in irrigation. A medium-duration wheat variety (Baaz) has ben evaluated in Odisha, and appears well suited for these ecologies with an average grain yield of 3.4 t ha^{-1} with 2 – 3 irrigations.

In Focus: Maize cultivation to cope with climate variability

Badbil is a remote and deeply impoverished, tribal village in the plateau region of Mayurbhanj, Odisha. The village is home to 200 families belonging to four indigenous tribes: Santal, Ganda, Bathudi and Lohar. They usually grow very short-duration (60 days) paddy called Sathia. Due to poor yields and regular droughts, families have started giving up farming and the land lies fallow for the most of the year. Some farmers grow local varieties of maize in home gardens for household consumption and sell the small surplus as green cobs in the local market.

In 2013, CSISA started working with a women's self-help group (SHG), *Johar Jaher Ayo*, for collective maize farming in the village. The productivity of maize improved with introduction of hybrids, appropriate plant populations using the seed drill and judicious nutrient management. The group earned a net profit of US $240 by selling surplus green maize and maize grain, in addition to harvesting a ton of green maize for use by their families and relatives, and were even able to share green ears with neighbors.

Seeing their success, two more women's SHGs successfully cultivated hybrid maize and earned a profit in 2014. This year, five more SHGs practiced collective maize farming in the village. *Saraswati* SHG earned a profit of US$ 1,200 by selling 12 quintals of green cob and 70 quintals of dry grain. Similarly, another group, *Subhapatni,* earned US$ 1,000 by selling 62 quintals of green cob and 30 quintals of dry grain.

All of these groups have adopted a set of improved practices introduced by CSISA, including herbicide application and fertilizer management. Moreover, to reduce costs, they hired a mechanical power weeder to help with weeding, hoeing and earthing-up.

Anita Lohar, a progressive woman farmer and member of *Jagat Janani* SHG, said, "The power weeder saves US$ 31 per acre for weeding and earthing-up and takes half the time of manual weeding, which makes it very useful as we have short dry periods with unpredictable rains during the rainy season. Next year my group is going to buy a power weeder for our own maize field as well as to provide custom services."

Padmini Naik, a woman farmer from *Subhapatni* SHG said, "Because of collective maize cultivation, we are able to feed our children nutritious green maize either in roasted or boiled form during the acute food insecure rainy season." Additionally, they are using chopped green maize straw as cattle feed.

According to Lohar, maize farming has changed their mindset from old traditional practices, which were labor consuming and less profitable, and has brought back their confidence in the agricultural sector. With 30% lower rainfall this year, they have realized that profitable maize cultivation in place of paddy can help them cope with drought.

In Person: Line sown pulses increase farmer's confidence

Dilip Kumar Baral is a farmer from Resinga village of Puri district in Odisha. In March of this year, he received the state award for the 'Best Farmer' from the Odisha Chief Minister, making him quite famous in his area. Dilip has been instrumental in promoting line sowing of pulses in his village. During the rabi season in 2014–15, Dilip covered 80 acres under line sowing of green gram and black gram, which provided 75% higher yield per acre for farmers.

Many areas of the coastal plain (>50% in some pockets) are unirrigated and currently are either fallowed or cultivated with 'low input–low output' pulse systems during the winter Rabi season. Farmers use the traditional method of broadcasting black and green gram, which give yields as low as 1.5 to 2 quintal per acre. CSISA has been promoting line sowing and zero tillage crop establishment methods in this region to improve the yields of pulses and to efficiently use the residual soil moisture for sowing a second crop immediately after paddy.

These days, a beaming Dilip thanks CSISA for the training and support that enabled him to provide service to many farmers in his village. However, there was a time six years ago when he abandoned line sowing with the seed drill machine. He had been introduced to the seed drill by a private company and he used the drill on five acres of land. Due to a lack of technical and management support, he didn't obtain any benefit and his yields didn't improve. With nobody to maintain or repair the machine, after one season Dilip lost interest in line sowing and moved back to broadcasting.

During the last rabi season, he met CSISA's Odisha team and attended a training organized by CSISA in collaboration with Department of Agriculture on line sowing of pulses using the seed drill. After the training and with the rented seed drill machine from CSISA, he covered 15 acres of his own land and provided line sowing services for other farmers at a cost of US$ 8 per acre. Farmers harvested 3 to 3.5 quintal per acre of green gram and black gram under line sowing.

"Realizing the business opportunity to provide services for line sowing pulses, I have already applied to buy a seed drill under the government subsidy scheme and will cover even more area in my village in the coming season," says a confident Dilip Kumar.

With the help of CSISA's interventions, a total area of 225 acres of pulses were sown under line sowing in Puri in the last rabi season and it is expected to go up to 2,000 acres this year.

Haryana Innovation Hub

CSISA's **Haryana Hub** continues to disseminate conservation agriculture-based crop management practices in collaboration with public and private sector partners. These partners include state agricultural universities, state department of agriculture, ICAR's research centers, KVK's, NGOs, private sector companies and farmer cooperatives.

Partnerships: CSISA's hub in Haryana has worked in collaboration with Haryana Kisan Ayog (HKA), department of agriculture (DoA), Chaudhary Charan Singh Haryana Agricultural University (CCSHAU), Central Soil Salinity Research Institute (CSSRI), the KVK of the National Dairy Research Institute (NDRI) and private sector companies to create a strong network of progressive farmers, resulting in the large scale adoption of zero tillage wheat, DSR, LLL, summer mungbean, and diversification in favor of *kharif* maize and sunflower.

Laser land leveling: LLL is now a widely adopted technology in Harayana, with 2,844 units of LLL available with the farmers. Out of this, 144 units available with DoA on a custom-hire basis have covered an area of 8,320 ha ha till July 2015. Based on feedback from the Haryana State Department of Agriculture, approximately 162,000 ha has been covered by 2,844 LLL units operated by individual farmers.

Diversification: Diversification in favor of *kharif* maize has been a priority of CSISA during last three years. Based on the anticipated targets of DoA the area under *kharif* maize in 2015 is expected to increase to 20,000 ha from an area of 8,000 ha in 2014. Rainfall deficit of 22% from April to September was responsible for increase in the area under *kharif* maize. To optimally utilize the time between wheat harvesting and rice transplanting summer mungbean was introduced. The area under mungbean in 2014-15 was 90,000 ha. In the process, the area in summer rice -the biggest draw on the water table- has been reduced. The area under sunflower was 11,600 ha.

Hybrid Rice and Herbicides: Based on the data from Bayer Crop Science, 500 t of hybrid rice was sold, equivalent to an area coverage of 56,700 ha. Among herbicides, 32,000 liters of bispyribac (2,000 by Bayer and 30,000 by PI Industry) was sold in Haryana and covered 160,000 ha area.

Zero Tillage: Haryana is the leading state in the adoption of zero tillage technology in wheat. Based on the data available from DOA, 23,598 ZT machines have been made available to the farmers and around 2.0 million ha has been covered since 2001. The state is maintaining momentum and has targeted additional 8,900 ZT machines including happy seeders in 2015. Based on feedback from KVKs approximately 100,000 ha have been covered under zero tillage in 2014–15. The current year strategies for improving wheat production include: the promotion of zero tillage, happy seeder, integrated weed management and multiple boom nozzle sprayers for improving herbicides.

Direct Seeded Rice: DSR has become an important intervention to save water and labor in Haryana. The promotion of DSR was focused though special campaigns by the DoA and 12,000 ha were covered in 2014–15.

Policy Reform: Based on the working group report called, "Conservation Agriculture for Sustainable Crop Production in Haryana," the need to eliminate subsidies on rotavators, a technology considered detrimental to soil health, was championed by CSISA and partners. As a result, the Haryana DoA agreed to discontinue the subsidy.

Exit policy: The successes achieved during the last 15 years, including the time of CSISA, can contribute to the success of Bihar, EUPH and Odisha hub in Phase III by linking the trained manpower in the DoA and the training institutes of these new ecologies through the Agriculture Technology and Management Agency.

Tamil Nadu Innovation Hub

CSISA in Tamil Nadu worked in Thanjavur, Thiruvarur and Nagapattinam districts, considered part of the rice bowl of the state. The dissemination of DSR was one of the major activities of the project. DSR crops in the Cauvery Delta Zone have been established mainly by seed drills from CSISA. More than 40 farmers have since purchased seed drills, and CSISA has supported them technically and helped them become service providers. CSISA has also supported the state government to produce a DSR video, which has been uploaded in to TNAU Agritech Web Portal for wider dissemination.

During its final year, CSISA's **Tamil Nadu hub** aims to engage in capacity building with key partners, and hand over CSISA-endorsed technologies and covered areas to its strategic partners. The major partners include the Department of Agriculture, Tamil Nadu Agricultural University, MSSRF (an NGO), and Reliance Foundation.

CSISA conducted field evaluations of MTNPR at three locations with 12 farmers in samba 2014 and summer 2015. The field evaluation results showed that rice grown in non-puddled conditions has an economic advantage over rice grown in puddled conditions and non-puddled establishment methods help reduce labor, cost and time. CSISA carried out 50 acres of demonstrations during 2013 thaladi season in Thanjavur district. Transplanter owners received technical backstopping by hub staff.

'Nutrient Manager for Rice (NMR)' evaluation trials were conducted during the *samba* and *thaladi* season. In total, 40 NM farmers' participatory trials were conducted in the old and new delta region of the Cauvery Delta Zone during samba season. Sixty nutrient manager evaluation trails were established during the *thaladi* season.

CSISA in Tamil Nadu works mainly with the partners for dissemination. The major CSISA partners are Tamil Nadu Agriculture University, Department of Agriculture Thiruvarur and Thanjavur, Tamil Nadu Rice Research Institute in Aduthurai, KVK Sikkal and Needamangalam, the Soil and Water Management Research Institute, Thanjavur, MSSRF Thiruvaiyar, and Reliance Foundation. The project handed over key CSISA-supported technologies to some of these partners and held a closing workshop in September 2015 at which project partners shared their experiences and successes. It was agreed that CSISA's dissemination activities would be continued through partners with the support from the Government of Tamil Nadu and TNAU.

Key accomplishments from Tamil Nadu include:

- In the last 5 years, CSISA scaled out water- and labor-saving technologies, which have reached over 25,000 farmers and have covered more than 70,000 acres in Thanjavur, Thiruvarur, and Nagapattinam, Ramanathapuram and Sivagangai districts.
- CSISA-trained farmers purchased seed drills and started providing custom hire services for DSR (40 service providers) and machine transplanting (54 service providers).
- DoA Thirvarur district has covered more than 27,000 acre of DSR using seed drill sowing in last *samba* season. This will also replicated larger area in the future years. DSR technology largely endorsed by the DoA and TNAU in TN. They were convinced on DSR technologies and confident to disseminate in the larger area. DoA, TNAU endorse MTNPR technology as an alternative resource conservation technology in the Cauvery delta zone.
- Reliance Foundation (RF) Bharat India Jodo Programme actively transfers the DSR technology at Sivagangai district with purchasing of 11 seed drills. RF will expand this technology for better scaling up in Sivagangai and Ramanad districts in Tamilnadu.
- DSR publication for CDZ in Tamil and English Version, Fact sheets of key CSISA technologies was distributed to partners and farming communities. DSR Guildelines been widely accepted by the TNAU and used by the department of agriculture for DSR dissemination material in Tamil Nadu.

In Focus: Partners in Tamil Nadu to continue CSISA initiatives

MSSRF is now extending training to farmers after its staff members attended CSISA's season-long training on dry direct seeded rice. The season-long training was piloted by CSISA in 2014 when participants received hands-on training on all aspects of crop production and management — from sowing to grain storage — during the entire growing season.

As part of its phase out, CSISA's Tamil Nadu Hub conducted a workshop to ensure that the advances made by CSISA and its partners continue beyond the project lifecycle. During the workshop, it was reported that CSISA has scaled out water- and labor-saving technologies to over 25,000 farmers and covered more than 70,000 acres in the last five years in Tamil Nadu.

Several improved rice crop technologies and management practices have been tested and scaled out including laser land leveling, mechanized dry direct seeding of rice, mechanical transplanting of rice, site-specific nutrient management and line sowing using a multi-crop seeder under reduced-tillage conditions. These technologies are helping farmers reduce the cost of production and increase their income.

Sivagangai and Ramanathapuram districts are two of the most arid areas in Tamil Nadu. With almost 73 percent of the population depending on agriculture, paddy is a staple crop grown only during the dry season (*rabi*), mainly under rainfed conditions, with seeds broadcasted before the rains. The practice of dry direct seeding of rice, which requires less water and labor, is helping transform uncultivable lands (geographically about 50 percent of the area) to productive agricultural areas in these districts.

The Reliance Foundation and CSISA worked in partnership to convert dry tracts of land from traditional broadcasted rice to dry direct seeded using a seed drill. As a result, 250 hectares in Sivagangai have already become cultivable and farmers' groups have purchased 11 seed drills and are renting out the equipment to other farmers.

CSISA has worked with several other partners - the Tamil Nadu Rice Research Institute of Tamil Nadu Agriculture University (TNAU), National Bank for Agriculture and Rural Development, ITC Agribusiness division, Syngenta, MS Swaminathan Research Foundation (MSSRF) and Reliance Foundation – to support the research, capacity-building and extension work for large-scale adoption of the technologies.

TNAU and MSSRF have agreed to extend and sustain the research and development activities started under CSISA. "TNAU will take up the outscaling of key technologies under CSISA although the project has already ended," said R. Rajendran, TNAU agronomist, who has been associated with CSISA for the last seven years. "TNAU will continue by extending technologies such as improved dry seeded rice cultivation, non-puddled machine rice transplanting and laser land leveling," Rajendran said. "Also, the research initiatives conducted through CSISA will not end. The research outcomes will be taken continually to the farmers with the support from the Government of Tamil Nadu and TNAU," he added.

Bangladesh

CSISA-Bangladesh

[*note: support for CSISA-BD from USAID-Bangladesh termed on September 30, 2015. The final project report is under preparation by IRRI and fully updated results will be provided in the next general CSISA progress report*]

The Cereal Systems Initiative for South Asia in Bangladesh (CSISA-BD) project is implemented through a partnership of three CGIAR centers, IRRI, CIMMYT, and WorldFish. CSISA-BD is funded by USAID's Feed the Future (FtF) initiative.

The **Cereal Systems Initiative for South Asia in Bangladesh** is implemented through a partnership between 3 CGIAR centers: IRRI, CIMMYT and WorldFish. CSISA-BD is funded by USAID's Feed the Future (FtF) initiative, and aims to test and disseminate new cereal system-based technologies that will raise family incomes for 60,000 farming families.

By the end of this reporting period, excluding the Sustainable Rice Seed Production and Delivery Systems for Southern Bangladesh (SRSPDS) project and the CIMMYT-managed CSISA Mechanization and Irrigation (CSISA-MI) project, the project had trained 130,446 farmers and conducted 47,472 trials and demonstrations. If farmers attending farmer field days and exchange visits are included, then the project has benefited 216,561 farmers**.** In addition, the SRSPDS project was thought to have benefited a further 1,312,935 farmers through seed distribution (999,517 farmers), training, and farmer field days and the CSISA-MI project has to date facilitated machinery services for 15,755 farmers. These data show that the project has far exceeded its original targets. In addition, as can be seen from the section on lessons learnt and the way forward, the project has developed sets of technologies that have changed the face of agriculture in southwest Bangladesh through variety change, new crops and cropping systems, and the introduction of mechanized agriculture.

Some of the main conclusions from the trials and demonstrations conducted during this period are:

- Strip-till-planted wheat and new wheat varieties BARI gom29 and 30 give the best results in a trial conducted at all six hub sites.
- Storing maize in a modified traditional grain store enabled farmers to store maize up to 9 months without substantial grain storage losses. This allowed them to take advantage of rising maize prices following the crop harvest and this substantially improves farmers' income compared with selling maize immediately after harvest. For example, storing for 3 months gave farmers an extra US$25/t while storing for 9 months gave farmers an extra $100/t.
- Some 3,915 farmers (40% women) were trained in aquaculture technology.
- The project has developed a unique set of cropping pattern recommendations for vegetable production on pond, freshwater gher, and saline-water gher banks that will help extension staff advise farmers on the best way of using this underutilized resource.
- Short-duration aman rice varieties do not yield less than longer-duration varieties. Growing these varieties allows farmers to plant wheat, maize, mustard, sunflower, and lentil on time by mid-November.
- BRRI dhan52 is still the most productive submergence-tolerant variety available.
- BRRI dhan34 is the best aromatic rice variety available.

- BRRI dhan54 provides good yield and early maturity on aman-season saline soils.
- Some locally grown aman-season rice varieties yield almost as well as modern high-yielding varieties.
- Relay intercropping mustard over standing rice as a means of rapidly establishing the crop after the aman rice in a rice-mustard-boro rice system is popular with farmers.
- 84 new local service providers were set up as machinery service providers $105,074 was spent by the private sector on importing and marketing new machines and 6,682 farmers received services from LSPs. This includes 1,422 farmers buying crop harvesting services.

In the reporting period, the project trained 17,108 farmers (30% women) and 32,308 farmers participated in farmer field days. The project presents results in this report from 323 trials and 6,391 demonstrations harvested in this reporting period (mainly the 2014 aman rice crop and the 2015 wheat and mustard crops).

In addition to the normal farmer field day program, the project conducted a farmer field day for senior staff from key hub-level partner institutions such as NARES, DAE, NGOs and the private sector. These “stakeholder FFDs” were held in each hub with the objective of showing our partners the work the project has done, to hear farmers’ opinions and to encourage key stakeholders to include the same technology in their trial and demonstration programs.

The project, with funding from the South Asia region-wide CSISA-South Asia project, provided seven grants totaling $110,000 in value to research institutes within the NARES or at the Bangladesh Agricultural University (BAU). These grants were used to conduct applied on-farm research on topics of mutual interest to both these institutes and CSISA-BD. The quality of research done by these research institutes was largely high, showing that this approach to funding agricultural research can be very rewarding.

As the project draws to a close, measuring the impact of the project in terms of technology adoption has become an important activity. A set of surveys that measure the adoption of CSISA-BD promoted technology by farmers trained or participating in demonstrations or by farmers learning about this technology from CSISA-BD farmers have been designed. Surveys were conducted with 2012 and 2013 farmers in 2013 and 2014. Surveys of 2014 farmers and a survey of farmers interviewed for the project baseline survey will be conducted in May and June 2015.

The project lost 56 working days due to hartals and blockades. Most of these losses occurred in February and March, when 36 working days out of a possible 41 were lost. This had an impact on machinery sales and LSP training and on project supervision. Most trial and demonstration programs were completed but many farmer field days had to be canceled.

CSISA-Mechanization and Irrigation (CSISA-MI)

To increase the uptake of resource-conserving agricultural practices, CSISA-MI promotes **four keystone technologies**: axial flow pumps (AFPs), multi-crop reapers, bed planters, and seeder-fertilizer drills that can be used for line-sowing and for conservation agriculture. Axial flow pumps are a low-fuel option for surface water irrigation; bed

The **Cereal Systems Initiative for South Asia - Mechanization and Irrigation** is operational in southwestern Bangladesh and is funded by the USAID Mission in Bangladesh under President Obama's Feed the Future (FtF) initiative. In CSISA-MI, CIMMYT partners strongly with International Development Enterprises (iDE) and works to transform agriculture in Bangladesh’s FtF zone by unlocking the productivity of the region's farmers during the dry season through surface water irrigation, efficient agricultural machinery and local service provision.

planters help farmers save on irrigation water volume and cost; and reapers and seeder-fertilizer drills address labor bottlenecks at harvest and planting and speed up the time between harvest and the planting of the next crop. These machineries help boost yields by maximizing the productive use of soil moisture, fertilizer and seed, while saving farmers' time, labor and money. Through dynamic public-private partnerships with machinery manufacturers and importers such as Advanced Chemical Industries (ACI) and Rangpur Foundry Limited (RFL) Group, CSISA-MI is working to commercialize and catalyze the availability of these machines for service providers in the FtF zone – with the ultimate goal of implementing self-sustaining value chains that will continue to deliver technologies to farmers long after the close of the project.

During the reporting period, a total of 4,765 farmers received short-term support and 1,075 public sector, NGO, and private-sector personnel received capacity-building support. Among them, 5,218 are males and 622 are females.

CSISA-MI trained 936 (112 women) LSPs, mechanics, private-sector actors, and farmers.

As part of developing targeted financial services to support the supply chain for agricultural mechanization products, CSISA-MI signed MoUs with micro-finance institutes Jagaroni Chakra Foundation (JCF), TMSS, and Rural Reconstruction Foundation (RRF) to ensure that LSPs have access to small-scale and low-interest loans for the purchase of reaper machines.

Local Service Provider demonstrating agricultural machinery

CSISA-MI also aims to improve the capacity of the public and private sector to ensure stronger science-led interventions, value chains for agricultural machinery and pumping equipment, and better services to farmers. As such, CSISA-MI strengthens relationships at the national as well as field level with the relevant government institutes and other partner organizations.

In this regard, CSISA-MI is also working with the Bangladesh Agricultural Development Corporation (BADC). BADC has received $1.5 million from USAID to clean and rehabilitate irrigation canals to improve access to surface-water irrigation in Barisal District. The project is currently excavating 50 km of canal systems, and installing sluice gates in strategic locations, in collaboration with CSISA-MI's engineers and irrigation scientists. Following rehabilitation, BADC will procure 40−50 AFPs for farmers to improve their ability to access water.

CSISA-MI has also been coordinating activities with the extension staff of the Department of Agriculture Extension (DAE). CSISA-MI provided DAE staff with information on the use of surface-water irrigation and advanced agricultural machinery. In addition, CSISA-MI continues to collaborate with the Bangladesh Agricultural Research Institute (BARI) to test and refine two-wheel tractor-based agricultural machinery and irrigation pumps. Importantly, CSISA-MI is facilitating the testing of new domestically produced AFP prototypes at BARI for quality control assurance and developing the capacity of RFL in producing the pump locally.

To drive the adoption of more precise and resource-conserving agriculture, CSISA-MI currently promotes four keystone technologies: the fuel-saving high-volume axial-flow pump (AFP) for surface-water irrigation, bed planters and seeder-fertilizer drills that can be used for line-sowing and conservation agriculture, and the reaper to overcome labor bottlenecks at harvest and speed up the time between harvest and the planting of the next crop. These machines help increase yields by maximizing the productive use of soil moisture, fertilizer, and seed, while saving farmers' time, labor, and money. Through public-private partnerships with machinery manufacturers and importers such as Advanced Chemical Industries (ACI), Metal Industries, Chittagong Builders, and the Rangpur Foundry Limited (RFL) Group, CSISA-MI is working to commercialize and catalyze the wide availability of these machines for LSPs in the FtF zone.

Science-based interventions are part of CSISA-MI's work. Within the project, CIMMYT scientists are conducting research to develop appropriate irrigation and nitrogen fertilizer regimes for maize and other cereal crops. Research is ongoing in using remote sensing and GIS to identify the appropriate environments and soils on which bed planters and PTOS can be used, and where AFPs can be employed to bring dry-season fallow and poorly productive land into intensive cultivation. These efforts are combined with applied econometric analyses to identify the factors that influence LSP's investment in agricultural machinery, and to uncover the predominant structure of irrigation water pricing in southern Bangladesh. This will allow the project to develop improved business models with the provision of affordable surface-water irrigation. Additional research considers the trade-offs between crop residue use for livestock vs. conservation agriculture, and, in partnership with Wageningen University, CSISA-MI is supporting one PhD and one MS student using advanced crop and farming systems design models to propose solutions to these pressing issues. In addition, the project is continuing research to improve the performance of the bed planter and domestic production of the AFP.


Billboards have been displayed in prominent locations in the FtF zone (Barisal)

During the reporting period, agricultural machinery and irrigation services promoted by CSISA-MI were applied on 2,995 ha. Out of this number, 1,237 hectares were irrigated by LSPs using fuel-efficient axial-flow pumps (AFPs). Crucially, RFL and individual LSPs invested $45,000 of their own funds to spread AFP services to farmers.

Since October, 1,096 hectares were cultivated by using seed-fertilizer drills (SFDs) and bed planters, in a suite of crops including rice, maize, wheat, jute, vegetable crops (onion and garlic), and lentils, among others. In order to make this happen, CSISA-MI's private-sector partners invested $30,400 of their own funds to expand use of the equipment. This included the advertising shown in Figure 26. An additional 662 hectares of wheat and rice were harvested using multi-crop reapers through local service provision and the action of our private-sector partners ACI and Metal, who demonstrated and advertised to farmers and potential LSP clients. Sales of reapers to LSPs are currently ongoing.

A total of 6,682 farmers in the FtF zone benefited from the project's activities through interventions implemented by the project and private-sector partners. During the same time period, 936 farmers, of which 824 were males and 112 were females, received short-term hands-on training on different agricultural technologies under CSISA-MI, and a total of 160 entrepreneurs received business development training from the project.

An interactive campaign that included baul songs, games, quizzes, and promotional videos was conducted in 12 upazilas of three districts to motivate the potential buyers of the machines. Promotional gifts were shared and referral coupons were distributed to potential equipment buyers. Through these activities, nearly 15,000 people were reached and exposed to the SFD; among them, 143 would-be customers were identified.

Unfortunately, because of political unrest, especially the series of strikes and blockades during the reporting period, many of CSISA-MI's planned field activities were hampered. But, despite these problems, reasonable progress was made.

A key measure of CSISA-MI's success is the willing investment of ACI, Metal, and RFL in the machinery technologies supported by the project. All are receiving technical support from CSISA-MI to import and market agricultural machines. In addition, LSPs also invested $105,000. RFL imported 246 Chinese SFD units for sale to LSPs. In addition, they are importing 200 more SFDs for sale outside the FtF zone.

Metal Private Ltd. signed a joint venture agreement with CSISA-MI to contribute in the sales of agricultural machines. These private-sector companies are generating demand for machinery technologies through promotional activities such as video road shows, billboards, local newspapers, and cable advertisements and other marketing materials. A number of practical demonstrations in local markets (haat-bazar) and dissemination of other communications items to enhance awareness and to motivate potential clients have been done.

Nepal

CSISA-Nepal (CSISA-NP)

CSISA's research focus in Nepal is aligned with the staple crop mandates of Feed the Future (FtF): sustainable intensification (SI) technologies for lentil, rice, and maize-based cropping systems. CSISA stages its work in the Mid and Far West development regions from offices in Nepalgunj, Surkhet, Dadeldura, and Dhangadhi. New investments by USAID support work on wheat agronomy, seed systems scaling and mechanization and irrigation.

The Cereal Systems Initiative for South Asia in Nepal receives funding from USAID Nepal with a co-investment from USAID Washington. In Nepal CSISA's focus is primarily on participatory technology development and verification, inclusive of insights into business and market development for machinery and seeds. Disseminating technologies vetted by CSISA is the responsibility of the Winrock-led KISAN initiative, the USAID Feed the Future project in Nepal.

Highlights from the period include:

SUSTAINABLE INTENSIFICATION

- Quantitative field evaluations demonstrate that rice hybrids consistently yield 0.5 – 2 t ha^{-1} more than elite varieties, even under farmer management where input levels are low. Hybrids not only improve yield but also nitrogen use efficiency, which is a critical concern in Nepal where fertilizer usage in staple crops is the lowest among South Asian countries.
- Hybrid rice matures 7- 10 days earlier than most varieties, thereby helping to ensure timely winter crop establishment.
- Labor constraints are delaying critical field operations like rice transplanting across the Feed the Future (FtF) zone. CSISA has introduced directly sown rice (DSR) technology to the Mid and Far West Terai districts as a means to save labor and ensure timely establishment. On-farm evaluation trials demonstrate that DSR yields can be roughly commensurate with transplanted rice, while crop establishment costs are reduced by $200 ha^{-1}.
- Evidence suggests that simple changes to rice agronomy such as increasing the planting density for older seedlings hold considerable scope for increasing resilience to climate extremes such as delayed onset of monsoon rains – a common occurrence in the last decade.
- Upland rice systems in the hills where yields are less than 1 t ha^{-1} are often consider too stress-prone for intensification. Nevertheless, CSISA data suggests that upland rice productivity can be doubled or even tripled with the adoption of modern varieties and judicious fertilizer use.
- Scale-appropriate mechanized seeding options for maize help ensure precision stand establishment (increasing yields by 50%) while reducing planting costs by half.
- Lentil yields in the Terai were again negatively impacted by significant winter rains, which negated any benefits from innovative agronomy or varietal replacement. Nevertheless, CSISA's network of crop-cut observations demonstrate that well-drained soils in the Terai have relatively stable yields in wet winters, suggesting that these lower-risk areas can be targeted for intensification.
- Lentil yields in the hills significantly out-performed those in the Terai, and the benefits of varietal replacement were high. Output market development for lentils in the hills will be an important 'pull' factor to incentivize increased production.

- Farmers in the FtF Zone use less fertilizer than elsewhere in Nepal. CSISA data demonstrates that the simple step of investing \$60 ha^{-1} in fertilizers can improve wheat yields by 1 t ha^{-1} while boosting profitability by \$140 ha^{-1}.
- Field evaluations of precision broadcasting technology for nitrogen topdressing demonstrates yield and efficiency gains of 9 – 12% for wheat while reducing labor costs.
- Productivity of rainfed wheat production systems in the hills were tripled with varietal replacement and modest investments in fertilizer.

SEED SYSTEMS

- SWOT analysis was utilized to document the current status and prospects for growth of Nepali seed enterprises. Business and technical mentoring are ongoing, including exchange visits with established seed enterprises in India.
- With assistance from CSISA, SEAN (Seed Entrepreneurs Association of Nepal) has reviewed and revitalized its visions of success and ambitions.
- With assistance from CSISA, the Ministry of Agricultural Development (MoAD) held the first of its kind 'Seed Summit' to identify near- and medium-term actions that will lead towards the ambitious goals established in the Seed Vision and ADS strategy documents for the emergence of robust seed systems in Nepal.
- Commercially available maize hybrids are not registered by the GoN for the hills or Terai in the FtF zone, which greatly limits farmer access to technology that can transform yield potential, even with no other changes in crop management. Based on existing data resources, CSISA is collaborating with the National Maize Research Program and Seed Quality Control Center to fast-track maize hybrid registration processes for the FtF zone.

MECHANIZATION

- CSISA helped form and continues to support the Nepal Agricultural Machinery Entrepreneurs Association (NAMEA) by:
    - supporting study and business linkage tours (China + India)
    - hosting the NAMEA secretariat
    - stimulating critical dialogues between the public and private sectors
    - jointly conducting market development activities through demonstrations and service provider trainings
- CSISA's approach to achieving impact with farmers through markets and public-private partnerships is starting to pay off. From a base of zero, private sector reaper sales for the 2-wheel tractor exceeded 100 units during the reporting period with importers adding new stocks of more than 400 units in advance of 2015-16 Rabi season. Similar sales growth has been observed for the electric maize shellers introduced into the FtF zone by CSISA.
- New marketing arrangements have been formed with Indian companies for Nepal-based stocking and distribution of zero-till seed drills and laser land leveling equipment. Before CSISA's efforts with the private sector, these technologies were not commercially sold in the FtF zone.

Cross-cutting Objective 1 Activities

A. Livestock

Increased uptake of locally adapted livestock feeding practices

In Bihar, the uptake of locally adapted livestock feeding practices, such as the use of urea-treated maize stover as feed, has increased through demonstrations, farmer trainings and on-farm trials. Self-prepared balanced concentrated feed and mineral mixture as feed supplements to basal diets of dairy cows has increased to 1,500 farmers across six districts. In Odisha, the use of chopped straw and fodder grass as basal diets for dairy cows, supplemented by improved concentrated feed and mineral mixtures, has grown to 1,200 farmers across three districts. In Bangladesh, the feeding of underutilized crop residues, specifically maize stover, has increased to 150 farmers in Jhenaidah District in Southern Bangladesh. Also, 1,553 farmers, two-thirds of whom are female, have adopted the mechanical chopping of crop residue. In Nepal, chopped straw as a basal diet supplemented with self-prepared balanced concentrate feed and mineral mixture has increased to 700 farmers in 5 VDCs, an increase from 10% pre-CSISA to 40% of farmers within and outside CSISA's farmer groups.

Complementary services and machine manufacturing

The increased uptake of certain technologies by farmers often generates demand for complementary inputs and services. CSISA has been instrumental in facilitating the development of these auxiliary service enterprises through training and capacity strengthening. In Bihar and Odisha, 8 and 5 local service providers, respectively, have been established for preparing balanced concentrate feed. In Bangladesh, with the increased adoption of chopped paddy straw as a basal diet among dairy cows, demand for chaff cutters also increased. Twelve LSPs have been established to provide straw-chopping services in the hub districts. The project has also facilitated the establishment of two fodder markets in Rangpur district to serve increased demand for fodder.

Expansion of feed resource base by growing other fodder crops & forages suitable to local context

Farmer awareness of alternative feed resources has improved through training and field demonstrations. In Bhadrak, Odisha, 10–12 farmers have started growing fodder crops such as oats and chickpeas. In Bangladesh, the establishment of fodder gardens is increasing with a total of 65 farmers now growing Napier grass in Rangpur. In Nepal, farmers have increased awareness about forage crops in addition to Berseem and Sudan grass, and have started growing other forage species such as Mulato, Paspalum, Setaria, Napier, Badame and Teosinte on their own plots.

Dissemination and testing of dual-purpose maize varieties for stover and grain

Evaluation of maize stover samples and subsequent on-station feeding trials showed promise for variety NK6240. Laboratory analysis of NK 6240 stover samples received from Bihar and other places consistently had higher IVOMD (55%), which influences intake by and performance of animals. In on-station feeding trials, replacing sorghum stover with maize stover of NK6240 did not significantly affect milk production in buffaloes but the cost of feeding decreased by 20%. On the other hand, milk production increased by 1 liter/d per animal in crossbred cows fed with NK 6240 maize stover, replacing millet stover in the diet. Taking these on-station results to farmer fields, NK6240 seeds were disseminated initially in two CSISA hub sites, involving 37 farmers covering 13 hectares of planted area in Bihar, and 5 SHGs involving 61 farmers in Odisha.

Improved animal productivity from complementary practices in health and shelter

In Nepal, CSISA has increased awareness of the benefits of deworming and improved animal health management and their effects in improving milk production. As a result, deworming at six-monthly intervals has become regular practice among farmers in the project areas. Through CSISA's demonstrations of the benefits of animal sheds, 14 farmers have adopted this practice. Based on a qualitative evaluation of project impacts, key stakeholders like the District Livestock Service Office (DLSO), District Agriculture Development Office (DADO), farmer groups, and private dairies have articulated that the project has contributed to the improvement of farmers' livelihoods through interventions in capacity building, animal feeding, shed improvement, and animal management.

Scaling out of best practices through strong linkages and durable partnerships

In Bihar, we have established strong partnerships with COMFED, dairy cooperatives, and NABARD. The latter was a supportive partner in disseminating knowledge gained from field-based trials, for example, enabling us to reach NABARD's more than 20,000 farmer-clients across the state. In Odisha, strong partnerships have been established with local veterinary services for disseminating knowledge. CSISA activities in Odisha are aligned with ongoing government programs in dairy development in the state.

A positive outcome from our partnerships and stakeholder engagements in Odisha was crystallized during the stakeholder workshop organized by ILRI in collaboration with SMILE, Dept. of Animal Husbandry and Veterinary Services (DAH&VS), Government of Odisha. In response to demand that was articulated by various stakeholders, the State Commissioner-cum-secretary, F&ARD requested ILRI to lead the design of a statewide program on feed and fodder development with support from SMILE, a training institute under the auspices of DAH&VS. A proposal about feed and fodder development to improve fodder availability in the state has been prepared for funding by the Govt. of Odisha and will potentially scale up the best practices and lessons from CSISA. The project will be implemented by DAH&VS, Gov't of Odisha in collaboration with ILRI. ILRI will lead the research and development component, while DAH&VS will lead on extension. The Department of Animal Nutrition in Odisha University of Agriculture and Technology (OUAT) will also be a partner.

In Bangladesh, we have facilitated strong integration of CSISA field activities within government initiatives, with the Directorate of Livestock Services and Bangladesh Livestock Research Institute supporting our field activities in the northern and southern hubs, and NGOs such as the Community-Based Dairy Veterinary Foundation under Bangladesh Agricultural University, Mymensingh, collaborating on implementation of trainings, demonstrations, feeding trials, and on disseminating information about improved animal health practices and animal husbandry. Likewise in Nepal, the project has facilitated strong linkages between dairy farmers and district-level line agencies through the organization of workshops, interaction meetings, exposure visits at various occasions, and empowering the farmers to proactively seek support from line agencies and service providers for technical assistance and services for dairy animal raising, milk production and marketing.

Transitioning the livestock portfolio in CSISA to partners and collaborators

We envision that partners and collaborators in the CSISA hubs will play a major role in ensuring that gains and lessons are not dissipated but used as building blocks for future outreach and scaling strategies beyond CSISA II. The foundation has been set; we need to make sure that it remains solid and effectively supports future initiatives for using livestock as a complementary and important component of livelihood options by farmers in cereal-based systems in South Asia. Designing and advocating for appropriate policies and institutions will be key to this end, and should be one, if not the primary, focus in developing the scaling strategy for CSISA.

C. Empowering women in agriculture

In India, women farmers and marginalized groups like tribals and scheduled castes tend to have poor connectivity with formal knowledge sources like state extension or private sector input systems that support agricultural development. On the other hand, national and state level livelihoods programs and the self-helps group (SHG) networks they support have tremendous reach within these communities. Many existing livelihoods initiatives (e.g. JEEViKA) include a focus on agriculture, but programming for staple crop management is often weak. Hence there is a strong value proposition for collaboration: CSISA gains access to gender-responsive scaling pathways and the livelihoods initiatives and communities they support benefit from our technical capacity.

In Bihar, CSISA is working to empower women farmers by ensuring their exposure and access to modern and improved technological innovations, knowledge, and entrepreneurial skills that can help them become informed and recognized decision makers in agriculture. Through the CSISA-formed *Kisan Sakhi* groups, CSISA has facilitated farmer-to-farmer learning and participatory technology evaluations. CSISA's work with these women farmers is built on three pillars: (1) Identity and leadership: acknowledging and validating women's role as farmers; (2) Knowledge: recognizing that women already possess knowledge about some agricultural practices, raising their knowledge of relevant and available new technologies, and seeking their feedback and preferences on new technologies, and (3) Ownership: increasing women's access to and control over farm income.

CSISA's participatory knowledge dissemination and technology adoption activities have revealed that *Kisan Sakhi* women are willing to experiment and take risks, particularly if they feel that the risks are shared with the group and that their voices are being heard in decision-making process. In 2014, *Kisan Sakhi* facilitated 200 women farmers to cultivate green gram and 100 women farmers to sow their wheat early and adopt zero tillage. Maize intercropping with pea and potato was undertaken by 150 women. Hundreds more women began cultivating spring maize. Notably, CSISA facilitated a women's group in Bandra, Muzaffarpur, to become mechanized service providers for rice establishment—the first entrepreneurs of this kind in Bihar.

In Odisha, CSISA engages with women's self-help groups and their federations in Mayurbhanj District (a predominantly tribal district) to undertake participatory technology testing and dissemination. As a result of CSISA's collaboration with these SHGs during *rabi* season 2013-14 and *kharif* season 2014, nearly 1,300 more women farmers tried at least one improved technology on her own land. The technologies ranged from the introduction of climate resilient varieties, direct sowing of rice, mechanical transplanting of rice, line sowing of maize, and post-harvest technologies. The strong interest among women in accepting new technologies resulted in part from a large-scale campaign of sensitization and training programs facilitated by CSISA in collaboration with 40 community resource persons, the SHGs and their leaders. The campaign reached a large number of villages and nearly 300 SHGs. More than 2,000 women members of different SHGs have been trained on a variety of relevant improved technology and practices.

In partnership with two women's SHG Federations, in the district of Mayurbhanj alone, the seed-related interventions for mitigating climatic risk (e.g., drought) for rice (e.g., use of Sahabhagi dhan) have shown growth, as women SHGs have supervised the local production, preservation and recirculation of fresh seeds in the *kharif* 2015 to new women farmers. Nearly 1,200 women farmers have been newly included into the fresh seed recirculation network (in addition to nearly 1,500 women farmers who were included in the first intervention year of 2014).

The community-level impact of the intervention has been seen in the form of interest and participation by a new women's federation from the adjoining district of Karanjia. This federation from Patana has triggered nearly 100 women farmers from their membership base, to adopt CSISA promoted technology in maize and rice this year. In the older federations (Sampurna and

Swayamsiddha), more than 500 new women farmers across different SHGs have adopted one or other improved technology such as DSR and small-scale mechanization.

In order to strengthen the program, CSISA has also carried out a detailed participatory and qualitative assessment study along with adopters as well as key stakeholders (community resource persons and representatives from partner organizations) to collect feedback on technology performance and dissemination methodology and the overall program performance, in order to improvise, replicate and scale-out the program. The analysis indicated positive perceptions of most of the technology in a span of one year of adoption, where during the evaluation the projected growth (no of farmers opting for technology application) in adoption for different technologies for 2015-16, over 2014-15. The results achieved in the current year also shows a synchrony with this projection by the farmers and stakeholder group. A detailed report compiling the outcomes of the evaluation of gender interventions, both in Odisha and Bihar will be giving a detailed overview of different aspects of impact, outcome as well as feedbacks from community.

Moving forward, CSISA's approach to supporting agricultural development among women farmers rests on the following interlinked activities, most of which are already underway with partners:

- *Participatory technology prioritization:* The needs, interests, and capacity for innovation of different types of women farmers are formalized to inform staple crop programming, ensuring that farm-level voices influence technology priorities.
- *Gender-responsive outreach materials:* Guides to better-bet staple crop management are produced in collaboration with INGENAES (http://www.meas-extension.org/home/associate-awards/ingenaes) so the literacy and numeracy levels of target audiences shape extension messaging.
- *Capacity development:* Enterprising women from self-help groups receive advanced training in staple crop management, permitting them to become compensated 'local resource persons' (LRPs) who extend advice to SHG members with financial support from their federations.
- *Reaching scale through SHG partnerships:* Through LRPs and livelihoods project staff, CSISA's gender-responsive guides to better-bet staple crop management reach 500,000+ households.
- *New enterprises***:** Small business formation around scale-appropriate mechanization (e.g. fertilizer spreaders) and community-level enterprises (e.g. seed nurseries) are encouraged through technology training and BDS.

D. Crop Manager decision support framework for precision management

In Odisha, Rice Crop Manager (RCM) beta version has received an initial endorsement from Orissa University of Agriculture & Technology. The RCM link **(http://webapps.irri.org/in/od/rcm/)** is now live on the OUAT website**.** National partners have been effectively mainstreamed into the development and evaluation of Rice Crop Manager through CSISA's efforts. On-farm evaluation of Rice Crop Manager has been completed in 11 districts of Odisha in collaboration with OUAT and the National Rice Research Institute (NRRI).

Initial results indicate that using RCM can increase yield, decrease fertilizer use, or both. Maize Crop Manager has been drafted and evaluated in the maize growing areas of the state. Workshops were conducted to sensitize new partners and to share results with the existing partners. Meetings were organized before the start of the season to sensitize the KVK scientists, DOA officers and farmers on the use of RCM and to provide RCM recommendations.

In Bihar and EUP, calculations were updated for field-specific nutrient management, which are based on results of field testing with rice and wheat. Under partnership initiated with Bihar Agriculture University and Banaras Hindu University for development and evaluation of Crop Manager, Rice–Wheat Crop manager (RWCM) was evaluated in nine districts of EUP and eight districts of Bihar.

NOPT trials were conducted in three districts of EUP and one district of Bihar. Fifty-two NOPT trials and 75 RWCM evaluation trials were conducted across the districts. A field-tested *Rice–Wheat Crop Manager* for eastern Uttar Pradesh and Bihar was fully developed. It is available as version 1.0 for use in English and Hindi at http://webapps.irri.org/in/brup/rwcm.

Rice–Maize Crop Manager for Bihar was developed as a beta version. It can be accessed at http://webapps.irri.org/in/br/rmcm. Field-testing was not included in CSISA, hence the field-specific nutrient management for rabi maize used principles of site-specific nutrient management developed by IRRI for maize at other locations.

In Tamil Nadu, the Tamil Nadu Hub Celebration (closing) Workshop was held from 15–16 September in Thanjavur. Based on the information provided by farmers about their fields, Nutrient Manager recommends the ideal amount of nitrogen, phosphorus and potassium to be added at critical growth stages, while taking into account the amount of fertilizer that farmer prefers to use. Farmers reported savings of 15–20% of nitrogen, 36–42% of phosphorous and 28% of potassium compared with the state fertilizer recommendation, and 33–42% of phosphorous and 30% of potassium compared with farmers' practice.

Rice Crop Manager for Bangladesh was developed as a product of research collaboration with the Bangladesh Rice Research Institute (BRRI). It can be accessed at http://webapps.irri.org/bd/rcm. RCM dissemination was done in 2014–15 in collaboration with BRRI and DAE with funding from CSISA and Bangladesh Association of Banks. A total of 551 individuals from the NARES and private entrepreneurs were trained on RCM use and operation. Maize Crop Manager (MCM) for Bangladesh was upgraded. It is available in English as version 1.0 at http://webapps.irri.org/bd/mcm.

In **Objective 2,** CSISA has focused its strategic research on sustainable intensification through conservation agriculture-based best crop management practices. Strategic research is conducted at three platform sites representing distinct agro-ecologies: Karnal, Haryana; Patna, Bihar; and Gazipur, Bangladesh. Four cropping system scenarios are explored at CSISA's research platforms: business as usual—conventional farmers' practices (scenario 1); established 'better-bet' management practices (scenario 2); labor-, energy-, and water-saving practices based on conservation agriculture (scenario 3); and diversified systems (CA 'plus') (scenario 4). In Phase II of CSISA, more emphasis has been given to on-farm strategic research outside of the experimental platforms as well as interdisciplinary work.

Karnal Research Platform

Results of five years of research at the Karnal platform consistently demonstrate that maize can be a profitable alternative to *kharif* rice in northwest India to arrest the declining groundwater table, and to address the issues of rising scarcity of labor in the region. Over the years, rice equivalent maize yield has been similar or higher than rice yields with 80-90% less irrigation water. In the 5th year, ZT maize provided higher economic yields (7.7 ha^{-1} rice equivalent) than rice (7.12 ha^{-1}), with 85% less irrigation water.

Platform research has also showed that weed problems in zero-till wheat reduced overtime, and hence herbicide use in continuous ZT wheat with rice residue mulch decreased compared to conventional system. After four years, the germinable weed seedbank of *Phalaris minor*, the most troublesome weed of wheat which has evolved multiple resistances to different herbicides, has decreased by 90–100% in continuous ZT wheat with retention of previous crop residues (full rice or 65% maize residues) as mulch compared to conventional till system. Similarly, the weed seedbank of other weed species also declined in full CA-based cropping systems compared to the conventional system. In rice, weed flora changed with the shift from puddled transplanted (PTR) to direct-seeded rice (DSR). Aerobic weeds such as *Leptochloa chinensis, Dactyloctenium aegyptium* and *Eragrostis japonica* have become more dominant in DSR with the emerging changes in soil physical charactertistics that encourage faster drainage.

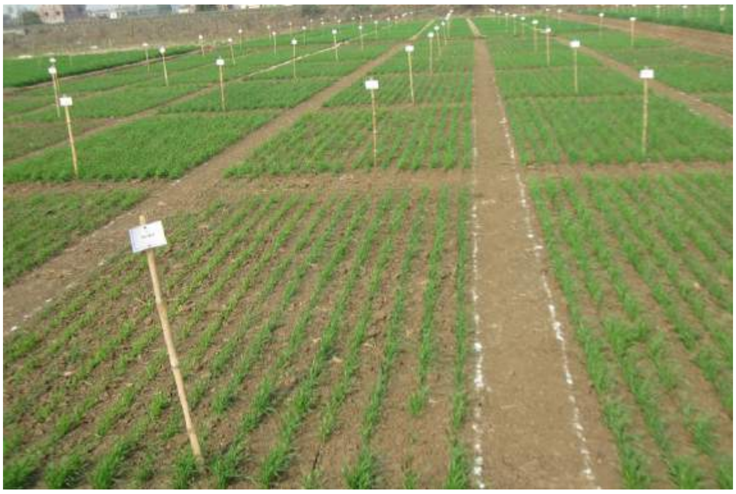
After four years, total soil organic Carbon content in 0–30 cm soil layer increased by 19% in the partial CA-based system (scenario 2) to 40-42% in the fully CA-based scenarios (scenario 3 and 4) compared to the conventional business-as-usual system (Scenario 1). In addition, with CA-based practices, other chemical parameters including N, P, and K content in soil increased over business-as-usual practices. The soil physical properties such as soil aggregates, mean weight diameter, steady state infiltration, and soil penetration resistance improved in full CA-based cropping systems (scenario 3 and 4) and partial CA-based cropping system (scenario 2) compared to conventional cropping system (Scenario 1). With this improvement in soil properties, component studies have been designed to study the hypothesis whether external fertilizer input can be reduced in CA-based practices in the long run. Results suggest that 15–30% N and up to 50% K can be saved in the long run if CA is followed with retention of full rice and mungbean residues on the surface.

In another new study initiated from 2013–14 at CSSRI, Karnal, to explore the scope and implications of diversification in Northwest India, DSR yields both under zero and conventional till were at par with PTR. Also maize yields were at par with rice yields. Irrigation water savings under DSR ranged from 25–28% compared to PTR, whereas, with shift from rice to maize, water saving ranged from 81–87% compared to PTR and 74–83% compared to DSR. Moreover, bed planting in maize further provided 25% water savings over flat bed.

Patna Research Platform

Research from Bihar suggests that mustard is a viable diversification option in winter (*rabi*) in eastern India, and can yield equivalent to wheat with savings in irrigation water. It can also lead to system intensification from 200% to 300% by allowing an additional crop of maize or mungbean in the spring after the mustard harvest. In the 6th year of a long-term trial, wheat yield was 0.45 t ha^{-1} higher under ZT (scenario 2 and 3) compared to conventional till (scenario 1). In scenario 4 (short duration rice–mustard–spring maize), wheat equivalent mustard yield was 5.4 t ha^{-1}, which was similar to ZT wheat but 0.6 t ha^{-1} higher than conventional till wheat, while saving of two irrigations.

To address the terminal heat stress issue in wheat, CSISA, in collaboration with Borlaug Institute for South Asia, worked on two strategies in 2014–15: (1) Escape strategy (escaping terminal heat by planting early so that the crop matures before terminal heat starts). In this study, the 21 best-performing genotypes identified last year (2013–14) from 183 genotypes were examined at 2 locations in Bihar. Similar to last year, all 21 genotypes yielded >5 t ha^{-1} under early planted conditions (late October planted) and some of them even yielded > 6 t ha^{-1}. (2) Coping/adaptive strategies for wheat that is planted a little late and grain filling falls in the terminal heat period. In this study, results showed that cultivar HD-2967 yielded 12 and 24% higher than CSW-16 and HD-2733, respectively, under late November (25 November) planted conditions. Additional irrigation in March during the grain-filling period at the time of terminal heat stress period improved the wheat productivity by 8%. Additional irrigation had positive effect only under conventional till, and ZT without residue conditions and where full rice residue was retained on the soil surface, March irrigation had no significant effect on yield. This suggests that additional irrigation during the grain filling period is more critical for conventional till systems and less for CA-based systems because residue conserves soil moisture and buffers the negative effects of terminal heat.



Wheat cultivars were screened under late (December 15) to very late (January 1) sown conditions using cultivars recommended for timely sown and late sown conditions. Cultivars recommended for timely sown conditions performed at par with cultivars recommended for late sown, even under very late sown conditions (January 1 sowing date), but performed similar or higher than some of the cultivars recommended for late sown conditions under late sowing (December 15 sown). PBW-373 (late sown cultivars) yielded the lowest among all under late to very late sown conditions. Baaz, a new variety, performed best among all cultivars under both late to very late sown conditions.

In a new study started in 2014–15 at the Patna Platform to identify the optimum nursery date for short, medium and long duration cultivars for maximizing system productivity. First year's results shows that with the use of shorter duration rice hybrids (Arize-6129), high system productivity in the range of 11–12 t ha^{-1} can be maintained if the nursery is sown between June 1 to July 20 and system productivity started declining when rice nursery sowing for short duration hybrids was delayed to August 1, with system productivity of 9.7 t ha^{-1} when seedling of 15 days old were transplanted to 5.8 t ha^{-1} when seedling of 30–35 days old were transplanted. Similar trends were observed with medium duration rice hybrids (Arize-6444). However, with the use of a long duration variety (MTU-7029), system productivity started declining if nursery sowing is delayed beyond 20 July (when younger seedling of 15–20 days old were used) or beyond July 6 (if older seedlings of 30–35 days were used). These results suggest that rice hybrids of shorter to medium duration have more flexibility and can yield higher under a wider range of nursery sowing dates compared to long duration varieties.

A new study was started during rabi 2014–15 season to assess planting pattern and urea placement on wheat productivity and nitrogen use efficiency. The first year result showed that wheat grain yield in the business-as-usual practice of line sowing at 20 cm spacing with urea application in 2 splits at first and second irrigation was either similar to paired row planting with 2 splits (50% drilled at first irrigation and 50% broadcast at 2nd irrigation) or higher than paired row planting with single split as 100% urea placement by drilling along the rows at first irrigation.

Two studies were initiated in 2013–14 in collaboration with the regional station of Indian Agricultural Research Institute (IARI), Pusa, Bihar on alternate crop establishment methods and on cropping system optimization for maximizing system yield and rationalizing resource use. The 2nd year data (*kharif* 2014) were consistent with first year and yields of all crop establishment methods tested ([puddled transplanting (PTR), machine transplanted non-puddled rice (MTNPR), system of rice intensification (SRI), and DSR] were similar. However, net income of MNTPR was higher than SRI mainly because of savings in labor and land preparation cost. In another trial, on cropping system optimization/intensification through hybrids/varieties of different maturity classes, it was found that system productivity (wheat equivalent) in two years (2013–14 and 2014–15) follows the following trend: cropping system 1 (CS1)-Short duration hybrid rice fb mustard fb spring mungbean = CS2-short duration hybrid rice fb mustard fb spring maize > CS3-medium duration hybrid rice fb wheat > CS4-long duration rice variety fb wheat. Medium duration rice hybrid in CS3 enabled wheat planting on time compared to after long-duration rice variety which resulted in higher wheat yield in CS3 than CS4. The system productivity of CS1 and CS 2 in 2014–15 were > 17 t ha^{-1} whereas of CS3 and CS 4 ranged from 10.7 to 11.5 t ha^{-1}. Shorter duration rice also enabled cropping system intensification from 200% (rice–wheat) to 300% in CS1 and 2(rice–mustard–spring maize/or mungbean). In the second year (2014–15), the rice yield in CS1 where mungbean was included in the system was higher (0.9 t ha^{-1}) compared to CS2 where spring maize was included.

To assess the role of field slopes in increasing the water productivity, on-farm trials were established in Vaishali, Bihar during 2014–15 comparing farmers' practice against flat (0%) and 0.1% slope in both rice- and maize-based cropping systems. Results suggest that rice yield were similar in plots with 0.0 and 0.1% slope but with 12% less irrigation water in 0.1% slope compared to 0.0% slope plots. In case of maize, yield was higher (0.4 to 0.9 t ha^{-1}) under 0.1% slope plots (flat or bed) than in 0% slope (8.4 t ha^{-1} versus 7.5 to 7.9 t ha^{-1}).

On-farm weed control studies demonstrated that new herbicides can improve cereal yields and can reduce the labor constraints. In rice (*kharif* 2014), on the basis of 15 on-farm trials, new herbicides (bispyribac + pyrazosulfuron) on average increased rice yield by >20% compared to current farmers' practice by providing effective control of complex mixed weed flora. Similarly, in kharif maize, halosulfuron and halosulfuron + tembotrione provided excellent control of purple nutsedge (Cyperus rotundus) and purple nutsedge dominated mixed weed flora, respectively.

Gazipur, Bangladesh Research Platform

Results of Gazipur research platform suggest that mustard instead of Boro rice followed by aus rice are more suitable alternative crops to diversify and intensify rice–rice cropping systems in Bangladesh. At Gazipur, machine transplanting under both puddled and non-puddled conditions was found promising. Machine transplanted rice with BMPs gave 0.3 t ha^{-1} higher yield than manual transplanted rice in both *aman* and *boro* season.

Rice yields in farmers' practice (scenario 1) were 3.9 t ha^{-1} in Aman 2014 and 5.2 t ha^{-1} in Boro 2014–15. In comparison to scenario 1, all scenarios (Scenario 2–4) increased the crop yields. Best management practices (BMPs) alone in scenario 2 increased rice yield by 1.2 t ha^{-1} (30%) in Aman 2014, by 1.3 t ha^{-1} (25%) in Boro 2014–15. Similar to scenario 2, the rice yield increased with BMPs under reduced tillage non-puddled conditions using the machine transplanter (Scenario 3) by 1.5 t ha^{-1} (39%) in Aman 2014 and by 1.6 t ha^{-1} (30%) in Boro 2014–15. Rice yield increased in scenario 4 with BMPs was only 0.2 t ha^{-1} (5%) in Aman 2014 and this mainly because of short duration variety grown in *aman* to accommodate mustard. Rice equivalent yield (REY) during *boro* 2014–15 of mustard during *boro* + *aus* rice in scenario 4 with BMPs was increased by 2.7 t ha^{-1} (52%) compared to scenario 1. In terms of system productivity, scenario 4 gave the highest yield. Machine transplanting was found promising technology with 0.3–0.5 t ha^{-1} yield gain over manual transplanting.

On-farm studies on decomposing rice yields of *aman* and *boro* rice study conducted in Gazipur and Kishoreganj districts showed that yield increased by 0.3–0.4 t ha^{-1} in *aman* season and by 0.5 t ha^{-1} in *boro* season by intervention of quality seeds, healthy seedlings and optimum population density; 0.5 to 0.6 (*aman* season) to 0.8 t ha^{-1} (*boro* season) by improved nutrient management using RCM and by 0.8-0.9 t ha^{-1} in *aman* and by 1.3 t ha^{-1} in *boro* season by best bet agronomy. The demonstrations of BMPs at seven farmers' fields in *boro* 2014–15 which include quality seeds, healthy seedlings, machine transplanting, RCM banded fertilization, use of herbicide and hand weeding if needed, harvesting by reaper and threshing by power-operated thresher showed a gain of 0.8 t ha^{-1} over farmers' practice.

In another on-farm study on intensification of rice–potato–fallow system by including spring maize, it was found that farmers can earn more by growing maize in between potato and *aman* rice without sacrificing yields of both potato and *aman* rice. In our study, potato gave 43 t ha^{-1} and maize in between potato and *aman* gave 6 t ha^{-1} yield.

Research in Odisha and Tamil Nadu

In the plateau region of Odisha, CSISA focused on maize on the following topics: site-specific nutrient management, crop establishment methods, yield gap evaluations, and evaluation of maize hybrids of different maturity classes. Based on an average of 8 locations, *kharif* 2014 results revealed that optimum plant population (around 70,000 ha^{-1}), optimum fertilization (140:50:75 kg N, P_2O_5, K_2O ha^{-1}), and improved weed management contributed 1,040, 900, and 165 kg ha^{-1} increases in maize yield over farmers' practice (45,000 ha^{-1}plant population and 80:40:40 kg N, P_2O_5, K_2O ha^{-1}). When all these interventions were layered (best bet agronomy), grain yield increased from 2.90 t ha^{-1} (farmers practice) to 5.28 t ha^{-1}. The nutrient omission plot technique (NOPT) trials in maize in lateritic acidic soils revealed 4.86, 5.03, and 0.76 t ha^{-1} response of N, P and K, respectively, over yields achieved with indigenous sources of each nutrient only, which suggest that these soils are highly degraded. Maize Crop Manager based recommendation increased yield from farmers' practice yield of 3.6 t ha^{-1} to 6.0 t ha^{-1}.

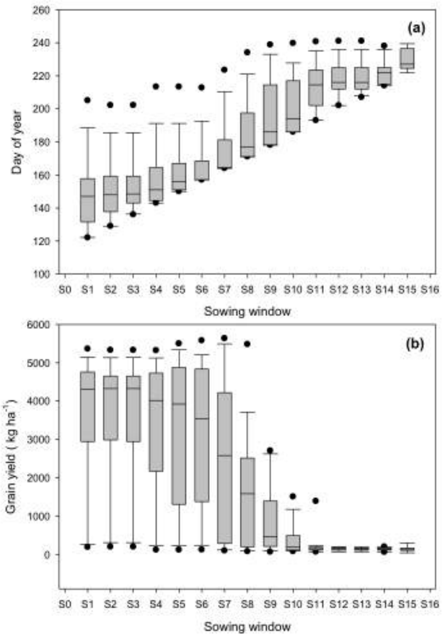
The research activities in collaboration with Odisha University of Agricultural and Technology (OUAT) have been focused on developing best management practices for non-puddled (transplanted or drill seeded) system of rice. The results of three seasons (one wet and two dry) indicated that good performance of both crop establishment methods, i.e. direct seed rice (DSR) and non-puddled transplanted rice (NPTR). Rice hybrids gave a yield advantage over inbreds. The leaf appearance rate significantly reduced with the water deficit stress of 40 kPa. However, both hybrid and inbred with 10 kPa stress in both establishment methods gave a similar grain yield of rice as compared to no stress during the dry season. However, a substantial number of irrigations was reduced with irrigation scheduled at 10 kPA rather than 0 kPa.

A study on mitigating cold at the early stage and terminal heat stress at the late stage of *boro* rice cultivation indicated maximum yields (6.3 t ha^{-1}) when nursery was established in first half of January (January 11). There was drastic reduction in the yield for the treatments when the nursery was seeded on or after January 31. Hybrids performed better under cold stress (when planted early in December) however, performance of both hybrids and inbreds did not differ in heat tolerance when planted late (after January 11).

The work on optimization of nitrogen for different rice cultivars in non-puddled conditions during the dry season (2014–15) indicated that Arize-6444 (hybrid) and Lalat (inbred) responded up to 120 t ha^{-1} but Naveen, another inbred only responded up to 80 kg/ha. Yields of all cultivars were same at 0 kg N/ha, however, hybrids yielded more than inbreds at all other level of N ranging from 40 to 160 kg/ha. The preliminary results on potassium optimization in puddled soil indicated that basal application of potassium (40 Kg K ha^{-1}) followed by 1% KNO_3 at panicle initiation stage produced significantly higher grain yield both in dry and wet seasons, as compared to remaining treatments.

On-farm testing of alternate wetting and drying (AWD) is ongoing in Puri districts (3 blocks, each having 3 villages) with the 144 farmers during Rabi 2015 with objective to study the receptivity of technology by farmers. Preliminary results are suggesting that the receptivity of AWD varied based on ownership of pumps, distance from the pump, leveling of the field and weed management.

The work on improving land configuration to reduce non-productive water losses has been ongoing. The results are similar at different sites, (Cauvery Delta of Tamil Nadu and Bihar) and soil type (clay, clay loam and sandy loam). In sandy loam soil, there was a 15% irrigation water saving with 0.1% slope in 50 m plot length. The saving of irrigation was without any yield penalty. On farm evaluation in Bihar has also indicated similar results for maize and rice.



Simulation studies were conducted to explore the feasibility of dry seeding in the eastern Indo Gangetic Plains for the likely range of rainfall conditions for a range of target sowing windows, the associated productivity risks, and irrigation strategies to minimize the risks. The APSIM model was parameterized and validated for the long duration (150 d) rice variety (MTU7029) grown in Bihar. Using historical weather data (1970-2010) from five districts (Patna, Bhagalpr, Dharbhanga, Motihari, Gaya) and different soil types (Silt Clay Loam, Silt Loam, Loam). The validated model was used to evaluate 15 DSR sowing windows staggered at 7-d intervals starting from 1 May, each sowing window ended on 31 August. In each sowing window sowing was done only when soil moisture (in 0–15 cm) was 40–80% of field capacity. Different irrigation schedules were evaluated as risk minimizing strategies. Comparisons of sowing and irrigation strategies were made in terms of probabilities of being able to sowing during the target window, yield, and irrigation water requirement.

In another simulation study we evaluated the probabilities of nurseries sowing and then transplanting dates based on rainfall scenarios and associated yield probabilities using the APSIM model following parameterization and validation. Rice nursery was sown any time after 15 May when cumulative rainfall received was => 50 mm in consecutive 3 days and transplanted only when surface pond is more than 50mm. Comparisons were made in terms of probabilities of being able to sow and transplant in optimum window and risk of crop failure due to drought stress. Efforts were made to find out the weather-related reasons for low productivity in different years.

Field scale simulation were performed to evaluate the impact of replacing wheat in NE with *rabi* maize on land and water productivity under different resources availability scenarios, for example low, medium, high fertilizer input, irrigated or rainfed under different future climate scenarios.

MODIS data analysis was done to know the *rabi* crops sowing dates variability and their dependency on *kharif* crop management and monsoon rainfall scenarios. Further analysis was done to study the inter-annual and intra-seasonal dynamics of *rabi* crop productivity to find out the homogenous zones in terms of productivity.

Objective 3: High-yielding, stress-tolerant rice varieties for current and future cereal and mixed crop–livestock systems

Objective 3 develops a new generation of rice varieties and hybrid parental lines for the target regions of South Asia. The target trait specifications used in the variety development pipelines emphasize higher yield potential, adaptation to dry direct seeding and water stresses (partial/non-flooded irrigation), heat tolerance, grain quality, and straw fodder value.

Objective 3.1 : Next generation of elite rice lines with increased yield potential, improved grain quality and superior feeding value.

Evaluation for yield and yield related traits of the seven recipient parents (PSB Rc82, PSB Rc158, NSIC Rc222 and NSIC Rc238, MTU1010, BPT5204 and Swarna) and the three donors (Habataki, ST6, ST12) was carried out in a replicated yield trial to compare the yield performance. The results indicated significant differences between the recipients and donor lines for the traits with high grain number, panicle branching, culm diameter and NSC suggesting the possibility of increasing yield potential of indica rice cultivars.

Comparative sequence analysis of target yield related gene regions were carried out by Sanger sequencing and whole genome sequence methods for both recipient and donor genotypes. SNP markers were developed for the major yield related genes, *Gn1a, SPL14* and *SCM2*. Three PCR-gel based SNP markers were developed for *Gn1a*-Habataki allele, two each for *SCM2* (Habataki and ST12- allele) and *SPL14*-ST12 allele and used for marker-assisted selection of the target genes present in the seven recipient Indica cultivars in F_3, F_4, BC_2F_1 and BC_3F_1 Progenies.

Initially, 21 different cross combinations were developed between the seven recipient cultivars including three elite Indian cultivars (MTU1010, Swarna and BPT5204) and three yield gene donors namely Habataki, ST6 and ST12 in WS2013. The newly designed SNP based markers for three target yield-enhancing genes (*Gn1a*, *Spl14*, and *SCM2*) were used for the advancement of the progenies to the next generation. A total of fifteen segregating populations of BC_2F_1 and BC_3F_1 generations in the three Indian cultivars background were evaluated in wet season 2015. The confirmed progenies having the target gene(s) and good plant type were advanced to next generation. Promising breeding lines with high yield potential will be evaluated in South Asian countries.

One hundred seventy entries grown under machine sown dry direct seeded conditions and 330 entries grown under puddle transplanted conditions were evaluated for straw digestibility traits like nitrogen content (N %), neutral detergent fiber (NDF %), acid detergent fiber (ADF %), acid detergent lignin (ADL %), silica content (%), in vitro organic matter digestibility (IVOMD %), and metabolizable energy (ME). Based on IVOMD, entries were classified into different categories: IVOMD: $\geq$45% = very good, 43–45 = good, 40–42 = medium, 37–39 = poor, and $\leq$36 = very poor. The IVOMD values of the entries tested under DSR ranged from 41 to 54 with more than 80 percent entries in very good category.Among the puddle transplanted entries IVOMD ranged from 43 to 54 with more than 85 percent of entries in very good group.

During the wet season 2014, 36 entries in early, 40 entries each in medium early and medium duration were evaluated under puddle transplanted condition at five locations in India viz Ludhiana, Pantnagar, Sabour, Hyderabad and Maruteru. The mean grain yield advantage of the top five entries over the best check in respective maturity groups ranged from 6-12% over Local check (5.01 t ha^{-1}) in early, 10-23% over MTU1010 (5.2 t ha^{-1}) in medium early and 7-12% over NDR 359 (5.02 t ha^{-1}).

A promising breeding line with improved plant type,bigger panicle and high yield potential.

Objective 3.2. Rice for mechanized direct seeding and water-saving irrigation

Five varieties suited for cultivation in dry direct seeded situation – CR dhan 201, CR dhan 202, CR dhan 203, CR dhan 204 and CR dhan 205 from breeding lines developed at IRRI have been released in India.

An array of new breeding lines with varied plant types and maturity groups with different grain types like medium and short slender, long slender and long bold and medium bold suitable for diverse market segments of northern, southern and eastern parts of India were developed. Many entries recorded more than 7.5–8.6 t grain yield per hectare. Twelve breeding lines are currently being evaluated in All India Coordinated Rice Improvement Program in India and eight breeding lines are in evaluation in State multi-location trials of Punjab, Uttarakhand, Bihar and Odisha provinces. Under dry DSR conditions, eight hundred and three hundred eighty breeding lines were tested in observational yield trials (OYT) and preliminary yield trials (PYT) respectively. Some of the newly developed breeding lines showed yield advantage of 12–29 percent over the best mega (check) variety MTU1010 under irrigated machine sown DSR situations.

During the wet season 2014, 36 entries in early, 40 entries each in medium early and medium duration were evaluated under machine sown dry DSR condition at seven locations in India viz Ludhiana, Pantnagar, Sabour, Jeypore, Aduthurai, Hyderabad and Gangavathi. The mean grain yield advantage of the top five entries over the best check in respective maturity groups ranged from 10–20% over Sahabhagidhan (4.9 t ha^{-1}) in early,14-19% over MTU1010 (5.6 t ha^{-1}) in medium early and 10-15% over NDR 359 (5.4 t ha^{-1}).

Promising entries under machine sown dry DSR condition at IRRI- SA hub, Hyderabad.

The donors for direct-seeded rice traits identified across experiments conducted at IRRI in previous four seasons such as early vigor: UPLRi7, NERICA4, Kali Aus; root length density, proportion of lateral roots, and proportion of roots at depth (below 15 cm): Samba Mahsuri, WAB880-1-27-9-2-PI-HB, Dular, NERICA4; root hair length: Swarna; root hair density: Mikhudeb; low canopy temperature under drought: Dular; response to fertilizer application: Vandana, Dular; nutrient use efficiency (yield/uptake): Dular have been used to develop complex crosses and F_1, F_2, F_3, F_4 segregating generations developed. More than 10,000 plants of each F_2 cross were planted and selections for the desirable plant type and high yield under dry direct seeded situation (DSR) were carried and selected plants were advanced to the next generation. From Moroberekan /3*Swarna population, breeding lines with early vigor, strong culm and reduced duration coupled with yield advantage of 13 to 23 percent over the popular rice variety MTU1010 have been developed.

Using the QTLs for traits desirable under dry direct seeded situation as well as genes for tolerance to biotic and abiotic stresses, a marker assisted selection (MAS) breeding program initiated earlier at IRRI is moving forward as per the plan. In the MAS, QTLs for anaerobic germination, genes for resistance to blast, brown plant hopper, bacterial leaf blight, gall midge; QTLs for grain yield under dry direct seeded situation, early uniform emergence, grain yield under drought and nematode tolerance are being combined in two high yielding backgrounds- IR09N538 and NSICRc-222. In DS 2015, closely linked peak/gene based markers for different traits in the background of IR09N538 and NSICRc-222 as well as flanking markers in the identified QTLs regions for different QTLs were identified. F_1s combining genes/QTLs for two traits were evaluated for presence of genes/QTLs for two traits, plants with presence of genes/QTLs for two traits were identified and crosses attempted to combine QTLs/genes for the four traits.

More than 500 new breeding lines with varied plant type, grain type and maturity groups to suit different market segments and cropping systems were developed and shared with NARES partners in India, Nepal and Bangladesh. More than 150 segregating generations were handled and around 12,000 breeding lines are in different stages of development.

Objective 3.3. Development of high yielding heat-tolerant rice varieties

Heat tolerance QTL on chromosome 4 was fine mapped to 1.2 Mb interval. Molecular markers are available for marker-assisted selection. Results were published in TAG. Advanced backcross lines (near isogenic lines, NILs) with heat tolerance QTL (qHTSF4.1) were phenotyped by using growth chambers. Results of BC5F2 plants showed the QTL can increase about 15-20% spikelet fertility at 38 ^{o}C at flowering. NILs of IR64HT (qHTSF4.1), IR64EMF (qEMF3.1), IR64HT+EMF and the check varieties (IR64, N22) were planted in IRRI greenhouse in January 2015, and treated in temperature-controlled growth chambers at flowering stage (March). At the same time, the same set of materials was planted in the field at IRRI, PhilRice Isabela, and Cagayan State University. The results showed that the pyramiding line flowered earlier than IR64, and it is more tolerant than the NILs with HT or EMF QTL if the heat stress caused after anthesis.

A recombinant inbred line (RIL) population consisting of 246 F9 lines was developed and is being used for high night temperature (HNT) QTL mapping and other heat tolerance studies Near isogenic lines (NILs) with N22 introgression in IR64 background were developed, BC5F5 lines were evaluated in the field along with the early morning flowering (EMF) NILs. A large number of germplasm for early morning flowering were surveyed and many donors were identified and evaluated.

Objective 4: High-yielding heat- and water-stress tolerant, and disease-resistant wheat varieties for current and future cereal systems

Objective 4 strives to develop bread wheat varieties that have higher yields (>5% than current varieties by year 5 and an additional 15% higher by year 10), are well buffered against the vagaries of climate change, and have preferred end-use qualities. Objective 4 aims to develop input-responsive varieties that also have greater resistance to biotic stresses such as leaf, yellow, and stem rusts, and spot blotch/leaf blight, adaptability to CA practices, and have consumer preferred end-use qualities.

Objective 4 made significant progress by releasing 17 new wheat varieties that are agronomically superior and well buffered against the vagaries of climate change, have greater resistance to biotic stresses (such as leaf, yellow, and stem rusts, and spot blotch/leaf blight), are fully adaptable to the CA practices and have consumer preferred end-use qualities. These varieties showed yield advantage of 5–14% and two-thirds of the varieties were shorter in duration than prevalent cultivars enabling their higher suitability for an intensive cropping system. Formal sector seed production figures indicated that CSISA bred lines account for 18% of sales in India, 24% in Nepal and 34% in Bangladesh. The continuity of varietal release was ensured for coming years through outcomes as nine other varieties were identified for release while more than 2,800 advanced lines were promoted to national/state/regional trials for their further evaluation. In addition, 3,200 new crosses (1,500 by CIMMYT and 1,700 by NARS) were attempted and >37,800 breeding populations (>20,000 by CIMMYT and >17,800 by NARS) were exposed to selection under terminal heat stress and conservation agriculture. More than thousand advanced lines and segregating (F3/F4) generations from South Asia were evaluated in Kenya for screening against Ug99 resistance. Five hundred eighteen participatory varietal selection (PVS) and adaptive trials were evaluated in farmers' fields. More than 200 trials (145 in 2014–15 and 169 in 2015–16) consisting of >2,000 advanced lines from CIMMYT were shipped from Mexico to collaborators – both public and private.

Forty-five hundred lines (2,000 at Aqua Fria and 2,500 by NARS) were screened for resistance to spot blotch. Fifty-two spot blotch resistant lines identified in superior agronomic background and 4 mapping populations phenotyped as well as genotyped. A panel of new advanced lines comprising high yield and/or biomass; based on strategic crosses to combine complementary source-sink traits were identified. Lines identified from genetic resource collections that show favorable expression of heat adaptive traits were phenotyped across South Asia and suitable physiological traits providing adaptation to heat stress were determined. Five hundred eighteen PVS and adaptive trials were evaluated in Nepal, India and Bangladesh and most recent varieties delivered to farmers. Molecular mapping for heat tolerance was achieved and robust markers identified. Linkage with HarvestPlus was strengthened by linking evaluation of agronomically superior biofortified lines in participatory trials in India and Pakistan.

Some important examples of leverage related to the work of Objective 4 have resulted from the success of new wheat varieties. For example, seeing the impact of new wheat varieties, the West Bengal (India) government decided to replace an older cultivar PBW 343. The Bangladesh government started discouraging cultivation of boro rice in traditional wheat areas due to increased profit obtained through new wheat varieties. The early-maturing rice varieties have been encouraged for timely sowing of wheat in Bangladesh. Finally, the Bangladesh government raised the procurement price of wheat from Rs. 26/kg to Rs. 28/Kg to provide incentive to the farmers for growing wheat

i. Wheat varieties released: Seventeen new varieties were released (Table 1).

Table 1. Wheat new varieties released in 2014-15 in South Asia				
No.	**Country**	**Variety**	**Pedigree**	**Location/ management**
1.	Bangladesh	BARI Gom 29	SOURAV/7/KLAT/SOREN//PSN/3/BOW/4/VEE#5.10/5/CNO 67/MFD// MON/3/ SERI /6/NL297 BD(DI)112S-0DI-030DI-030DI-030DI-9DI	NWPZ/ IR-TS
2.	Bangladesh	BARI Gom 30	BAW 677/BIJOY BD(JA)1365S-0DI-15DI-3DI-HR12R3DI	NWPZ/ IR-TS
3.	Nepal	Danphe (NL 1064)	KIRITATI//2*PBW65/2*SERI.1B	NWPZ/ IR-TS
4.	Nepal	Tilottama (NL 1073)	WAXWING*2/VIVITSI	NWPZ/ IR-LS
5.	India	HD 3118	ATTILA*2/PBW65//WBLL1*2/TUKURU	NEPZ/ IR-LS
6.	India	HI8737 (durum)	HI8177/HI8158//HI8498	CZ/ IR-TS
7.	India	DBW 107	TUKURU/INQALAB91	NWPZ/ IR-LS
8.	India	DBW 110	KIRITATI/4/2*SERI1B*2/3/KAUZ*2/BOW//KAUZ	CZ/ IR-TS
9.	India	WH 1142	CHEN/Ae.Sq.(TAUS)/FCT/3/2*WEAVER	NWPZ/ RI-TS
10.	India	UAS 446 (durum)	DWR185/DWR2006//UAS419	PZ/RF-TS
11.	India	HS542	MILAN/KAUZ//PRINIA/3/BABAX	PZ
12.	India	WH1124	MUNIA/CHTO/AMSEL	NWPZ-LS
13.	India	NW5054	THELIN//2*ATTILA*2/PASTOR	NEPZ-TS
14.	India	HS562	OASIS/SKAUZ//4*BCN/3/2*PASTOR	NHZ-RF, TS
15.	India	HD4728	ALTAR84/STINT//SILVER_45/3/SOMAT_3.1/4/GREEN_14//YAV_10/AUK	CZ-IR, TS
16.	India	PBW677	PFAU/MILAN/5/CHEN/AEGILOPS SQUARROSA(TAUS)//BCN/3/VEE#7/BOW/4/PASTOR	Punjab, IR-TS
17.	India	PBW725		Punjab, IR-TS
IR-Irrigated; RS-Restricted irrigation; TS-Timely sown; LS-Late sown; NWPZ–North western plains zone; NEPZ-North eastern plains zone; CZ-Central Zone; PZ-Peninsular zone				

ii. Wheat variety identified for release: Seven new varieties were identified for release (Table 2).

Table 2. New wheat varieties developed in association with CSISA identified for release in south Asia in 2014-15				
No.	**Country**	**Variety**	**Pedigree**	**Location/ management**
1.	Nepal	BL 3623	XIA-984-10YAASKUNMING/BL1868	Terai; TS-I
2.	Nepal	BL 3629	XIA-984-10YAASKUNMING/BL1868	Hills; TS-I
3.	Nepal	NL1164	NG8201/KAUZ/4/SHA7//PRL/VEE#6/3/FASAN/5/MILAN/3/KAUZ/6/ACHYUT/7/PBW343*2/KUKUNA	Terai; TS-I
4.	Bangladesh	BAW 1170	CHIR7/CBRD//GOURAB BD(DI)1327S-0DI-3DI-1DI--DIRC4	All Bangladesh including southern part with salinity upto 8 dS/m.
5.	Bangladesh	BAW 1177	PRODIP/GOURAB BD(JOY)459S-0DI-8DI-010DI-010DI-R5DI	All over Bangladesh including southern part having salinity up to 8 dS/m.
6.	Bangladesh	BAW 1200	MINIVET/PRODIP//SHATABDI	Whole Bangladesh; Early maturing - 102-107 days; High yielding (4300-5200 kg ha-1); Resistant to LR and tolerant to spot blotch; Heat tolerant; grains are white & bold
7.	Bangladesh	BAW 1200	SHATABDI/GOURAB	Whole Bangladesh; Early maturing, heat tolerant - 100-105 days; High yielding (4600-5000 kg ha-1); Resistant to LR and tolerant to spot blotch.
8.	Bangladesh	BAW 1182	KAL/BB/YD/3/PASTOR CMSS99M00981S-0P0M-040SY-040M-040SY-16M-0ZTY-0M...	All over Bangladesh including southern part having salinity up to 8 dS/m.
9.	India	UAS 347	(TOB/ERA//TOB/CNO67/3/PLO/4/VEE#5/5/KAUZ/6/FRET2) / DWR-162	PZ; TS-RF
IR-Irrigated; RS-Restricted irrigation; TS-Timely sown; LS-Late sown; NWPZ–North western plains zone; NEPZ-North eastern plains zone; CZ-Central Zone; PZ-Peninsular zone				

Objective 5: Improved policies and institutions for inclusive agricultural growth

Overview

Objective 5 supports CSISA's wider goals through several well-defined interventions: strategic policy-relevant studies, continuous feedback to project planning and priority setting, and communication of evidence-based policy recommendations. Together, these interventions aim to effect long-term change in the sustainability of South Asia's cereal systems. Through its policy research, Objective 5 continues to produce novel insights on issues relating to (i) resource conservation and climate risk management; (ii) technology development and demand for new agricultural technologies; and (iii) private sector investment incentives and new market opportunities. Through its communications activities, Objective 5 continues to inform decision makers through high-profile events that open new space for debate, share research findings, and influence policy and investment choices toward pro-poor outcomes in Bangladesh, India, and Nepal.

Objective 5 continues to address the policy environment needed to remove constraints to the adoption of new technologies and enhance the benefits of improved agricultural growth. It explores strategies to catalyze durable change at scale through improvements in technology development and delivery, private investment in inputs and services, and public-private partnerships. During the reporting period, Objective 5 worked intensively on the design, data collection, and analysis of several field studies related to mechanical rice transplanters, new stress-tolerant rice cultivars coupled with a weather index insurance, and laser land leveling adoption.

Key accomplishments

During the period under report, IFPRI researchers and their Objective 5 collaborators have been working intensively on the design, data collection, and analysis of several field studies that explore (a) farmers' valuation of the use of mechanical rice transplanters (MRTs) in Bihar, India; (b) farmers' uptake of new stress-tolerant rice cultivars coupled with a weather index insurance product in Odisha, India and Bogra, Bangladesh; and (c) the impact on common pool resource availability of laser land levelling adoption in eastern Uttar Pradesh, India. In addition, IFPRI researchers and collaborators have been analyzing various dimensions of public policies related to (a) seed system regulatory reforms in Bangladesh and Nepal, (b) scale-appropriate mechanization in India, and (c) financial risk management solutions in Bangladesh and India.

Research findings from these studies have been at the center of several high-profile policy conferences, seminars, roundtables, and related communications and outreach events. These events have served as platforms for CSISA to directly engage with decision makers in the public, private, and civil society sectors, most notably with key figures in the agricultural research and extension systems, bilateral and multilateral donor community, fertilizer and seed distributors and regulators, industry leaders, and farmer organizations. These events were accompanied by forays into the wider media space, including the popular press, blogs, and op-eds. Key events included the following.

- IFPRI and the Institute of Economic Growth (IEG) convened a high-level international policy conference titled '<u>Innovation in Indian Agriculture</u>' in New Delhi on December 4-5, 2014. The conference brought together a set of internationally renowned scholars were on hand to discuss issues relating to agricultural productivity growth, environmental sustainability, and social equity, and was highlighted by the presentation of several CSISA research outputs from IFPRI, CIMMYT, and IRRI. Importantly, the event engaged key Indian policymakers as speakers, panelists, and session chairs as a means of transmitting evidence to India's new government and inform its agriculture and rural development strategies.
- IFPRI and CSISA convened its second private sector roundtable on '<u>Deepening Private Sector Engagement in the Vulnerable and Underserved Markets of Eastern India</u>' in New Delhi on December 8, 2014. This event brought together several leading corporate players and civil

society organizations with the policy research community to chalk out investment opportunities and build partnership opportunities in CSISA's project coverage area.

- The Modernizing Extension and Advisory Services (MEAS) project, CSISA, and IFPRI organized a learning event on 'Strengthening Agricultural Research, Extension, and Input Markets in South Asia: Evidence from Regional and Global Practice,' in Washington, DC, June 8-9, 2015. Key partners from the agricultural research and extension systems of Bangladesh, India, and Nepal participated in this event as an add-on to their participation in the global MEAS symposium held during the prior week. The event was an opportunity for participants to explore extension system reforms in a new and critical light.
- IFPRI, along with CIMMYT, IRRI, and other CSISA partners, contributed to the National Seed Summit convened by the Nepal Ministry of Agricultural Development, Kathmandu, September 14-15. The event was an important pan-stakeholder event designed to translate Nepal's new Seed Vision 2020 into implementation, with emphasis placed on reforms to regulations governing variety registration, quality control, and private sector investment.
- IFPRI and its collaborators made additional contributions that drew on CSISA's policy research at national and regional events including the Asian Society of Agricultural Economics annual meeting in Savar, Bangladesh; the annual Bangladesh Policy Research and Strategy Support Program conference in Dhaka, Bangladesh; a conference on irrigation and land use change in Kathmandu, Nepal; and the International Rice Congress and Asian Maize Conference in Bangkok, Thailand.

Anticipated activities

In this last period of CSISA Phase II, Objective 5 will wind up several of its field studies and work towards data analysis, write-up and publication of its findings. Objective 5 researchers will use this period to continually seek out new opportunities to present their work to policymakers and other CSISA stakeholders, including its donors and partners. Meanwhile, Objective 5 staff will begin gearing up for CSISA Phase III.

Objective 6: Project management, data management, monitoring & evaluation and communications

Objective 6 covers CSISA's governance and project management components, which in Phase II are designed to (1) enable better linkages with national and regional stakeholders, (2) simplify reporting and ensure clear lines of accountability, (3) enable better teamwork and synergy across Objectives and CG partners, and (4) build a more inclusive model for outreach and research that leverages the strengths and addresses the needs of key partners. The reporting period included quarterly Executive Committee meetings, monthly Management Team meetings, semi-annual Advisory and Investment Committee meetings, and semi-annual planning & evaluation meetings. Our communications platforms, M&E techniques and data management tools all matured & expanded.

Governance: Country-based Management Teams (MT) for India and Bangladesh met every 1-2 months and led strategy development, activity planning, and provided comprehensive technical oversight for the non-breeding objectives of CSISA. The MT is composed of the Country Coordinator (chair) and scientists from each of the CGIAR Centers that lead the activities in Objectives 1, 2, 5 and 6 in that country.

Semi-annual Planning and Evaluation Meetings: CSISA held *rabi*-season planning and evaluation meeting in September 2015 and October 2016, and a kharif-season planning meeting in April 2015. These country-specific and objective-specific meetings are held in advance of the seasons to evaluate the past season's work and develop impact pathways for the coming season's activities. Approval of activities and subsequent allocation of funds is done at the subsequent MT meeting.

Data Management and Making Data Public: CSISA is continually upgrading its data management protocols and procedures, and improving the ways in which data is collected and shared. In India, CSISA uses Surveybe software and portable netbook computers to streamline field-based data collection for socio-economic surveys and CSISA also uses simple survey forms designed with Open Data Kit (ODK) for deployment on Android-based smartphones to capture trainings, locations and types of technology demonstrations, etc. CSISA is currently integrating this ODK data into a mapping application on the web site. The Bihar and EUP hubs have provided data logbooks to service providers. CSISA has also launched internal initiatives to ensure data and other files are well organized and backed up regularly, and will be publishing as much CSISA II data as possible as we enter into Phase III.

Communications: CSISA's web site, **csisa.org**, and its accompanying **quarterly newsletter**, disseminate information about CSISA's activities and outputs across Bangladesh, India, and Nepal. CSISA is in the process of linking data gathered through Open Data Kit to a mapping program on the web site so that the geographic spread of our activities can be better displayed. Our internal newsletter, ***CSISA Magazine***, provides information about meetings, new staff, hub and research platform updates, and other important information to the CSISA Phase II team. Two new **CSISA Research Notes** have been published, which serve as briefs for the research coming out of CSISA. Our **Facebook** page, **Picasa** account, and **Twitter** feed provide additional mechanisms for sharing information about CSISA's activities with a wide audience.

In Focus: Challenges faced during the reporting period

In **India**, in Bihar and Eastern UP, the monsoon rains started well, But they tapered off, and on 31 July, the rainfall deficit in Bihar on 31 July stood at 31%. The distribution of rainfall was highly skewed with only 355 mm rains against an average of 512 mm rains in the month of July, which is most critical month for rice transplanting. There was no pre-monsoon shower this year.

El Nino was one of the factors leading to deficient rainfall in the hub domains of Bihar and EUP. The drought-like situation in major part of June, whole July and first half of August had serious consequence on the expansion in area under direct seeded rice (DSR) and even maize.

The assembly elections in Bihar in the month of September and October delayed the planning meetings in Bihar. It also affected the availability of ZT machines.

In **Bangladesh**, CSISA lost 56 working days due to hartals and blockades. Most of these losses occurred in February and March, when 36 working days out of a possible 41 were lost. This had an impact on machinery sales and LSP training and on project supervision. Most trial and demonstration programs were completed but many farmer field days had to be canceled.

Nepal suffered a 7.8 M earthquake on 25 April 2015 and a 7.3 M earthquake on 12 May, as well as many aftershocks. The earthquakes affected about about 8 million people, with smallholders in hilly regions being most hard-hit. There were over 8,800 killed and 25,000 people injured. The Government of Nepal and Ministry of Agricultural development prioritized earthquake recovery over other pending matters for months thereafter, resulting in administrative delays for CSISA and other projects in the Feed the Future zone.

Violence and strikes in the Mid and Far West Terai region started in mid-July 2015 as a result of the contested constitution-making process and have reduced CSISA field staff's ability to manage day-to-day activities. In addition, the import of critical inputs from India has been severely curtailed. Since September, agitating Terai groups with allies in India have effectively closed the border, resulting in severe fuel shortages across the country that are undermining farmers' ability to harvest rice and establish winter crops – in many areas there simply is no fuel to be had at any price.

Looking ahead to CSISA Phase III

Key Elements of the Structure and Goals of CSISA Phase III

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

- The first outcome **('Widespread adoption of sustainable intensification technologies and management practices in South Asian cereal systems')** emphasizes the primary scaling pathways embraced by CSISA.
- To further enhance sustainability and scale, CSISA's second outcome ('**Mainstreamed innovation processes'**) seeks to extend the most successful elements of the CSISA model into the programming of national, state, and district-level government institutions in order to improve the impacts achieved with current and future investments in agricultural R&D. Specifically, CSISA will seek to: (i) integrate geo-spatial data and analysis into planning and ML&E, (ii) strengthen on-farm participatory evaluations of new technologies to inform investment priorities and management recommendations, (iii) foster closer linkages with the private sector including small- and medium-scale enterprises (SMEs) such as mechanized service providers, and (iv) develop new insights into farmer decision processes.
- With national research partners (e.g. ICAR in India, BARC institutions in Bangladesh, and NARC in Nepal), CSISA's third outcome focuses on the generation of **critical knowledge and research-based products (R&D)** that will support technology scaling and impact generation. This outcome is organized thematically to address major challenges and opportunities for sustainable intensification in CSISA's priority geographies, often from a systems perspective rather than with single technologies.
- CSISA's fourth outcome (**'Improving the policy environment to support SI'**) enters a transition phase that is highlighted by a scaling up of work with national partners to address policy constraints and improve the policy environment for realizing sustainable SI futures in CSISA's target geographies and populations. During this transition phase, CSISA will focus on the following core policy areas that are foundational to SI: **seed systems, agricultural mechanization, risk management, and input markets**. For each policy area, CSISA will synthesize the evidence base, diagnose the policy landscape, and bring diverse stakeholders together in support of SI-related dialogue, consensus building, and policy reform at the national and sub-national levels. The policy outcome targeted by CSISA Phase III is a more supportive policy environment for SI that will be achieved through learning events, theory of change workshops, and the mainstreaming of analyses and insights into long-term and strategic planning processes that are owned and endorsed by national partners.
- The fifth outcome is about **good governance**: CSISA functions as a coherent, efficient, and impact-oriented initiative for strong governance, management and monitoring, learning and evaluation systems in place.

Phase II of the project began in 2012 with a narrower geographic mandate that emphasized Eastern India (Bihar, Odisha) and Bangladesh as areas with high concentrations of rural poverty and, fortuitously, the highest staple crop yield gaps and opportunities for agricultural growth in South Asia. In the proposed Phase III, work will continue within innovation hubs in Bihar, Eastern Uttar Pradesh (EUP), and Odisha in India (BMGF SUPPORT). In Bangladesh, a more concentrated approach will focus on hubs in the Rangpur, Khulna, and Barisal Divisions (BMGF AND USAID SUPPORT). In Nepal, engagement will be strengthened in the Mid and Far-West Development Regions while including new work in the Terai Plain of the Central Development Region where the private sector is poised for rapid growth (USAID SUPPORT).

A few elements of CSISA's proposed work for Phase III require additional partner consultations, synthesis of experience to date, and *ex ante* analysis. Within the first six months from inception, CSISA will conceptualize an investment plan for further developing and refining scalable nutrient and irrigation decision support tools and will finalize a five-year plan for policy reform. Both plans will be sanctioned by BMGF and USAID with 'go / no go' decisions made by May 30, 2016. CSISA will also secure specific resource commitments (funding and in-kind) from partners during this six-month planning period that will support approved Phase III activities and inform a further articulation of hub-specific strategies, impact targets, and associated work plans.

Innovation decoupled from scaling, and scaling unsupported by favorable policies, contributes to the current trajectory of slow growth in South Asian cereal systems. CSISA has made its mark as a 'big tent' initiative that deliberately works to close these gaps, an approach that will continue to be leveraged in Phase III through integrated planning process and strategic partnerships that unite and coordinate across the four planned outcomes. CSISA has done so by collaborating with researchers in the national agricultural systems, extension systems, and agricultural departments, and with civil society and the private sector. By continuing to integrate the efforts of CIMMYT, IRRI, and IFPRI scientists and development professionals with national partners, we envision that CSISA will benefit more than 8 million farmers in India, Bangladesh and Nepal by the end of Phase III through adoption of new technologies, enhanced knowledge of better-bet management practices, and sustainable access to more robust support services for innovation through public and private sector partners.

Annex 1. New Papers, presentations, and outreach activities

(in chronological order)

Objectives 1 and 2

Krupnik, T.J, Ahmed, Z.U., Timsina, J., Yasmin, S., Hossain, F., Mamun, M., Mridha, A., McDonald, A.J., 2015. Untangling crop management and environmental influences on wheat yield variability in Bangladesh: An application of non-parametric approaches. *Agricultural Systems* (in press).

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Objective 5:

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Conferences, workshops and seminars

Bhargava, A, T. J. Lybbert and D. J. Spielman. 2014. The public benefits of private technology adoption. Paper presented at the Agricultural and Applied Economics Association's Annual Meeting, Minneapolis, MN, July 27–29.

Arora, A., S. Bansal and P. S. Ward. 2014. Farmers' preferences for abiotic stress tolerant rice seeds in India: Evidence from Odisha. Presentation at the European Association of Environmental and Resource Economists (EAERE) Summer School on Economics of Adaptation to Climate Change, Venice, Italy, July 11.

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Agriculture Organization (FAO) and the Asia-Pacific Seed Association (APSA), Bangkok, Thailand, July 1–4.

Ward, P. S. 2014. Participated in workshop titled "Mechanization and Agricultural Transformation in Asia and Africa: Sharing Development Experiences," organized by the International Food Policy Research Institute (IFPRI) and the Peking University National School for Development, Beijing, China, June 18–19.

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Singh, V. 2014. Lessons from the CSISA project: Implications for project design and gender dimensions of social networks and technology adoption in eastern Uttar Pradesh, India. Presentation given at a seminar on "Addressing Gender, Agriculture and Assets in Agricultural Development Projects" organized by the International Food Policy Research Institute under the Gender, Agriculture and Assets (GAAP) Project, New Delhi, March 26.

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Arora, A., S. Bansal and P. S. Ward. 2014. Eliciting farmers' valuation for drought tolerant rice seeds in India. Presentation at the Jawaharlal Nehru University Centre for Economic Studies and Planning Young Scholars Seminar, New Delhi, India March 12.

Bansal, S., A. Arora and P.S. Ward. 2014. Farmers' preferences for abiotic stress tolerant rice seeds in India: Evidence from Odisha. Presentation at UC-Davis Agricultural and Resource Economics Department Seminar Series, Berkeley, CA, March 4.

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Appendix B: USAID Indicators

4.5.2(2): Number of hectares under improved technologies or management practices as a result of USG assistance

Current Selection				
Reporting Organization : USAID				
Indicator / Disaggregation	2015 Comment	2015 Deviation Narrative	2015	
			Target	Actual
4.5.2(2): Number of hectares under improved technologies or management practices as a result of USG assistance (RIA) (WOG)	See below	See below		
Technology type			250,000	**321,126**
crop genetics			35,000	24,027
cultural practices			70,000	118,751
pest management				38,193
disease management				0
soil-related fertility & conservation			5,700	17,450
irrigation				0
water management (non-irrigation)			250	0
climate mitigation or adaptation			30,500	9,302
other			108,550	113,403
total w/one or more improved technology			250,000	321,126
Disaggregates Not Available				0
Sex			250,000	**321,126**
Male			15,000	14,627
Female			6,000	1,417
Association-applied			500	465
Disaggregates Not Available			228,500	304,617

2015 Comment:
This is an Objective 1 indicator. The numbers shown here are for CSISA's work in Bihar, EUP, Odisha, Haryana and Tamil Nadu. Priority hub data has been provided to USAID India and all other data has been provided to USAID Washington.

2015 Deviation Narrative:
Although our hectares and individuals are compiled from a wide variety of technologies, a significant proportion comes from: improved wheat varieties, improved rice varieties, improved weed management in wheat, improved weed management in rice, and the early sowing of wheat. The spread of these technologies has allowed us to exceed our target. The majority of our numbers have been contributed by our priority hubs of Bihar, EUP and Odisha.

4.5.2(5): Number of farmers and others who have applied new technologies or management practices as a result of USG assistance

Current Selection				
Reporting Organization : USAID				
Indicator / Disaggregation	2015 Comment	2015 Deviation Narrative	2015	
			Target	Actual
4.5.2(5): Number of farmers and others who have applied improved technologies or management practices as a result of USG assistance (RIA) (WOG)	See below	See below		
Sex			750,000	568,556
Male			45,000	18,585
Female			12,000	6,626
Disaggregates Not Available			693,000	543,345
Technology Type			750,000	568,556
crop genetics			55,000	38,305
cultural practices			160,000	324,940
livestock management			300	2,826
pest management				59,169
disease management				0
soil-related fertility and conservation			5,500	8,645
irrigation				371
water management (non-irrigation)			600	0
climate mitigation or adaptation			1,250	5,131
marketing and distribution				43
post-harvest handling and storage			150	1,085
value-added processing				3
other			527,200	128,037
Disaggregates not available				0
total w/ one or more improved technology			750,000	568,556

2015 Comment:

This is an Objective 1 indicator. The numbers shown above are for CSISA's work in Bihar, EUP, Odisha, Haryana and Tamil Nadu, and ILRI's cross-cutting work. Priority hub data has been provided to USAID India and all other data has been provided to USAID Washington.

2015 Deviation Narrative:

This deviation narrative applies to our totals, which include the data provided to USAID India and USAID Washington. Although our hectares and individuals are compiled from a wide variety of technologies, a significant proportion comes from: improved wheat varieties, improved rice varieties, improved weed management in wheat, improved weed management in rice, and the early sowing of wheat. The majority of our numbers have been contributed by our priority hubs of Bihar, EUP and Odisha. The ratio betwen the # of hectares into the # of farmers across our geographies varies, and has affected the relationship between our number of hectares and number of farmers. Although we tend to exceed our number of hectares, we fall short of our number of farmers because our assumptions about average landholding size was inaccurate.

4.5.2(7): Number of individuals who have received USG supported short-term agricultural sector productivity or food security training

Current Selection				
Reporting Organization : USAID				
Indicator / Disaggregation	2015 Comment	2015 Deviation Narrative	2015	
			Target	Actual
4.5.2(7): Number of individuals who have received USG supported short-term agricultural sector productivity or food security training (RIA) (WOG)	See below	See below		
Type of individual			15,000	**13,582**
Producers			11,910	11,458
People in government			2200	1,445
People in private sector firms			30	250
People in civil society			535	135
Disaggregates Not Available			325	294
Sex			15,000	**13,582**
Male			11,750	11,200
Female			3,250	2,382
Disaggregates Not Available			0	0

2015 Comment:
This is an Objective 1 indicator. The numbers shown above are for CSISA's work in Bihar, EUP, Odisha, Haryana and Tamil Nadu, and ILRI's cross-cutting work. Priority hub data has been provided to USAID India and all other data has been provided to USAID Washington.

2015 Deviation Narrative:
Not required

4.5.2(11): Number of food security private enterprises (for profit), producers organizations, water users associations, women's groups, trade and business associations, and community-based organizations (CBOs) receiving USG assistance

Current Selection				
Reporting Organization : USAID				
Indicator / Disaggregation	2015 Comment	2015 Deviation Narrative	2015	
			Target	Actual
4.5.2(11): Number of food security private enterprises (for profit), producers organizations, water users associations, women's groups, trade and business associations, and CBOs receiving USG assistance (RIA) (WOG)	See below	See below		
Type of organization			1,500	2,336
Private enterprises (for profit)			1,315	2,180
Producers organizations			75	43
Water users associations				4
Women's groups			75	54
Trade and business associations				9
Community-based organizations (CBOs)			35	25
Disaggregates Not Available				21
New/Continuing			1,500	2,337
New			610	699
Continuing			890	1,638
Disaggregates Not Available				0

2015 Comment:

This is an Objective 1 indicator. The numbers shown above are for CSISA's work in Bihar, EUP, Odisha, Haryana and Tamil Nadu, and ILRI's cross-cutting work. Priority hub data has been provided to USAID India and all other data has been provided to USAID Washington.

2015 Deviation narrative:

We exceeded the target on this indicator because our number of service providers, reported in the Private enterprises category, grew significantly during the reporting period.

4.5.2(12): Number of public-private partnerships formed as a result of FTF assistance

Current Selection				
Reporting Organization : USAID				
Indicator / Disaggregation	2015 Comment	2015 Deviation Narrative	2015	
			Target	Actual
4.5.2(12): Number of public-private partnerships formed as a result of FTF assistance (S)	See below	See below	6	**18**
Agricultural production			1	1
Agricultural post harvest transformation			1	1
Nutrition			1	1
Multi-focus			2	6
Other			1	9
Disaggregates Not Available				0

2015 Comment:
This is an Objective 1 indicator. The numbers shown above are for CSISA's work in Bihar, EUP, Odisha, Haryana and Tamil Nadu, and ILRI's cross-cutting work. Priority hub data has been provided to USAID India and all other data has been provided to USAID Washington.

2015 Deviation narrative:
We exceeded our target because ILRI facilitated new PPPs in Odisha, Nepal and Bangladesh as part of their phase-down plan (since ILRI is not a partner in CSISA Phase III).

4.5.1 (24): Number of policies/regulations/administrative procedures in each of the following stages of development as a result of USG assistance in each case: (Stage 1, 2, 3, 4, 5)

Current Selection				
Reporting Organization : USAID				
Indicator / Disaggregation	2015 Comment	2015 Deviation Narrative	2015	
			Target	Actual
4.5.1(24): Number of agricultural enabling environment policies completing the following processes/steps of development as a result of USG assistance (S)	See below			
Area			7	10
Institutional architecture for improved policy formulation				3
Enabling environment for private sector investment				1
Agricultural trade policy				0
Agricultural input policy				2
Land and natural resources tenure, rights, and policy				0
Resilience and agricultural risk management policy				4
Nutrition				0
Other				0
Disaggregates Not Available				0
Process/Step			7	
Analysis			3	10
Stakeholder consultation/public debate			1	10
Drafting or revision			1	1
Approval (legislative or regulatory)			1	1
Full and effective implementation			1	0
Disaggregates Not Available				0
Total policies passing through one of more processes/steps of policy change				

2015 Comment:
This is an Objective 5 indicator. Data are provided by IFPRI.

2015 Deviation narrative:
During the reporting period, the policy research team has explored issues with key stakeholders in several new areas that require analysis. This includes analysis and consultations with key government decision makers involved in agricultural research and extension in Bangladesh, India and Nepal in conjunction with the MEAS-CSISA-IFPRI learning event and other forums. This is the reason we exceeded our target for this indicator.

4.5.2(39): Number of new technologies or management practices in one of the following phases of development: (Phase I/II/III)

Current Selection				
Reporting Organization : USAID				
Indicator / Disaggregation	2015 Comment	2015 Deviation Narrative	2014	
			Target	Actual
4.5.2(39): Number of technologies or management practices in one of the following phases of development: (Phase I/II/III) (S)	See below	See below		
Phase 1 Number of new technologies or management practices under research as a result of USG assistance			30	46
Phase 2 Number of new technologies or management practices under field testing as a result of USG assistance			94	90
Phase 3 Number of new technologies or management practices made available for transfer as a result of USG assistance			65	66
Disaggregates Not Available				

2015 Comment:
This indicator includes combined data from Objectives 1 and 2, and from the breeding Objectives 3 and 4. This data has been provided to USAID Washington.

2015 Deviation narrative:
This number has exceeded its target because Objective 2 has contributed technologies to this indicator that are still under research.

Appendix C: Results Framework

CSISA Phase II: RESULTS FRAMEWORK - KEY MILESTONES			
Key Milestones	**Period Three**		
	Oct 1, 2014 to Mar 31, 2015	*Apr 1, 2015 to Sept 30, 2015*	**Period three update in annual report, Nov 2015**
	Target at period end		
Objective 1. Widespread dissemination of production and postharvest technologies to increase cereal production, resource efficiency, and income			
Sub-objective 1.1. Implementation of a goal-oriented road map for transitioning existing hubs in Punjab, Haryana, Tamil Nadu, and Pakistan, and modalities for operationalizing new hubs in E. UP, Bihar, and Odisha			
1.1.1.1. Road map for transitioning existing hubs in Punjab, Haryana, Tamil Nadu, and Pakistan implemented.	Implement strategy and transition hubs so that no CSISA support is required by Jan. 2015. Strategy revisited and the merit of continued CSISA support evaluated.		Punjab hub has been transitioned to CCAFS. Haryana Hub has been transitioned to the Central Soil Salinity Research Institute. The Tamil Nadu hub has been transitioned to Tamil Nadu Agricultural University. None of these hubs currently receives funding from CSISA.
1.1.2.1. Primary impact pathways for each hub domain defined to provide a goal-oriented road map that combines innovation, product development, and strategic partnerships.	Another 1 million farmers reached through change agents supported by CSISA's impact pathway logic. Impact pathway assumptions and efficacy re-assessed and adjusted (if needed) in advance of the rabi and kharif cropping seasons.		Impact pathway documents were generated in September for the Rabi 2014-15 season, and in April for the Kharif 2015 season.

Key Milestones	**Period Three**		
	Oct 1, 2014 to Mar 31, 2015	*Apr 1, 2015 to Sept 30, 2015*	**Period three update in annual report, Nov 2015**
	Target at period end		
Objective 1. Widespread dissemination of production and postharvest technologies to increase cereal production, resource efficiency, and income			
Sub-objective 1.2. Participatory technology testing and adaptation for sustainable intensification			

1.2.1.1. Production and livestock feed technologies that address key knowledge gaps and specifically address the needs of women.	At least 10 adaptive research trials addressing prioritized knowledge gaps conceived and implemented in each hub, including 6 that meet women's needs during the principal growing seasons.	Across the CSISA countries, more than 50 types of agronomic research trials implemented in the past year. Strategic socio-economic surveys on the service economy for SI technologies as well as sensible entry points for change among woment farmers have been completed to complement the agronomic trials.
1.2.2.1. Prioritized production and livestock feed technologies that have been tested and improved in the context of communities to match the needs of different regions, farmer groups, and women.	At least 25 participatory technology verification trials or demonstrations, and animal feed development groups active in at least 4 hubs, with innovative feed strategies defined and tested during principal growing seasons.	Target exceed, with more than 20 types of technology demonstrations conducted at over 3,000 locations in India alone.
	Partial budget analyses of three key technology interventions conducted in each hub.	Completed as planned for technologies such as zero-tillage wheat, directly sown rice, mechanically transplanted rice, laser land leveling, options for integrated weed management, pathways for maize intensification, post-harvest mechanization, and site-specific nutrient management.
1.2.4.1. Strategies to overcome principal gender-differentiated causes of postharvest cereal losses in each hub domain.	Options to overcome primary causes of postharvest losses demonstrated to men and women in at least four hubs.	New technology options for mechanized harvesting, threshing, and innovative drying and storage technologies evaluated and adopted in Bangladesh, Nepal, Bihar, and Odisha.

1.2.5.1. Strategies to overcome biophysical, socioeconomic, and policy-related constraints to farmer adoption of key production, livestock feed, and postharvest technologies.	Strategies to overcome adoption constraints implemented as part of the impact pathway-driven planning process.		Adoption constraint studies continue to inform activity planning and implementation for DSR, mechanical transplanting, threshing, ZT wheat, and expansion of service provision
Key Milestones	**Period Three**		
	Oct 1, 2014 to Mar 31, 2015	*Apr 1, 2015 to Sept 30, 2015*	**Period three update in annual report, Nov 2015**
	Target at period end		
Objective 1. Widespread dissemination of production and postharvest technologies to increase cereal production, resource efficiency, and income			
Sub-objective 1.3. Translating research into actionable products and insights			
1.3.1.1. Web and mobile-phone based applications to aid decision-making by men and women farmers at large scale but with context-specific information, including site-specific nutrient management for different crops, cropping systems, and regions.	New approaches, information sources, and decision guides implemented for existing decision tools in collaboration with partners.		Field trials completed with updated Crop Manager recommendation with enhanced calculations vis-a-vis farmers' practices and state fertilizer recommendation for rice in Odisha and for rice wheat in Bihar. Results from nutrient omission plot trials compiled for use in developing updated Crop Manager. RCM and RWCM developed in a way that they have the capability of readily adding components of crop management, compatible with conservation agriculture. Beta version of Rice Maize crop Manager developed for further testing in field.

	At least three versions of Nutrient Manager (NM), NM Mobile, or Nutrient Expert (NE) software released, and demand-driven agronomic information and best practices provided in Bangladesh, India, or Nepal, and constraints to use assessed.	**RCM gets initial endorsemnet from OUAT. RCM link is now live on OUAT website.** Pilot dissemination of Rice Crop Manager done in Odisha with KVKs and DOA. Promotion of released Rice Crop Manager continued in Bangladesh. Results from field testing used to improve beta versions of Crop Manager for rice-wheat in Bihar and eastern UP and rice in Odisha prior to wider deployment.Beta version of Rice-Maize Crop Manager for Bihar is ready for field testing. Maize Crop Manager (MCM) for Bangladesh developed and available for use.
1.3.2.1. Strengthened and diversified dissemination pathways for agricultural knowledge and technologies using traditional approaches and ICTs.	At least 10000 farmers and partners exposed to new technologies through community-based demonstrations, trainings, and at least 10 cross-hub exposure visits.	More than 13,000 farmer exposed to new technolgies in India alone through trainings etc.
	Instructional videos developed based on uptake assessment, and deployed to more than 700 villages; uptake following exposure to videos assessed.	ZT wheat and DSR video disseminated to thousands of farmers through the State Departments of Agriculture in Biahr and Odisha.
	At least 25 new entries incorporated, and at least 10 hub staff and partners in each hub introduced to/updated on CKB.	New 'simple tips' guides for rice, wheat, and maize developed and disseminated through partners.
1.3.4.1. Identify and facilitate dissemination of superior dual-purpose rice, wheat, and maize breeding lines and hybrids in South Asia through breeding networks, farmers, and fodder traders.	High-performing dual-purpose rice, wheat, and maize promoted through breeding networks, seed companies, fodder traders, and for demonstration in hubs.	Feeding trial of superior variety of maize (NK-6240) has been implemented in three villages in Mayurbhanj district in Odisha i.e. Badbil, Jhalkiani and Saranga Garh covering 20 dairy animals. The feeding trial will be completed by last week of November, 2015.

	Advanced rice lines with superior 'dual purpose' traits subjected to multi-locational testing across CSISA's prioritized production ecologies.	In process
	Heat and disease-resistant maize cultivars with superior grain and stover yields, and good fodder quality promoted with input from partners and national programs including through the IMIC network.	Completed
1.3.5.1. Business models targeting men and women entrepreneurs for sustaining change through private enterprise and investment.	At least 5 business models developed or strengthened; 2 new types of businesses initiated or existing ventures strengthened by SMEs in hubs; challenges to business development addressed as possible.	New business opportunities for small machinery (power tillers, hand seeders, precision fertilizer applicators, weed control) and post-harvest activities (e.g. threshers, reapers) identified and assessed. Business model logic for laser leveling, DSR, mechanical transplanting, and ZT wheat strengthened.

Key Milestones	**Period Three**		
	Jun 2014	*Jan 2015*	**Period three update in annual report, Nov 2015**
	Target at period end		
Objective 1. Widespread dissemination of production and postharvest technologies to increase cereal production, resource efficiency, and income			
Sub-objective 1.4. Mobilizing partnerships for catalyzing impact at scale.			
1.4.1.1. Advisory committees and partnerships to help define research and development directions, link other players to hub activities, and promote CSISA technologies and out-scaling methodologies.	TWG, AIC meetings held in each hub to revise workplans in light of learning and new partnership opportunities.		AIC meeting held in Bihar, Odisha and Bangladesh. Partnership funds disbursed to collaborators to support strategic R for D efforts aligned with CSISA's objectives.

	At least 5 major partnerships established or strengthened each year in the priority hubs with support from the TWG/AIC.		Partnership funds disbursed to Bihar Agricultural University, Banaras Hindu University, and VASFA (NGO in Bihar). Directed funding to OUAT for scholarship and research infrastructure development. New collaborative work in Bangladesh supported through BRRI, BARI, and Department of Fisheries.
Key Milestones	**Period Three**		
	Jun 2014	*Jan 2015*	**Period three update in annual report, Nov 2015**
	Target at period end		
Objective 1. Widespread dissemination of production and postharvest technologies to increase cereal production, resource efficiency, and income			
Sub-objective 1.5. Strategic capacity development to support key agents of change.			
1.5.1.1. Capacity development for men and women CSISA staff and public and private sector partners/actors to play leading roles in accelerating impacts at scale for farmers.	Trainings for hub staff and partners conducted, with modules on participatory technology development, user-driven communication strategies, gender in agricultural development.		Training and guidance imparted during semi-annual E&P meetings along with direct mentorship through field visits by visiting scientists (e.g. comms team, gender expert, etc.) as well as by Objective leadership team.
	Leadership course conducted for at least 20 women engaged in agricultural research, development, and extension.		Working with SHGs and their federations, leadership mentoring provided in Bihar, Odisha, and Bangladesh.
	Training course with modules covering at least 5 animal husbandry topics conducted for staff and partners at prioritized hubs.		Some 29 training sessions have been implemented in CSISA Bihar Hub on crop residue-based feeding practices and supplementation with home-made concentrate feed and mineral mixtures, with at least 697 farmers participating, of which about 85 are women participants. Extension materials including one video on benefits of feeding mineral mixture were developed for dissemination.

	Demand-driven trainings conducted for at least 300 local service providers to improve mechanized, better-bet agronomy and business development skills for new and existing entrepreneurs.	The number of service providers that CSISA supported during the reporting period exceeded 2.000.
	Two exams administered to about 100 and 250 agro-dealers, student performance reviewed, and successful candidates certified.	Activity defer until further consultation with MANAGE and government partners in Phase III.
1.5.3.1. Next generation of cereal systems scientists and development professionals, especially women, strengthened.		Student research on-going through a strong mix of national (e.g. OUAT, RAU, BAU) and foreign (e.g. University of Nebraska, Wageningen University, University of Illinois) institutions.
	Training modules developed and short-term advanced courses conducted for hub staff (including animal husbandry) and at least 75 young male and female scientists.	Short-courses completed on advanced statistics, geo-spatial methods, and farm design.
	At least 30 interns (30% female) placed in CSISA hubs and partner institutions.	A total of 22 interns were placed during the reporting period across the CSISA hubs in India, including 7 female students (31.8%).

Key Milestones	**Period Three**		
	Oct 1, 2014 to Mar 31, 2015	*Apr 1, 2015 to Sept 30, 2015*	**Period three update in annual report, Nov 2015**
	Target at period end		
Objective 2. Crop and resource management practices for future cereal-based systems.			

2.1.1. Optimized cereal-based cropping systems based on performance assessments of new and current technologies that are optimized for productivity, resource efficiency, and GWP.	Four research platforms continued; contributions of cereal residues to livestock, soil quality and livelihoods analyzed; comparative performance of the optimized systems assessed.	Platform based research continued at three sites: Karnal (Haryana), Patna (Bihar) in India and at Gazipur in Bangladesh. New strategic research platform established in Bhubaneshwar at Odisha University of Agriculture and Technology, Bhubaneshwar. Cereal residues were analysed for nutritional quality for livestocks and soil quality analyzed at these long-term platform sites. Productivity, profitability, resource use and environmental footprints of the new optimized systems assessed against current bussiness-as-usual systems.
	In collaboration with NARES partners, CA-based systems evaluated with process-based research trials that will lead toward system refinements.	Both on-farm and on-station strategic research trials conducted across CSISA hub domain related to sustainable intensification in collaboration with NARES partners including KVKs, SAUs, ICAR regional institutes. Themes of these strategic research trials include cropping system optimization/diversification, weed management, coping with temeprature extremes (cold and terminal heat stresses), conservation agriculture (CA)-based practices, site-specific nutrient/crop management, decomposing yield gaps, water management, GIS and crop modelling etc.
2.2.1. Models for assessing cropping system performance under different agro-ecological conditions and climate-change scenarios.	Apply improved validated crop-livestock systems models to exploring new cropping systems and crop management options for at least 4 hubs	Simulation studies were conducted on following aspects: 1. Exploring feasibility of dry seeded rice in E-IGP for likey range of rainfall condiitons for range of target sowing wondows, the associated productivity risks and irrigation strategies to mininize these risks using APSIM model; 2. evaluating probabilities of nursery sowing dates and transplanting dates based on rainfall scenarios and associated yield probabilities using APSIM model; 3.assessing impact of replacing wheat in northeast India with rabi maize on land and water productiity under various rsource availability scenarios; 4.Modis data analysis to map rabi crops sowing dates of Bihar and EUP and analysis inter- and intra-seasonal dynamics of rabi crop productivity.

2.3.1 Platform trials are adjusted to incorporate key knowledge gaps identified from on-farm adaptive research and technology verification trials. New insights developed at the platforms informs the design of on-farm trials for multi-locational testing.	Joint planning and evaluation meetings held between Objective 2 and Objective 1 teams twice a year.		One dedicated objective 2 planning and review meeting was held in delhi. In additiion, planning and review for obj 2 was done with obj 1 meeting and directly at hub level.
Key Milestones	**Period Three**		
	Oct 1, 2014 to Mar 31, 2015	*Apr 1, 2015 to Sept 30, 2015*	**Period three update in annual report, Nov 2015**
	Target at period end		
Objective 3. High-yielding, heat- and water-stress-tolerant rice varieties for current and future cereal and mixed crop-livestock systems.			
3.1.1. Next generation of elite rice lines with increased yield potential, improved grain quality, and superior feeding value, heat tolerance released.	HYP and high fodder quality lines/hybrids evaluated in CSISA hubs and AICRIP; genotypes identified and intercrossed to develop new breeding populations; predictive models based on empirical data and apply on diverse breeding populations.		An array of new breeding lines with varied grain and plant types with different maturity duration were developed and tested across South Asia. Dozens of promising lines are in advanced stages of multi-location testing and release.Most of the lines were found to have better straw digestability traits viz., high IVOMD,Metabolizable energy and high N content. A large number of new breeding populations were developed . SNP markers were developed for the major yield related genes, Gn1a, SPL14 and SCM2 and are being transfered to mega varieties viz., Swarna,MTU 1010 and BPT 5204 through MAS.

3.2.1. Rice for mechanized direct seeding and water-saving irrigation practices developed and released.	Male sterility-facilitated recurrent selection used to improve germplasm for DSR; QTLs for efficient water and nutrient uptake root traits mapped; pyramided Pup1/AG lines evaluated in on-farm trials.	Hundreds of new breeding lines with early seedling vigour,improved plant type,high yield potential and strong culm were developed by recurrent selection and dozens of lines are in advanced stages of testing and release. Many QTLs for early seedling vigour,high yield under DSR,efficient water and nutrient uptake were identified and are being validated. Through an agressive MAS program , QTLs for anaerobic germination, genes for resistance to blast, brown plant hopper, bacterial leaf blight, gall midge; QTLs for grain yield under dry direct seeded situation, early uniform emergence, grain yield under drought and nematode tolerance are being combined in two high yielding backgrounds- IR09N538 and NSICRc-222.
3.3.1. At least two heat-tolerant rice varieties nominated for national varietal testing.	Near-isogenic mega-variety, heat tolerant lines developed and evaluated; inbred lines for HDT generated; mapping populations developed for identifying HNT tolerance QTL; at least 10 elite breeding lines evaluated at 5 sites.	IR 64 NILs with HDT and early morning flowering (EMF) and their combinations were developed and tested under both field and controlled conditions. The advantage of these QTLs in enhancing HDT tolerance has been proved beyond doubt . A mapping poulation consisting of 246 F9 lines for HNT was developed. IR 64 NILs for HDT and EMF were tested at three locations and NARES partners in Bangladesh and India are utilizing these markers in the development of MAS products in their region specific popular varieties.

Key Milestones	**Period Three**		
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	Target at period end		

Objective 4. High-yielding, heat- and water-stress tolerant, and disease-resistant wheat varieties for current and future cereal and mixed crop-livestock systems.

4.1.1. Improved early, medium, and normal-maturing bread wheat varieties for heat- and water-stressed environments.	30 lines tested; at least 200 breeding populations selected; new crosses made; 5 best lines evaluated under CA in multilocation yield trials; at least 3 new varieties released by NARES and private-sector partners.	Achieved through 145 bread wheat trials consisting of >1000 advanced lines planted across 40 locations in south Asia in 2014-15 cycle. For 2015-16 cycle 169 sets of trials and nurseries prepared at Mexico and shipped to south Asia. More than 3200 new crosses made and >378000 breeding populations selected. Superior lines (>150) evaluated under CA in multilocation trials. Seventeen new wheat varieties were released, nine identified for release while more than 2800 promoted to national/state/regional trials.
4.2.1. Spot blotch-resistant wheat germplasm and molecular markers for resistance to the disease.	Resistance to spot blotch characterized; 3 RIL/DH populations phenotyped/genotyped; resistance genes and robust flanking markers identified	Resistance to spot blotch characterized by evaluating around 2000 genotypes at Mexico and 2500 by collaborators in South Asia. Four RIL mapping populations were phenotyped. Genomic regions with flanking markers obtained.
4.3.1. Improved heat and drought tolerance in wheat.	Genetic resources for heat and drought tolerance screened; genomic regions most likely to provide candidates for marker-assisted selection identified.	A panel of new advanced lines comprising high yield and/or biomass characterized based on strategic crosses to combine complementary source-sink traits. Lines with suitable physiological traits providing adaptation to heat and drought stress were determined. Mapping results provided genomic regions for marker assisted selection.

Key Milestones	**Period Three**		
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	Target at period end		
Objective 5. Improved policies and institutions for inclusive agricultural growth			
5.1.1. Improved policies and incentives that encourage private investment and public-private partnerships in pro-poor technology development and delivery.	At least 2 examples of changed policies related to input use can be plausibly connected to CSISA policy efforts.		a) Nepal's National Seed Vision 2013-2025 moving toward implementation with input from CSISA research on effective seed system and market development. b) New donor investments (e.g., Asian Development Bank) in weather index insurance products for risk management in agriculture being made partly on the basis of results shared from ongoing CSISA research.

5.2.1. Improved policies and incentives that address changing labor, gender, assets, and migration dynamics related to pro-poor technology development and delivery.	Gender recommendations communicated to key decision makers.		Findings and recommendations on gender dimensions of technology adoption and social networks communicated to key research partners with influence on agricultural research and extension investments in India and Bangladesh.
Key Milestones	**Period Three**		
	Oct 1, 2014 to Mar 31, 2015	*Apr 1, 2015 to Sept 30, 2015*	**Period three update in annual report, Nov 2015**
	Target at period end		
Objective 6. Project management, data management, communication, evaluation, and decision support.			
Sub-objective 6.1. Project management			
6.1.1.1. Effective and efficient project management.	Hold monthly and quarterly meetings with CSISA objective leaders and institutional partners; biannual meetings with advisory and investment committees, annual forum with key NARES representatives from across S. Asia.		Management Team meetings held every 1-2 months. Objective-specific meetings held semi-annually. Additional internal cross-project meetings held on M&E, communications, finance and administration and mechanization. Leadership participatedn in strategic regional fora.
Key Milestones	**Period Three**		
	Oct 1, 2014 to Mar 31, 2015	*Apr 1, 2015 to Sept 30, 2015*	**Period three update in annual report, Nov 2015**
	Target at period end		
Objective 6. Project management, data management, communication, evaluation, and decision support.			
Sub-objective 6.2. Data management and communication			

6.2.1.1. Standardized data collection across project, minimum data set characterized by consistent metadata schema for ease of reuse, data easily retrievable, mined across project.		Surveybe now available for use by socioeconomic and agronomic staff in Delhi as well as at the priority hubs. ODK used to capture data on trainings, service providers, input dealers, and agronomic trials and demos. Data manager circulates to hubs to train staff on data management, standardized file naming, data backup, and other components of the SOPs.
6.2.1.2 Key CSISA datasets made widely available through public access data repositories.	Important CSISA datasets are updated every quarter into publically available data repositories as a regular business practice for the project.	Dataverse, AgTrials, and the CSISA website used as public repositories and dissemination portals for most important CSISA datasets. CSISA has launched an initiative with the partners to make Phase II datasets public in the beginning of Phase III.
6.2.2.1 Improved communication across project personnel and locations, shared learning, record of project, and accountability, improved PR and dissemination of information about CSISA.	Continued maintenance of communication platform and web site.	Web site (csisa.org) is kept updated, and CSISA has an external quarterly newsletter, an internal monthly newsletter, and a Research Brief series. We also have brochures, posters, and standees for our communications needs. Our semi-annual and annual reports have been significantly improved and refined during Phase II. We are launching a mapping application to display our ODK data on our web site.
Key Milestones	**Period Three**	
	Oct 1, 2014 to Mar 31, 2015 / *Apr 1, 2015 to Sept 30, 2015*	**Period three update in annual report, Nov 2015**
	Target at period end	
Objective 6. Project management, data management, communication, evaluation, and decision support.		
Sub-objective 6.3. Project evaluation of outcomes and impacts		
6.3.1.1. Comprehensive assessment and continual refinement of project processes, outcomes, and impacts, with lessons learned incorporated and communicated to partners, donors, and stakeholders.	At least 1 qualitative case study and 1 quantitative impact assessment conducted in each hub, disaggregated key indicators uploaded, adoption and impact of interventions assessed in baseline survey HH, implications from these reported to stakeholders.	CSISA uses a variety of mixed methods to capture data for its indicators and for its semi-annual and annual reports. Seasonal and monthly refinement of hub-based impact pathways facilitates regular evaluation of our approach, our outputs and our outcomes.