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Cereal Systems Initiative for South Asia (CSISA) Phase II

Annual Report 2014

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October 1, 2013 to September 30, 2014

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)

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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.

Table of Contents

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** (Appendix C) and towards the over-arching 10-year vision of success for the initiative. In the heat-prone Eastern Gangetic Plains, fostering the spread of early planting is an important adaptation mechanism for coping with contemporary and projected climate extremes. CSISA has successfully out-scaled key messages on the importance of early wheat sowing by sharing lessons learned from on-farm experiments and compelling the State Department of Agriculture in Bihar to change its official recommendation in favor of planting before November 15th. With a statewide media campaign that was supported by CSISA, the new state department recommendation reached every corner of Bihar. In CSISA's direct working areas, field surveys estimate that 340,000 farmers in Bihar and 280,000 in EUP are planting wheat earlier based on these efforts. In addition to cost savings and improvements in soil quality, zero tillage (ZT) is an important entry point for advancing wheat planting. With technical and business development training, CSISA in India supports a network of more than 1,700 mechanized service providers. For technologies such as zero tillage, these entrepreneurs provide crop establishment services to more than 20 households each—a core example of CSISA's strategy for achieving sustainable intensification at scale through change agent intermediaries. Across Bihar and EUP, over 50,000 hectares of ZT wheat were sown by CSISA-supported service providers in 2013–14, reflecting an area increase of 42% over the previous year. Econometric studies suggest that ZT increases grain yields by 458 kg ha^{-1}, a production gain with an aggregate estimated value of approximately $4,400,000 for CSISA-support service providers in 2013–14. In Odisha and Bihar, CSISA has taken advantage of the social capital of the many women's self-help groups that have been formed by the government and other civil society partners. These groups have provided 'ready made' entry points for training and social mobilization, while also providing other antecedents for innovation including access to credit. CSISA has conducted participatory

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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.'

assessments of technology options and entrepreneurship opportunities so that CSISA's programming to effectively support women farmers is demand-driven and more likely to succeed.

CSISA continues to strengthen **strategic partnerships** with the state Department of Agriculture, the Krishi Vigyan Kendras (KVKs), state agriculture universities (SAUs), and NGOs for scaling locally appropriate SI technologies and better-bet agronomic practices. CSISA has also formed partnerships with the private sector to support dealer training and input market development—dealers are the most common source of information and advice for most farmers in India. As part of this strategy, CSISA has fostered closer linkages between the state extension system and the private sector so that extension also supports agents of change (e.g., dealers and service providers), which will help ensure that government investments reach a larger number of farmers through intermediaries.

In **Bangladesh**, the CSISA sub-project called *Sustainable Rice Seed Production and Delivery Systems for Southern Bangladesh* was completed in December 2013. This initiative benefitted more than a 1,000,000 farmers through the provision of seed of rice varieties tolerant to soil salinity, flooding and drought and also the introduction of new, high-yielding varieties among seed growers.

CSISA-BD's rice, maize and wheat programs trained 27,801 farmers in best agronomic practices, with an additional 10,194 farmers trained in advanced aquaculture techniques. Farmers who adopted the rice production technology promoted by CSISA had gross margins for Boro rice that were 64% ($280) higher than those of farmers who did not adopt best practices. In farmer-managed evaluations of aquaculture technologies, CSISA interventions raised homestead fishpond production by 265%. CSISA successfully introduced maize as a cash crop in areas where it was not widely cultivated through technical trainings and support to 200 maize producer associations. Profits of $600-$1,000 ha^{-1} are attainable when grain is sold to poultry feed mills. CSISA continues to work with public, private, and development sector partners to build robust and inclusive markets for crops like maize.

New survey research has also assessed the capacity for different CSISA training activities to generate income among 'indirect' beneficiaries. For example, for every farmer receiving assistance from the project a further 1.52 rice farmers, 1.95 maize farmers and 3.59 aquaculture farmers adopted the same technology. CSISA is actively seeking methods to increase the 'spillover' from classical training-based approaches, including video-based dissemination methods for simple technologies.

In July 2013, CSISA launched a new initiative in southern Bangladesh (CSISA Mechanization and Irrigation, or CSISA-M.I.) that focuses on efficient development of surface water resources and precision agriculture with scale-appropriate machinery. This initiative is predicated on compelling private investment in the commercialization of both machinery and associated services. As an early indication of success, around 2,300 ha were irrigated by service providers using fuel-efficient axial flow pumps (AFPs) supplied through Rangpur Foundry Limited (RFL) in the first year of the project. Crucially, RFL and local service providers invested $327,974 of their own funds to spread axial flow pump technology to farmers. Seeder-fertilizer drills and bed planters improve the precision of seeding and fertilizer placement, while facilitating the conservation of labor and water resources. In year one, CSISA's private sector partners invested $482,092 of there own funds in commercializing these technologies. Underpinning these efforts are CSISA's science-driven insights into technology performance and target domains, essential elements for making the 'business case' for new investment in Southern Bangladesh where the private sector is comparatively weak.

In **Nepal**, maize yields in the mid-hills are persistently low and few efforts have systematically identified sensible entry points towards sustainable intensification that can be selectively matched to the needs and constraints faced by different farmers. On-farm trials identified low-cost interventions such as maintaining optimal plant populations and improving weed management that can double grain productivity. With all management factors well managed, grain yields of maize increased to 10 t ha^{-1}, five times higher than those achieved through farmer practice—an astonishingly large yield gap. When best practices were combined with zero tillage, similarly high yields were obtained. ZT significantly reduces crop establishment costs and can minimize soil erosional losses—a paramount concern in the hills for ensuring long-term sustainability. To increase access to SI technologies, CSISA is working to bring scale-appropriate machinery options, such as the 'mini' two-wheel tractor, to the hills in collaboration with finance organizations, NARES, private sector, and development partners such as the FtF-funded KISAN initiative.

Cross-cutting activities included the field evaluation and fine-tuning of ICT-based decision support frameworks for nutrient and crop management in Tamil Nadu, Odisha, Bihar, Eastern UP, and Bangladesh; dissemination of improved post-harvest practices and associated business models across the CSISA domain; and the efficient deployment of improved livestock feeding practices through innovative partnerships with dairy cooperatives in Odisha and Bihar.

In aggregate more than 55,000 farmers received training from CSISA during the reporting period. In tandem with market development and other companion measures that are coordinated through impact pathway logic, these efforts have generated uptake rates for key technologies that suggest that CSISA is well on its way to fulfilling its 10-year vision of success of sustainably intensifying cereal-based systems at scale in South Asia.

Through research at CSISA's research platforms, **Objective 2** has conclusively demonstrated sustainable intensification pathways that have enhanced crop productivity (11%), increased profitability (32%), reduced energy investments (-46%), and markedly reduced irrigation requirements (-71%). Core constituents of these future-oriented systems include the integration of crop diversification, precision management, and conservation agriculture. CSISA recognizes that the challenges of SI require an expanded focus that extends beyond research stations. An example of Objective 2's new strategic research activities include exploring the scope and implications of diversifying rice–wheat systems in the northwest Indo-Gangetic Plains by integrating studies on water management and salinity dynamics with maize market demand projections, regional hydrology, and farmer perceptions of risk and willingness to innovate. Crop genetic advances are also essential to making these strategies feasible; in addition to CSISA's work on wheat and rice (see below), key traits for diversified systems such as anaerobic germination potential for Kharif maize production and stover digestibility for mixed crop-livestock systems have also been identified.

Objective 3 has made steady progress towards developing elite rice lines with increased yield potential, improved grain quality and superior feeding value, rice for mechanized direct seeding and water-saving irrigation practices, and high-yielding heat-tolerant rice. In the DSR wide-screen evaluations, hybrids performed best with yield advantages of a few top hybrids in the range of 23–34% in the early, 26–35% in the medium-early, and 16–19% in the medium maturity groups.

Objective 4 has undertaken similar activities—breeding trials and screening nurseries—in pursuit of high-yielding heat- and water-stress tolerant, and disease-resistant wheat varieties for current and future cereal and mixed crop-livestock systems. During the reporting period, Objective 4's work within CSISA has fully come to fruition with 12 new wheat varieties released for different production ecologies in South Asia.

Objective 5 continued to address the policy environment needed to remove constraints to the adoption of new technologies and enhance the benefits of improved agricultural growth. CSISA completed studies on the projected demand heterogeneity for drought-tolerant rice cultivars as a means of improving strategies for reaching vulnerable farmers; the impact of the Mahatma Gandhi National Rural Employment Guarantee Scheme on labor-saving agriculture technology and machinery/equipment adoption; and the influence of gender dimensions of social networks on technology adoption.

Under **Objective 6**, a variety of regional, country-level, and state-level governance and management mechanisms continue to be implemented, including Management Team meetings for India and Bangladesh, and Advisory and Investment Committees for Bihar, Odisha, and Bangladesh. CSISA has strengthened its M&E team and associated systems, and has implemented inference techniques for evaluating outcomes. As part of Objective 1, several 'deeper-dive' studies have been conducted (e.g., direct-seeded rice adoption, zero-tillage adoption, structure and function of service provision markets) that inform these 'quick but credible' inference techniques. CSISA has also launched a new web site (csisa.org), revised its CSISA bulletin, and initiated CSISA Research Notes to better disseminate research findings.

As CSISA's level of impact moves from the field to landscape scale, new tools are required to detect change for monitoring, internal learning, and evaluation. CSISA has teamed up with Oak Ridge National Laboratory and the GEOGLAM initiative to devise the Landscape Crop Assessment Tool (LCAT) concept. Currently under development, LCAT will leverage 'real time' remotely sensed information and geo-spatial analysis to aid certain types of technology adoption assessments, targeting and crop performance forecasting.

Key Findings and Accomplishments

Objectives 1 and 2

– India

- In 2010, the first full year of CSISA in Bihar, there were a total of 17 **zero-tillage service providers** across our working domains. In 2013–14 alone, the hub supported the emergence of 421 additional zero tillage service providers, and now has a network of 1,012 service providers in Bihar.
- Across Bihar and EUP, over **50,000 hectares of ZT wheat** were sown by CSISA-supported service providers, reflecting an area increase of 42% over 2012–13. Econometric studies in farmers' fields suggest that ZT increases grain yields by 458 kg ha^{-1}, a production gain with an aggregate **estimated value of approximately $4,400,000** in 2013–14.
- **Advancement of wheat sowing** has a profound impact on grain yield with progressive declines in productivity from > 5.0 to less than 2.5 t ha^{-1} when planting is shifted from the first half of November to the last half of December. CSISA's field surveys indicate that more than 120,000 ha of wheat now benefit from timely planting in Bihar and EUP. The Government of Bihar has accelerated change by modifying its planting date recommendations based on data-driven advocacy by CSISA.
- To explore **rice establishment options** for increasing yield and maximizing net returns, four techniques (MTNPR, DSR, SRI and PTR) were compared in collaboration with the IARI regional station, Pusa. Results show that paddy yields were similar. However, the net profits were $1032, $838, $822, $741 per ha in MTNPR, DSR, SRI and PTR, respectively. CSISA's efforts to make the promotion of rice establishment methods data-driven are now shifting policy within the Bihar DOA in favor of MTNPR.
- In Odisha, the number of farmers practicing **mechanical transplanting of rice** increased from 40 last year to 1,555 in 2014. With savings of $100 ha^{-1} in establishment costs, demand for this technology is high, particularly in the coastal belt where labor is scare and expensive.
- CSISA prioritizes maize-based systems work with women farmers in Bihar and Odisha. On-farm testing reveals that transformative benefits (ca. > 50% increase in land productivity) are achievable through **cropping system design and diversification** with maize included in triple cropping systems in Bihar.
- To **build market linkages** with maize mills as an enabling factor for intensification and income generation, CSISA organized community consultations with representatives of five poultry feed mills in the dominantly tribal belt in the plateau of Odisha.
- CSISA's work on **modified axial-flow threshing** for rice resulted in new service providers emerging with high levels of profitability (ca. $600/season), a broad customer base (ca. 175 rural families), with significant cost and grain savings achieved by farmer clients.
- In Odisha, as a result of CSISA's collaboration with SHGs, nearly 1,300

women farmers tried at least one improved technology on her own land, and nearly 800 acres spread across five blocks were brought under improved technologies. Similar results have been achieved in Bihar with the formation of the *Kisan Sakhi* women's group.

- On a systems basis, results from Karnal research platform demonstrate that by combining **crop diversification** with CA and precision resource management, crop yields and land productivity can be enhanced (11%) with fewer investments in energy (decrease of 46%) and irrigation (decrease of 71%) while profitability is transformed (increase of 32%).

– Bangladesh

- More than **1,000,000 farmers benefitted from rice varieties** with abiotic stress tolerance (salinity, flooding and drought) or high yield potential.
- The rice, maize and wheat programs **trained** 27,801 farmers in best agronomic practices, with an additional 10,194 farmers trained in advanced aquaculture techniques. Multiplier effects were evident with every farmer receiving assistance from the project enabling a further 1.52 rice, 1.95 maize and 3.59 aquaculture farmers to adopt.
- CSISA-MI's private sector partners co-invested in **machinery commercialization** with more than $800,000, a leading edge indicator of scale potential and rapid market development.

– Nepal

- CSISA research showed that with the same level of inputs and management intensity, **maize hybrids** in the hills can produce > 4 t ha^{-1} more than the local landrace and 2.5 t ha^{-1} more than the best OPV. However, other hybrids were on par with the OPVs, highlighting the importance of data-driven extension messaging.

Objective 3

- Out of 60 **rice** entries tested during the 2014 dry season under machine sown dry direct-seeded rice, 15 entries recorded more than 7.5 tons/ha.

Objective 4

- During the reporting period, 12 **new wheat varieties** were released, 10 were identified for release and more than 2,000 were extended to national and regional partners for evaluation and subsequent release.

Objective 5

- IFPRI held a **private sector roundtable on "Sustainable intensification in South Asia's cereal systems: Investment strategies for productivity growth, resource conservation, and climate risk management"** in New Delhi in May 2014, bringing together a select group of representatives from India's private sector, foundations, and research institutions.

Objective 6

- CSISA launched a research brief series called, "**CSISA Research Notes**," which gives readers access to 2–4 page concise versions of some of CSISA's key research.

India

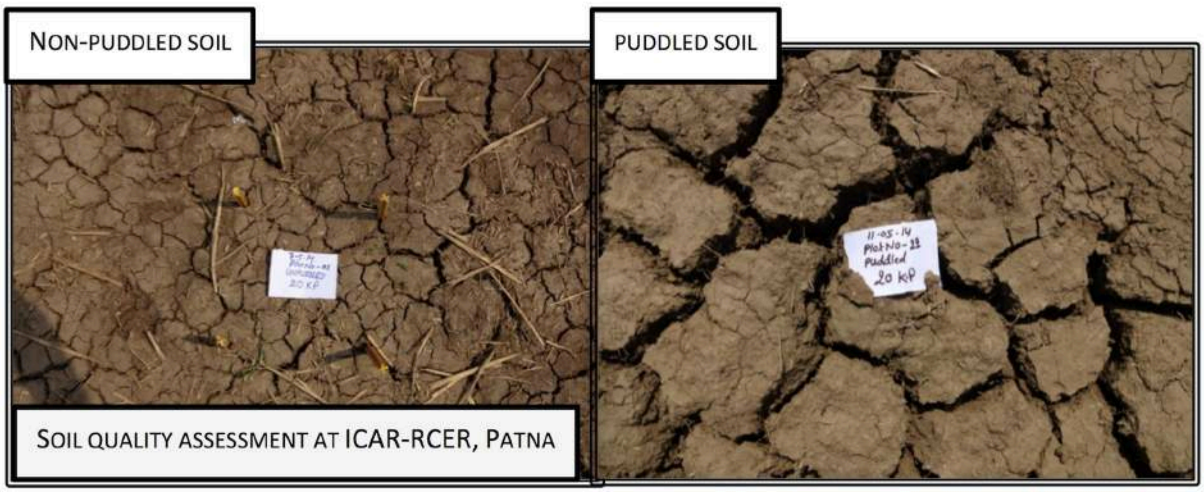
Bihar Innovation Hub

During the reporting period, CSISA's Bihar hub focused on direct seeded rice (DSR) and machine-transplanted non-puddled rice (MTNPR), hybrid rice, hybrid maize, early wheat sowing and zero tillage wheat.

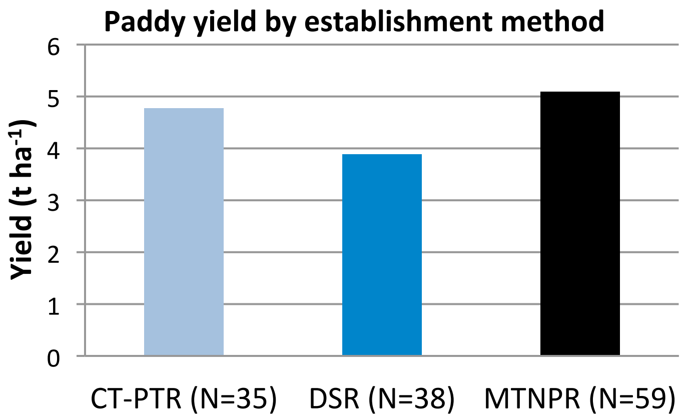
Machine transplanting of rice under non-puddled conditions allows farmers to address issues of labor scarcity and imprecise stand establishment, minimizes transplant shock, facilitates the use of appropriately aged seedlings, and reduces the water requirements for crop establishment, a particularly important consideration in years with a weak start to the monsoon, such as 2014. Further, soil physical properties are degraded with soil puddling, which has near and long-term consequences for dryland crops that follow rice in the crop rotation. CSISA and the Department of Agriculture (DOA), Bihar, have worked together to popularize MTNPR to an expanding base of farmers, and four new machinery manufacturers (VST Tillers, Kisan Kraft, Redlands and Mahindra and Mahindra) entered Bihar through new distribution channels in the current year following the market development efforts prioritized by CSISA. Increased competition has already significantly reduced machinery costs and we anticipate commensurate improvements in machine quality with time. When CSISA was initiated in 2009, mechanical transplanting was an unknown technology in Bihar. In our working domain, service providers for transplanting increased from four in 2012, 22 in 2013, and 48 in 2014.

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.

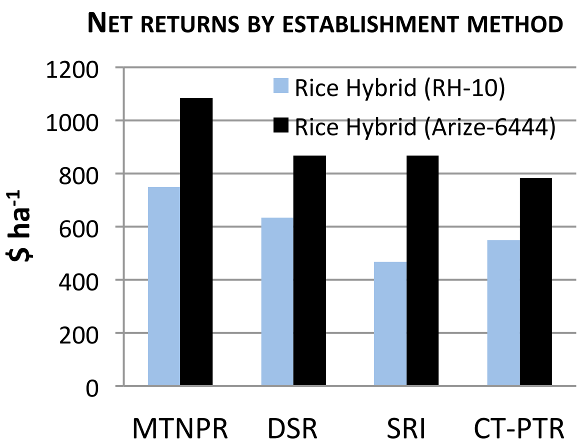
The **Bihar and Eastern Uttar Pradesh (EUP) Hubs** focus on scalable and sustainable technologies that can have a huge impact on system productivity (such as early sowing of wheat), on change agents who can scale up technologies and carry them forward past the life of the project (such as service providers),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



In collaboration with innovative service providers, CSISA mainstreamed best practices for mechanical transplanting, including transplanting of young seedlings (14-day-old) and increased spacing (to 23x19cm)—practices that reduce costs and improve yields. The Bihar Agricultural Management & Extension Training Institute (BAMETI), with whom CSISA collaborates, helped generate broad-based awareness and demand for MTNPR services by circulating a CSISA video among its field officers and extension workers, who subsequently showed the video to large numbers of farmers.



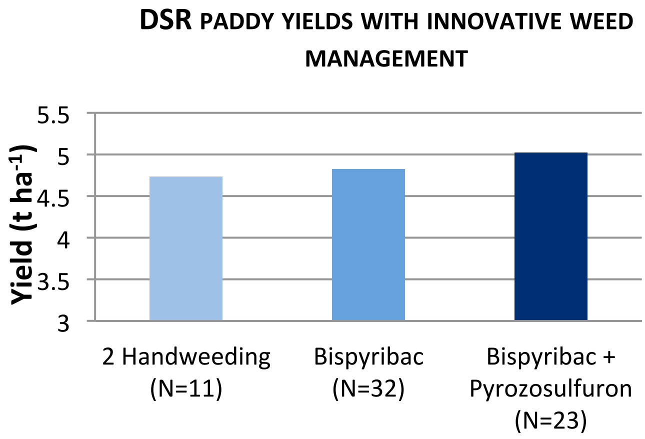
In CSISA's network of on-farm technology evaluations, the average paddy yield with MTNPR was 5.1 t ha^{-1}, compared with 4.8 t ha^{-1} with puddled transplanted rice and 3.9 t ha^{-1} with direct seeded rice. Rice establishment has been a priority area for investment by the Bihar Department of Agriculture for several years. Nevertheless, the empirical basis for these investments, particularly as it pertains to promotion of the System of Rice Intensification (SRI), has been insufficiently established. To explore all established options with the joint objectives of increasing yield and maximizing net returns under conditions where each system is well managed, four rice establishment techniques (MTNPR, DSR, SRI and PTR) were compared in collaboration with IARI regional station, Pusa. Results show that paddy yields of Arize 6444 under all establishment methods were similar, ranging from 7.3 to 8.5 t ha^{-1}, with an edge for MTNPR. However, the net profits were $1032, $838, $822, $741 per ha in MTNPR, DSR, SRI and PTR, respectively. Accelerating labor shortages, coupled with CSISA's efforts to make the promotion of rice establishment methods data-driven, are now shifting policy within the Bihar DOA in favor of MTNPR. CSISA's data demonstrates that this rice establishment technique can increase on-farm profitability by 30–40% while creating new jobs for service providers.



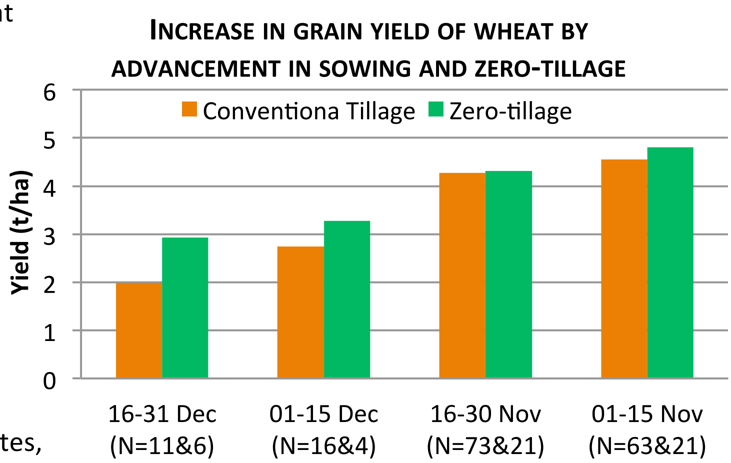
Both MTNPR and hybrid rice (i.e. similar or higher yields with shorter growth duration than common varieties) help to optimize cropping systems by allowing the timely harvest of rice and the early planting of wheat, thereby generating higher productivity at the systems level. According to CSISA's survey of agro-dealers, the sale of rice hybrids is fast increasing, especially in areas where early planting of wheat is taking hold (including Samastipur, Vaishalli, and Begusarai Districts).

Despite continued efforts during the last four years, uptake of **direct seeded rice** was lower than expected. DSR addresses labor availability issue for crop establishment, and also takes advantage of the multi-crop seed drills that farmers and service providers are purchasing for ZT wheat. Nevertheless, several production challenges remain pervasive in CSISA's target ecologies in Eastern India that, without adjustments to prevailing rice management practices, will continue to limit technology adoption. During the 2013 Kharif season, the monsoon was poor and erratic, with no rain for 35 days after the DSR crop had been established. With no floodwaters in place to help suppress weeds during the critical period for control, many fields were overrun with weeds and subsequently abandoned or very low yielding.

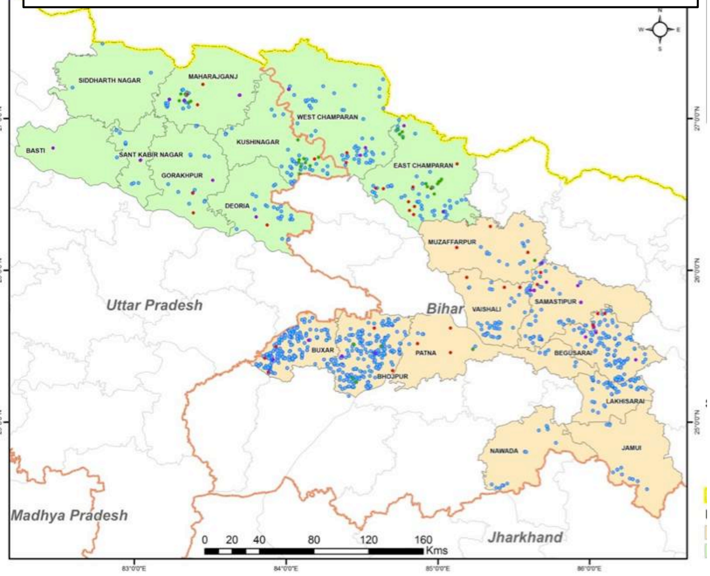
To improve the success of DSR, **integrated weed management (IWM)** was assessed with cultural methods such as 'stale seedbeds' evaluated in tandem with judicious use of modern herbicides. Nutsedge (*Cyperus rotundus*)-dominated complex weed flora in rice was effectively controlled with the tank mix combination of bispyribac with pyrazosulfuron, applied 20–25 days after sowing (DAS). The average paddy yields were 5.0, 4.8 and 4.7 t ha^{-1}. under bispyribac + pyrazosulfuron, bispyribac alone, and two manual weed control treatments, respectively. In the drought-like conditions that prevailed this year, bispyribac ($33 ha^{-1}) and its combinations ($41 ha^{-1}) provided very significant costs savings compared to manual weeding ($206 ha^{-1}) and was favorably perceived by farmers. Moreover, weeding is a time-bound operation that must be completed during the critical period of control. Labor for weeding is often not available at any cost, highlighting the imperative of scaling a diverse suite of management options for weed control in rice. Working with private sector partners, CSISA has helped build new markets for safe and effective herbicides that were previously not available in Bihar or EUP, which are now used on an estimated 85,000 ha. Dealer, service provider, and farmer training on best practices and integrated management (conducted jointly with public and private sector partners) helps ensure that use of new herbicides is sustainable, safe, and economical for farmers.



Early wheat sowing has rapidly expanded this year compared to 2012–13, and is one of CSISA's key successes in India's eastern ecologies, especially in the impoverished east where non-cash management innovations have particular relevance. In Bihar, average wheat grain yield increased in tandem with the advancement of wheat sowing to the first two weeks of November. CSISA has now established that early planting provides a scale-neutral pathway for sustainably increasing wheat yields while building resilience to terminal heat stress. With conventional tillage, wheat yields in the first half of December (2.7 t ha^{-1}) were 1.8 t ha^{-1} lower than those achieved with timely planting in the first half of November (4.5 t ha^{-1}). Across different planting dates, additional yield advantages were observed with zero tillage (ZT) and ranged from 0.1 to 0.9 t ha^{-1}, with greater advantages observed at later planting dates.



CSISA'S NETWORK OF SERVICE PROVIDERS IN BIHAR AND EUP (ONE DOT DENOTES A SINGLE SP)

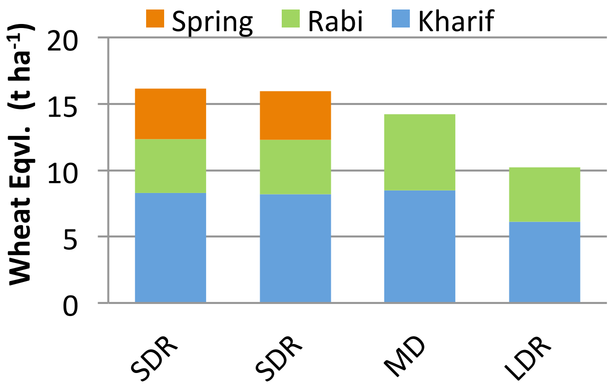


In 2010, the first full year of CSISA in Bihar, we estimate that there were a total of 17 zero-tillage service providers across our working domains. In 2013–14 alone, the hub supported the emergence of 421 additional **zero tillage** service providers, with a total strength of 1,012. CSISA trained these SPs on technical issues, financial and business literacy (through record-keeping logbooks), and connected them to extension services as well as private sector partners through jointly sponsored training events. The later is particularly important to ensure access to machinery repairs, inputs, and technical advice that will be sustained beyond the life cycle of CSISA. Socio-economic surveys have identified technology awareness as the most limiting bottleneck for ZT expansion, and CSISA and the DOA undertook joint social marketing campaigns with grassroots extension workers of the DOA to encourage farmers to take up early wheat sowing and zero tillage. As practiced by farmers and service providers, a survey of more than 1,000 ZT adopters demonstrates that the combination of yield enhancement and cost-savings with ZT increases profitability by \$53 ha^{-1} – an increase in gross margin of 13%. In the current Rabi season (2014–15), DOA has adjusted its field program and taken up zero tillage as their first priority.

The average net profit of 51 surveyed SPs was \$472 per season after accounting for the costs of the ZT seed drill. Scaled across the total number of SPs supported by CSISA, this implies net annual profit generation among service providers currently supported by CSISA in Bihar and EUP of almost \$600,000 for ZT alone. Even if seed drill purchase subsidies currently provided by the DOA are discounted, service providers are still profitable in the first year of business (ca. \$372). Further, CSISA's surveys show that most service providers are expanding their businesses with the mean area serviced in Bihar jumping from 13 ha in 2010 to 55 ha in 2012, implying increased profitability and business generation with time.

CSISA research found that all **long-duration wheat varieties** exhibited better performance when sown early. Based on data from 186 sites, the grain yield of wheat is directly proportional to the number of days a variety was in the field before the onset of terminal heat—around March 25. Wheat varieties including HD 2967, HD 2824, HD 2733, and PBW 502 which are all long-duration varieties, showed substantial yield benefits at 5.2, 5.0, 4.8 and 4.5 t ha^{-1} over shorter duration alternatives such as PBW 373, Lok 1, PBW 154 and HUW 234 with a grain yield of 3.3, 3.0, 2.5, and 2.4 t ha^{-1}, respectively. CSISA's survey of seed dealers shows that the project's

CROPPING SYSTEM OPTIMIZATION



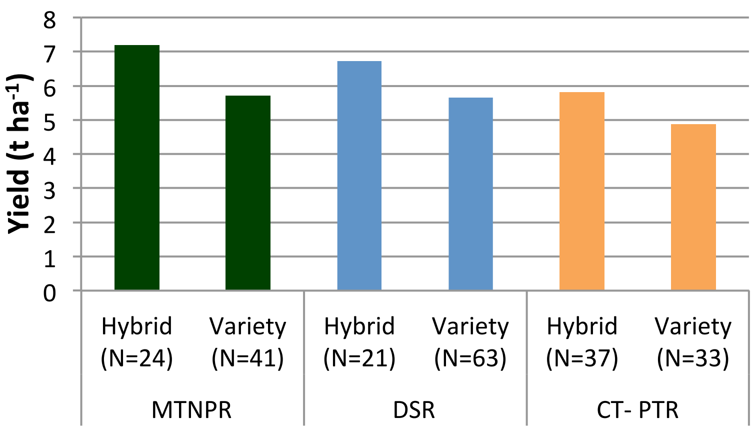
messaging on the value of longer duration varieties is taking hold at scale with dealers reporting sales declines for shorter duration wheat varieties on the order of 10 to 21% from the previous year. Coupled with sales data for hybrid rice, our data clearly shows that farmers in CSISA's target domains are transitioning to high-yielding and resource-efficient systems based on long-duration wheat and short-duration rice.

CSISA prioritized **maize-based interventions with women farmers**, since women play a comparatively larger role in the management of these systems. The intercropping of maize and potato helped increase the maize equivalent yield from 6.2 t ha^{-1} (with maize as sole crop) to 10.8 t ha^{-1} when maize was intercropped with potato. Participatory on-farm trials for systems intensification also showed that short-duration hybrid rice followed by mustard and followed by spring maize provided a wheat equivalent yield of 16.2 t ha^{-1} compared to 16.0 t ha^{-1} with short-duration hybrid followed by mustard followed by mungbean, 14.2 t ha^{-1} with medium-duration rice hybrid followed by long-duration wheat, and 10.3 t ha^{-1} with long-duration rice followed by long-duration wheat. The latter is the prevailing system in CSISA target domains, and CSISA's work demonstrates that transformative benefits (ca. > 50% increase in land productivity) are achievable through **cropping system design and diversification**.

Eastern Uttar Pradesh (EUP) Innovation Hub

Based on on-farm evaluations of MTNPR, DSR and CT-PTR, paddy yields with hybrids were 7.2, 6.7 and 5.8 t ha^{-1}, respectively. A similar pattern was evident with rice varieties, with average yields of 5.7, 5.6 and 4.8 t ha^{-1}, respectively. On average, the high paddy yield in DSR—compared to conventionally transplanted rice—highlights the need to appropriately target this technology to production ecologies where it is most likely to succeed. In contrast to many areas in Bihar where DSR has been compromised by complex weed flora and high weed densities, many areas in EUP where DSR performance has been on par with MTNPR have been in lowland ecologies where weed pressure is comparatively low. Based on CSISA's network of on-farm technology evaluations, we are now prioritizing DSR in these ecologies.

PADDY YIELD BY ESTABLISHMENT METHOD

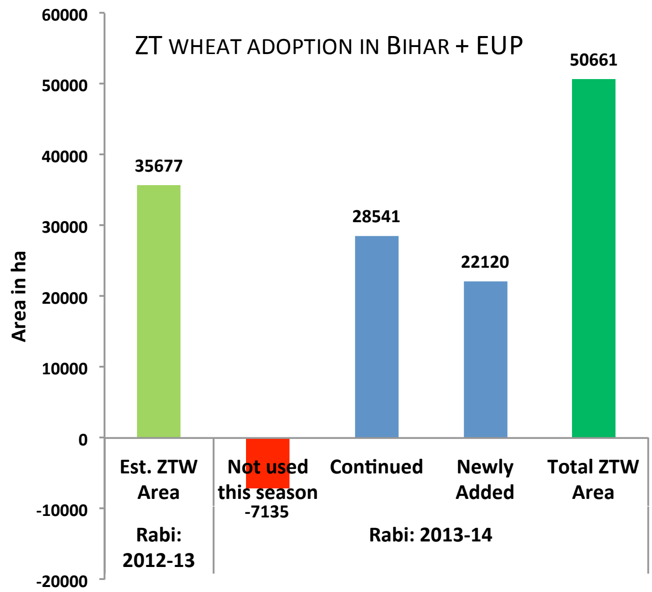


Across establishment methods, the average paddy yield of hybrids was 6.5 t ha^{-1}, which was 18% higher than for older conventional varieties with the same level of inputs and management intensity. Market survey data suggests that more than 65,000 ha in Bihar and EUP are now being cultivated with hybrids and modern varieties, due in part to CSISA's efforts to quantify and disseminate the performance advantages of shifting from older varieties.

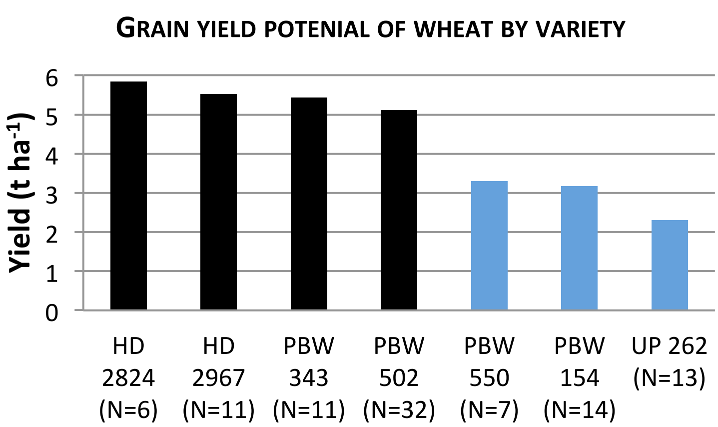
FORGOING FIELD DRYING OF RICE HELPS ENSURE TIMELY WHEAT PLANTING

To support early wheat sowing and zero tillage, as well as to increase the profitability of rice cultivation, CSISA has encouraged **mechanical threshing of rice** to avoid sun drying in the open field. Field drying can delay the sowing of wheat by as much as two weeks. Mechanical paddy threshing, compared to manual threshing, also reduces post-harvest grain loss by 3%, while reducing labor costs and drudgery. CSISA has supported the emergence of 54 paddy thresher service providers and each SP has earned an average profit of $1,286 in their first year of operation—even after accounting for the capital costs of the machinery. Mechanical threshing is seen as a critical intervention to the future success of advancing wheat sowing. In order to further increase the adoption of this technology, CSISA modified the existing axial flow thresher, which facilitated maintenance of full-length straw by reducing the pulley diameter. Farmers prefer this modification because it facilitates the use of straw as livestock fodder after threshing.

Aligned with results from Bihar, the **advancement of wheat sowing** has a profound impact on grain yield with averages of 5.4, 4.9, 3.1 and 2.4 t ha^{-1} in CSISA's network of on-farm testing, with progressively later two-week sowing windows from November 1st through December, respectively. CSISA's key informant survey indicates that early wheat sowing has been even more successful in EUP than in Bihar, with more than 80,000 ha now benefiting from timely planting.

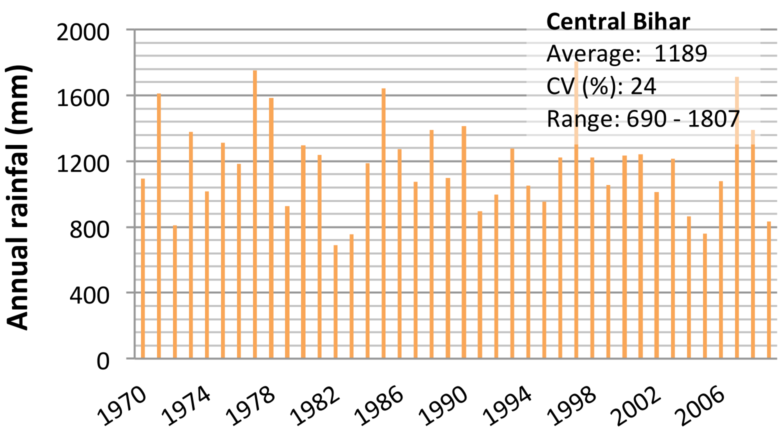


The grain yield of wheat from **zero tillage** in the corresponding range of sowings were 5.5, 4.9, 3.1 and 2.3 t ha^{-1} compared to 5.0, 4.7, 3.0, and 2.3 t ha^{-1} under conventional tillage. These gains are not simply theoretical. Across Bihar and EUP in 2013–4, over 50,000 hectares of ZT wheat were sown by CSISA-supported service providers, reflecting an area increase of 42% over 2012–13. Econometric surveys in farmers' fields (n=1,000) suggest that, with all other management factors held constant, ZT increases grain productivity by 458 kg ha^{-1}, a production increase with a value of $87.6 ha^{-1}. Scaling this estimate across all areas under ZT adoption in Bihar and EUP suggests an increased aggregate economic value of wheat with ZT of over $4,400,000 in 2013–14 alone. Just as encouragingly, village-level surveys (n=240) from this past Rabi season demonstrate that smaller farmers (< 0.4 ha) are adopting zero tillage through service provision at the same rate as their larger neighbors and that, by and large, farmers are transitioning their entire wheat crop to ZT–demonstrating the emerging confidence that farmers have in this technology. Insights into adoption dynamics for ZT from socio-economic surveys suggests that technology awareness and penetration of service provision are the core limiting factors for uptake, and CSISA is aggressively addressing both factors through social marketing and support for ZT entrepreneurs.



In CSISA's on-farm trials in EUP, **long-duration wheat varieties** performed better than short-duration varieties. Averaged over dates and crop establishment methods, long-duration varieties including HD 2824, HD 2967, PBW 343, and PBW 502 nearly doubled the yield achieved from the common short duration varieties PBW 550, PBW 154 and UP 262. Even though the yield potential of long-duration varieties is reduced under late sowing, yield levels are comparable to short-duration varieties under those conditions, suggesting broad adaptability for long-duration varieties over a range of sowing dates and differences in growing-season climate conditions. Sales surveys at the agro-dealer level has confirmed that the market share of long-duration varieties is rapidly increasing, and they now are planted on approximately 19,500 ha in the project's prioritized geographies in Bihar and EUP, in no small part due to CSISA's efforts and the synergies achievable with early planting.

Complex weed flora dominated by *Phalaris* has emerged as a major threat to wheat productivity in EUP. In addition to early sowing and zero tillage, which help reduce the population of *Phalaris*, CSISA has advocated the use of sulfosulfuron- or clodinafop-based **herbicide mixtures**. The successful control of such weed flora with these mixtures resulted in an average grain yield of 4.6 and 4.1 t ha^{-1} against an average of 2.9 t ha^{-1} with the use of the older herbicide 2,4-D, which is commonly used in EUP and Bihar. CSISA has disseminated messages about effective weed control through service provider logbooks, handbooks on weed management, and regular trainings of extension staff in both the public and private sectors.



By nature, the monsoon in India is highly erratic and farmers must be prepared for excess and deficit conditions, often within the same growing season. CSISA has explored the scope for increasing resilience to monsoon failure by evaluating maize production in upland landscape positions in Bihar. While maize performs very well under a weak monsoon, it can be damaged under excess moisture conditions (see Objective 2 for anaerobic germination traits in hybrids). Bed **planting in maize** ensures better drainage and growth conditions in wetter years (4.8 vs. 4.0 t ha^{-1} with planting on the flat in 2014). Although primarily associated with gains in irrigation efficiency during the dry season, **laser land leveling** (LLL) also has an important role to play in coping with precipitation excess and deficit by ensuring whatever precipitation does fall is well-distributed within the field. Bihar and EUP hubs have supported the emergence of 26 SPs for LLL.

In Focus: *Early wheat sowing wins farmers' confidence*

FARMERS ASSESS WHEAT AT MATURITY

SEEING IS BELIEVING: FIELD DAYS AT HARVEST SPREAD THE WORD ON THE VALUE OF EARLY PLANTING

The negative impacts of high temperatures at the beginning of a wheat season and terminal heat at the time of grain filling have led to pessimism among farmers and extension agencies about the profitability and viability of wheat cultivation in the eastern Indo-Gangetic Plains. In 2009, CSISA launched a campaign in Bihar and Eastern Uttar Pradesh (EUP) to promote early sowing of wheat to combat the negative effects of rising temperatures. Due to ingrained habits and recommendations from the Departments of Agriculture (DOA), very few farmers were willing to sow their wheat before November 15, even on a trial basis.

In 2009, only four farmers in Eastern UP agreed to sow their wheat early. Encouraged by early successes, albeit with a small footprint, CSISA steadily increased the area under early sowing (i.e. before November 15th). In 2010–11, the public harvesting events demonstrated early planting resulted in a grain harvest of 6.1 t ha^{-1}. In 2011–12, early planting achieved more than 7.0 t ha^{-1}, and the harvesting operation was undertaken in collaboration with the DOA, a result that was replicated this past year in both Bihar and EUP. To place these on-farm grain yields in context, the average productivity in CSISA's working domain is around 2 t ha^{-1} and those achieved in Punjab (the 'prime' wheat basket of India) average 4.5 t ha^{-1}. In 2012 and 2013, we further mainstreamed our approach by joining the DOA's pre-season planning meetings, where extension workers developed their action plans for the following wheat season—an approach that permitted CSISA to gain significant spillover effects beyond our immediate working areas.

Based on recent surveys conducted by CSISA, the number of farmers planting wheat early has risen rapidly, reaching 0.34 million farmers in Bihar and 0.28 million in EUP hub domains. Two additional interventions were also promoted: zero tillage, which permits wheat to be planted quickly, and long-duration varieties, which lead to higher yields with early planting. The most important component of CSISA's strategy has been our strategic collaboration with the DOA, whose annual guidance to farmers strongly influences farmers' willingness to innovate. CSISA also closely engages with DOA's district-level agriculture officers, the department's 'boots on the ground', to ensure message consistency and to provide technical backstopping. This collaboration speeds dissemination of new technologies, and provides a strong foundation for sustainability.

In Focus: *On-farm performance of zero tillage*

FROM A VERY LOW BASE IN 2009, CONTIGUOUS TRACTS OF ZT WHEAT ARE INCREASINGLY COMMON IN BIHAR AND EUP

Zero-tillage (ZT) is a cornerstone sustainable intensification technology that has demonstrated considerable agronomic, economic, and environmental benefits in controlled-condition field trials across South Asia. However, few studies have systematically characterized performance in farmers' fields in the stress-prone ecologies of eastern India.

In the context of the E-IGP, scaling capital-intensive technologies like ZT in is predicated on enhancing service provision. CSISA is studying the business dynamics of service provision to best target training programs and other enabling factors for SP expansion.

To assess the performance of ZT wheat in farmers' fields, data were collected in a random sample of 1,000 farm households with ZT users and non-users spread across 40 randomly selected villages in six districts of Bihar. Among the sample, ZT wheat plots produced an average yield gain of 202 kg ha^{-1} (7.7%) over conventional-tillage (CT) wheat plots while using 12.3 kg ha^{-1} (8.8%) less seed. ZT reduced crop establishment costs by \$25 ha^{-1} (45.9%), on average. Although herbicide and pesticide expenses were higher on ZT wheat plots, the absolute amounts remained low; in total, capital input was \$36 ha^{-1} (15.2%) lower on ZT wheat plots; together with the yield increment this resulted in an average gain in gross margin of \$53 ha^{-1} (13.7%) compared to the conventional practice.

However, these observed ZT benefits may be misattributed or even under-estimated due to systematic differences between ZT users and non-users with respect to input use and crop management skills. To control for this potential selection bias we use Cobb-Douglas type stochastic production frontiers to estimate the effects of ZT on wheat yields with a *ceteris paribus* approach. By holding all other factors of production constant, we upwardly revise the estimate yield increment associated with ZT adoption to 17.5%. Relative to the average yield of CT wheat of 2,620 kg ha^{-1} this equals an estimated absolute gain of 458 kg ha^{-1}, valued at \$89 ha^{-1}, which is in line with findings from controlled studies in the E-IGP. The considerable difference between the observed and estimated yield and monetary gains is caused by significantly lower capital and labor inputs on ZT wheat plots. In part, this can be attributed to the ZT technology itself (e.g., cost savings in crop establishment), but part of it may be due to selection bias between ZT users and non-users. Overall, based on a large random sample, the study verifies that farmers in Bihar do reap substantial monetary benefits from current ZT practices.

Smallholder access to the beneficial ZT technology hinges on ZT services being provided by wealthier tractor owners. Our analysis shows that it is the large and well-educated farmers with extensive social networks who are most likely to engage in ZT service provision. However, among this group, it is the relatively smaller farmers and those with a relatively low own-farm productivity who are most likely to provide ZT services at a larger scale. Comparatively low returns from agriculture reduce the opportunity costs of engaging in service provision, thus making it a more attractive additional income source.

In Person: *The business case for new techologies*

In order to help bridge the gap between the demand for new technologies and the supply of those services, CSISA focuses on strengthening individual entrepreneurs who can spend time and other resources providing custom-hire services to fellow farmers in their area. These are CSISA's service providers.

A SERVICE PROVIDER WITH RICE SEEDLING MATS IN BIHAR

PARMANAND PANDEY AND HIS RICE TRANSPLANTER

In 2012–13, CSISA provided training and support to 775 service providers (SPs) in Bihar and EUP; in 2014, the number rose to 1,400. SPs received training on technologies such as zero tillage, machine transplanting of rice, direct seeded rice, laser land leveling, mechanized harvesting and threshing and better bet management practices. CSISA also provided training on financial management, giving SPs logbooks that allow them to track their income, expenditures and hectares serviced. CSISA also facilitates linkages between SPs and the state Department of Agriculture for technical backstopping and with dealers and distributors, who provide key inputs.

Creating a cadre of SPs has allowed CSISA to reach farmers who are otherwise unreached by capital or knowledge-intensive technologies. For smallholder farmers, the ability to avail custom-hire services rather than buying new machines can boost yields while immediately reducing production costs (e.g. with ZT) without incurring the types of debt that are common with most productivity-enhancing investments. CSISA's survey data of the production economics of rice show that farmer's who purchase labor for manual transplanting can save around \$100 ha^{-1} in crop establishment costs by transitioning to mechanical transplanting without soil puddling. Hence, the economic case at the consumer level is strong and immediate.

Mr. Parmanand Pandey purchased a mechanical transplanter in 2013 and struggled to clear a profit in his first year of operation with a margin of only \$40. With guidance from CSISA and an expanded footprint of operations, Mr. Pandey earned a net income of \$712 from mechanical transplanting in 2014, after accounting for depreciation and loan interest. At this level of profitability, his payback period will be approximately two years. He also diversified his business by producing his own mat-nursery seedlings, which further increased his profits by \$286.

CSISA is also working with partners to bring down machinery costs through diversifying the number of manufacturers distributing transplanters in Bihar and encouraging competition. In 2013, unit costs were greater than \$3,500 per machine but came down to \$2,600 in 2014.

By empowering service providers with technologies that have a strong business case at every step along the value chain, CSISA works to facilitate the uptake of sustainable intensification technologies that would otherwise be beyond the reach of most farmers.

Odisha Innovation Hub

The **Odisha Hub** works in the districts of Puri, Bhadrak and Mayurbhanj, and on machine transplanting in puddled rice, direct seeded rice, better-bet agronomy for rainfed maize, zero tillage for green gram and mustard, post-harvest technologies, and collaboration with women's groups to disseminate technology that specifically meets the needs of women farmers.

Unlike in most areas in the Indo-Gangetic Plains that benefited from many years of investment and innovation (e.g. through the Rice–Wheat Consortium), CSISA's priority technologies have not been extensively evaluated in Odisha, and awareness of sustainable intensification technologies among most farmers is essentially non-existent. From a low base, the adoption of CSISA-promoted technologies in 2013–14 has been steady, reaching 3,939 farmers on an area of nearly 2,700 ha. Our partnership with the Odisha DOA and support to newly created service providers through hands-on trainings (for example on the raising of mat-type nurseries and the operation of paddy transplanters) has accelerated the adoption of technologies—for example, the number of adopters of machine rice transplanting increased 42 times and the area increased 12 times in 2013–14 compared to 2012–13.

In the Odisha hub domain, paddy yield performance with mechanical transplanting into puddled soil (MTPR) averaged 4.8 and 5.2 t ha^{-1} in Bhadrak and Puri, respectively. The corresponding paddy yields from **machine transplanting of non-puddled rice (**MTNPR) were 4.6, 5.6 and 4.0 t ha^{-1} in Bhadrak, Puri and Mayurbhanj, respectively. These results demonstrate that the costly, water-consumptive and soil-damaging impacts of puddling can be avoided without reducing rice yields in mechanically transplanted systems. On average, the paddy yield from both types of mechanical transplanting were statistically the same, but were consistently better than manual transplanting with yield gains ranging from 0.5 to 1.0 t ha^{-1}. The adoption rate of MTNPR is still very low, which indicates the need for more awareness about this technology. The work that has been carried out in 2013–14 shows that the direction of technology adoption has begun to change in favor of machine transplanting.

Odisha has significant area under broadcast-sown DSR spread across CSISA's three districts. Under this form of broadcasting, farmers use high seed rates and subsequently use '*beushaning*' (i.e. post-establishment tillage) to thin initially high plant populations and control weeds. Under these practices, costs are high and yields are typically very low. CSISA has partnered with the DOA to introduce **DSR with line sowing** using zero till seed drills. In comparison to traditional broadcast methods, DSR with line sowing consistently and substantially improved the productivity of rice from 3.0 to 4.0 t ha^{-1} in Bhadrak, from 3.5 to 5.1 t ha^{-1} in Puri and from 2.3 to 3.3 t ha^{-1} in Mayurbhanj. In areas with double-cropped rice systems, CSISA has observed some problems with weed management from 'volunteer' rice from the previous crop, which may limit expansion of DSR in the Rabi season.

In the plateau region of Mayurbhanj District, grain yields of **maize under line sowing** and **better bet agronomy** (optimum population, proper weed management and nutrient management) were 4.5 and 5.2 t ha^{-1}, respectively, against an average yield of only 3.0 t ha^{-1} under existing farmers' practice. These results were achieved under rainfed conditions during the Kharif season on the nutrient-depleted, lateritic soils that dominate Odisha's plateau region. These areas are often dismissed as too risk-prone and resource-degraded to support high crop yields. CSISA's work has opened the eyes of famers, DOA, and other partners to the yield and economic returns achievable for rainfed maize in these areas with sound agronomic management. Based on 30 demonstrations, maize grain yield increased from 2.5 t ha^{-1} from farmers' practice to 3.9 t ha^{-1} from precise stand establishment achieved with line sowing using a multi-crop ZT planter.

Farmers in Mayurbhanj, including tribal farmers—who constitute more than half the population—directly consume maize and generate income by sale of 'fresh' green cobs. Most of the maize production comes from water-limited upland areas where rice cannot be grown. While the sale of green cob can be remunerative, it is a perishable commodity which cannot be stored and local markets often become saturated with product, leading to lower prices and 'distress' sales. At the regional scale, there are very large markets for dry grain among feed and food millers. However, these end-users source maize in bulk (not from individual farmers) and none of the established feed mills in Odisha are purchasing maize grain from the eastern plateau region of the state. In order to highlight the maize production potential in Mayurbhanj that is achievable with better-bet crop and soil management and to build potential market linkages with mills, CSISA organized a site visit and community consultation with five poultry feed mills (Eastern Hatchery, Pasupati Feeds, Amrit Feeds, Diamond Agro-Vet, Godrej Agro-Vet) in consultation with district-level officers of the DOA. The following points emerged from the September 2014 consultation:

- Grain quality is a must, especially acheiving appropriate mositure content at the farm level since grain drying capacity at the mills is limited.
- In order to facilitate bulk purchase, product aggregations has to be accomplished through collection centers either by commission agents, traders or commodity groups.
- In the plateau areas of southern Odisha (Nabarangpur District), maize markets for grain have rapidly developed and lessons can be learned for the eastern plateau.

FALLOWS DEVELOPMENT WITH WOMEN FARMERS

At the same time that new technical options for improved post-harvest management are being evaluated with farmers and potential service providers, CSISA is organizing knowledge exchanges and site visits with progressive maize farmers, community group leaders, and grain traders in Nabarangpur. As part of this initiative, CSISA is collaborating with the KIIT Institute of Rural Management to seek opportunities to strengthen maize value chains across Odisha. Integrating technological innovation with market-development approaches forms the basis for CSISA's 'theory of change' for achieving durable impacts at scale in places such as Mayurbhanj.

CSISA also focuses on **crop diversification** in Odisha, identifying important niches for crops like wheat and chickpea in partially irrigated areas of the plateau. CSISA introduced the short-duration wheat variety Baaz, and early feedback from farmers suggests that significant yield gains are possible as Baaz is well suited for the climate and the limited irrigation water available in the Odisha plateau. With optimum fertilizer + weed management, the grain yield of Baaz was 4.0 t ha^{-1} against an average of 3.0 t ha^{-1} under prevailing farmer practices.

Many areas of the coastal plain (>50% in some pockets) are un-irrigated and currently either fallowed or cultivated with 'low input–low output' pulse systems during the winter Rabi season. To speed rice harvest and reduce turn-around time between crops, CSISA has coupled axial flow thresher technology for rice with zero tillage crop establishment methods for mungbean, mustard, and gram. These approaches synergistically conserve soil moisture and improve rainfed crop performance.

In Focus: *Mechanical transplanting expands in Odisha*

Mat nursery ready to be transplanted

Rice field after mechanical transplanting

In Rabi 2013–14, CSISA significantly expanded its work on mechanical transplanting of puddled and non-puddled rice (MTPR and MTNPR) in Odisha. From a very low base of 40 farmers adopting MTPR on 40 ha in 2013, CSISA now supports uptake of mechanical transplanting for 1,555 farmers covering 1,747 ha. In addition to assisting existing service providers to make the best use of their machines, 20 new service providers purchased transplanters in 2014. CSISA provided hands-on training for entrepreneurship development around mat-type nurseries and MTR to 74 existing service providers and 167 others with interest in business formation, and technical training on machine transplanted rice to 936 farmers across the hub's three districts of Puri, Bhadrak, and Mayurbhanj.

Mechanical transplanting is piquing interest among farmers because it addresses the major problems of labor scarcity and the high cost of labor. CSISA data shows that mechanical transplanting saves farmers about $100 per hectare when purchased through service providers. CSISA provided hands-on training to these SPs for 2–3 weeks prior to the Kharif season so that they can become "Master Trainers" for new SPs.

In order to support mechanical transplanting SPs in Odisha, CSISA is: increasing awareness about the technology, linking SPs with machinery dealers and allowing dealers to use CSISA platforms for demonstrating the technology to farmers, facilitating successful SPs to share their experiences with other SPs and potential SPs, and helping SPs evaluate the profitability and 'business case' for the technology. SPs are linked with machine dealers not only to increase the catchment area of dealers but to help them negotiate machinery prices.

The success of MTNPR in Puri district has demonstrated an additional pathway forward to save costs and increase system-level productivity. Gunonidhi Pradhan, a smallholder farmer, was not convinced at first when CSISA suggested that he try non-puddled transplanted rice. When finally convinced, Gunonidhi agreed to implement MTNPR on 1.6 acres. He found that he could control weeds successfully with herbicides, but also that his field did not suffer damage from flooding in early August, as drying was faster in non-puddled fields than other fields. Gunonidhi said that earlier, he assumed that "Rice cannot be grown without puddling because of the possibility of more weeds" (*Mu kalpana kari paru na thili-dhana kipari bina kaduare ropana karajai pariba? Ghasaku nei mu khub bhayabhita thili*). However, after his success with MTNPR, he now expects to expand his area in the next season.

In Person: *Hybrid maize thrives in Odisha's plateau region*

Chaitanya Majhi with his improved, hybrid maize crop

Jay Maa Ambica SHG with their maize

Nearly fifty percent of the potentially arable land in the plateau areas of Mayurbhanj district of Odisha is considered 'upland' (e.g. unsuited for rice), much of which remains either fallow or extensively cultivated during the principal Kharif cropping season. When the mainly tribal farmers in the region do grow crops like maize in the upland area, the reward on investment is meager due to low productivity (i.e., 1.5–2 t ha^{-1}) because of poor agronomic practices due to knowledge gaps. To combat these constraints, CSISA has been working with tribal farmers to increase maize productivity by adopting low-cost best agronomic practices and to enhance profitability and reduce risk by linking farmers with new and established markets for maze grain.

Chaitanya Majhi, 41, a physically challenged tribal farmer from Kasipal village of Jashipur block, has grown maize on 1.5 acres for the last 10 years. Last year his net profit was $213 using traditional agronomic practices. In 2014, under CSISA's guidance, he cultivated hybrid maize in the same 0.4 ha area and adopted improved technologies such as line sowing using seed drill, new herbicides, timely nutrient management and timely sowing. As a result, he transformed the profitability of his enterprise to $931 by more than doubling his yields from 2.4 t ha^{-1} to 5.4 t ha^{-1}. Realizing Chaitanya's success with improved maize cultivation, other maize growing farmers from this village are keen to adopt the technologies next Kharif season.

Similarly, 12 tribal women farmers belonging to the Jay Maa Ambica self-help group of Nua Deogaon village opted for collective maize cultivation on two hectares of barren land. Initially they had some apprehension about maize cultivation on fallow land since that land had not been cultivated for the last five years—by banding together and taking risks as a group, these fears were assuaged. With an investment of $557, the group has already earned $578 by selling 3.5 tons of green cob. They expect to earn an additional $983 from the sale of dry grain. Besides the financial benefit, family members of these 12 households and their relatives have consumed nearly 250 kg of green cob, increasing nutritional security during the lean period during rainy season. Moreover, livestock under-nutrition has also been addressed through the high quality fodder produced by maize and these farmers have learned how to optimize its value through chopping and technical guidance provided by ILRI staff. Collective maize cultivation by the women's self-help group has been an eye-opener for the villagers and other SHGs, who are now showing interest in taking up collective maize cultivation next season.

Haryana Innovation Hub

CSISA staff has showcased and disseminated technologies through the creation and capacity building of service providers, field demonstrations, field days, travelling seminars, videos, and trainings. As a result, awareness and adoption of CA-based crop management practices in rice–wheat systems of Haryana are growing. During the reporting period, the hub promoted **zero-tillage** and **residue management in wheat** and **diversification** through triple cropping of rice-based cropping systems. The hub also evaluated the performance of the **dry seeded rice** that was promoted by CSISA in 2013.

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.

Zero-tillage and residue management in wheat: CSISA has made significant contributions towards the large-scale dissemination of ZT wheat in Haryana. With the efforts of SAU, State DOA, Farmers' Commission and CSISA, ZT wheat was planted on about 210,000 ha in 2013–14. The Turbo Happy Seeder provides an alternative to rice residue burning by enabling direct drilling of wheat into standing or loose residue of a previous rice crop. During Rabi 2013–14, the DOA implemented 260 ha of demonstrations on residue management in wheat through the Turbo Happy Seeder. More than 350 ha have been planted using the Turbo Happy Seeder this year, as compared to 180 ha in 2012–13. CSISA directly contributed towards 125 demonstrations covering 220 ha on residue management in wheat across the hub domain. Crop cut data from 50 fields shows that net returns were higher by \$120 and \$135 under ZT and ZT+R respectively compared to conventionally tilled plots. The grain yields were 5.2, 5.45 and 5.56 t ha^{-1} under CT, ZT and ZT+R, respectively.

Diversification through intensification of rice-based cropping systems: As compared to rice–wheat systems, short duration rice followed by potato followed by spring maize has emerged as a profitable system in potato growing areas of Haryana. The results of CSISA's demonstrations on planting spring maize after potato are very encouraging. With CSISA's efforts, in close collaboration with state department and SAU, the area under spring maize after potato has increased to 10,000 ha.

Dry seeded rice (DSR): The area under dry-seeded rice in Haryana has increased from 226 ha in Kharif 2009, to 8,000 ha in 2012, and to 10,800 ha in Kharif 2013. Based on data from 86 crop cuts in 2013, it was found that DSR provides multiple benefits to farmers compared to conventional puddled transplanted rice, including a reduction in cultivation costs by \$90 ha^{-1}, similar grain yields, and significant savings in irrigation water.

Trainings/field days/events: During the reporting period, there were 10 trainings, travelling seminars, or field events organized to build the capacity of the stakeholders. Participants included 1,471 farmers, 81 extension officers, and 87 scientists.

Recognition and awards to CSISA farmers: Multiple farmers associated with the Haryana hub are being honored for their significant contribution to CA. Two farmers from farmer cooperatives closely working with CSISA were awarded \$830 each from the Chief Minister of Haryana. One of the farmers received \$1,630 for the development of his village by the Chief Minister of Haryana. Five CSISA farmers also received "best farmer" awards from Central Soil Salinity Research Institute during the Rabi Kisan Mela.

In person: *Champion spreads CA technology in Haryana*

HARPREET SINGH IN HIS FIELD WITH NEIGHBORING FARMERS

HARPREET RECEIVING AN AWARD FROM THE CHIEF MINISTER OF PUNJAB

Harpreet Singh is a progressive farmer from Kalvehdi village of Karnal District in Haryana. He first contacted CSISA in 2011 to learn about dry seeded rice (DSR), a resource-reducing and cost-effective rice establishment technique. Harpreet attended a CSISA training program on DSR at Karnal Kisan (Farmer's) Club prior to the season, and then requested CSISA to demonstrate DSR at his farm that very season. CSISA later demonstrated other new resource-efficient technologies and management practices at his farm including zero tillage wheat, rice residue management using the Turbo Happy Seeder, rice and wheat cultivar evaluation under DSR and ZT, and new irrigation systems for direct sown rice–wheat systems.

After gaining confidence in these technologies, Harpreet came forward to help scientists and extension staff explain the merits of these technologies as well as refine them to suit to local farmers' conditions. He offered his land and his experience to the researchers and extension personnel, and he started promoting conservation agriculture-based techniques to his fellow farmers by providing technical backstopping. He also formed the "Conservation Agriculture—Small Farmers Association, Kalvehdi."

Harpreet practiced DSR on five hectares during Kharif 2011. After seeing Harpreet's final harvest, other farmers became ready to implement DSR, hoping it would also help alleviate constraints associated with labor shortages during transplanting, high water requirements for puddled transplanted rice, and escalating production costs. During Kharif 2013, the farmers' society expanded their area under DSR to 80 hectares. Similarly, their area under zero-tillage and residue management reached 49 hectares during Rabi 2013–14.

Scientists and extension agents from State Agricultural University, NARES, State DOA, private companies and farmers regularly visit these sites. More than 200 people from the public and private sectors, including many important policymakers, have visited Harpreet's farm. He has helped form four more farmers' societies and provides them technical support.

Because of his contributions to promoting these technologies, Harpreet has received many awards. In 2012, he was honored by the Chief Minister of Haryana with an award for his outstanding contribution to agriculture. In 2013, he won an award of $16,290 from the Chief Minister of Haryana for outstanding contribution to sustainable and environment-friendly agricultural technologies (CA-based) and for further expansion of these technologies in his village. The noble work done by Harpreet Singh was recognized at the national level when he was appreciated at Krishi Vasant Mela at Nagpur in February 2014. He also received a reward of $830 from the Chief Minister of Haryana on February 19, 2014.

Punjab Innovation Hub

CSISA's **Punjab hub**, in its last year operating as a CSISA hub, focuses on (1) strategic research for the sustainable intensification of rice–wheat, cotton–wheat and maize–based systems, (2) smart mechanization options, (3) capacity development for new researchers, and (4) strategic partnerships for linking CSISA's research outputs to wider audiences.

During the reporting period, the key activities undertaken by CSISA in Punjab include, (a) two strategic research trials for improving water and nutrient use efficiency, profitability and soil properties in rice–wheat rotation; (b) four strategic research trials in maize-based systems focused on improving nutrient and water use efficiency, soil health and farm profitability; and (c) one on-station and 10 on-farm research trials for the sustainable intensification of the cotton–wheat system.

One key achievement is that Punjab Agricultural University (PAU), Ludhiana and CSISA have jointly recommended a **drip irrigation schedule for spring maize** for saving irrigation water and increasing water productivity. This recommendation has now been included in the package of practices published by PAU Ludhiana for wide-scale adoption by farmers. The **relay planting of wheat in standing cotton** (see photo) has gained the attention of many farmers in Punjab and is likely to be adopted on a large scale in northwest India, which will be a significant achievement by CSISA and PAU. Based on the initial results of CSISA trials, it appears that **precisely defining component technologies for water and nutrient management in CA-based rice–wheat and maize–wheat systems** is critical not only for sustainable intensification but also for acceptance of CA-based management practices by farmers in the northwest IGP. **Evaluation and refinement of CA machinery** in collaboration with strategic partners is continuing. A large number of local stakeholders (farmers, extension agents, researchers, and service providers) were exposed to new technologies/practices undertaken by CSISA in Punjab to create awareness and accelerate adoption of these technologies.

The below listed studies were also underway at CSISA's Punjab hub during the reporting period:

Rice–wheat rotation

- *Long-term research on conservation agriculture in a rice–wheat rotation under loamy sand soils of northwest IGP*
- *Enhancing N fertilizer use efficiency in wheat under conservation agriculture in rice–wheat system*

Maize systems

- *Crop and water productivity of spring maize–Kharif maize–vegetable peas as influenced by crop residue and irrigation methods under permanent bed planting*
- *Enhancing nitrogen use efficiency in maize–wheat system under conservation agriculture*

Cotton–wheat systems

- *Sustainable intensification of cotton–wheat system through conservation agriculture management practices*
- *On-farm validation of relay planting of wheat in cotton–wheat rotation for improving crop productivity, profitability and energy use efficiency*

Going forward, the Punjab hub will (1) synthesize key research findings and share them with stakeholders; (2) transition joint research over to the partner (PAU); (3) transition other activities to ongoing CIMMYT programs; and (4) continue supporting PhD students until September 30, 2015.

Tamil Nadu Innovation Hub

During its time as a CSISA hub, the Tamil Nadu hub has seen significant success in partnering with the state Department of Agriculture, state universities, and NGOs for the testing and uptake of innovative productivity-enhancing technologies and the capacity building of key stakeholders. As a result of CSISA's ongoing engagement with the government, the Tamil Nadu Agriculture Department has now recommended that farmers use drill seeding for rice in the Cauvery Delta region. The Tiruvarur District Department of Agriculture covered around 11,000 hectares through direct seeding using a seed drill during the reporting period. A DSR Guideline manual has been distributed by the DOA to support this expansion. One contributor to the success of direct seeding through seed drill is that around 90 CSISA farmers have become service providers, supporting other farmers in the adoption of direct seeding using seed drills. The success of this service provider model will be scaled out to other parts of the delta over the next year.

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 has collaborated with TNAU to run a Training of Trainers (ToT) course on direct seeded rice for field level extension staff of the Department of Agriculture at KVK Needamangalam (see *Season-long training for extension staff in Tamil Nadu* in this report.) Forty extension staff have been exposed to all aspects of drill-seeded rice, which has prepared them to later disseminate DSR technology in their area. The course has been designed to provide 10 days of training over a period of 5.5 months, spread across the season. To enable young future agricultural professionals with the necessary skills for promoting promising technologies, CSISA has also proposed a DSR module for integration into the curriculum for TNAU's diploma courses, which has been approved for implementation by TNAU.

In its work with NGOs and private companies, CSISA has trained technical staff of MSSRF in their respective locations on conservation agriculture technologies and has also provided subsequent technical backstopping. Relevant knowledge materials have been developed jointly and have been distributed through the MSSRF fortnightly magazine. The hub also extended technical support for a telecast called 'Reliance Foundation Information Services for the Farmer – Experts Live Interaction' centered on CSISA technologies (http://irri-news.blogspot.de/2014/06/reliance-foundation-and-csisa-use-power.html). CSISA technology was also filmed by Makkal TV, the state's private satellite channel, which then broadcast the footage. These important media outlets have generated greater awareness of CSISA technologies among farming communities in Tamil Nadu.

In its support of decision-making tools for farmers, Nutrient Manager for Rice evaluation trials were conducted during the Kuruvai, Samba and Thaladi seasons. The hub is also evaluating MTNPR in Kururavi, Samba season for endorsement.

The Tamil Nadu hub has been continuously providing the technical assistance and capacity building to various stakeholders in the Cauvery Delta. The focus of TN hub for the remainder of CSISA Phase II will be to expand the area under CSISA technologies through key partners such as the Department of Agriculture, TNAU and other community-based organizations.

In Person: *Generating savings through SI in Tamil Nadu*

SUNDARAJ

SUNDARAJ'S LASER LEVELLED AND DIRECT SEEDED RICE FIELD

'Conservation agriculture is all about savings,' says Sunderaj, a farmer in Thiruvaiyaru, a village in Thanjavur district in Tamil Nadu. Sunderaj has five acres of land on which he has long cultivated rice using conventional practices. For the past few years, though, labor and water shortages have been so rampant that he thought about quitting agriculture. Through CSISA's participatory trainings and demonstrations, Sundaraj learned about sustainable intensification practices such as DSR and laser land leveling, which he feels allow him to use less water, labor, and seed than his customary rice-transplanting methods. He says that these practices also reduce his drudgery. This year, instead of his traditional practices, he laser leveled his field and direct seeded his rice using a seed drill.

Transplanting one acre of rice usually required Sundaraj to hire 18 laborers, whereas DSR allowed him to only need 2 or 3. Moreover, DSR used only 12 kg of seeds, instead of 30 kg. Most important for his area, DSR allowed him to adjust to local water availability, which depends heavily on local weather conditions as well as the release of water from the Mettur dam. This year, Sundaraj's yields went up to 6 from 5 t ha^{-1} with 40–50 percent less water and less drudgery. Overall, Sundaraj feels that he was able to save 45% on fertilizer, seeds, tillage and other costs. He also mentioned that with support from CSISA, he was also able to plant maize and pulses using his seed drill.

Because of Sundaraj's success with DSR, many other farmers in his village enquired about the technologies that he used and expressed a desire to adopt them in their own fields. To capitalize on this business opportunity, Sundaraj purchased one multi-crop seed drill and is now acting as a service provider to other farmers in his village, providing direct rice seeding services at low cost. His village started with 2.5 ha under DSR, but now 20 ha are under seed drill sowing. In addition to servicing his own land, Sundaraj will be providing custom hire services to as many farmers in his village and neighboring villages as he can.

Sundaraj's confidence and experience with CA technologies has enabled him to convince many farmers in his village to adopt drill sowing and he expresses confidence that more will continue to see the value of this innovative technology. His capacities are also expanding, as Sundaraj increasingly provides guidance to farmers on additional practices such as better bet weed management in DSR. His confidence in the profitability of agriculture has been restored.

In Focus: *Season-long training for extension staff in Tamil Nadu*

FOR TAMIL NADU STATE EXTENSION STAFF, SEEING IS BELIEVING WHEN THEY NURTURE A RICE CROP THROUGH ITS ENTIRE LIFECYCLE IN THE SEASON-LONG CSISA-TNAU DIRECT SEEDED RICE (DSR) COURSE.

The current course, which runs from September 8, 2014 through January 29, 2015, has enrolled around 40 Agricultural Officers of the Department of Agriculture in Thiruvarur districts and 3 staff members of partner NGOs. Following the course, participating staff will be equipped to serve as the backbone of the Department of Agriculture and the Tamil Nadu Rice Research Institute's efforts to convert the establishment of 20,000 ha of rice in Thiruvarur district from dry broadcasting to drill seeding.

Mechanized rice production, including mechanized drill seeding, has the potential to improve yields and reduce labor demand in Tamil Nadu. Because mechanized rice production involves a relatively knowledge-intensive set of practices, extension agents involved in providing support and information must receive proper training. Capacity building efforts for state extension agents have thus far been insufficient and existing training programs often suffer from being either too theoretical or narrowly focused on a small window of the cropping cycle.

To provide a comprehensive and hands-on training experience, and to build capacity within the state extension system of Tamil Nadu, Tamil Nadu Agriculture University and CSISA piloted a season-long training course at the KVK Needamangalam in Thiruvarur District. The training covers all aspects of growing drill-seeded rice. Course materials were fine-tuned and adapted to the specific conditions of Tamil Nadu in a joint workshop by TNAU and CSISA staff.

The training program covers 13 major steps for successful rice production, from crop planning to milling to processing. The course is composed of 10 training days spread across the production cycle of rice, and includes classroom sessions as well as practical exercises and applications in the field.

The beginning of the curriculum includes an overview of rice ecosystems, rice morphology and the cropping calendar, followed by a field-based introduction to laser land leveling. Subsequent modules focus on land preparation, farm power and tractor operation and maintenance, and are followed by exercises on crop planning, financial management and matching equipment to farm size. Students then actually prepare land for DSR. The next steps include practical exercises on seed quality measurement, seed drill calibration, and sowing. This is followed by lessons and exercises on weed and water management and population maintenance. The emergence of the crop will be monitored, emerging weeds identified, and the post-emergency herbicide applied. The next training day focuses on nutrient management of rice with an introduction to the nutrient requirements and deficiency symptoms of rice, SSNM, LCC and Nutrient Manager. Additional lessons cover insects, rodents and diseases in rice and their control, pesticide safety, knapsack sprayer use. Harvest day sees students taking yield measurements, harvesting, threshing, and drying rice. Practical exercises on assessing grain quality are done with the IRRI Rice Quality Assessment Kit. The course completes with an excursion to a modern rice mill after lessons on rice storage, milling and processing as well as a practical introduction to the 'Superbag' and 'Cocoon' as hermetic storage system.

In the next step, CSISA will introduce the season-long training concept into Odisha with focus on mechanical transplanting of rice.

Bangladesh

CSISA-Bangladesh

CSISA-Bangladesh's (CSISA-BD) objective is to increase household income in impoverished and agriculturally dependent regions of Bangladesh. This will be done by testing and disseminating new cereal and aquaculture system based technologies that will raise family incomes by at least $350 for 60,000 farming families (mostly marginal and poor). It is anticipated that a further 300,000 farmers will adopt new technology through participation in field days and farmer-to-farmer information and technology transfer. The project works in 28 districts, 16 of which are in the Feed the Future zone of influence in southwest Bangladesh and 12 are in north and northwest Bangladesh. This five-year project started in October 2010 and will end in September 2015. The project is implemented by a partnership between the International Rice Research Institute (IRRI), International Maize and Wheat Improvement Center (CIMMYT) and WorldFish. IRRI is the lead partner.

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.

Between March 2011 and December 2013 the project implemented a sub-project called the Sustainable Rice Seed Production and Delivery Systems for Southern Bangladesh. This project, managed by IRRI, benefitted 1,005,953 farmers through the provision of seed of rice varieties tolerant to soil salinity, flooding and drought and new high yielding varieties.

Building on CSISA-BD's work testing machine-based conservation farming technology, a project called CSISA Mechanization and Irrigation (CSISA-MI) was initiated in July 2013. This project will make mechanization technology available to farmers through private sector partnerships.

In FY14 CSISA-BD trained 36,898 farmers, conducted trials and demonstrations with 14,424 farmers and through participation in training, trials and demonstrations benefited 36,119 rural households. This brings the total number of households who have benefitted directly from the core project (excluding SRSPD and CSISA-MI activities) to 68,648. The project midterm review predicted that by the end of the project 285,000 farmers would indirectly benefit from the project.

The focus of project trials, demonstrations and training has been on technology that will allow farmers to intensify cropping patterns and raise aquaculture production in a sustainable manner. The key to crop intensification is the adoption of early maturing monsoon season rice varieties. These mature some 30 days before traditional varieties allowing farmers to plant dry season (Rabi season) crops such as oil seed mustard, wheat, maize and grain legumes on time and through this utilize land normally left fallow in the dry season. In FY14 the rice program conducted 5,621 trials and demonstrations on early maturing Aman season rice varieties. There were 1,181 maize, 587 wheat, 219 mungbean production technology demonstrations grown as part of an Aman rice–Rabi cropping system demonstration and 4,732 mustard demonstrations grown as part of an Aman rice–mustard–winter (Boro) rice cropping system demonstration.

In the coastal region of southwest Bangladesh soil salinity results in large areas of land being underutilized during the dry season. Here the project has been promoting salt tolerant varieties of rice through 296 variety demonstrations and salt tolerant crops through 926 sunflower and 119 sesame production technology demonstrations. These trials and demonstrations have shown farmers that it is possible to profitably utilize land that is saline.

The maize and wheat program has developed and demonstrated mechanized planting techniques which allow farmers to rapidly plant maize, wheat and other dry season crops with minimal land tillage. These conservation agriculture techniques conserve soil moisture and organic matter and reduce planting time and costs. They have also introduced machine harvesting of rice and wheat, which allows farmers to rapidly harvest crops giving them more time for the planting of the next crops. Scale out of these mechanization systems is an integral part of the CSISA-MI project.

The rice, maize and wheat programs trained 27,801 farmers in the best agronomic practices for rice, maize, wheat, mustard, sunflower, sesame and mungbean production technology. This included planting methods, line planting and line transplanting, optimal fertilizer rates and application methods and crop harvesting and storage methods. The web based Rice Crop Manager was used by 780 farmers to obtain farm specific rice fertilizer and crop production recommendations.

A survey of farmers receiving training and demonstrations in FY12 showed that farmers who adopted the rice production technology promoted by CSISA-BD had gross margins for their Boro rice which was 64% ($280) and for the Aman rice 41% ($175) higher than that for farmers who did not adopt this technology. The same survey showed that 50% of farmers who were shown how to grow maize or wheat in 2012, relatively new crops to SW Bangladesh, continued to grow these crops in 2013. The survey showed that for every farmer receiving direct assistance from the project a further 1.52 rice farmers, 1.95 maize farmers and 3.59 aquaculture farmers adopted the same technology. This was through acquiring seed from their neighbors or observing the results of demonstrations.

Production of crops in groups allows farmers to share equipment, training and marketing opportunities. In FY4 2,391 farmers in maize groups, 3,152 farmers in premium quality rice (basmati and aromatic rice) groups, 759 farmers in sunflower groups and 4,732 farmers in mustard groups received support through training, trials and demonstrations and links to buyers (millers and feed companies) and input suppliers (maize seed companies).

The aquaculture program provided 10,194 farmers (6,640 farmers new to the program this year) with training and 208 demonstrations of technology that has been shown in farmer-managed trials to raise homestead fishpond production by 265%. The income raised from this activity is used to finance crop production as well as increase household nutrition. Trials to determine the best ways of utilizing shaded and seasonal ponds, raising vegetables on banks of ponds used for brackish water shrimp production, producing fish feed from locally produced crops and reducing water temperature in fish hatcheries to improve fish fingerling production will all generate technology that will have a direct benefit to aquaculture farmers.

The project provides women with support through training in crop production and postharvest technology and through participation in field day events. Aquaculture and the related vegetable production programs attract the greatest participation from women. The project has now begun to consider developing the business capacity of women. In November, a workshop funded in partnership with UN Women was held in Khulna for women who have already initiated micro and small agriculture-based businesses. The workshop had two objectives: identify constraints faced by women in establishing and expanding a business and link women-managed businesses in southwest Bangladesh with supermarket chains, food processors, and women's enterprise associations.

The USAID M&E team conducted a thorough Data Quality Analysis of the project data collection systems. The team also visited randomly selected CSISA-BD farmers to verify that data collected by the project from CSISA-BD farmers was accurate. As a result of this DQA, the physical storage of hard-copy M&E data at the hub level has been greatly improved and the development of the M&E guidelines and the database system was commissioned.

In December 2013, the project implemented, through a local firm of consultants, a "Technology Adoption Survey." The key question posed by the survey is what proportion of farmers continue to use technology a year after they first adopted it and how many passed this technology on to other farmers. A follow-up survey will ask those farmers who learned about new technology from a CSISA-BD farmer and what technology was adopted and if they will continue to use the technology in future seasons. Preliminary results indicate continued adoption of key CSISA-BD technology and that outscaling to other farmers was between 1 farmer and 1.52 farmers for rice technology, 1.95 for maize technology, and 3.59 for aquaculture technology.

In March, the project had a mid-term Evaluation from an independent external evaluator. Initial indications were that the evaluation was very positive but that it will recommend greater integration of CSISA-BD work with government institutions.

CSISA-Mechanization and Irrigation (CSISA-MI)

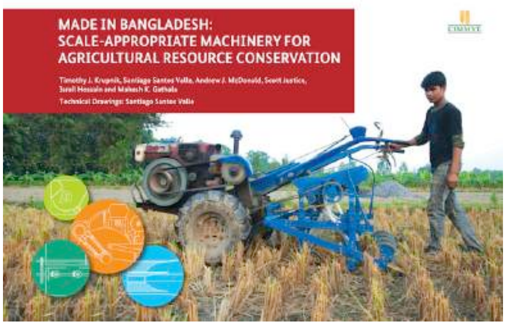
The **Cereal Systems Initiative for South Asia - Mechanization and Irrigation** project is a CIMMYT-led initiative that operates under the wider CSISA program in Bangladesh. CSISA-MI is operational in southwestern Bangladesh and is funded by the USAID Mission in Bangladesh under President Obama's Feed 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.

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 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 first year of the project, and despite general strikes lasting over two months during Bangladesh's elections, CSISA-MI's work led to 3,584 hectares of land being brought under different targeted agricultural machineries and irrigation services. Out of this number, 2,322 ha were irrigated by local service providers using fuel-efficient axial flow pumps supplied primarily through purchases made from CSISA-MI's core private sector partner, Rangpur Foundry Limited. Crucially, RFL and local service providers invested

$327,974 of their own funds to spread axial flow pump services to farmers. Seven hundred sixty-seven hectares were cultivated using seeder-fertilizer drills and bed planters, in a suite of crops including rice, maize, wheat, jute, and vegetables (onion and garlic) among many others. Seeder-fertilizer drills and bed planters improve the precision of seeding and fertilizer placement, while facilitating the conservation of labor and water resources. The spread of these technologies were facilitated by CSISA-MI's private sector partners investing $482,092 of their own funds to expand the use of the equipment. An additional 594 ha of wheat and rice were harvested using multi-crop reapers, through local service provision and the action of Advanced Chemical Industries as a private sector partner to demonstrate and advertise to potential service provider clients.

Sales of reapers to local service providers are currently ongoing. A total of 9,073 farmers in the FtF zone benefited from the project's activities through diffuse interventions implemented by the project and our private sector partners through market mechanisms. During the same time period, 5,840 farmers (of which 5,218 were male and 622 were female) received short-term, hands-on training on different agricultural technologies under CSISA-MI, and a total of 276 entrepreneurs received business development services from the project. These figures fall in line with the project's scaling strategy, which seeks to develop core market and partnership systems in the first three years of the project and facilitate full scaling up and take off of independent adoption in later years.



Science-based interventions form the core of CSISA-MI's work. Within the project, CIMMYT scientists are leading on applied research to develop appropriate irrigation and nitrogen regimes for maize grown in the FtF region. During the reporting period, based on scientific research, the project published a book titled 'Made in Bangladesh: a scale-appropriate machinery for agricultural resource conservation' and a research report called "Axial flow pump can reduce energy use and costs for low-lift surface water irrigation in Bangladesh." Further research uses remote sensing and GIS to identify the appropriate environments and soils on which bed planters can be used, and where AFPs can be employed to bring dry season fallow and poorly productive land into intensified cropping.

Successes and Challenges

CSISA-MI has laid a strong foundation for the development of a viable and eventually self-sustaining value chain to assure that all the targeted technologies are deployed through the private sector in the future. During the first year, private sector partners encountered difficulties in selling the anticipated number of machines due to repeated general strikes and political violence in Bangladesh.

CSISA-MI's commercialization approach plays a temporary and catalytic role in the development of a scalable machinery service provision model that is designed for sustainability, and built to continue to function beyond the duration of the project. We expect large outcomes in Year 2, and the sustained adoption of machinery services and technologies by smallholders, leading to year-to-year benefits for continuing farmers, with the aim of reaching the crucial 15% population threshold by 2018, after which self-propelled and private sector-led value chains will continue to deliver technologies after the project closes.

Nepal

CSISA-Nepal (CSISA-NP)

> **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.

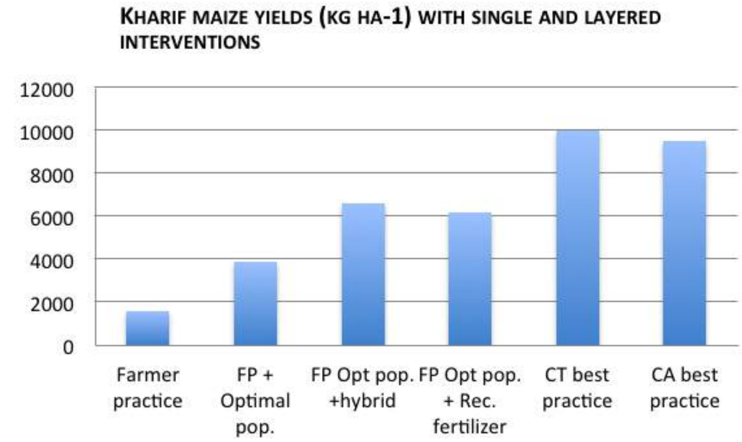
CSISA's research focus in Nepal is aligned with the staple crop mandates of Feed the Future (FtF): sustainable intensification (SI) technologies for lentil, rice, and maize-based cropping systems. CSISA stages its work in the Mid and Far West development regions from offices in Nepalgunj, Surkhet, Dadeldura,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

This reporting period covers Kharif (monsoon season) harvest from 2013, Rabi (winter) season 2013–14, and the pre-harvest period for Kharif 2014. Progress is reported by theme. Highlights from the period include:

RICE GENOTYPES AND CROPS ESTABLISHMENT METHODS: OUT WITH THE OLD, IN WITH THE NEW? Variety replacement rates for grain staples like rice are extremely low in Nepal, and most farmers cultivate varieties that were released decades ago. Field trials in the Terai evaluated newly released varieties and one hybrid against commonly planted 'old' rice varieties. Improved rice varieties included: Tarahara-1, Hardinath-2, Sukha Dhan-1 and -3, Anmol Mansuli, and Swarna Sub-1 (for low-lying, flood-prone areas). The hybrid used was the relatively short-duration, high yielding DY69. Planting methods (i.e., dry broadcast, dry directing sowing in lines, and conventional transplanting) were also evaluated to assess crop performance and farmer preferences for labor- and cost-saving technologies. Across the evaluation sites, our data suggests consistent advantages of around 1 t ha^{-1} for adoption of new varieties of similar maturity class if farmers are growing Bineshwari ('Bind'), but little advantage otherwise. Large gains in yield potential are possible with hybrids and also longer duration material like Swarna-Sub1, but farmer acceptance appears to be low for the latter because of its very long growth duration, which compromises timely winter season planting in areas where poor drainage conditions do not persist. Based on these data, targeted efforts to replace Bind and increase market availability of hybrids have been initiated.

In general, yields were similar across planting methods for each rice variety, suggesting broad adaptability across management systems for the genotypes evaluated. Both dry establishment methods significantly reduce production costs for labor, diesel and machinery rental. With yields on par with transplanting, cost savings potentially make these novel establishment methods very attractive options for the relatively impoverished western regions of the country. With private sector and government parnters, CSISA is working to support the emergence of service providers to increase access to rice establishment alternatives.

ENTRY POINTS FOR SUSTAINABLE INTENSIFICATION: At less than 2 t ha^{-1}, maize yields in the mid-hills are persistently low and few efforts have systematically assessed either the production potential in these systems or identified sensible entry points towards sustainable intensification that can be selectively matched to the needs and constraints faced by different types of farmers. In 2014, CSISA began to systematically explore the expected benefits and costs associated with different management interventions. On-farm trials were conducted in two mid-hill districts. Low-cost interventions to maintain optimal plant populations and improve weed management doubled grain productivity to 3.8 t ha^{-1}. Adding either a hybrid or higher levels of fertilizer to these interventions further increased yields to over 6 t ha^{-1}. With all management factors well managed, grain yields of maize increased to 10 t ha^{-1}, five times higher than those achieved through farmer practice – an astonishingly large yield gap that can be closed with better management. When best practices were combined with zero tillage crop establishment practices (conservation agriculture—'CA'), similarly high yields were obtained. CA significantly reduces crop establishment costs and can minimize soil erosional losses—a paramount concern in the hills for ensuring long-term sustainability. Production economics and investment costs for these management options are now being assessed, and will be evaluated in the context of farmer preferences, risk bearing-capacity, and ability to invest in intensification before the next maize season (collaborative with Wageningen University), and will help development partners such as KISAN and DOA better prioritize interventions.



MAIZE HYBRIDS FOR THE HILLS? Farmers in the rainfed hill regions of Nepal typically grow maize for household consumption as well as for livestock feed. Despite the importance of maize to food security and livelihoods in the hills, very few farmers grow hybrids. Ten different medium- to short-duration hybrids were tested at five locations in 2014, under the logic that short- to medium-duration hybrids will permit farmers to reliably establish a second crop that will yield well in the dry season based on timely planting. Due to a weaker monsoon and higher levels of solar radiation, the yields attained in these evaluations were exceptional, with Bioseed 9220 (10.9 t ha^{-1}) and Commando (11.4 t ha^{-1}) as the highest yielding hybrids, producing > 4 t ha^{-1} more than the local landrace and 2.5 t ha^{-1} more than the best OPV (Arun-2), respectively, with the same levels of inputs. However, other hybrids were on par with the OPV Arun-2, highlighting the importance of data-driven extension messaging rather than blanket promotion of hybrids in the hills. Farmers also value non-yield related traits such grain colour, and CSISA conducted the first evaluations of white-colored hybrids in the hills (K-65). CSISA is working with dealers and KISAN ensure farmers understand the benefits of cultivating elite maize hybrids and OPVs and that market availability of hybrids increases.

CREDIT FOR INNOVATION AND INCLUSIVE GROWTH

Nepal has one of the highest out-migration rates in the world, which has lead to a rapid feminization of the agricultural workforce. Dr. Sumitra Gurung recently established the first for-profit banks in Nepal providing rural women micro- and meso-credit. The bank is headquartered in Chitlang, Makwanpur, with one of the five branches located in Rolpa district in the mid-west. Dr. Gurung approached CSISA to explore the possibility of demonstrating and training hill women to enable them to effectively own and operate small machinery. A catalog of small farm agro-machinery tools and equipment especially suitable for Nepali women entrepreneurs has been completed by CSISA in consultation with Dr. Gurung and her colleagues. This catalogue will to help guide policies and lending practices for banks that are unfamiliar with loans for agricultural machinery, including scale-appropriate options for women and smallholders, thereby enabling more women to purchase machinery and to form small business.

Cross-cutting Objective 1 Activities

A. Livestock

ILRI implements two major strands of activities within CSISA: residue-based feed technology development and adaptation, and capacity development for technology uptake and out-scaling.

Technology development/adaptation

CSISA is addressing major feed constraints in rice-, wheat-, and maize-based systems by improving the efficiency of rice and wheat straw feeding; increasing the use of inexpensive, locally available and nutritionally dense supplementary feeds such as maize grains; and promoting underutilized cereal residues such as maize stover. ILRI's team in Hyderabad contributes to the identification of superior lines for breeding dual-purpose cereal crops for grain (human nutrition), fodder quantity and quality (animal nutrition), and for mainstreaming and evaluating on-farm performance and adoption of promising lines in CSISA sites. Improved varieties of dual-purpose cereals have been shown to provide higher grain yields for both food and feed while supplying more and higher-quality biomass for fodder[2] as feed to livestock.

Using near infra-red spectroscopy, ILRI's team has evaluated food-feed traits of 24 pipeline maize hybrids grown in 4 locations in India. Results show that out of the 24 pipeline hybrids one has very high grain yield, high stover nitrogen and high digestibility. This hybrid has been disseminated in Bihar and Odisha and is currently being harvested for stover, which will be sent to Hyderabad for further livestock productivity trials. CSISA also collected three different qualities of wheat straw traded in Patna (with each quality being collected from four different traders) and sent the samples to ILRI Hyderabad for livestock productivity trials with sheep to better understand fodder traders and farmer perception about wheat straw quality and pricing. Difference in wheat straw digestibility of 3 percent units (43 vs. 40%) was found to be associated with a price premium of ~8%.

On-farm feeding trials showed that a maize-based feeding regime results in superior productivity effects (in terms of milk yield and milk fat) compared to a sorghum-based diet: 6% higher milk yield and 26% higher milk fat content resulting in 6% higher income from milk sales. Field-testing of two promising maize cultivars is underway in selected CSISA sites in Bihar and Odisha in collaboration with the CSISA hub teams. Fodder quality testing of maize stover and rice straw from farmer-grown fields is also ongoing, with regular collection of stover and straw samples being sent to Hyderabad for analysis. In addition, pipeline cultivars of rice from national and CG breeding programs are analyzed for variations in straw quality and straw quality relationships for later use in CSISA hubs. Compound feeds and feed ingredients from Bihar and Odisha are also regularly sent to Hyderabad for feed quality estimates to design least cost rations.

Complementary farmer **f**eeding trials within the CSISA Bihar hub on the **effects of feeding urea-treated maize stover** have also exhibited promising results, with milk yield increasing by 0.4 liter/animal/day and fat and solid non-fat content higher by 0.1% among 43 farmers under this feeding regime. In Odisha, the demonstration of **chopping of rice straw** through farmer trials has shown considerable benefits through improved digestibility and energy intake. Specifically, milk yields increased by 0.3–0.5 kg/day among 90 farmers who have tested this practice. When chopped

[2] ILRI's work in ILRI projects (Tata–ILRI ELKS program, Enhancing Livelihoods through Livestock Knowledge Systems) is an important source of best-practice knowledge in this aspect.

rice straw was fed in combination with mineral mixtures, milk yield increased by 0.4–0.7 kg/day, and fat and SNF content were also higher by 0.13%. Estimated economic benefits from feeding chopped rice straw supplemented with mineral mixtures showed that the practice translates to an equivalent of $79 additional income per animal per year, of which about 30% accrues from reduced feed cost due to savings generated from chopping. This suggests the potential of straw chopping as a feeding practice in engendering higher efficiency in straw utilization on-farm as well as in terms of digestibility that translates to improved feed-energy conversion. More than 2,000 farmers have been trained by CSISA and have taken up this practice in India, Nepal and Bangladesh.

In CSISA sites such as Bihar that have relatively intensive dairy cattle production, ILRI has focused on **improving the use of concentrate feeding** within farmers' feeding practices. By utilizing locally available feed resources and using a least-cost ration calculator, balanced concentrate feeding has been adapted to the local context and is continuously tested on-farm. Results from 240 farmers showed a 10% higher milk yield, while significant changes in fat (+0.86%) and SNF (+0.42%) are also observed under the improved concentrate feeding regime; consequently, farmers' dairy income increased by $0.80 per animal/day. Despite promising productivity effects due to higher nutrient content vis-à-vis commercially available concentrates, wider uptake has been constrained by cost. Further work to evaluate more cost-effective rations through focusing on lower-cost ingredients in the balanced concentrate feed formulation is ongoing.

Capacity development and partnerships for feed technology uptake and out-scaling

Enhancing technology uptake by target beneficiaries has been precipitated by various **targeted training** activities. The main topics have been on chopping of crop residues, production of balanced concentrate feed, implementation of feeding trials, demonstrations of feeding of maize stover and balanced concentrate feed, and supplementation with locally adapted mineral mixtures. Capacity building in terms of provision of chopping equipment to expose target users to their use and expected benefits, and development of local service providers (LSPs) for straw chopping and concentrate feed production have been implemented to increase availability and access by the poor while providing income opportunities to local private entrepreneurs. To date, 10 LSPs have been established in Bihar, 2 in Odisha, and 10 in Bangladesh.

Developing and nurturing partnerships for out-scaling is an important complementary activity being pursued to ensure a greater adoption of best practices. In Bangladesh, ILRI and CSISA partners work with local manufacturers of chopping equipment in adapting chopping specifications to suit local conditions and contexts, e.g., modifications in design for suitable length of straw for different types of animals (cattle vs. goats), adding wheels for improving mobility, and developing new prototypes that could run on batteries for areas without a constant supply of electricity. Collaboration with dairy farmer groups and cooperatives (OMFED in Odisha, COMFED in Bihar), women's self-help groups in Nepal and Bangladesh, and non-government organizations (LWI in Odisha, CDVF in Bangladesh) are being strengthened, while opportunities are being explored for integration and/or linkages with other CG partners and CRP projects (as for example the Aquatic Agricultural Systems and Livestock and Fish CRPs). The establishment of fodder markets in Bangladesh is also a promising development that will enhance the availability of fodder and the uptake of improved practices.

B. Post-harvest technologies

CSISA's postharvest component aims to create awareness of improved postharvest options, establish local stakeholder partnerships, and follow a business ecosystem approach to adoption and delivery. In Bihar and Odisha in 2014, CSISA scaled out **open drum threshers** amongst marginal farmers and women's Self-Help Groups (SHGs), building upon a successful business model pilot that generated income through contract threshing services. Pilots with four NGOs led to 65 women farmers being provided services. The local fabricator involved in the process has started promoting the modified thresher to meet newly emerging demand. Two women's self-help groups, after seeing benefits, have invested $260 to purchase two threshers for use in Kharif 2014. One hundred thirty-four women farmers from three NGOs (AKRSPI, BSSS Federation and CWS) and have been trained in safe usage in 3 training sessions.

CSISA's work on **modified axial-flow threshing** is primarily aimed at commercial service providers whose clients are farm households. During 2014, CSISA assisted stakeholders to modify an axial-flow thresher (AFT) design that had previously been rejected by farmers five year ago as it left straw output chopped up and difficult to manage for use as fodder and thatch. As a result, 175 farmers from 17 villages signed up to receive services from a contract service provider who helped pilot the modified AFT. The service provider charged $9.77/hour and threshed 83 hectares of paddy, with revenue of $2,263 and a net profit of $602. Farmer clients reported estimated savings of $372 and 9,800 kg of paddy.

In 2014, CSISA-Bangladesh partnered with Ali Seed Farm to technically improve a 4-ton **flatbed dryer** (FBD) that serves an association of 167 small- and medium-sized farmer seed producers. These producers face huge risks when sun drying seed, particularly as the main harvest (Boro) can occur as the first monsoon rains arrive. In 2012, the seed association could not properly dry 400 tons of seed, which lost its germination potential. As a result, US$154,000 of seed from the association had to be sold as lower-value grain for $77,000, a loss of nearly half the expected revenue. The investment costs to the farmer entrepreneur for this first commercially successful FBD in Bangladesh were recovered the first year and this site serves as an open training site for educating other actors and stakeholders.

CSISA has promoted **improved storage** solutions by setting up a dependable supply chain through Grainpro Inc. (and their India distributor, Pest Control of India) to provide products on demand, development of a training modules, and ToTs to build capacities of CSISA partners, and motivating several NARES partners (ICAR, four KVKs) and NGOs (Catholic Relief Services, PRADAN, DHAN, 19 STRASA project allied NGOs) to embed promotion of improved options in their action plans. Over 250 farmers are storing their Rabi paddy, wheat, lentils and mung beans seeds in hermetic superbags and cocoons in Odisha and Bihar. Over 4,800 hermetic superbags have been bought by partners for use by their client farmers. More than 2,000 farmers will store their paddy seeds in the upcoming after Kharif harvest in 2014.

C. Empowering women in agriculture

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.

Sumintra Devi says, "In spite of doing all kinds of work in the field, I never got the respect as a farmer that men farmers would get. Here with CSISA's intervention we have an identity. Now we are *Kisan Sakhi*." Bholi Sakhi asserts that "Learning new ideas and people approaching us with new knowledge on agriculture has increased our confidence and adopting new technology has increased our production. Knowledge creation and intervention are adding value to us and we find that this will increase in the next season as other farmers are going to follow us. We have to develop and develop other women farmers also."

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 201314 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 during the reporting period.

Change is not necessarily an easy, smooth, or steady process. Many of the women who have come forward to experiment with new technologies have felt fear, apprehension, discouragement, and sometimes a lack of support from their family, particularly their male counterparts. Sitting with CSISA on evening in November, 2014, widows from Jhalkiani village shared their story with us. Turi Devi says, "When the sowing operation was complete for DSR in my field, after few days, I saw very low plant population, and I started wondering that I am only left with this small piece of land, and if I don't get sufficient yield, I have to be hungry for the year and I was quite restless and started complaining to Malati didi, our cluster leader who motivated me to go for it. But after some days, as explained to me, I took care of my plant stand and I observed the good growth and tillers in plant. Today my crop is ready for harvest and I am very hopeful that I will be getting good yield. I remember last season when I did sowing in this small patch of land (0.75 acre), I used 1.5 *theka* of paddy seed (approx. 45 kg), and this time I saw while sowing through machine, I could even complete 1 *theka*. Malati didi and the scientists visiting to my field say that it is possible to even reduce the amount of seed further. This is something which is quite good in this technology and I never imagined that is possible in seeded rice."

This is not just a story of one or two women, or a few villages like Durgapur or Jhalkiani or Deogaon. There are many such villages and thousands of women realizing the potential for growth, learning about new labor-saving and productivity-enhancing technologies. In Mayurbhanj, the results so far indicate that these hundreds of SHGs, their leaders and members, and the cadre of trained community agents, have exemplified the participatory technology delivery model for women farmers, which has a high potential for successful replication. This model and the number of women farmers associated and involved in the technology delivery and adoption program, also now strongly establish the fact that women are also mainstream farmers and have a major role to play in the effort for enhance productivity, income and food security in their households and in the rural economy.

D. Crop Manager decision support framework for precision management

A beta version of **Rice–Wheat Crop Manager** (RWCM) was developed for field testing for wheat and rice within CSISA in Bihar and EUP. The RWCM uses a 'systems approach' in which field-specific nutrient and crop management recommendations are provided to farmers for optimizing the cropping system rather than an individual crop. The calculation of field-specific fertilizer requirements in RWCM utilized results from nutrient omission plot technique (NOPT) trials conducted with rice in five districts (Sant Kabir Nagar, Sidhharth Nagar, Gorakhpur, Maharajganj, and Kushinagar) of EUP and eight districts (Ara, Patna, Buxar, Muzzaffarpur, Vaishali, Samastipur, Begusarai, and Lakhisarai) of Bihar.

Field-testing of RWCM with wheat indicated an increase in yield compared to the farmers' nutrient management practice of 0.4 t ha^{-1} for sites in Bihar and 0.2 t ha^{-1} for sites in EUP. The application of additional potassium fertilizer to wheat further increased yield by 0.3 t ha^{-1} at sites in Bihar but not EUP, indicating different requirements for potassium fertilizer across CSISA sites.

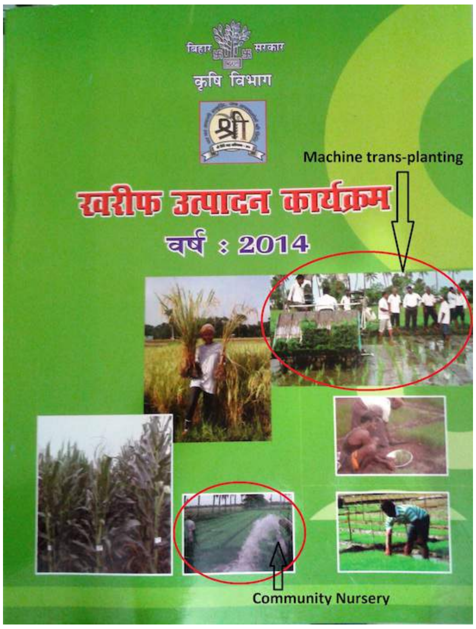
A site visit by technical experts on Crop Manager from IRRI on March 10–14, 2014 led to collaboration with Banaras Hindu University (BHU), Varanasi and Bihar Agriculture University (BAU), Bhagalpur. Field-testing of RWCM with rice in 2014 was conducted in three districts of EUP through BHU and three districts of Bihar through BAU. In addition, NOPT trials were conducted in these districts to further refine the nutrient management calculations in RWCM and collect data for use in the anticipated future endorsement RWCM by the universities.

A beta version of Rice Crop Manager (RCM) was developed for field-testing in Odisha in collaboration with OUAT, CRRI and DOAC, Odisha. Initial testing of RCM during Kharif 2013 in four districts (Puri, Bhadrak, Mayurbhanj & Cuttack) was used to refine and enhance RCM prior to further field-testing in the 2013–14 Rabi and 2014 Kharif seasons. The refined RCM was field-tested in three districts (Puri, Bhadrak & Mayurbhanj) through CSISA and in two districts (Jajpur & Kendrapara) through CRRI. Technical experts on Crop Manager from IRRI visited OUAT on May 12–13, 2014 for an update on RCM and to expand areas of collaboration with OUAT. During 2014 Kharif, OUAT conducted 30 RCM and 30 NOPT trials in six districts (Balasore, Dhenkanal, Kendrapara, Keonjhar, Koraput and Sundergarh). A pilot dissemination program will be initiated in Rabi 2014 in collaboration with KVK, Bhadrak to test the dissemination of RCM recommendations, including SMS, to the farmers. Discussions are in progress to test the RCM through *Kisan Call Centers* run by OUAT.

A preliminary **Maize Crop Manager** (MCM) was pilot tested in Mayurbhanj District of Odisha.

A beta version of **Nutrient Manager for Rice** (NMR) was developed for field-testing in the Cauvery Delta of Tamil Nadu. The NMR was refined based on field-testing in 2013 and was field-tested in 2014 through 14 on-farm trials in Kuruvai season and 40 on-farm trials in Sambha season. Initial results indicated an increase in yield and cost saving following NMR recommendation over farmer's practice. A proposal is under development for submission to Tamil Nadu government for collaboration on large-scale field testing of NMR by the staff of Department of Agriculture & Co-operation.

REVISED GUIDANCE FROM GOVERNMENT OF BIHAR ON WHEAT PLANTING DATES



INCLUSION OF CSISA TECHNOLOGIES IN BIHAR 2014 KHARIF PRODUCTION ACTIVITIES GUIDE

The benefits of CSISA's work are not confined only to CSISA's geographic domains, key crops, or strategic partners. Recommendations, technologies, and management practices are being utilized and applied to areas within and outside of our working domain, generating benefits beyond what we have generated through our direct efforts. The following list provides a few key examples.

Largely due to CSISA's policy advocacy, the Bihar Department of Agriculture has promoted early wheat sowing and zero till technology in its 2013 advisory to farmers state-wide, reversing earlier guidance that wheat only be sown in the last two weeks of November. The State Agriculture Officers also directed their Block Agriculture Officers, agriculture coordinators, and *Krishi Salhakars* (farm advisors at the *Panchayat* level) to ensure maximum area under early wheat sowing, preferably under zero-tillage.

The Bihar agriculture department has also included machine transplanting under non- puddled conditions (MTNPR) and direct dry seeded rice (DSR) in the road map of 'Kharif Production Activities 2014.' This success can be largely attributed to CSISA's efforts to promote the rice establishment methods (MTNPR, DSR and community nursery) and get these technologies mainstreamed through the state department.

As a result of CSISA's ongoing engagement with the government, the Tamil Nadu Agriculture Department has now recommended that farmers use drill seeding for rice throughout the Cauvery Delta region.

Punjab Agricultural University (PAU), Ludhiana, and CSISA have jointly recommended a drip irrigation schedule for spring maize for saving irrigation water and increasing water productivity. This recommendation has now been included in the package of practices published by PAU Ludhiana for wide-scale adoption by farmers.

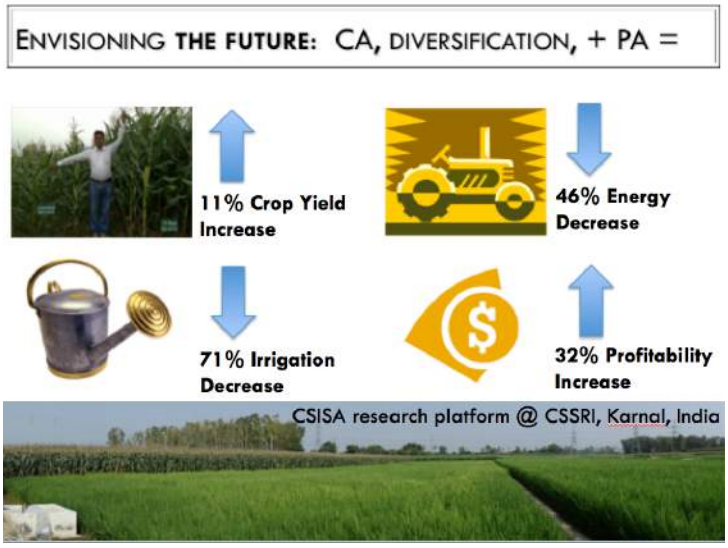
Thanks to the efforts of CSISA's Objective 4, the Government of Bhutan gave the go-ahead to release two new improved wheat varieties (Bajosokhaka and Gumasokhaka) from CIMMYT. This is first release of any wheat variety in this country in last 20 years. Both varieties yielded, on average, 50 percent higher than the most popular variety, Sonalika, in three years of multi-location testing in and have water stress tolerance and good resistance to yellow rust.

Objective 2: Crop and Resource management practices for future cereal-based systems

Karnal Research Platform

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.

The results of four years of research at the Karnal Research Platform (RP) consistently demonstrate that Kharif maize is a profitable and resource-conserving alternative to rice in the rainy season in northwest India to address the issues of rising scarcity of water, labor and energy in the region. In the 4th year, ZT maize provided higher yields (9.36 t ha^{-1} rice equivalent yield) than rice (8.0 t ha^{-1}), using 90% less irrigation water. On a systems basis, results from Karnal demonstrate that by combining diversification with CA and precision resource management ('PA'), crop yields can be enhanced (11%) with fewer investments in energy (decrease of 46%) and irrigation (decrease of 71%) while profitability is transformed (increase of 32%). These results identify practical SI development pathways for a production ecology where achievement of high yields with more sustainable production practices has enormous implications for regional food security.



Despite these benefits, there are still unanswered questions associated with strategies such as **diversifying from rice to maize**, keeping in mind the history of these soils as reclaimed salt-affected areas. Unanswered questions include the possibility of re-salinization caused by reduced irrigation application and the economic risks associated with production of a freely traded commodity that, unlike rice, is not procured through the government system and protected by a minimum support price. CSISA has initiated new field and simulation studies to explore the scope and implications of diversifying rice with maize in northwest India, including potential benefits for **groundwater decline** which is a major policy imperative for the Government of India in the national 'bread basket' that is NW India.

Platform research has also shown that the yield of dry seeded rice **(**DSR) remained at par with puddled transplanted rice for the initial three years, but decreased in the 4th year, in part due to severe iron deficiency signaling a note of caution on another potentially important management pathway for arresting groundwater decline and highlighting the importance of longer-term experimentation. Weed problems in zero-till wheat reduced over time, and hence herbicide use in continuous ZT wheat with rice residue mulch decreased compared to the conventional system. After four years, the weed seedbank of *Phalaris minor*, the most troublesome weed of wheat because it has evolved multiple resistances to different herbicides, has decreased by 90-100% in continuous ZT wheat with retention of previous crop residues (CA-based management) as mulch, compared to a conventional till system. Similarly, the weed seedbank of other weed species also declined with CA compared to the conventional system. Over the last two years (2012–13 and 2013–14), **no herbicide has been applied in CA wheat plots** for weed control. The combination of ZT and residue retention also increased soil C content in the upper 15 cm soil layer. After four years, soil C increased by 45% in full CA-based rice-wheat-mungbean and maize-wheat-mungbean systems compared to the conventional rice-wheat system. Soil physical properties such as soil aggregation, mean weight diameter, steady state infiltration, and soil penetration resistance also improved in full CA-based cropping systems (scenarios 3 and 4) and also the partial CA-based cropping system (scenario 2) compared to the conventional cropping system (Scenario 1).

In wheat, component studies focused on the effects of planting dates, tillage, and residue amount on weed suppression, terminal heat stress, moisture conservation and yield. ZT with full rice residue retention gave a significantly higher yield (5.3 t ha^{-1}) over ZT with anchored residue (5.1 t ha^{-1}) and without residue (4.8 t ha^{-1}). Planting wheat between the 25th of October and the 5th of November provided similar yields but yield declined when the wheat was planted after November 5th. The combined effects of both early planting and residue mulching suppressed weeds and minimized the terminal heat stress effect. Mulching helps conserve soil moisture, especially early in the season when evaporative losses from the soil surface are high, and this varies with quantity of residue retained.

On-farm studies also explored the prospect of improving water productivity through land configuration (e.g., slight slope versus zero slope laser leveling) and improved conveyance management (e.g., border irrigation). In DSR, border irrigation by creating eight irrigation blocks per hectare reduced irrigation water application by 18 cm ha^{-1} compared to no blocking. Also, giving a 0.08% field slope further reduced the irrigation water application by 22 cm ha^{-1} compared to 0% field slope without incurring any yield penalty. Similarly in wheat, irrigation water application was about 50% less with a 0.5 t ha^{-1} yield advantage in plots with 0.08% slope compared to plots with 0% slope. Both approaches limit deep percolation losses of water that do not contribute to yield. Similar trials are ongoing on the heavier textured soils in Bihar.

KHARIF MAIZE UNDER ZT AT CSISA RESEARCH PLATFORM, KARNAL, HARYANA. BASED ON 4 YEAR RESULTS, KHARIF MAIZE APPEARS TO BE AN ECONOMICALLY VIABLE DIVERSIFICATION OPTION FOR RAINY SEASON RICE IN NORTHWEST INDIA

ZT WHEAT SOWN IN FULL RICE RESIDUE AT KARNAL PLATFORM. CONTINUOUS ZT WITH RESIDUE MULCH HELPED IN ALMOST ELIMINATING WEED PROBLEMS IN WHEAT. NO HERBICIDE OR OTHER WEED CONTROL PRACTICES HAVE BEEN APPLIED IN 2 YEARS.

Patna Research Platform

At the Patna Research Platform in Kharif 2013, machine transplanted rice in non-puddled conditions produced the highest yields, followed by puddled transplanted rice and DSR. In the diversified cropping system scenario (scenario 4), mustard was included in the system after shorter duration rice followed by spring maize. Data on comparative performance of hybrids or varieties of mustard in terms of yield are sparse. Evaluations in 2013–14 found that yield ranged from 1.8 to 2.8 t ha^{-1} with difference of seven days in maturity duration. Hybrids outperformed inbreds; all hybrids yielded > 2 t ha^{-1}, whereas all inbreds were in the range of 1.7 to 2.0 t ha^{-1}.

In a study initiated in 2013–14 at the regional station of Indian Agricultural Research Institute (IARI), Pusa, Bihar, on **cropping system optimization** through planting hybrids and varieties of different maturity classes, it was found that system productivity (wheat equivalent) follows the following trends: Short-duration hybrid rice (Arize-6129 of 115–120 days duration) followed by (fb) mustard fb spring mungbean (16.3 t ha^{-1}) = short-duration hybrid rice (Arize-6129) fb mustard fb spring maize (15.8 t ha^{-1}) > medium duration hybrid rice (Arize-6444 of 135–140 days duration) fb wheat (14.2 t ha^{-1}) > long duration rice variety (MTU-7029 of 155–160 days duration) fb wheat (10.2 t ha^{-1}). Shorter or medium duration rice hybrids enabled wheat planting on time compared to after long-duration rice variety which resulted in higher wheat yield. Shorter duration rice also enabled cropping system intensification from 200% (rice–wheat) to 300% (rice–mustard–spring maize/or mungbean).

Two new on-station trials were started in collaboration with the Borlaug Institute for South Asia (BISA), Pusa, Bihar during Rabi 2013–14 for evaluating **strategies to tackle terminal heat stress** in wheat. In the first trial, 183 genotypes were evaluated to identify suitable cultivar for early wheat planting—an 'escape' strategy for threat of late heat. Twenty genotypes yielded ≥ 5 t ha^{-1} with early planting and utilizing a 25% higher seed rate with early sowing had a positive effect on grain yield by compensating for reduced tillering. In another trial, the role of integrating agronomic practices for beating terminal heat stress was assessed. The first year results revealed that ZT produced greater yields than conventional till, which was further improved with residue retention (i.e. full CA-based system) by conserving soil moisture which lead to reductions in canopy temperatures late in the season.. Additional irrigation during grain filling helped in mitigating the negative effects of late heat and improved the grain yield by 0.3 t ha^{-1}. The positive effect of additional irrigation increased in the following order: CT > ZT > ZT with residue, owing to the drier condition of CT late in the season.

CROPPING SYSTEM OPTIMIZATION BY RICE HYBRIDS/VARIETY OF DIFFERENT MATURITY CLASS IN BIHAR. HYBRIDS LIKE ARIZE-6129 AND 6444 CAN BE AS PRODUCTIVE AS LONG DURATION VARIETY MTU-7029 AND ENABLE WHEAT PLANTING EARLY LEADING TO HIGHER SYSTEM PRODUCTIVITY. SHORTER DURATION RICE ALSO ENABLES INTENSIFICATION OF SYSTEM FROM 200% (RICE-WHEAT) TO 300% (RICE-MUSTARD-SPRING MAIZE/ OR MUNGBEAN)

Gazipur, Bangladesh Research Platform

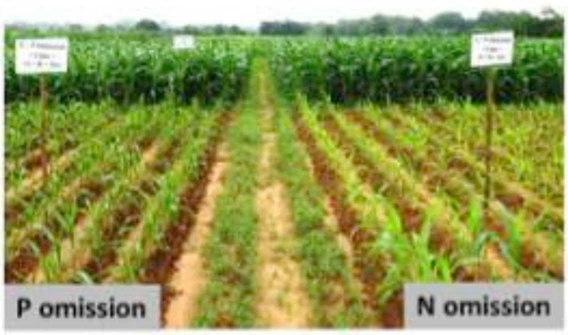
At the Gazipur Research Platform, research results consistently demonstrate the benefits of best management practices (BMPs) in terms of **productivity, profit and resource use efficiencies**. In comparison to farmers' practice (scenario 1), the best management practices alone in scenario 2 increased system productivity (24−33%), total water productivity (16−50%) and net economic returns (85−169%), and decreased specific energy (11−17%). Similar benefits in terms of system productivity and total water productivity were also observed with BMPs under non-puddled conditions (reduced tillage) using mechanization (scenario 3) but with a

further reduction in labor use and variable cost, and hence resulted in a higher economic return. The system productivity was further increased in scenario 4 with BMPs + crop diversification with potato in place of Boro rice and intensification with maize or mungbean in between Boro and Aman rice. Although the substitution of Boro rice with potato and the inclusion of summer crops yielded 1.9–3.7 times higher net economic returns than farmers' practice of a rice-rice system, it is a risky rotation because of the increasing cost of potato production, highly fluctuating potato prices and the associated risk of variable rainfall patterns.

At the Gazipur RP, there were difficulties in practicing zero tillage and drill-seeding, which are typically key components of CA, due to heavy and unpredictable rainfall during seeding and poor crop establishment associated with the heavy textured on site. Therefore, transplanting under non-puddled conditions was used. On the other hand, crop diversification, which is another important component of CA, resulted in significantly higher system performance. However, it is important to mention that the selection of alternative crops is an important consideration because of the chance of heavy rainfall and volatile market prices. We found that potato as an alternative to Boro rice proved not to be a viable option in year 2 because of higher rainfall and the lower market price of potato. Likewise, the inclusion of maize in between Boro and Aman rice is also associated with a risk of high rainfall, but mungbean, being a short duration crop, can escape the risk of high rainfall in summer months. In the fourth year, maize was cultivated in place of potato and provided good yields. Our research highlights the need of more long-term cropping systems research to identify compatible alternative crops to increase farmers' profitability.

Research in Odisha and Tamil Nadu

In the predominantly rainfed plateau region of Odisha, CSISA focused on maize and 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 9 locations, Kharif 2013 results revealed that optimum plant population (75,000 ha^{-1}), optimum fertilization (140:50:75 kg N, P_2O_5, K_2O ha^{-1}), and improved weed management contributed 800, 660, and 170 kg ha^{-1} increased in maize yield over farmer's practice (55,000 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 3.0 t ha^{-1} (farmer's practice of these production factors) to 5.2 t ha^{-1}. In hybrid evaluation, maize yields decreased in the following order: long duration hybrids (6.8-7.4 t ha^{-1}) > shorter duration hybrids (6.0 t ha^{-1}) > high yielding long duration inbred (3.5 t ha^{-1}). Experiments were implemented in Kharif 2014 to establish the **trade-offs and system optimization strategies** for attaining high maize yields while ensuring strong performance of the second crop through maize cultivar selection and management interventions that ensure timely establishment.



Soil fertility issues in plateau are very different than in the alluvial soils in the coastal belt, and nutrient omission plot technique (NOPT) trials in maize revealed 4.7, 4.9, and 1.4 t ha^{-1} response of N, P and K, respectively, over yields achieved with indigenous sources of each nutrient only. These results demonstrate the depleted conditions of the soils in the plateau, but also dispel the myth that these soils do not respond to fertilizer inputs. Phosphorous nutrition is commensurately important to nitrogen in these ecologies.

In rice, the focus was on efficient use of irrigation water, developing weed management solutions for DSR, and optimization of K nutrition. On-station experiment at OUAT, Bhubaneswar evaluating different cultivars under different establishment methods and irrigation schedules is ongoing. Rabi

2013–14 season results showed that there was substantial water saving with irrigation at 10 Kpa stress as compared to no water deficit stress without any yield penalty. The grain yield was higher with hybrids than inbred irrespective of establishment and stress condition. However, in Kharif season, the yield of US323 (short duration hybrid) was lowest. On-farm testing of alternate wetting and drying (AWD) for **irrigation scheduling** is also ongoing in Puri and Bhadrak districts of Odisha, including assessments of farmer receptivity to AWD.

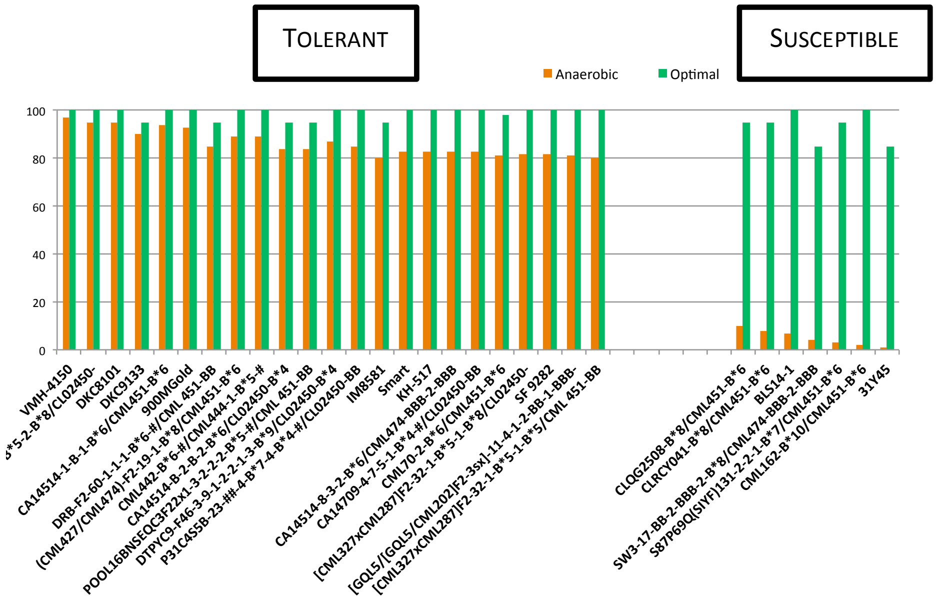
For improving **weed control** in DSR, three field experiments are ongoing, including the testing of different herbicide molecules and the optimization of pre-emergence herbicide efficacy under different establishment methods. Efficacy of pre-emergence herbicide decreased with the delay in herbicide application after DSR sowing in dry conditions followed by irrigation mainly because of a loss of moisture from the surface. In DSR sown in *vattar* condition (planting at field capacity after pre-sowing irrigation) where soil moisture in the surface soil is less, the efficacy of pre-emergence herbicide increased with increase in spray volume from 300 l ha^{-1} to 700-900 l ha^{-1}. In general, weed emergence was much lower in *vattar* DSR than in DSR sown in dry conditions followed by irrigation—highlighting a no-cost management intervention that can form the backbone of **integrated weed management approaches for DSR**.

In Odisha, soil fertility recommendations are dated, and few farmers apply potassium. A trial on the optimization of K fertilization through different K management practices was established at OUAT. The initial result indicated that the highest yield was obtained with 30 kg K_2O ha^{-1} (basal) + 30 kg K_2O ha^{-1} topdressing at PI stage, which was significantly higher only from treatment 6 (straw incorporation +20 kg K_2O ha^{-1} (basal) + 20 kg K_2O ha^{-1} topdressing at PI stage) and the control. Two new experiments were established during Kharif 2014 season: 1) Cropping system optimization through different rice establishment methods, cultivars with different maturity classes, and by diversifying and intensifying the system; and 2) Optimization of nitrogen rates for different rice cultivars (hybrids and inbreds) under novel establishment practices (i.e. non-puddled transplanting).

In Cauvery Delta of Tamil Nadu, the adoption rate of DSR is increasing. Therefore, the focus of the strategic research is on improving irrigation and N use efficiency in DSR. The water advance rate in farmers' fields is generally very low because of the flat configuration, which results in high rates of drainage below the root zone, more so at the head end of the field than at the tail end because of the longer period of flooding of the soil surface at the head end. Therefore, research activities have been initiated in 2014 in both sandy loam and clay soil to evaluate the performance of different degrees of slopes for increasing the water productivity of rice grown in non-puddled soil. In sandy loam soil, there was ~15% irrigation water savings with a 0.1% slope, which slightly increased to 16% with a 0.2% slope. The saving of irrigation was without any yield penalty. The experiment on N dynamics in relation to different crop establishment methods and residue management indicated better yields with a basal dose of nitrogen in the residue retention scenario.

Integration of genetics and agronomy for new production systems: maize tolerance to anaerobic germination and excess moisture

Excessive soil moisture is one of the most important abiotic constraints to maize production in the Asian region, particularly when maize is used as a resilience-building diversification option in Kharif production systems. Rainfed maize crops often receive monsoon rainfall during planting time, which results in temporarily waterlogged soils, resulting in anaerobic conditions. Waterlogged soils adversely affect seed germination, seedling establishment, and early growth, and eventually overall plant stand and final yield potential. While it is commonly accepted that excessive soil moisture following planting and early seedling stage adversely affects the establishment and early growth of maize, the genotypic variability of these traits has not been determined. We identified the available genotypic variability among existing elite maize hybrids (commercial and pipeline products) for **tolerance to pre-germination anaerobic stress** and early seedling stage, with early results demonstrating a greater than 80% germination percentage for more than 20 of the hybrids tested. In constrast, several hybrids were highly susceptible with germination less than 10%. This information is being fed forward to Objective 1 and to private sector partners so that farmers planting Kharif maize can minimize risks of crop establishment failure by selecting appropriate hybrids.



In Focus: *Modeling DSR sowing dates in Bihar*

In Bihar where water is expensive and farmers are reluctant or incapable of apply irrigation for rice, the start of DSR sowing depends on the onset of monsoon rains and whether field access is prevented by excess soil moisture. CSISA has used simulation approaches to evaluate the risks and yield potential of DSR adoption across different monsoon rainfall scenarios.

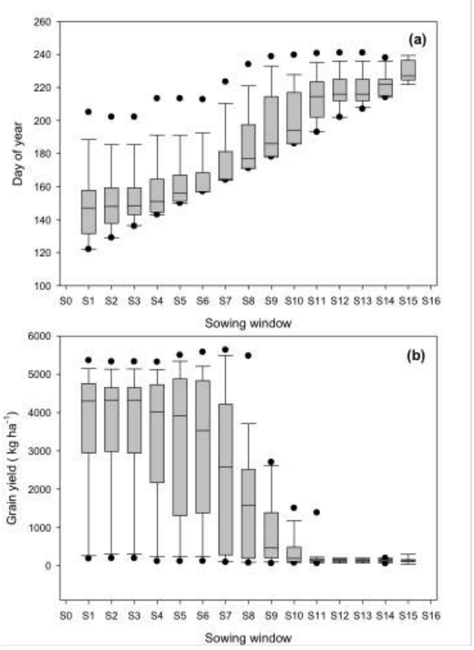


Fig 1. The effect of sowing scenario (S1-S16) on probability of rainfed DSR sowing date (a) and rice grain yield (b).Vertical shaded bars are 25th-75th percentiles; whisker caps are 10th and 90th percentile and black dots 5th and 95th percentile over 40 years (1970-2010). Sowing windows start dates are 1 May (S1), 8 May (S2), 15 May (S3), 22 May (S4), 29 May (S5), 5 June (S6), 12June (S7), 19 June (S8), 26 June (S9), 3 July (S10), 10 July (S11), 17 July (S12), 24 July (S13), 31July (S14), 7 August (S15).

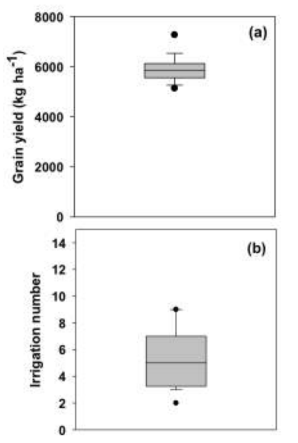


Fig 2. (a) Grain yield and (b) number of irrigations under irrigated DSR crop. Vertical shaded bars are 25th-75th percentiles; whisker caps are 10th and 90th percentile and black dots 5th and 95th percentile over 40 years (1970-2010).

In this study we used Patna District weather data (1970–2010), silt loam soil parameters, and a long-duration rice variety (150 days) to evaluate 16 sowing windows at 7-day intervals starting from May 1 to August 31. Sowing criteria were set up based on the moisture content of the topsoil layer (0–15 cm). Sowing was done only when soil moisture was 40–80% of field capacity in the topsoil layer. Simulation results suggest that there is high inter-annual variability of potential sowing dates. For example, in S3 (sowing window starting from 15 May), the sowing date ranged from May 16 to August 10 with a median of May 31 (Fig 1a).

Sowing date variability represents uncertainty in the onset of the monsoon and variability in the amount of rainfall. With a delay in starting the sowing window there is a decrease in sowing date variability as there is a high probability of meeting the sowing criteria due to a high chance of rainfall. However, there was an increase in the probability of missing sowing due to excess soil moisture. For example, in May or June sowing there were about 3 out of 40 years when sowing was not possible due to field non-accessibility because of excess soil moisture. The number of instances increased to 20 out of 40 under mid-July sowings and later sowings. In sowing windows starting from May and early June all of the sowing dates fell in first fortnight of June because the soil was too dry to sow before this window and too wet after it. Simulation results suggested that the optimal target for DSR sowing should be the first fortnight of June.

Rice grain yield was higher in early sowing scenarios, median yield was similar under May and early June planting (around 4.3 t ha^{-1}) (Fig 1b), and after the S6 (June 13) sowing window there is a sharp decline in grain yield potential and an increase in grain yield variability. Lower grain yield under later sowing was due to low temperature during the grain filling period. To achieve a higher grain yield, the cutoff date for DSR sowing is mid-June. The crop was water stressed even when it was sown before the cutoff date due to variation in rainfall amounts and distribution.

If a farmer has access to irrigation to start the crop, DSR can be reliably be sown in most years during the optimum sowing window to maintain high yield potential and to reduce year-to-year production variability (first fortnight of June). With irrigation to permit timely establishment and to relieve stress during dry spells. simulation results suggest that yields will increase by 1.6 t ha^{-1} as compared to the rainfed crop (Fig 2a) and on average a farmer needed to invest in 5 irrigations, depending on rainfall (Fig2b).

Simulation results will be leveraged to provide better guidance to farmers on DSR management in 2015, including the yield gains and risk-reduction associated with irrigation.

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.

The genetic yield potential of four elite varieties (NSIC Rc82, NSIC Rc158, NSIC Rc222, and NSIC Rc238) and three mega varieties of India (Swarna, Samba Mahsuri and MTU1010) is being enhanced by incorporating three cloned genes—high grain number (*Gn1a*), bigger panicle size (*Spl14*) and strong culm (*SCM2*). SNP marker assays for a large number of candidate genes and cloned QTLs for key traits, including yield components, have been designed for running an Infinium 6K SNP chipin addition to earlier reported 24-SNP sets on the Fluidigm EP1 system in the Genotyping Services Lab at IRRI. These trait-specific SNPs will enable rapid marker-assisted selection and QTL pyramiding to develop high yield potential rice varieties.

Bi, tri and multiple parent recurrent selection has been taken up to enhance genetic yield potential and to incorporate many other traits like lodging tolerance, non-chalkiness, stay-green leaves, modified plant architecture, earliness and prolonged grain filling. Out of 200 lines tested in observational yield trials 17 entries ranked in the top 3% category. In IR 36 background recessive GMS gene (ms ms) was fine mapped on chromosome 2 and 70 new GMS lines were developed. Of the 58 entries tested in multi-location trials conducted at four locations, 12 promising entries were identified. In the OYT, 30 promising entries with more than 6 ton/ha grain yield were identified. Three hundred forty-eight entries were phenotyped during dry and wet seasons for the purpose of genomic selection. Straw quality of 100 entries was tested and five mapping populations are being developed. 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 are in national level multi-location trials.


PROMISING BREEDING LINES WITH GOLDEN BROWN GRAIN COLOUR (SIMILAR TO THAT OF MEGA VARIETY SWARNA) MEDIUM SLENDER GRAIN TYPE, STRONG CULM ,LONG & HEAVY PANICLES , MEDIUM-EARLY DURATION, STAY GREEN CHARACTER AND HIGH YIELD POTENTIAL UNDER DRY DIRECT SEEDED CONDITION

Under machine sown dry direct seeded conditions, one hundred entries composed of hybrids, breeding lines and varieties from IRRI and public sector NARES partners were evaluated at six locations in India. In general, hybrids performed better in terms of rapid germination and emergence, early stage seedling vigor, fast canopy coverage, better crop establishment and grain yield. The yield advantage of a few top hybrids was in the range of 23–34% in the early, 26–35% in the medium-early and 16–19% in the medium maturity groups. Among the breeding lines the yield advantage was in the range of 9–17%, 14–27% and 9% in respective maturity groups. Out of 60 entries tested during the 2014 dry season under machine sown dry DSR, 15 entries recorded more than 7.5 t ha^{-1}. Many promising entries for DSR were identified in Nepal and Bangladesh.

Through marker assisted back crossing, IR64-Pup1-AG1 and Samba Mahsuri-Sub1-AG1-Pup1 are being developed. An array of new breeding lines having varied plant types with high grain yield potential, tall stature (> 100 cm), early stage seedling vigor; lower panicle position with strong culm; erect, dark green & prominent top leaves with slow leaf senescence, long and heavy panicles, prolonged grain filling duration, lower grain shattering with low to intermediate threshability, biotic stress tolerance i.e., BLB, Blast, BPH, desirable grain quality and varied maturity groups to suit different cropping systems were developed. Many promising entries are in national multi-location trials. One QTL each was identified for first emergence (*qFSE-8)* and final uniform emergence (*qUSE-8)* on chromosome 8. Seven QTLs viz., *qEV-1, qEV-2, qEV-3, qEV-6, qEV-7, qEV-9 and qEV-11.1* were identified for early and uniform emergence on chromosomes 1, 2, 3, 6, 7, 9, 11 respectively.

LONG TERM RECURRENT SELECTION FOR INCREASED PANICLE LENGTH, VERY LOW GRAIN CHALKINESS AND HIGH YIELD POTENTIAL

The heat tolerance QTL qHTSF4.1 was fine mapped to 5 cM region. PCR based markers and protocol for marker-assisted selection of qHTSF4.1 were developed. Near isogenic lines (NILs) with N22 introgression in IR64 background were developed and BC5F3 lines were evaluated in the field along with the early morning flowering (EMF) NILs. A recombinant inbred line (RIL) population consisting of 246 F7 lines was developed and is being used for high night temperature (HNT) QTL mapping and other heat tolerance studies. A greater respiratory loss in response to high night temperatures was documented in susceptible genotypes compared to the tolerant cultivars with a much larger loss after flowering than before flowering stages, quantified under realistic field conditions using unique field based tents. An array of new breeding lines with reproductive stage heat tolerance were developed. IR64 introgression lines with fine mapped QTL region on chromosome 4 of N22 tested in two independent experiments (i) short duration stress (6 hours) coinciding with anthesis and (ii) for 14 days covering the entire flowering period. Across both these exposures spikelet fertility was increased by 10 – 15%. Anthers from the NILs and parents are currently undergoing metabolomic analysis at Max Planck, Institute, Germany. Ten advanced heat-tolerant lines were nominated to MET and 17 lines for International heat tolerant nursery (IRHTN). One entry viz., IR10C146 is in advanced stage of testing (MET-2).

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.

During the reporting period, 12 new wheat varieties were released, 10 additional varieties poised for release, and more than 2,000 distributed to partners for further evaluation. In addition, 1,875 new crosses (1,000 by CIMMYT and 875 by NARS) were attempted and >18,000 breeding populations (10,000 by CIMMYT and 8,000 by NARS) were exposed to selection under various environments and management conditions. More than 1,100 advanced lines and segregating (F3/F4) generations from South Asia were evaluated in Kenya for screening against Ug99 resistance. Five hundred forty-nine participatory varietal selection (PVS) and adaptive trials were planted in farmers' fields by collaborators in Nepal, India and Bangladesh. More than 100 CSISA trials were grown by 31 collaborators, with several of these funded and run by the private sector in India. Seed growers and farmer groups continued seed dissemination of superior lines with the result that breeder seed indent and production figures indicated that CSISA-bred lines covered 18% area in India, 24% in Nepal and 34% in Bangladesh. A former CSISA fellowship holder (Chhavi Tiwari) from India was awarded "Women in Triticum" award by Borlaug Global Rust Initiative (BGRI)l. Likewise CSISA wheat breeder (Arun Joshi) was awarded the 4th WIT Mentor award by BGRI. Eight papers were published in refereed journals.

Major accomplishments of Objective 4:

1. Twelve outstanding wheat varieties released for different environments and management conditions of South Asia.
2. Ten additional varieties set for release.
3. One hundred sets of trials/nurseries from Mexico consisting of 278 advanced lines planted at sites in India (66), Nepal (13), Bangladesh (14) and Pakistan (13).
4. More than 1,100 lines entered in trials for evaluation.
5. NARS collaborator planted 897 advanced lines in stations trials from their own breeding program while around 3,000 lines planted in replicated trials at Mexico.
6. Around 18,000 breeding lines attained advanced stage of evaluation.
7. More than 1,600 crosses/backcrosses and 18,000 segregating populations were exposed to selection by breeding teams in different locations of South Asia, Mexico and Kenya.
8. More than 1,000 advanced lines/segregating populations from South Asia planted at Kenya for evaluation of resistance to Ug99.

9. Fifty-two spot blotch resistant lines identified in superior agronomic background and 4 mapping populations phenotyped.

10. A panel of new advanced lines comprising high yield and/or biomass; based on strategic crosses to combine complementary source-sink traits were identified.
11. 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.
12. Results of multi-location yield trials of the WYCYT supported the proof of concept that yield potential can be increased through strategic physiological trait (PT) crossing. The results of the 1st WYCYT –averaged over a total of 25 international sites– showed PT lines to have superior yield and biomass at 8% and almost 20% over local checks, respectively. Results of the 2nd WYCYT grown in the following spring wheat cycle (2014), averaged across CSISA sites showed that PT lines again out performed local checks by similar amounts.
13. 569 PVS and adaptive trials were planted in Nepal, India and Bangladesh for farmer's participatory evaluation and delivery of most recent varieties.
14. Molecular mapping for heat tolerance was achieved and robust markers were identified.
15. Linkage with HarvestPlus was strengthened to deliver agronomically superior biofortified lines to farmers in India and Pakistan.
16. Eight publications in peer reviewed journals published.

Leverage seen in Objective 4 in south Asia influences by success of new wheat varieties

1. West Bengal (India) government decided to replace older but popular cultivar PBW 343.
2. Increased profit due to new wheat varieties has led to discouragement of Boro rice by Bangladesh government in traditional wheat areas.
3. Bangladesh government promoting of early maturing rice varieties to encourage timely sowing of wheat in Bangladesh.
4. Bangladesh government decided to provide incentive to the farmers for growing wheat.

Spillover seen in objective 4 in South Asia

1. Two wheat varieties from Punjab (PBW 621, PBW 644) that were released for NWPZ have got large seed indent from Bihar.
2. CSISA bred wheat varieties in Bangladesh, have spread to new areas—southern Bangladesh (Mymensingh, Jessore, Rangpur, Khulna, Barisal) benefitting around 10,000 farm families.
3. The most tangible spillover output of CSISA Obj 4 occurred on August 13, when the Government of Bhutan gave the go-ahead to release two new improved wheat varieties (Bajosokhaka and Gumasokhaka) from CIMMYT. This is first release of any wheat variety in this country in last 20 years. Bajosokhaka has the pedigree (ATTILA*2/STAR/4/SNI/TRAP#1/3/ KAUZ*2/TRAP//KAUZ) while Gumasokhaka is developed from the cross KIRITATI//HUW234+ LR34/PRINIA). Both varieties yielded, on average, 50 percent higher than the most popular variety, Sonalika, in three years of multi-location testing in Bhutan. Both varieties are believed to have water stress tolerance and good resistance to yellow rust.

Objective 5: Improved policies and institutions for inclusive agricultural growth

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 expanded its research and communications activities to strengthen the policy environment around of the development and delivery of new technologies and practices relevant to CSISA. Particular emphasis was placed on strengthening private investment in inputs and services, and fostering stronger partnerships between the public and private sectors.

Policy analysis and research

Field experiments on heterogeneity in demand among farmers for drought-tolerant rice cultivars in Bihar have offered insight into how delivery strategies can be improved for abiotic stress tolerance traits to reach particularly vulnerable farmers. These CSISA experiments also demonstrate the potential space for participation by both the public and private sectors in developing and delivering abiotic stress-tolerance traits. These topics have been further explored in a study being undertaken with collaborators at the Jawaharlal Nehru University Centre for Economic Studies and Planning, and in studies on the policy and regulatory dimensions of seed systems and markets in India, Nepal, and Bangladesh.

A study on the impact of India's Mahatma Gandhi National Rural Employment Guarantee Act (MGNREGA) on the adoption of resource-conserving and labor-saving technologies informs CSISA's technology promotion activities by providing greater insight into the effects of a large-scale public-policy intervention on labor, gender and asset dynamics, potentially improving the targeting of resource-conserving technologies. Findings from this survey were shared at an international conference on MNREGA held in Mumbai in March, and in several professional forums.

A study undertaken in collaboration with the Gender, Agriculture, and Assets Project examines the **formation and composition of men and women's social networks and how they might affect technology adoption**. This study specifically examined laser land leveling in eastern Uttar Pradesh. The study specifically explored the question of whether gendered dimensions of information acquisition play a role in household decision-making on adoption.

A **study to examine the interplay between abiotic stress-tolerant rice cultivars, weather index insurance, and drought risk management strategies among farmers in Bangladesh** was inspired by discussions with principal investigators at the Feed the Future BASIS Assets and Market Access Innovation Lab. It leverages recently released rice cultivars developed by the Bangladesh Rice Research Institute and the Stress-Tolerant Rice for Africa and South Asia project; seed procured from the Bangladesh Agricultural Development Corporation; strategic advice from IRRI; and input from several other partner organizations. The study is designed to explore the impacts on household production, consumption, and risk management decisions of stress-tolerant cultivar adoption and weather index insurance uptake. This study extends prior IFPRI research funded by the Bangladesh Policy Research and Strategy Support Program led by IFPRI, the CGIAR Research Program on Climate Change, Agriculture and Food Security, and Index Insurance Innovation Initiative under the BASIS Innovation Lab mentioned earlier.

Four new studies warrant mention: (1) In partnership with the Indian Institute of Management Ahmedabad, IFPRI has initiated a **study that examines the organization of the agricultural machinery and equipment industry and the policy environment that enables or hinders its growth trajectory**. (2) **Field experiments aimed at studying the impact of mechanical rice transplanters on**

labor displacement and gender are being planned in Bihar, while possibilities are being explored for similar experiments with other machinery in Nepal and/or Bangladesh. (3) A new **study aims to examine institutional arrangements that facilitate women's representation in water user associations in Nepal**, and (4) another study in Nepal explores the role of **social capital in securing the benefits of livestock transfer programs in the country's mixed livestock-cereal systems**.

Outreach and communications

Objective 5 served as a platform for policy dialogue and encouraged lively discussion and debate among partners in the public, private, and civil society sectors. Outreach activities were accompanied by forays into the wider media space, including the popular press, blogs, and op-eds.

A **private sector roundtable on "Sustainable intensification in South Asia's cereal systems: Investment strategies for productivity growth, resource conservation, and climate risk management"** in New Delhi in May 2014 brought together a select group of representatives from India's key seed companies, input service providers, high-tech startups, financial services firms, foundations, and research institutions. The meeting allowed partners to explore research and investment opportunities with CSISA covering a broad spectrum of services and products. Several new partnerships were forged between CSISA and the private sector as a result of this roundtable, while existing partnerships were strengthened. A follow-up event is slated for December 2014.

A series of international, national, and local engagements were held throughout the region on policies to improve the prospects for strengthening seed systems and delivering improved hybrids and cultivars to smallholders. Opportunities to present findings from CSISA research have allowed us to demonstrate the untapped potential for increasing both public- and private-sector investment in the development and delivery of better seed products. Messages have informed decision-making at the local level (e.g., at the Seed Summit held in Bihar in May 2014) and the regional level (e.g., in expert consultations convened by the Regional Strategic Analysis and Knowledge Support System for Asia in Siem Reap, Cambodia in May 2014).

Awards and recognition

The IFPRI study titled **"Risk and ambiguity preferences and the adoption of new agricultural technologies: Evidence from field experiments in rural India"** received special recognition for excellence in research at the IVth International Conference on Applied Econometrics held in March 2014 at IBS, Hyderabad, India. Vartika Singh of EPTD New Delhi participated in paper was awarded the Best Paper of the Conference out of 86 papers that were presented.

IFPRI was given thanks by a number of NGO partners in Bangladesh for **supplying foundation seed of a new drought-tolerant rice cultivar (BRRI Dhan 56)** that was leftover following distribution to farmers in Bangladesh in June 2014 under the study on abiotic stress-tolerant rice cultivars, weather index insurance, drought risk management strategies among farmers in Bangladesh.

Anticipated activities

IFPRI and the Institute of Economic Growth, Delhi University will convene a high-level international policy conference on **"Innovations in Indian Agriculture"** in New Delhi on December 4–5, 2014.

The second **roundtable with the private sector** is slated for December 8, 2014. This event will bring in civil society actors alongside key corporate representatives to strengthen CSISA's existing partnerships and explore new avenues for collaboration.

Alongside these high-profile events, Objective 5 will continue with its intensive research agenda and undertake **strategic studies** to address constraints and opportunities identified by CSISA's hubs, management, partners, and donors. Objective 5 will continue to **support hubs and management** and provide feedback to project planning and priority setting to strengthen CSISA's operations.

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: The CSISA **Executive Committee** (EC), composed of senior representatives of CSISA's CGIAR partners, meets quarterly and monitors project progress and work plan development. The EC is also designed to approve fund allocation for regional investments and ensure integration with other activities of the Centers/CGIAR Research Programs in the region. Country-based **Management Teams** (MT) for India and Bangladesh meet monthly and lead strategy development, activity planning, and provide 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. **Advisory and Investment Committees (AICs) for Bihar, Odisha, and Bangladesh** consist of NARES leaders and other representatives from the public, private, or civil society sectors, and help align the project with government priorities, policies and investments, and provide new mechanisms for catalyzing partner-driven delivery of activities. AICs allocate funds to proposals that are aligned with CSISA's goals.[3] Funds are are managed by the AICs in consultation with CSISA MTs.

Semi-annual Planning and Evaluation Meetings: Each year, country-specific and objective-specific meetings are held in advance of the Kharif and Rabi 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: CSISA is continually upgrading its data management protocols and procedures, and improving the ways in which data is collected and shared. In India, CSISA's four CGIAR partners continue to use Surveybe software and portable netbook computers to streamline field-based data collection for socio-economic surveys. 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. In ODK, every sample point is automatically geo-referenced, and can be synced to a server in real-time; data are also easily mapped for quick visualization. The CSISA Bihar and EUP hubs have provided data logbooks to service providers. An Access database has been created to manage CSISA's relationship with service providers. These tools and processes are documented in CSISA's M&E Handbook. Standard Operating Procedures for CSISA data management have been developed, including the basic metadata schema to be included with every data set, file-folder naming and organization protocols, data storage guidelines, and data-related roles and responsibilities of staff at each CSISA hub.

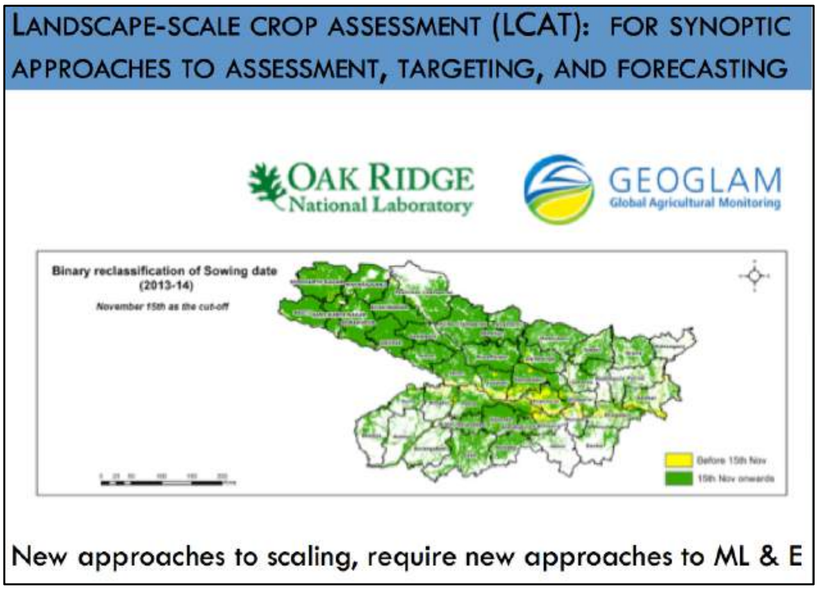
Enabling wider access to CSISA data: Several CSISA data sets have been uploaded into AgTrials (http://agtrials.org), a global repository developed by the CGIAR Research Program on Climate change, Agriculture and Food Security (CCAFS), with eight current CGIAR partners. However, while the AgTrials database is powerful, the user interface requires improvement. A CSISA/CIMMYT–CIAT collaboration has been cemented to further develop AgTrials, with current work plans focusing on usability-interface issues, metadata schema and forms, optimizing the search functionality, and making further refinements following user testing. Since this effort requires coordination among

[3] Total funding support to the AIC's during Phase II is $1.2 million USD.

multiple institutions and funding sources, progress towards interface completion has been slower than anticipated, but continues. Agronomic trial traits have been developed to enhance the agronomic content in the Crop Ontology (http://www.cropontology.org) used by both AgTrials and the Generation Challenge Program's (GCP) Field Book. A former GCP consultant has worked with CSISA/CIMMYT's data management team and the Bioversity-based GCP semantics and ontology expert to add these traits to the Crop Ontology and to develop an Agronomy Field Book. When completed, CSISA agronomists will use this online Field Book and those working in other projects/centers to standardize data collection templates, facilitate meta-analyses, and better integrate breeding and agronomy data. The Agronomy Field Book will also allow users to analyze data using pre-loaded R scripts, and to store data sets. Via another new collaboration between the GCP and AgTrials, the Field Book will also enable a one-click upload of data from the Field Book into AgTrials. An instance of DataVerse(http://dvn.iq.harvard.edu/dvn/dv/IFPRI) has been installed on a CIMMYT server, and is being evaluated for use as a repository for CSISA's survey and technology tracking data.

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. Five **CSISA Research Notes** have been published, which serve as briefs for the research coming out of CSISA. Our **Facebook** page, **Picasa** account, and upcoming **Twitter** feed provide additional mechanisms for sharing information about CSISA's activities with a wide audience.

Monitoring and Evaluation: The CSISA M&E team, complemented by our socioeconomics team, develops tools for directly capturing data on our activities and outputs, and identifies inference techniques for capturing numbers on large-scale impact that expand beyond our ability to capture data directly. M&E activities are identified seasonally during the impact pathway planning process. Examples of activities for which our 'footprint' is comparatively small and we can still capture data directly include mechanical rice transplanting and laser land leveling. Technologies that have been adopted at scale that require the use of inference techniques to estimate adoption numbers include early wheat planting, transitions to hybrids and elite varieties, and improved weed management.

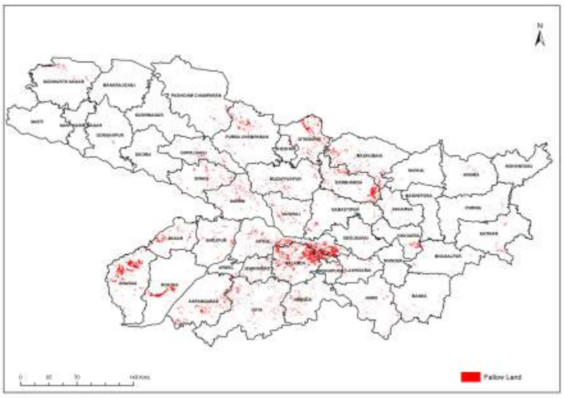


New approaches to scaling, require new approaches to ML & E

As CSISA's level of impact moves from the field to landscape scale, new tools are required to detect change for monitoring, internal learning and evaluation. CSISA has teamed with Oak Ridge National Laboratory and the GEOGLAM initiative to devise the 'LCAT' concept. Currently under development, LCAT will leverage 'real time' remotely sensed information and geo-spatial analysis to aid certain types of technology adoption assessments (e.g. planting date adjustments), targeting (e.g. fallows development), and crop performance forecasting (e.g., for use in dynamic decision support frameworks for fertilizer management).

In Focus: *Challenges faced during the reporting period*

FLOODING IN ODISHA FROM CYCLONE PHAILIN TOWARDS THE END OF KHARIF 2013



RICE SEASON FALLOWS CAUSED BY EARLY DROUGHT IN EUP AND BIHAR (2014)

CSISA faced a number of weather-related challenges during the reporting period, most notably cyclone Phailin, which hit India in mid-October 2013, additional flooding that hit Odisha in July–August 2014, and the delayed 2014 monsoon, which arrived in CSISA's priority hub domains a month late, causing drought-like conditions.

Cyclone Phailin caused high winds and torrential rains in India's eastern states starting on October 12th, 2013. In Bihar and Eastern UP, the rice crop, which had excellent growth and was nearing maturity, was badly affected and suffered substantial yield losses. In Odisha, Phailin caused extensive damage to the infrastructure and the standing crops in the districts of Ganjam, Puri, Khordha, Gajapati, Balasore and Mayurbhanj. Reservoirs for different irrigation projects also released excess water at the same time to accommodate incoming floods, which led to the prolonged submergence of the affected areas. As per the assessment of the Department of Agriculture, the total crop area affected by the cyclone and floods in the State was estimated at 1.3 mha out of a total area of 6.11 mha under the Kharif crop, of which 0.78 mha has sustained more than 50% loss. The damage to the agriculture sector was mainly due to loss of standing crops from prolonged submergence and damage to agriculture infrastructure. The overall crop loss was estimated to be as high as $25.1 million.

In July–August 2014, Odisha suffered flooding triggered by heavy rains, adversely affecting the districts of Puri and Bhadrak within CSISA's domain area. Floods coincided with nursery raising period/early transplanting of the crops, causing huge damage to traditional rice varieties. In Bhadrak, the floods wiped out many rice nurseries entirely. Major rivers such as the Mahanadi burst their banks submerging large swathes of farmland.

In Bihar & EUP, the onset of the monsoon was late and there was sluggish progress until the beginning of August. There was some rain in first week of July, followed by no or little rains for 45 days. The rainfall deficit as of August 14 was 82, 70, 40, 34, 34 and 38% in Buxar, Ara, Patna, Muzaffarpur, Vaishali and Begusarai, respectively. The rainfall deficit as of September 15 was 40% in EUP. A drought-like situation arose in many districts, leading to delayed transplanting or no transplanting (see graphic), which may lower rice production in Kharif 2014. It is worth noting that this scenario was not well predicted and anticipatory planning based on forecast information was not possible.

In Focus: *Direct measurement vs. inference techniques*

Hybrid maize cultivation

Mat nurseries for machine transplanting of rice

Harvest of early-planted wheat

In addition to our progress reports and results framework updates, CSISA reports annually on a limited set of indicators, which are submitted to USAID's Feed the Future online monitoring system. The compilation of CSISA's indicator numbers involves a combination of direct measurement, which is used for technologies that have a relatively limited footprint, and inference techniques, which are used for technologies that have spread far beyond what CSISA can measure directly. The information below provides a snapshot of how data are compiled for each technology.

CSISA's indicators:
4.5.2(2) Number of hectares
4.5.2(5) Number of farmers
4.5.2(7) Number of short-term trainings
4.5.2(11) Number of organizations and enterprises
4.5.2(12) Number of public-private partnerships
4.5.2(39) Number of technologies
4.5.1(24) Number of policies
4.8.2(26) Number of stakeholders with greater adaptive capacity to climate change

CSISA collects data directly on these technologies:

- Laser land leveling
- Machine transplanting of rice
- Direct seeded rice
- Maize hybrids
- Maize bed planting
- Intercropping of maize
- ZT of oilseeds and pulses, including soybean
- Post-harvest handling / paddy threshing
- Summer moong

CSISA uses special surveys and inference techniques to collect data on the following technologies:

- Rice herbicide mixes (dealer survey)
- Wheat herbicide mixes (dealer survey)
- Long-duration varieties in wheat (dealer survey)
- Improved rice varieties (dealer survey)
- Early wheat planting (key informant/service provider survey)

Looking ahead to Rabi 2014-15

Impact pathways for Bihar, EUP, and Odisha

Zero till wheat

Direct seeded rice

Hybrid maize

The foundation of CSISA's seasonal planning process for Bihar, Eastern UP, and Odisha is the development of seasonal impact pathways, which identify the primary outcomes, intermediate outcomes, activities, geographies, timelines, and partners needed to achieve our goals for the upcoming season. These documents are drafted in seasonal planning & evaluation meetings and then discussed with the CSISA Management Team so that ideas are vetted, activities are coordinated, and resources are deployed accordingly. The final documents are then used by the M&E and Communications teams to plan for the data collection, knowledge management and communications needs of the project.

Looking ahead to Rabi 2014, these are the primary outcomes that form the foundation of the impact pathways for Bihar, Eastern UP, and Odisha. Intermediate outcomes and activities are defined for each primary outcome, and then the work is monitored and the plan is updated on a monthly basis. Each activity plan is tailored to the needs of the specific hub domain.

Primary Outcomes

- Farmers engage in early wheat sowing in the first two weeks of November
- Farmers widely adopt zero tillage practices for wheat
- Farmers widely adopt long-duration and high-yielding wheat varieties
- Farmers widely adopt improved weed management in wheat
- Where risks and economics are favorable, farmers adopt machine-transplanted non-puddled rice
- Farmers widely adopt improved direct seeded rice in lowland ecologies where irrigation is available
- Cropping systems are diversified and intensified with maize, mustard & green gram
- Farmers adopt better practices in post-harvest activities
- Women in agriculture are empowered through systematic inclusion in farming practices and processes/value chains
- Water productivity is increased in rice-based cropping systems
- Farmers widely adopt best bet agronomy in maize
- Laser land leveling is seen as an important component of cropping system planning and is adopted by farmers
- Crop Manager-based recommendations are made available to farmers

Annex 1. New Papers, presentations, and outreach activities

(in chronological order)

Objective 2: Punjab Hub

Yadvinder-Singh, Kukal, SS, Jat, ML and Sidhu, HS. 2014. Improving Water Productivity of Wheat-Based Cropping Systems in South Asia for Sustained Productivity. *Advances in Agronomy*, 157, 159-258. http://dx.doi.org/10.1016/B978-0-12-800131-8.00004-2

Vicky Singh, Sidhu, HS, Jat, ML, Manpreet-Singh and Yadvinder-Singh. 2014. Conservation Agriculture based Management Technologies for Improving Productivity and Profitability of Cotton-Wheat System in Northern- Western Indo-Gangetic Plains of South Asia. Paper presented in 6th WCCA; June 21-24, Winnipeg, Manitoba, Canada

Parvinder-Singh, Sidhu, HS; Pankaj-Singh, Yadvinder-Singh, Jat, ML and McDonald A. 2014. Residue mulching and precision water management in permanent raised bed planted spring maize in northwest India: Crop yield and water productivity. Paper submitted for the 12th Asian Maize Conference, October 30-November 1, 2014, Bangkok, Thailand.

Objective 4:

Mondal S., Singh R.P., Crossa J., Huerta-Espino J., Sharma I., Chatrath R., Singh G.P., Sohu V.S., Mavi G.S., Sukaru V.S.P., Kalappanavar I.K., Mishra V.K., Hussain M., Gautam N.R., Uddin J., Barma N.C.D., Hakim A. and A. K. Joshi (2013) Earliness in wheat a key to adaptation under terminal and continual high temperature stress in South Asia. *Field Crop Research*. 151: 19–26

Tiwari C., H. Wallwork, U. Kumar, R. Dhari, B. Arun, V.K. Mishra, M.P. Reynolds, A.K. Joshi (2013) Molecular mapping of high temperature tolerance in bread wheat adapted to the Eastern Gangetic Plain region of India. *Field Crops Research* 154: 201–210

M. Eisa, R. Chand, A.K. Joshi (2013) Biochemical and histochemical traits: a promising way to screen resistance against spot blotch (*Bipolarissorokiniana)* of wheat. *European Journal of Plant Pathology* 137:805–820

M. Eisa, R. Chand, A.K. Joshi (2013) Biochemical and histochemical factors associated with slow blighting to spot blotch in wheat. *Zemdirbyste-Agriculture*, 100 (2):191–198

Paliwal R., B. Arun, J.P. Srivastava and Arun K Joshi (2013) Inheritance of terminal heat tolerance in two spring wheat crosses. *Cereal Research Communications*. 41(3):400–408

Pask, A.J.D., M.P. Reynolds, I. Sharma, R. Chatrath, G.P. Singh, V.S. Sohu, G.S. Mavi, V.S.P. Sukaru, I.K. Kalappanavar, V.K. Mishra, A. Balasubramaniam, Y. Mujahid, M. Hussain, N.R. Guatam, N.C.D. Barma, A. Hakim, A.K. Joshi (2013) The CSISA wheat phenotyping network. *In* Reynolds M.R., Braun H., (Eds.). Proceedings of the 3rd International Workshop of the Wheat Yield Consortium. CENEB, CIMMYT, Cd. Obregón, Sonora, Mexico, 5–7 March 2013. Mexico, DF.: CIMMYT.

Pask A.J.D., A.K. Joshi, Y. Manes, I. Sharma, R. Chatrath, G.P. Singh, V.S. Sohu, G.S. Mavi, V.S.P. Sakuru, I.K. Kalappanavar, V.K. Mishra, B. Arun, M.Y. Mujahid, M. Hussain, N.R. Gautam, N.C.D. Barma, A. Hakim, W. Hoppitt, R. Trethowan, M.P. Reynolds (2014) A wheat phenotyping network to incorporate physiological traits for climate change in South Asia. *Field Crops Research* 168, 156–167. http://dx.doi.org/10.1016/j.fcr.2014.07.004.

Mondal S., A.K. Joshi, Huerta Espino J. and R. P. Singh (2013) Early maturity in wheat for adaption to high temperature stress. 12th International Wheat Genetics Symposium. Book Chapter (Submitted).

Objective 5:

Peer-reviewed journal articles, book chapters, and books

Ward, P. S. and V. O. Pede. 2014. Capturing of social network effects in technology adoption: the spatial diffusion of hybrid rice in Bangladesh. *Australian Journal of Agricultural and Resource Economics* 58: 1–17, forthcoming.

Ward, P. S., D. L. Ortega, D. J. Spielman and V. Singh. 2014. Heterogeneous demand for drought-tolerant rice: Evidence from Bihar, India. *World Development* 64: 125–139.

Spielman, D. J., D. E. Kolady, A. Cavalieri, N. C. Rao. 2014. The seed and agricultural biotechnology industries in India: An analysis of industry structure, competition, and policy options. *Food Policy* 45: 88–100.

Dey, M.M., D.J. Spielman, A.B.M. Mahfuzul Haque, M.S. Rahman, and R. Valmonte-Santos. 2013. Change and diversity in smallholder rice-fish systems: Recent evidence from Bangladesh. *Food Policy* 43: 108–117.

Discussion/working papers

Krishna, V. V., D. J. Spielman, P. C. Veettil and S. Ghimire. 2014. *An empirical examination of the dynamics of varietal turnover in Indian wheat*. IFPRI Discussion Paper 1336. Washington DC: IFPRI.

Ward, P. S. and V. Singh. 2014. *Risk and Ambiguity Preferences and the Adoption of New Agricultural Technologies: Evidence from Field Experiments in Rural India*. IFPRI Discussion Paper 1324. Washington DC: IFPRI.

Ward, P. S., D. L. Ortega, D. J. Spielman, and V. Singh. 2013. *Farmer Preferences for Drought Tolerance in Hybrid versus Inbred Rice: Evidence from Bihar, India.* IFPRI Discussion Paper 1307. Washington DC: IFPRI.

Magnan, N., D. J. Spielman, T. J. Lybbert, and K. Gulati. 2013. *Leveling with Friends: Social Networks and Indian Farmers' Demand for Agricultural Custom Hire Services*. IFPRI Discussion Paper 1302. Washington DC: IFPRI.

Policy briefs, research notes, and other publications

FAO Regional Office for Asia and the Pacific. 2014. A regional strategy for sustainable hybrid rice development in Asia and the Pacific. (with contributions from P.S. Ward). URL: http://www.fao.org/docrep/019/i3643e/i3643e.pdf.

Magnan, N.M, D.J. Spielman, K. Gulati, and T.L. Lybbert. 2013. Gender dimensions of social networks and technology adoption: Evidence from a field experiment in Uttar Pradesh, India. In Gender, Agriculture, & Assets Project (GAAP): Learning from Eight Agricultural Development Interventions in Africa and South Asia, A. Quisumbing, R. Meinzen-Dick, J. Njuki, and N. Johnson, eds. GAAP Note. Washington, DC: IFPRI. URL: http://www.ifpri.org/sites/default/files/publications/gaapcollection2013.pdf.

Project documents

Magnan, N., D. J. Spielman, K. Gulati, and T. J. Lybbert. 2013. Gender dimensions of social networks and technology adoption: Evidence from a field experiment in Uttar Pradesh, India. In *Gender, Agriculture, & Assets Project (GAAP): Learning from Eight Agricultural Development Interventions in Africa and South Asia*, A. Quisumbing, R. Meinzen-Dick, J. Njuki, and N. Johnson, eds. GAAP Note. Washington, DC: IFPRI.

Published datasets

IFPRI (International Food Policy Research Institute). 2014. Farmers' preferences for abiotic stress tolerance in hybrid versus traditional rice: Evidence from Bihar, India (2012-13). Washington, DC: IFPRI. URL: http://dx.doi.org/10.7910/DVN/26930.

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.

Ward, P. S., D. J. Spielman, D. Kolady, P. Ward, H. A. Rashid and K. Gulati. 2014. The economics of hybrid rice in Asia: Technology adoption, public expenditures and private incentives. Presentation at the conference titled "Expert Consultation on Hybrid Rice Development in Asia: Assessment of limitations and potential," organized and sponsored jointly by the Food and 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.

Spielman, D.J., R. Ahuja, P.K. Joshi, P. Ward, R.K. Malik, A. McDonald, V. Nazareth, and others. 2014. "Sustainable Intensification in India's Risk-Prone Ecologies: Investment strategies for productivity growth, resource conservation, and climate risk management." Presentation given at the IFPRI-CSISA Private Sector Roundtable, New Delhi, May 19.

Ward, P. S., D. L. Ortega, D. J. Spielman and V. Singh. 2014. Are farmers willing to pay for drought-tolerant rice? Evidence from Bihar, India. Presentation given at the IFPRI-CSISA Private Sector Roundtable, New Delhi, May 19.

Spielman, D.J. 2014. Policy dimensions of India's seed market and opportunities for growth in risk-prone ecologies. Presentation given at a Seed Summit on "Enhancing the Seed Supply Chain in Eastern India," Patna, Bihar, May 14–15.

Magnan, N., K. Gulati, T. J. Lybbert and D. J. Spielman. 2014. Gender, social networks, technological change and learning: Evidence from a field experiment in Uttar Pradesh, India. Presentation given at a conference on "Addressing Gender and Assets in Agricultural Development Projects" organized by Gender, Agriculture, & Assets Project (GAAP), Washington, DC, May 8.

Magnan, N., K. Gulati, T. J. Lybbert and D. J. Spielman. 2014. Gender dimensions of social networks and technology adoption in eastern Uttar Pradesh, India. Paper presented at the 11th Midwest International Economic Development Conference, University of Minnesota, May 2–3.

Bansal, S., A. Arora and P. S. Ward. 2014. Eliciting farmers' valuation for drought tolerant rice seeds in India. Presentation at the Rutgers University Department of Agriculture, Food, and Resource Economics Departmental Seminar Series, New Brunswick, New Jersey, April 4.

Bansal, S., A. Arora and P. S. Ward. 2014. Consumer and farmer attitudes towards new agricultural technologies: Evidence from India. Presented at the Seventh Annual Berkeley Bioeconomy Conference, UC-Berkeley, Berkeley, CA, March 27.

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.

Bhargava, A. 2014. Agriculture technology adoption and the MNREGA Scheme in India. Paper presented at a conference on "The MNREGA in India: Taking Stock, Looking Ahead" organized by the International Food Policy Research Institute, Cornell University and Indira Gandhi Institute of Development Research (IGIDR), IGIDR, Mumbai, March 26–28.

Singh, V and P. S. Ward. 2014. Risk and ambiguity preferences and the adoption of new agricultural technologies: Evidence from field experiments in rural India. Paper presented at the IVth International Conference on Applied Econometrics, organized by the Indian Econometrics Society, ICFAI Business School, Hyderabad, March 20–21.

Gulati, K., Magnan, N., D. J. Spielman, and T. J. Lybbert. 2014. Gender dimensions of social networks and technology adoption: Evidence from a field experiment in Uttar Pradesh, India. Paper presented at the 2014 Pacific Conference for Development Economics, Los Angeles, CA, March 15.

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.

Ward, P. S., D. J. Spielman, D. L. Ortega and V. Singh. 2014. Are farmers willing to pay for drought tolerant rice? Evidence from Bihar, India. Paper presented at the Agricultural Sector Council Seminar organized by the USAID Bureau for Food Security, Ronald Reagan Building, Washington, DC, February 26.

Bansal, S., A. Arora and P. S. Ward. 2014. Eliciting farmers' valuation for drought tolerant rice seeds in India. Presentation at UC-Davis Agricultural and Resource Economics Department Seminar Series, Berkeley, CA, February 19.

Ward, P.S and V. Singh. 2013. Risk and Ambiguity Preferences and the Adoption of New Agricultural Technologies: Evidence from Field Experiments in Rural India. Paper presented at the International Food Policy Research Institute (IFPRI) Research Seminar, World Agroforestry Center (ICRAF) Board Room, National Agricultural Science Center, New Delhi, November 8.

Appendix B: USAID Indicators

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

Indicator / Disaggregation	2014 Comment	2014 Deviation Narrative	2014 Target	2014 Actual	2015 Target
Current Selection					
Reporting Organization : USAID					
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			120,000	194,751	250,000
crop genetics				28,446	
pest management				0	
disease management				0	
soil-related				4,788	
irrigation				0	
water management				217	
post-harvest handling and storage				1,217	
processing				0	
climate mitigation or adaptation				45,922	
other				114,161	
total w/one or more improved technology				112,785	
Disaggregates Not Available					
New/Continuing			120,000	194,751	250,000
New			63,320	79,124	148,000
Continuing			56,680	8,977	102,000
Disaggregates Not Available				106,651	
Sex			120,000	194,751	250,000

Male				11,065	
Female				1,551	
Joint				415	
Association-applied				491	
Disaggregates Not Available				181,230	

2014 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.

2014 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 majority of our numbers have been contributed by our priority hubs of Bihar, EUP and Odisha, although the success of the Haryana Hub has also boosted this indicator. Data have been captured through direct measurement, service provider surveys, dealer surveys, and key informant surveys, and is often cross-checked against data from our government partners.

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	2014 Comment	2014 Deviation Narrative	2014		2015
			Target	Actual	Target
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			
New/Continuing			500,000	**407,677**	750,000
New				58,698	
Continuing				12,461	
Disaggregates Not Available				336,517	
Sex				**407,677**	
Male			165,000	38,311	
Female			335,000	5,011	
Joint				4,233	
Association Applied				17	
Disaggregates Not Available				360,105	

2014 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.

2014 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, although the success of the Haryana Hub has also boosted this indicator. Data have been captured through direct measurement, service provider surveys, dealer surveys, and key informant surveys, and is often cross-checked against data from our government partners.

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	2014 Comment	2014 Deviation Narrative	2014		2015
			Target	Actual	Target
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	17,186	15,000
Producers				14,041	
People in government				2,167	
People in private sector firms				67	
People in civil society				502	
Disaggregates Not Available				409	
Sex			15,000	17,186	15,000
Male			11,250	12,405	11,250
Female			3,750	4,781	3,750
Disaggregates Not Available					

2014 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.

2014 Deviation Narrative:

This deviation narrative applies to our totals, which include the numbers submitted to USAID India and the numbers submitted to USAID Washington. CSISA exceeded its 2014 target for this indicator, with the majority of trainees reached through CSISA's priority hubs of Bihar, Eastern Uttar Pradesh, and Odisha. Each year, CSISA holds numerous technical trainings in advance of the two main planting seasons: Rabi (winter) and Kharif (summer/rainy), covering a wide variety of topics relevant to wheat, maize, and rice cultivation, as well as other cross-cutting technologies like laser land leveling. This indicator has also captured data on trainings on post-harvest processing and ILRI's work throughout CSISA's geographic domain. Many of CSISA's trainings are provided to intermediaries such as service providers and staff of the Department of Agriculture, KVKs, and state agriculture universities.

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	2014 Comment	2014 Deviation Narrative	2014		2015
			Target	Actual	Target
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			1,200	1,472	1,500
Private enterprises (for profit)			1,070	1,327	1,338
Producers organizations				50	
Water users associations			0	1	0
Women's groups			8	65	10
Trade and business associations			5	2	6
Community-based organizations			32	27	40
Disaggregates Not Available					
New/Continuing			1,200	1,472	15,000
New				619	
Continuing				853	
Disaggregates Not Available					

2014 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.
2014 Deviation narrative:
This deviation narrative applies to our totals, which include the numbers submitted to USAID India and the numbers submitted to USAID Washington. CSISA exceeded its target for this indicator. CSISA captures the number of sole entrepreneurs (such as service providers) that it assists in this indicator, and CSISA has been excelling in this aspect of its work. Most of the numbers reported in this indicator came from the priority areas of Bihar and Eastern Uttar Pradesh.

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

Current Selection					
Reporting Organization : USAID					
Indicator / Disaggregation	2014 Comment	2014 Deviation Narrative	2014		2015
			Target	Actual	Target
4.5.2(12): Number of public-private partnerships formed as a result of FTF assistance (S)	See below	See below	6	19	6
Agricultural production				3	
Agricultural post harvest transformation				2	
Nutrition				1	
Multi-focus				10	
Other				3	
Disaggregates Not Available					

2014 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.

2014 Deviation narrative:
This deviation narrative applies to our totals, which include the numbers submitted to USAID India and the numbers submitted to USAID Washington. CSISA has exceeded its target for this indicator. For the most part, PPPs formed during the reporting period are relatively evenly spread across CSISA's priority and transition hubs. However, the number received a boost from the Haryana Hub, which facilitated partnerships between its private sector partners and its public sector partners in order to boost sustainability of CSISA's work now that Haryana hub is in the late stages of being a transition hub.

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	2014 Comment	2014 Deviation Narrative	2014		2015
			Target	Actual	Target
4.5.1(24): (OLD) Numbers 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) (S)	See below	See below			
Sector			7	13	7
Inputs				10	
Outputs				0	
Macroeconomic				0	
Agricultural sector-wide				0	
Research, extension, information, and other public service				0	
Food security/vulnerable				2	
Climate change adaptation or natural resource management (NRM) (ag-related)				1	
Disaggregates Not Available					
Stages of development			7	13	7
Stage 1 of 5 Number of policies / regulations / administrative procedures analyzed			3	12	3
Stage 2 of 5 Number of policies / regulations / administrative procedures drafted and presented for public/stakeholder consultation			1	0	1
Stage 3 of 5 Number of policies / regulations / administrative procedures presented for legislation/decree			1	0	1

Stage 4 of 5 Number of policies / regulations / administrative procedures prepared with USG assistance passed/approved			1	1	1
Stage 5 of 5 Number of policies / regulations / administrative procedures passed for which implementation has begun			1	0	1
Disaggregates Not Available					

2014 Comment:
This is an Objective 5 indicator. Data are provided by IFPRI. The following policies were analyzed: Nepal: fertilizer and seed; Bangladesh: mechanization, seed and private R&D priorities and incentives; India: public and private R&E priorities and incentives, mechanization, biotechnology, rural social protection, and gender and social capital. This data has been provided to USAID Washington.

2014 Deviation narrative:
CSISA's work on policy research expanded rapidly during the period at the behest of project management and hub staff, as well as several key stakeholders. The policy research team is exploring issues in several new areas that require analysis, for example, appropriate-scale mechanization and industry structure; rural social protection and technology adoption; and gender and social capital dynamics in technology adoption.

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	2014 Comment	2014 Deviation Narrative	2014		2015
			Target	Actual	Target
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			35	83	30
Phase 2 Number of new technologies or management practices under field testing as a result of USG assistance			87	88	94
Phase 3 Number of new technologies or management practices made available for transfer as a result of USG assistance			60	74	65
Disaggregates Not Available					

2014 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.

2014 Deviation narrative:

Because this indicator draws from Objective 1 (innovation hubs), Obj 2 (strategic research platforms), Obj 3 (rice breeding) and Obj 4 (wheat breeding), it captures a wide variety of technologies, many of which are considered to be multiple stages of development, depending on where they are being implemented. This is why it appears that there are many technologies still in Phase 1. Also, the breeding objectives tend to weight their technologies towards this phase. However, one can see the technologies moving through the phases, as the number of technologies in Phase II is on target, and the number listed in Phase III has exceeded the target.

Appendix C: Results Framework

Key Milestones	Period Two	
	October 1, 2013 to September 30, 2014	**Period two update in annual report, Nov 2014**
	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.	Strategy revisited and the merit of continued CSISA support evaluated. Begin transition of hubs. Implement options for partial self-sufficiency. Hubs should provide half of their own support by Jan. 2014.	Funding sources for continuation of work in Punjab and Tamil Nadu secured (i.e. Reliance Foundation, GoI, CCAFS, WHEAT CRP). Major CSISA technologies mainstreamed through the State Department of Agriculture in Haryana, Tamil Nadu, and Punjab.
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.	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 pathways devised for priority hubs twice a year: in January for Kharif season, and in September for Rabi season. Impact pathways were reviewed and approved by the Management Team, and then reviewed and refined at the hub level each month.
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.	In India alone, more than 40 types of agronomic research trials implemented in the past year. Nine socio-economic surveys have been completed to complement the agronomic trials. Gender aspects of HH welfare outcomes as well as enabling factors such knowledge networks have been evaluated.
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 adopted by 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 inform activity planning and implementation for DSR, mechanical transplanting, threshing, ZT wheat, and expansion of service provision

Key Milestones	**Period Two**	
	October 1, 2013 to September 30, 2014	**Period two update in annual report, Nov 2014**
	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.	The utility of different 'real time' recommendation dissemination platforms (e.g. SAU agro-advisories, private sector ICT) to meet the identified needs of smallholder assessed, and recommendations derived for improving existing tools in consultation with partners.	Letter of agreements signed with NARES partners (BHU, UP; BAU, Bihar; OUAT, Odisha and CRRI, Odisha) for Crop Manager. Expertise from the NARES partners used to design and modify the Crop Manager for their respective States and to test and deploy the recommendations. Discussions initiated in India with the respective State Department of Agriculture for dissemination strategies.
	At least three versions of Nutrient Manager (NM), NM Mobile, or Nutrient Expert (NE) software piloted in Bangladesh, India, or Nepal; Crop Manager application validated in farmers' fields design refined based on feedback from men and women farmers.	Pilot dissemination of Rice Crop Manager initiated in Bangladesh. Results from field testing of beta versions of Crop Manager for maize in Bangladesh, rice-wheat in Bihar and eastern UP, and rice in Odisha used to refine and improve the Crop Manager. Initial evaluation of the nutrient management component of a Maize Crop Manager initiated in Odisha.
1.3.2.1. Strengthened and diversified dissemination pathways for agricultural knowledge and technologies using traditional approaches and ICTs.	At least 8000 farmers and partners exposed to new technologies through community-based demonstrations, trainings, and at least 10 cross-hub exposure visits.	Target exceeded with more than 55,000 farmers, service providers, extension, and partner staff trained on CSISA-supported technologies in the prioritized hubs in Bangladesh, Bihar, EUP, and Odisha.
	Instructional videos developed based on uptake assessment, and deployed to more than 700 villages; uptake following exposure to videos assessed.	In India, videos developed and delivered at the community level through State Department partners on mechanical transplanting, early wheat planting, and DSR. Farmer-to-farmer knowledge exchange facilitated through participatory video production in collaboration with Digital Green, with uptake metrics being assessed in Odisha. Thousand of villages reached.

	At least 25 new entries incorporated, and at least 10 hub staff and partners in each hub introduced to/updated on CKB.	High profile outreach materials prioritized, including guides for rice intensification (Odisha, Nepal), operator manual for mechanical transplanting (Bihar, Odisha), DSR (Tamil Nadu), weed identification (India), and machinery design (Bangladesh).
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.	Using NIRS (near infra-red spectroscopy), ILRI's team has evaluated food-feed traits of 24 pipeline maize hybrids grown in 4 locations in India. Field testing of 2 promising maize cultivars is underway in selected CSISA sites in Bihar and Odisha in collaboration with the CSISA-hub teams. Fodder quality testing of maize stover and rice straw from farmer-grown fields is also ongoing, with regular collection of stover and straw samples that are sent to Hyderabad for analysis. In addition, pipeline cultivars of rice from national and CG breeding programs are analyzed for variations in straw quality and straw quality relationships for later use in CSISA hubs. The establishment of fodder markets in Bangladesh is also a promising development that will enhance the availability of fodder and the uptake of improved practices.
	Varietal release committees are apprised of the fodder traits of promising rice lines.	The case for maize stover trait analysis during cultivar advancement and release was further argued along an invited lecture at the Asia maize conference in Bangkok. On rice, a meeting involving rice breeders and the private seed sector is currently being discussed to look at the variation in rice straw fodder quality in popular and widely grown varieties as well as in pipeline material.
	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.	Feeding trials within the CSISA Bihar hub on the effects of feeding urea treated maize stover have exhibited promising results, with milk yield increasing by 0.4 liter/animal/day and fat and SNF content higher by 0.1% among 43 farmers under this feeding regime. In Odisha, the demonstration of chopping of rice straw through farmer trials has shown considerable benefits through improved digestibility and energy intake. Specifically, milk yields increased by 0.3-0.5 kg/day among 90 farmers who have tested this practice. When chopped rice straw was fed in combination with mineral mixtures, milk yield increased by 0.4-0.7 kg/day, and fat and SNF content were also higher by 0.13%. Estimated economic benefits from feeding chopped rice straws supplemented with mineral mixtures showed that the practice translates to an equivalent of $79 additional income per animal per year, of which about 30% accrues from reduced feed cost due to savings generated from chopping. This suggests the potential of straw

			chopping as a feeding practice in engendering higher efficiency in straw utilization on-farm as well as in terms of digestibility that translates to improved feed-energy conversion. More than 2000 farmers have been documented to have been trained and taken up this practice in India, as well as in Nepal and Bangladesh.
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 Two		
	October 1, 2013 to September 30, 2014		**Period two update in annual report, Nov 2014**
	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.	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 through the AIC for a second year 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 Two	
	October 1, 2013 to September 30, 2014	**Period two update in annual report, Nov 2014**
	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.	Activity has been re-oriented to target women entrepreneurs. Training and linkage workshop between new women entrepreneurs, banks, and mentors held in Bangladesh in Q4 2013. A similar events were held in Bihar and Odisha during Q1 / Q2 2014 with an emphasis on engagement through SHG's.
	Training course with modules covering at least 5 animal husbandry topics conducted for staff and partners at prioritized hubs.	Trainings on dairy cattle management had been implemented in addition to trainings on feeding strategies to milk production in dairy cattle; training materials as well as other communication materials (leaflets, video and posters) that were developed based on results of field trials and demonstrations have been shared with participants and development partners. In addition, efforts to scale out the feeding practices and adapted feed technologies were accelerated in collaboration with NGOs, Govt's and entrepreneurs through dissemination of information on best practices; e.g., NABARD, a development partner had disseminated the leaflets on balanced concentrate feed at their own costs in two districts where their "Priyadarshini" program are being implemented.
	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.	Targeted exceed with over 1,700 service providers trained in Bihar, EUP, Odisha alone. BDS aspects strengthened with a business training modules under develop.
	Two exams administered to about 100 and 250 agro-dealers, student performance reviewed, and successful candidates certified.	Dealer training program strengthened with BAMITE and private sector partners (e.g., UPL). Decision on certification program has been deferred until the potential 'phase III' of CSISA.
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.	Completed for site-specific nutrient management, advanced statistical analysis simulation approaches, geo-spatial analysis, and the fundamental of machinery use and operation. Planning completed for course on Farm Design in Q1 2015.

	At least 30 interns (30% female) placed in CSISA hubs and partner institutions.	21 interns placed in India alone during the reporting period, including 8 female interns

Key Milestones	**Period Two**	
	October 1, 2013 to September 30, 2014	**Period two update in annual report, Nov 2014**
	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 with appropriate changes to assess and optimize technologies for greenhouse gas (GHG) emissions of different crop rotations × management systems.	Platform-based research continued in Haryana and Bihar in India and at Gazipur in Bangladesh. New strategic research platform established at Odisha University of Agricultural and Technology in Bhubaneswar. Key learnings from Haryana and Patna Platform were published and paper from Gazipur platform has been submitted for publication
	In collaboration with NARES partners, CA-based systems evaluated with process-based research trials that will lead toward system refinements.	On-farm and on-station strategic research trials continued across all CSISA hub domain. The major thematic areas focused for these trials include: Cropping system optimization/ intensification, crop diversification and its short to long term implication, water management, weed management, climate change including terminal heat stress, resource efficient tillage and crop establishment methods (CA-based), decomposing yield gaps, site-specific nutrient management, GIS and crop modeling approaches 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, and generate scenarios for further field evaluation in Objective 1.	Simulation work was completed for risk analysis, irrigation / energy requirements, and yield potential of DSR in the context of cropping systems optimization. Various crop management strategies, for example, replacing long duration rice variety with short duration high yielding rice variety, introducing short duration wheat variety, shifting rice transplanting early as compared to current transplanting dates, were evaluated using APSIM crop model to cope up with terminal heat stress in wheat. Validate model processes especially for Wheat response to high temperature (late wheat) and Rice response to low temperature (late rice)

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.	Dedicated semi-annual meetings held for objective 2. In September 2013, review and planning meeting for Rabi-season held in Kathmandu. For Kharif season review and planning, two separate meetings were held for India and Bangladesh. Meetings held separately to keep discussions focused and to fully integrate CSISA-II strategic research at Gazipur platform work with CSISA-BD and MI in Bangladesh. Bangladesh objective 2 meeting held in April at Gazipur Research Platform. India objective 2 meeting was held in May 2014 in Kathmandu. All the key national partners also attended these objective 2 meetings.

Key Milestones	Period Two	
	October 1, 2013 to September 30, 2014	**Period two update in annual report, Nov 2014**
	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.	Selected breeding lines evaluated; trait-based selection for high yield potential (HYP) conducted on germplasm and elite lines, yield and fodder quality-related genes/QTLs genotyped.	One hundred twenty new breeding lines with desirable traits are being evaluated at six locations in India. Eight entries are in provincial /national level testing program. Six hundred lines are in preliminary yield trials. Three mega varieties viz. Swarna, Samba Mahsuri and MTU1010 are being improved for higher yield potential through incorporation of cloned genes viz. high grain number (Gn1a), bigger panicle size (Spl14) and strong culm (SCM2). SNP markers with G/A and C/T polymorphism for the genes Gn1a and SPL14 respectively were developed using Sanger sequencing method and validated by Fluidigm SNP assays. Straw quality of 116 entries is being tested and six mapping populations are being developed. An array of new breeding lines has been developed by recurrent selection.
3.2.1. Rice for mechanized direct seeding and water-saving irrigation practices developed and released.	Precise plant development and growth stages described for DSR in 3 contrasting locations; *Pup1* introgressed into at least 2 mega-varieties and pyramided with anaerobic germination in IR64; promising lines evaluated in network trials, hubs, and platforms .	One hundred sixteen entries are being tested at six locations in India. Five entries are in provincial/ national level testing programs. Precise plant development and growth stages for DSR are being studied. One QTL each for root hair density, first seedling emergence, uniform seedling emergence and 7 QTLs for early seedling vigor were identified. Out of 60 entries tested during dry season 2014 under machine sown dry DSR, 15 entries recorded more than 7.5 tons/ha.IR64-Pup1-AG1 and Samba Mahsuri-Sub1-AG1-Pup1 are being developed by marker assisted back crossing.

3.3.1. At least two heat-tolerant rice varieties nominated for national varietal testing.	QTL high day temperature (HDT) tolerance mapped and flanking markers developed; promising entries for high night temperature (HNT) tolerance identified; donors for early morning flowering (EMF) identified and evaluated	PCR based markers and protocol for marker-assisted selection of qHTSF4.1 were developed. IR64 introgression lines with fine mapped QTL region on chromosome 4 of N22 tested in two independent experiments (i) short duration stress (6 hours) coinciding with anthesis and (ii) for 14 days covering the entire flowering period. Across both these exposures spikelet fertility was increased by 10 – 15%. Anthers from the NILs and parents are currently undergoing metabolomic analysis at Max Planck, Institute, Germany. Near isogenic lines (NILs) with N22 introgression in IR64 background were developed, BC5F3 lines were evaluated in the field along with the early morning flowering (EMF) NILs (at IRRI farm). A recombinant inbred line (RIL) population consisting of 246 F7 lines was developed and is being used for high night temperature (HNT) QTL mapping and other heat tolerance studies. Germplasm for EMF surveyed, donors identified and evaluated. Ten advanced heat-tolerant lines were nominated to MET and 17 lines for International heat tolerant nursery (IRHTN) .One entry viz.,IR10C146 was advanced to MET 2 stage of testing.

Key Milestones	**Period Two**	
	October 1, 2013 to September 30, 2014 **Target at period end**	**Period two update in annual report, Nov 2014**
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 100 bread wheat trials consisting of 278 advanced lines planted across 31 locations in south Asia in 2013-14 cycle. More than 1800 new crosses made and >12000 breeding populations selected. Superior lines evaluated under CA in multi-location trials. Twelve new wheat varieties were released, ten identified for release while more than 2000 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, and preliminary flanking markers for resistance identified.	Resistance to spot blotch characterized by evaluating around 2000 genotypes at Mexico. In addition, 2200 lines were characterized by collaborators in South Asia. Four RIL mapping populations were again phenotyped. Genotyping done. First mapping results obtained.

4.3.1. Improved heat and drought tolerance in wheat.	Potential parents characterized and early-generation breeding progeny selected.	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 stress were determined.

Key Milestones	Period Two	
	October 1, 2013 to September 30, 2014	**Period two update in annual report, Nov 2014**
	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.	a) Survey and data collection completed and published to public site. b) Assists the project to catalyze at least one Public/Private Partnership MOU or contract signed by each Hub.	a) CSISA baseline data published. Other surveys for related studies also completed. Assistance to hubs and CSISA management on public-private partnerships provided. b) IFPRI- CSISA Roundtable meeting complete and new MOUs signed between CSISA and several private companies.
5.2.1. Improved policies and incentives that address changing labor, gender, assets and migration dynamics related to pro-poor technology development & delivery.	Recommendations for hubs and policymakers developed for improving women's access to key assets and increasing their technology adoption.	Recommendations for hubs and policymakers developed and research, communication and outreach activities undertaken.

Key Milestones	Period Two	
	October 1, 2013 to September 30, 2014	**Period two update in annual report, Nov 2014**
	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.	Meetings held: Management Team meetings held monthly; Executive Committee meetings held quarterly; Objective-specific meetings held semi-annually; AIC meetings held semi-annually. Additional internal cross-project meetings held on M&E methods, breeding advances, and mechanization. Participation in strategic regional fora (e.g. Indian Weed Science Society, All India Wheat and Maize meetings, Summer and Winter Crop workshops (Nepal), WRC annual review meeting (Bangladesh).

Key Milestones	Period Two	
	October 1, 2013 to September 30, 2014	**Period two update in annual report, Nov 2014**
	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.	SOPs, IBP regularly used, biannual training on data management held.	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.
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, internal monthly newsletter, and 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.

Key Milestones	Period Two	
	October 1, 2013 to September 30, 2014	**Period two update in annual report, Nov 2014**
	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 conducted in each of the hubs around key innovations, collect and upload disaggregated (by hub, gender) key indicators, draw out lessons and implication from these, and report on them to relevant 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.