# Cereal Systems Initiative for South Asia (CSISA)

## Annual Report 2012-13

## Condensed Technical Report

**Annual Report #1**

**October 1, 2012 to September 30, 2013**

# CEREAL SYSTEMS INITIATIVE FOR SOUTH ASIA (CSISA) PHASE II

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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 5
Executive Summary 7
Program Overview and Performance 10
Key Accomplishments and Developments 10
Objective 1 12
India 12
Bihar and Eastern Uttar Pradesh 12
Odisha 15
Haryana 17
Punjab 18
Tamil Nadu 19
Bangladesh 19
Nepal 21
Cross-cutting Objective 1 Activities 24
Reducing PH losses through improved technologies and business models 24
Livestock activities 24
New models of outreach through strategic partnerships 26
Decision tools for site-specific management 26
Business models and the dynamics of technology adoption 27
Training, spillover effects, and continuity of technology adoption 28
Characterizing knowledge and social networks in CSISA districts in Bihar 28
Investing in new analytical tools: strategic science partnership with AgMIP 29
Objective 2 29
Objective 3 31
Objective 4 32
Objective 5 33
Objective 6 34
Key challenges and strategies to reduce them 38
Extreme weather in Bihar, Eastern UP, and Odisha 38
Hartals in Bangladesh 40
Bandhs in Nepal 41
Intellectual property rights issues for rice 41
Internal Review Board restrictions 41
Sustainability and scalability 42
Major initiatives for the next year 42
Annex A: Success stories 48
Annex B: Results framework 57
Annex C: USAID indicators 72
Annex D: Environmental Monitoring and Management Plan (USAID) 82
Annex E: Publications and important links 94

**LIST OF ACRONYMS AND ABBREVIATIONS**

| Acronym | Full Name of Acronym |
|---|---|
| AgMIP | Agriculture Model Intercomparison Improvement Project |
| BHU | Banaras Hindu University |
| BRAC | Bangladesh Rural Advancement Committee |
| CA | Conservation agriculture |
| CCAFS | Climate Change Agriculture and Food Security |
| CGIAR | 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-M.I. | CSISA Mechanization and Irrigation project |
| CSISA-NP | CSISA-Nepal |
| CSSRI | Central Soil Salinity Research Institute |
| CT | Conventional tillage |
| DOA | Department of Agriculture |
| DSR | Direct-seeded rice |
| FTF | Feed the Future |
| GCP | Generation Challenge Program |
| HYP | High yield potential |
| HYV | High-yielding variety |
| IARI | Indian Agricultural Research Institute |
| ICAR | Indian Council of Agricultural Research |
| ICAR-RCER | ICAR-Research Complex for Eastern Region |
| ICRM | Integrated crop and resource management |
| ICT | Information communication technology |
| IFPRI | International Food Policy Research Institute |
| IGP | Indo-Gangetic Plains |
| ILRI | International Livestock Research Institute |
| IRRI | International Rice Research Institute |
| IV | Improved variety |
| JEEViKA | Bihar Rural Livelihoods Project |
| KVK | Krishi Vigyan Kendra |
| LAMP | Large sized Multipurpose Cooperative Society |
| LLL | Laser land leveling |
| LoA | Letter of agreement |
| LSP | Local service provider |
| MTNPR | Machine-transplanted non-puddled rice |
| NARC | Nepal Agricultural Research Council |
| NARES | National agriculture research and extension systems |
| NDRI | National Dairy Research Institute |
| NDVI | Normalized difference vegetation index |
| NGO | Non-governmental organization |
| NM | Nutrient Manager |
| NREGA | National Rural Employment Guarantee Act |
| ODK | Open Data Kit |
| OFSP | Orange-fleshed sweet potato |
| OPV | Open pollinated variety |
| OUAT | Orissa University of Agriculture and Technology |

| | |
|---|---|
| PAU | Punjab Agricultural University |
| PB | Permanent raised beds |
| PTR | Puddled transplanted rice |
| PVS | Participatory varietal selection |
| QTL | Quantity trait locus |
| SATYN | Stress Adaptive Trait Yield Nursery |
| SAU | State agriculture university |
| SHG | Self-help group |
| SP | Service provider |
| SSNM | Site-specific nutrient management |
| TNAU | Tamil Nadu Agricultural University |
| TPR | Transplanted puddled rice |
| TRRI | Tamil Nadu Rice Research Institute |
| UAS | University of Agricultural Sciences |
| UBKV | Uttar BangaKrishiViswavidyalaya |
| USAID | United States Agency for International Development |
| VAW | Village agricultural worker |
| WRC | Wheat Research Center |
| 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 labour availability, and climate variability pose steep challenges for achieving sustainably intensified cereal 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 a set of interventions with an integrated systems approach designed to catalyze durable change at scale in South Asia's cereal systems.

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) Improved project management, data management, monitoring and evaluation, and communications.

In the past year, CSISA has made steady progress towards the goals set out in its **results framework** (Appendix A). In India, CSISA has successfully promoted early wheat sowing and zero tillage as best management practices in Bihar and Eastern UP, reaching more than 9,000 farmers in 2012-2013. It has supported more than 750 mechanized service providers with technical and business skills training, accelerated work with women farmers on maize-based intercropping and small enterprise formation, and introduced machine transplanting and community nurseries for rice, with the former providing an important adaptation strategy for coping with climate variability and change. In Odisha, CSISA has started the calibration and testing process for the development of *Nutrient Manager* tools for rice and maize, which will enable site-specific nutrient management to be practiced in the state through ICT-based extension tools. A tool for rice in Tamil Nadu has already been released for advanced on-farm evaluations.

CSISA has strengthened **strategic partnerships** with the state Department of Agriculture, the Krishi Vigyan Kendras (KVKs), state agriculture universities (SAUs), NGOs, and local service providers as needed for the promotion of locally appropriate resource-conserving technologies and better-bet agronomic practices that can be implemented at scale. CSISA has also formed partnerships with the private sector to support dealer training – an essential activity that supports the most common source of information and advice for most farmers in India.

In **Bangladesh**, CSISA has provided 128,340 farmers with new Boro (dry) season rice varieties tolerant to saline soils, and introduced new short-duration Aman (monsoon) season rice varieties into the cropping system, allowing farmers to fit a third mustard crop between the Aman and Boro rice crops. Other CSISA

activities in Bangladesh include the promotion of crops that require less irrigation than Boro rice, such as wheat, maize and sunflower; the promotion and facilitation of mechanized planting using two-wheel tractor-drawn strip till planters and bed planters; the promotion of irrigation interventions using axial flow pumps, which use only two-thirds of the fuel to pump water as conventional pumps; and the formalization of collaborations with NGOs and private sector partners that facilitate the widespread out-scaling of technologies.

In **Nepal**, CSISA implemented on-farm lentil trials to assess the effects of improved practices and spring maize trials with new hybrids and farm varieties to assess their performance under different management practices. For rice, participatory evaluation trials have indicated strong performance for hybrids, line-sown DSR, and optimum fertilizer practices. The project also facilitated access for women farmers to women-friendly, scale-appropriate machinery, including two-wheel tractors and rice and wheat harvesting equipment.

**Cross-cutting activities** included the field evaluation and fine-tuning of a *Nutrient Manager for Rice* inTamil Nadu and Bangladesh; the formalization of partnerships to promote and mainstream community-based extension models in Odisha; dissemination of improved post-harvest practices and viable business models across the CSISA domain; innovations around small-scale mechanization; and the development of improved livestock feed mixing and distribution enterprises through women's self-help groups in Bihar, Odisha, and Bangladesh.

In aggregate more than 52,000 farmers in India and Bangladesh received training from CSISA in 2013. Training is often a precondition for success but, crucially, CSISA is parlaying these efforts and others into tangible outcomes. We estimate that more than 185,000 farmers in India implemented sustainable intensification technologies this past year due in part to CSISA's efforts. In Bangladesh more than 128,000 farmers adopted new stress-tolerant rice. Uptake rates of key technologies suggest that CSISA is well on its way to fufilling its 10-year vision of success.

**Objective 2** has derived results from three years' worth of Phase I studies across the project's four research platforms, and has developed key messages for different regions of the Indo-Gangetic Plains. For northwest and eastern India, CSISA has highlighted the beneficial impact of conservation agriculture practices on resource utilization and system productivity, and the viability of direct seeded rice as an alternative to transplanted rice. In northwest India, Kharif maize appears to be a suitable and profitable alternative to rice, and in eastern India, a rice–maize+potato–relay cowpea cropping system appears to be a profitable, albeit labor-intensive, cropping system. Crucially, research results from all the platforms demonstrate that high cereal yields can be attained while saving considerable amounts of labour, water, and energy, while increasing profitability.CSISA recognizes that the challenges of sustainable intensification 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.

**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. The major activity was the production, crossing, and evaluation of thousands of rice lines in order to select for desirable characteristics. **Objective 4** has undertaken similar activities—breeding trials and 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. Objective 4 work has resulted in new wheat varieties being promoted to national and state trials for their evaluation and subsequent release, and the approval of a new wheat variety for release in the state of Punjab in India.

**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 undertook studies on market segmentation strategies for new technologies based on field experiments with laser land levelling (LLL) in eastern Uttar Pradesh, the impacts of the National Rural Employment Guarantee Act on adoption of resource-conserving technologies, farmers' preferences for abiotic stress tolerance traits embodied in different rice backgrounds, and farmers' attitudes toward risk and ambiguity.

Under **Objective 6**, a variety of regional, country-level, and state-level governance and management mechanisms were implemented, including the establishment of an Executive Committee for CSISA regionally, 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, structure and function of service provision markets) that inform these quick inference techniques. CSISA has also launched a new web site (csisa.cimmyt.org), revised its CSISA bulletin, and begun preparing CSISA Research Notes to better disseminate research findings.

CSISA has faced a number of **key challenges** in the countries in which we work, including in the current volatile political climate in Bangladesh and the preponderance of *Hartals*, and the periodic flare up of *bandhs* in Nepal. CSISA has taken multiple contingency measures in each of these situations in order to maintain the momentum of the work. Eastern India has suffered both drought and cyclone-related flooding this year, resulting in significant crop losses in many areas where CSISA work – particularly in the coastal belt of Odisha.

In July, CSISA launched a **new initiative** in Southern Bangladesh (CSISA Mechanization and Irrigation – '**CSISA-M.I**.') that focuses on efficient development of surface water resources and precision agriculture with scale-appropriate machinery. With funding from USAID-Bangladesh, this award is run as a sub-initiative of the larger CSISA project and aims to transform agriculture in the impoverished south by unlocking the potential productivity of the region's farms during the dry season.

# I. Program Overview and Performance

## A. Results Framework

The CSISA Results Framework / Key Milestones have been placed in Annex B.

## B. Indicators

The CSISA Indicator results have been placed in Annex C.

## C. Environmental Monitoring and Management Plan

The CSISA Environmental Monitoring and Management Plan have been placed in Annex D.

## D. Key Accomplishments and Developments

- To democratize access to mechanized innovations among small and medium-scale farmers, CSISA has supported the emergence and strengthened **750 service provider entrepreneurs** in E. India for capital-intensive technologies such as zero tillage, laser land leveling, and mechanical rice transplanting. On average, each zero-tillage service provider covers approximately 33 acres and meets the needs of more than 20 farmer-clients. CSISA will expand its support to more than **1,300 service providers in E. India in 2014**.

- In the stress prone production ecologies of the E. Indo-Gangetic Plain, timely planting of wheat can nearly **double yield potential by avoiding the threat of terminal heat stress** as the crop matures. CSISA has convinced the state government of Bihar (India) to launch an ambitious social marketing campaign to raise awareness of the importance of early planting and methods for how this can be achieved. In its 2013 Rabi season guidance to farmers, the Bihar government recommended—for the first time—that farmers plant their wheat in the first two weeks of November, contrary to its earlier guidance that wheat be planted in the last two weeks of November or early December. Farmer-to-farmer knowledge exchange on timely planting is also facilitated by CSISA through videos and partnership with Digital Green. We anticipate that more than **75,000 farmers will plant wheat earlier this year** in Bihar and E. Uttar Pradesh in response to these efforts.

- In most of CSISA's prioritized production ecologies, input markets are relatively weak, which limits the ability of farmers to innovate. Projects cannot change this equation in isolation. CSISA's new work on mechanization and irrigation in southern Bangladesh (initiated in July 2013 with iDE as an implementing partner) has already resulted in **private companies importing 1,200 axial flow pumps and several hundred planters and reapers** for the two-wheel tractor. None of these machines has been widely available in the Bangladesh market in previous years.

- To overcome the **challenges to long-term sustainability** caused by accelerating trends of resource scarcity (labor, water, and energy) coupled with an increase in climate variability and weather extremes, work at CSISA's strategic research platforms has demonstrated that Conservation Agriculture (**CA) in tandem with other best-bet agronomy practices have the potential to achieve and sustain high cereal yields** without any yield penalty **while using less resources** including labor,

water, energy and input costs than conventional practices leading to major improvements in environmental footprints, yield stability, as well as higher profitability. Zero-till DSR-wheat systems yielded similar or more compared to conventional practices but with 33 and 14% less irrigation water and 26 and 23% less energy use in NW and NE India, respectively. Also diversifying conventional rice-wheat with CA based maize-wheat in NW India resulted in savings in irrigation water (70%) and energy use (46%) with significantly higher profitability of US$ 500 $ha^{-1}$. The state government is investing accordingly, in part due to the high-quality analysis emerging from the research platforms. CSISA has initiated new studies to further explore the scope and implications of diversification of rice-wheat systems in India.

- CSISA's breeding objectives for rice and wheat prioritize the development and release of new varieties with improved tolerances to biotic and abiotic stresses, strong performance under alternative crop management practices such as zero-tillage or direct sowing for rice, as well as higher yield potential than current HYVs. For example, 10 elite wheat varieties with these traits were released in 2013 with leadership from CSISA. **More than 13 additional elite wheat varieties are proposed for release in India, Bangladesh, and Nepal in the coming year.**

- Without efficient scaling methods to bring knowledge-based innovations to farmers, most such innovations achieve little (if any) impact. ICT-based communication platforms potentially change the game, but must be accompanied by decision support frameworks that translate information into locally relevant and actionable knowledge. CSISA has developed ICT-based tools for site-specific nutrient management that will significantly increase profitability while improving the environmental footprint of fertilizer use in S. Asia. Tools for rice (Tamil Nadu, Bangladesh) and maize (Bangladesh) were released in 2013 **with three additional ICT-based tools (rice-wheat for Bihar, rice-maize for Bihar, and rice for Odisha) slated for release and extended field evaluations in 2014**.

- New technologies such as abiotic stress-tolerant cultivars provide a potential avenue for vulnerable farmers to manage natural hazards such as floods and droughts. In a series of studies in eastern India (Bihar and Odisha), IFPRI has been studying demand for abiotic stress-tolerant technologies such as drought tolerant (DT) and submergence tolerant (SubT) rice cultivars. Currently DT and SubT varieties exist thanks to public sector research efforts. But there is an unanswered question of whether the private sector might play a future role in developing similar traits through applications of advanced biotechnology, and whether their R&D efforts would benefit poor and vulnerable farmers in hazard-prone ecosystems. In Bihar, our research has found that **most farmers are willing to pay a substantial premium for drought tolerant cultivars, regardless of income category or caste**. Furthermore, many are willing to pay a higher price for DT hybrids developed by the private sector. Furthermore, we find that risk-averse and loss-averse farmers are more likely to opt for these hybrids and varieties rather than reverting to their status quo varieties, barring any other constraints such as liquidity or credit. There is a great deal of variation in demand for DT hybrids and varieties, suggesting natural market segmentation. This indicates that both DT hybrids and DT varieties could co-exist in a vibrant market serving needs across a diversity of poor and vulnerable farmers.

## Objective 1: Catalyzing widespread adoption of production and postharvest technologies to increase cereal production, resource efficiency, and incomes

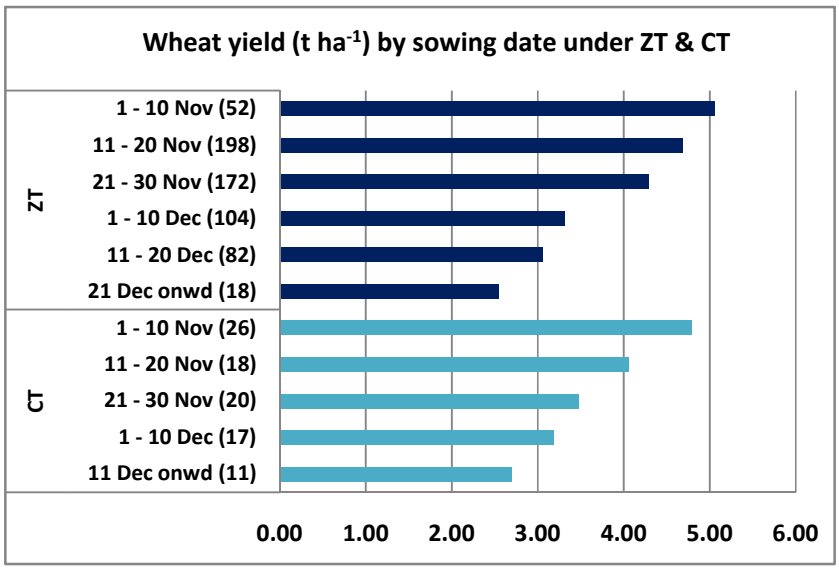
Objective 1 focuses on achieving both short- and long-term impact on sustained cereal production growth by reducing yield gaps, accelerating the adoption of innovative technologies, forming private- and public-sector partnerships, employing sustainable business models and information systems, and undertaking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

### INDIA

The scale of CSISA's impact markedly increased in 2013 with a sharpened focus on supporting 'change agents' like service providers and dealers, strengthening markets, and ensuring state-level policy makers have sound guidance on technical, investment, and training priorities. We estimate that approximately 285,000 farmers have deployed CSISA-supported technologies on more than 67,000 hectares by investing their own resources. As such, CSISA is embracing the catalytic role envisioned in Phase II and has oriented all project planning and implementation around prioritized impact pathways (see Objective 6). Highlights by innovation hub are as follows.

#### Bihar and Eastern Uttar Pradesh Innovation Hubs

**WHEAT:** During the 2012-13 Rabi (winter) season, CSISA prioritized the expansion of area under **timely wheat establishment,** which is an essential adaptation measure for coping with contemporary and projected climate stresses in the Eastern Gangetic Plain. Achieving broad-scale adoption of wheat sowing by November 15th




[1]The Objective 1 priority hubs in India are located in Bihar, Eastern Uttar Pradesh, and Odisha, and the transition hubs are in Haryana, Punjab, and Tamil Nadu; in Bangladesh hubs are located in Khulna, Jessore, Barisal, Faridpur, Rangpur, and Mymensingh Districts; in Nepal, activities are concentrated in Banke, Dadeldhura, Achham, and Surkhet Districts.

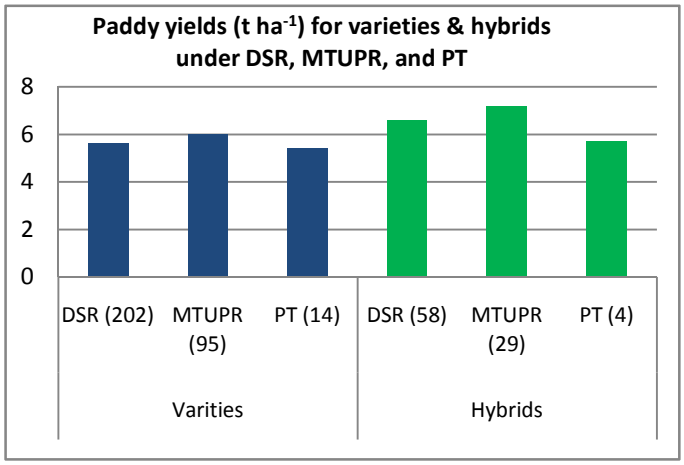
provides a foundation for sustainable intensification, as well as a decisive break from past practices as state recommendations have specified that wheat sowing should begin on or after November 15th. Early wheat sowing intervention protected wheat against the terminal heat event that occurred at the end of March 2013.

On-farm trials from 2013 illustrate that **early wheat sowing can double yield potential** from 2.5 t $ha^{-1}$ (mid-December planting) to 5.0 t $ha^{-1}$ with timely planting in the first two weeks of November (see figure). The pattern was the same for both **zero tillage**(ZT) and conventional tillage (CT), but it is important to note that ZT permits farmers to plant earlier by foregoing land preparation. With earlier planting, systematic gains in yield potential (0.25 – 0.6 t $ha^{-1}$) were also observed with ZT over CT. On average, **ZT wheat adopters earned $367 $ha^{-1}$ compared to $151 $ha^{-1}$**for non-adopters in 2012-13. In Bihar alone, more than 9,000 farmers adopted ZT last wheat season with an additional 4,384 in EUP.

Early sowing also allows farmers to adopt longer-duration varieties, which further increases yield potential. Adoption of early sowing in Eastern UP hub districts has already facilitated a change in varietal choice with the areas under PBW 502 (longer duration wheat) increasing from 25% in 2011-12 to 42% in 2012-13.The importance of wheat varietal choice was illustrated during multi-locational screening trials that demonstrated a 2 t $ha^{-1}$ yield advantage for longer-duration cultivars under early planting and zero-tillage conditions.

**RICE:** The hub revisited its strategy for addressing low productivity in rice-based cropping systems. **Machine transplanting** into non-puddled soil (MTUPR) and the concept of **community nurseries** have been introduced. Community nurseries are a particularly important innovation since the transplanting of old seedling is a binding constraint to rice yields in rainfed areas where monsoon onset governs transplanting times. By selling seedlings of multiple ages, these nursery enterprises ensure that farmers will consistently have access to seedlings that can be transplanted at the optimal time which, in turn, will help ensure high rice yields and resource use efficiencies. Most districts in Bihar and EUP suffered from an extended period of drought in 2013 (ca. 35 days) that prevented transplanting. Farmers with access to community nurseries were able to establish their crops with appropriately aged seedling, whereas many other farmers either planted very old seedlings or left their fields fallow which highlights the importance of the concept to **enabling farmers to adapt to climate variability and change**.

**Dry direct seeding for rice** (DSR) is a also being evaluated and disseminated in the Bihar and EUP hubs, particularly for lowland ecologies where weed pressure is comparatively low. On-farm field trials conducted in the 2012 Kharif season (which were harvested during this reporting period) demonstrate that **the productivity with both machine transplanting and DSR can match or exceed achievable yields under the conventional practice** of transplanted rice into puddled soils (see figure). Conventional practices are

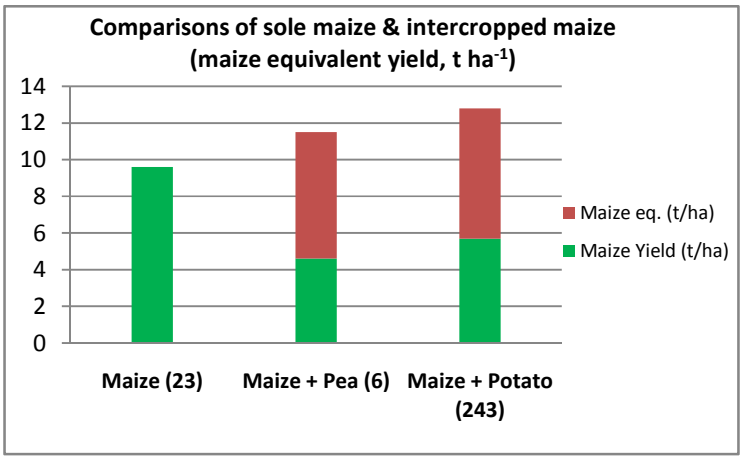


resource intensive with respect to irrigation water and energy inputs for puddling. There are risks associate with both early season drought (e.g. 2013) and flooding for DSR and the CSISA team is conducting on-farm and on-station research to devise complementary management practices that address these production challenges.

The use of hybrids in the Bihar and EUP hub domains has grown steadily and is now accepted practice among farmers with rice yield advantages typically in the range of 0.5 – 1.0 t $ha^{-1}$ over conventional high yielding varieties with no other changes in management.

Unlike NW India, weed ecologies in Bihar and Eastern UP are dominated by complex flora and this presents a unique problem for DSR because weed pressure is typically much higher than in transplanted systems and hand weeding alone is not economical. On-farm trials demonstrate that when bispyribac is mixed with 2,4-D, it improves **weed control in DSR**. Paddy yields in Bihar were 4.2 t/ha compared to 3.8 t/ha with bispyribac alone. The corresponding yields from MTNPR fields with the same weed management treatments were 5.3 and 4.3 t $ha^{-1}$, respectively.

**CROPPING SYSTEMS INTENSIFICATINO AND DIVERSIFICATION:** Intercropping maize with vegetable crops can significantly increase incomes, especially for women farmers who commonly manage these systems. To assess the potential of these systems during the 2012-13 Rabi season, maize was intercropped with potato or peas. **Maize equivalent yield increased by 2 – 3 t $ha^{-1}$ under intercropping**(see figure). Participating women farmers are being encouraged to use hand-held tools for precision stand establishment and fertilizer application. They are also being trained to take up custom services for these tools and being given advice on how to market their produce.




In the Kharif season, the main focus has been on replacing rice in upland conditions as a diversification strategy for coping with the frequent drought-like conditions that occurred in the last two monsoons. Intercrop experiments with turmeric and maize demonstrate that maize equivalent yields can be increased from 4 to 11 t $ha^{-1}$ by moving from sole to intercropping. Maize hybrids yield also increase under **bed planting** at 3.36 t $ha^{-1}$, as compared to 2.77 t $ha^{-1}$ under zero tillage (ZT), and 2.55 t $ha^{-1}$ under CT during the Kharif season. These results highlight the importance of innovative agronomy

To democratize access to mechanized innovations, CSISA has supported the emergence and strengthened **750 service provider entrepreneurs** in Bihar and EUP for capital-intensive technologies such as zero tillage, laser land leveling, and mechanical rice transplanting. On average, each zero-tillage service provider covers approximately 33 acres and meets the needs of more than 20 farmer-clients.

to close pervasive yields gaps as the average maize grain yields in the hub domain is 1.55 t $ha^{-1}$.

**GOING TO SCALE:** The involvement of **service providers (SPs)** has helped tip the scale in favour of early sowing as a best management practice for wheat in Bihar. For example, 588 service providers were assisted with technical and business development advice by the Bihar hub during the wheat season of 2012–13, compared to 110 during the last three years. Additionally, another 10 laser land levelling and 22 machine transplanting service providers have received training and mentorship from CSISA. In the presence of service providers, small landholders do not need to invest in tractors or new machines as they can turn to SPs, who can offer rental services from seeding to harvesting. Crucially, training support has been undertaken with the full partnership and support from the State Department, a powerful and evolving institution that increasingly understand the importance of supporting key intermediaries such as service providers as 'agents of change'. This change in outlook is partially attributable to the influence of CSISA in Bihar.

Most farmers in E. India rely on **dealers and distributors** for inputs as well as advice on crop management. CSISA has focused on developing the capacity dealers to give sound advice to farmers through an innovative partnership that unites the public and private sector. During the reporting period, CSISA collaborated with National Fertilizer Limited, Tata chemicals, and BAMETI (Bihar Agricultural Management, Extension, and Training Institute) to provide training to 164 dealers, distributors and managers. They were trained on the basics of better-bet agronomy as well as on emerging technologies such as conservation agriculture.

The **basic capacity of district-level extension workers** has also been increased with CSISA providing training for 805 extension workers and 29 officers before the start of Rabi 2012-13 and more than 400 workers before the start of Kharif 2013. Forming strong linkage with the State Department of Agriculture in Bihar has also been instrumental in supporting major policies shifts and technical priorities at state level. For example, in Bihar the State Department has just revised its recommended planting date for wheat to early November with advocacy and support from CSISA.

Prior to the inception of CSISA in 2009, very few modern herbicides were available in the market in Eastern India. CSISA has worked with the private sector to **expand the market availability and best use practices** for safe and effective herbicides. A market survey in EUP indicates that the market for bispyribac increased from 4000 liters in 2009 to 21,200 liters in 2012. The corresponding coverage area for this herbicide was 84,800 ha in 2012.

## Odisha Innovation Hub

**GETTING STARTED:** The 2012-13 Rabi (winter) season was CSISA's inception period in this new hub for Phase II, when major activities were centered on establishing a physical infrastructure, the identification of entry points, the selection of CSISA districts, and evaluation of a few selected technologies such as zero tillage. A full technical program was implemented this past Kharif

season (2013), and strategic partnerships were established with institutions such as Orissa University for Agriculture and Technology (OUAT), the department of agriculture (DOA) and NGOs. The Odisha hub works in the coastal rice-producing districts of Puri and Bhadrak, and the upland (dominantly tribal area) of Mayurbhanj.

In the first year of implementation, a variety **of technologies have been evaluated with participatory approaches in farmer's fields**. On-farm evaluations are complemented by station research trials implemented in partnership with KVKs, OUAT, and the State Department's research farm in Bhadrak District.

**TRAINING AND CAPACITY BUILDING:** To strengthen the implementation of CSISA and scale up its activities in Odisha, the hub organized a series of **exposure visits and training programs** to promote particular technologies. Initiatives included an exposure visit by 11 Odisha farmers and service providers to the Tamil Nadu hub to learn about mat nursery preparation, mechanical transplanting of rice, and direct seeded rice. CSISA also conducted trainings on nursery management in rice, agricultural machinery, weed management, seed treatment, site-specific nursery management, nutrient omission plot techniques, and improved maize and paddy cultivation.

**TECHNICAL PRIORITIES AND RESEARCH TRIALS:** For rice cultivation, research and demonstrations were conducted on the following technologies and practices: direct seeding, mechanical transplanting under puddled and non-puddled conditions, integrated weed management in transplanted rice, best management practices for crop establishment, nutrient omission plot techniques, and *Nutrient Manager for Rice* evaluations. In the plateau region of Odisha, CSISA conducted maize research and evaluations on the following topics: site-specific nutrient management, crop establishment methods, yield gap evaluations, varietal trials for maize hybrids of different maturity classes, and line sowing using a seed drill. Data collection and synthesis is ongoing.

**ALIGNMENT WITH NATIONAL AND STATE INITIATIVES:** To facilitate cross-learning among agricultural research and development initiatives in Odisha, and to **facilitate alignment between the activities undertaken by the national initiative *Bringing the Green Revolution to India* and CSISA**, the Ministry of Agriculture (Government of India) and USAID initiated a two-day planning workshop that was held on 10–11 May, 2013 at the Central Rice Research Institute, Cuttack, Odisha. During this workshop, a preliminary roadmap was composed for activities to be jointly supported by national, state, and CSISA partners in Odisha during the 2013 Kharif season. This workshop was a coordinated effort between MOA and CSISA to help identify key gaps in existing rice- and maize-based production systems in Odisha, to promote learning from *Bringing the Green Revolution to Eastern India* and National Food Security Mission programs, to identify broad categories of intervention like mechanization, improved nutrient management, better bet agronomy, post-harvest management issues and cropping systems diversification, and to collaboratively design an actionable work plan for the next planting season and beyond.

After an overview of relevant issues, needs, and opportunities in Odisha agriculture was completed, workshop participants formed cross-institutional working groups around the following prioritized topics: nutrient management decision-support tools, post-harvest management, mechanized rice establishment,

and maize system intensification in the plateau region of Odisha. Some of the important possible entry points identified for different agro-ecologies of Odisha included: introducing and promoting zero tillage in rice fallows, mechanical transplanting under non-puddled conditions, site-specific nutrient management, laser land leveling, mat nursery management, improving postharvest storage, capacity building of stakeholders, and new and innovative modes of extension.

A follow up workshop called, "Convergence of CSISA promoted technologies and Government of Odisha Programs" was held in collaboration with the Department of Agriculture, Government of Odisha in Baripada, and Mayurbhanj on October 23, 2013. The outcome of this workshop established the scope and action plan for collaborations in the upcoming Rabi season, 2013 for the district of Mayurbhanj. Block wise plans were prepared to promote CSISA technologies through government programs. In addition to representatives of the Odisha government, IRRI, and CIMMYT, all of the assistant agricultural officers of Mayurbhanj's 26 blocks, subject matter specialists, district agriculture officers participated in the workshop. Similar workshops are being held in Bhadrak and Puri Districts.

## Haryana Innovation Hub

CSISA's Haryana hub promotes conservation agriculture (CA) based crop management practices in collaboration with farmers and other stakeholders including state agriculture universities, the State Department of Agriculture, national research centers, *krishi vigyan kendras*(KVKs), NGOs, the Indian Council of Agriculture Research, private sector companies and farmer cooperatives. Haryana hub facilitates the showcasing and dissemination of technologies through field demonstrations, field days, travelling seminars, and training courses. Technologies, management practices, and other initiatives include: crop establishment methods in rice, laser land leveling, zero-tillage and residue management in wheat, and diversification and intensification in wheat and rice-based systems through intercropping with maize and other crops. Realizing the complexities in scaling out of conservation agriculture-based crop management practices, **CSISA has secured broad-based government support and investment for prioritized technologies.**

**CROP ESTABLISHMENT FOR RICE:** Faced with the threat of **depleting groundwater and a shortage of labor**, farmers in Haryana are shifting away from puddled transplanted rice to dry drill-seeded rice. On-farm trials conducted by CSISA demonstrate that direct seeded rice reduces cultivation costs by US$ 85 $ha^{-1}$ and reduces irrigation water use by 25%. Moreover, when wheat is grown after DSR, wheat productivity has been found to be 8-10% higher than when grown after a crop of puddled transplanted rice.

With support from CSISA, **the State Agriculture Department, Haryana Agricultural University and Farmers Commission are promoting DSR**, which has led the area under DSR to increase from 226 ha in 2009 to 10,800 ha in 2013.

**LASER LAND LEVELING (LLL):** From a very low base at the inception of CSISA in 2009, **laser land leveling has been adopted on a large scale** in the hub domain (ca. 100,000 ha in 2013), driven in part by a subsidy for the machines through the Haryana state government with past advocacy from CSISA. The benefits of laser land leveling include a 25% savings in irrigation water, improved crop establishment, improved fertilizer use efficiency, and increased crop productivity.

**ZERO-TILLAGE AND RESIDUE MANAGEMENT IN WHEAT:** Zero-tillage wheat has been widely accepted by farmers in Haryana (ca. 201,000 ha in 2012-13). Happy Seeder technology provides an **alternative to burning rice residues** and allows the direct drilling of wheat into standing as well as loose residues. Results from CSISA research conducted on 180 ha showed that compared to conventional tillage, ZT and ZT + residue retained (using Turbo Happy Seeder) provided a yield advantage of 0.10 and 0.26 t $ha^{-1}$, respectively. ZT also reduced production costs by USD 60-70 $ha^{-1}$ and ultimately improved overall farm profitability by USD 86-110$ha^{-1}$ compared to conventional tillage. CSISA has mad instrumental contributions towards the adoption of ZT at scale in Haryana.

## Punjab Innovation Hub

Rice-wheat and cotton-wheat are the two most predominant cropping systems in the northwestern Indo-Gangetic Plains (IGP), both of which can be heavily taxing on water resources and soil nutrients. In response to the constraints on and effects of these dominant cropping systems, CSISA's Punjab hub targets (1) strategic research in rice-wheat, cotton-wheat and maize systems (upcoming and potential crop rotations); (2) smart mechanization options; (3) capacity development of new generation of researchers; and (4) strategic partnerships for up-scaling technologies generated under CSISA.

Highlights in Punjab include:

**LONG-TERM CONSERVATION AGRICULTURE EXPERIMENTS IN THENORTHWEST IGP:** Trials are evaluating the effect of rice establishment, tillage and rice straw management systems on crop yields and profitability in rice-wheat cropping systems. The results from this three-year study revealed that transplanted rice with machine under zero till conditions produced significantly lower yields and nutrient uptake than dry-direct seeded rice under zero till conditions, direct-seeded rice under conventional till conditions, and conventional puddled transplanted rice, which were not significantly different. The study also suggested that considerable reduction in cost of cultivation can be achieved by adopting dry-direct seeded rice under zero till followed by zero till with rice straw removed with straw retention using Happy Seeder.

**DOUBLE ZERO-TILL SYSTEMS FOR THE COTTON-WHEAT ROTATION:** Eight on-farm trials on cotton-wheat systems were established during 2011-12 and are continued to assess the effect of tillage and crop establishment techniques, and relay sown wheat on productivity and profitability of cotton-wheat cropping system in southwestern region of Punjab. Three management scenarios are being evaluated: (1) zero till cotton (ZTC) – zero till relay wheat (ZTRW), (2) conventional till cotton (CTC) – ZTRW, and (3) CTC

-conventional till wheat (CTW). Recently developed 2-wheeltractor-based relay seeder was used to plant wheat in standing cotton. Results showed that **relay planting of wheat increased the mean wheat grain yield by 33.5%** over the conventional practice of planting wheat. Relay seeding helped advance the wheat planting by 19-31 days compared to the crop planted after harvesting of cotton. On the basis of two years investigation we conclude that zero till cotton followed by zero till relay wheat was the most productive and profitable system and could be an alternative option to raise yield potential of CW system in South Asia.

### Tamil Nadu Innovation Hub

CSISA's working domain in Tamil Nadu has three major cropping seasons, all of which depend to a greater or lesser extent on provision of irrigation from canals supplied by the Mettur Dam on the Cauvery River. The **timing and reliability of water releases** from the Mettur Dam determines the rice production in the Cauvery Delta region. In recent years, the timing and reliability of water release has become the top constraint to rice productivity in Tamil Nadu.

Dry seeded rice is becoming an attractive option for farmers in the Cauvery Delta region due to the elimination of the labor requirement for nursery preparation, maintenance, and transplanting. Perhaps more importantly, **DSR also has a lower water requirement for crop establishment** making farmers less reliant on canal water availability. Furthermore, the total crop cycle is shorter by 10-15 days because of the absence of the transplanting shock.

With support and leadership from CSISA, the government is now promoting DSR for the Cauvery Delta region and has purchased 30 seed drills to further promote the technology. The State government has also communicated to the district agriculture officials that the DSR technology has to be rolled out on at least 20% of the total cropped area in the Cauvery Delta. The government has launched a 50% subsidy for purchasing seed drills and announced various input incentives for adopting the DSR technology. Service provider entrepreneurs supported by CSISA are convinced and have started to purchase seed drills. In addition, five women's self help groups have been trained for providing crop establishment by seeding with DSR drills and machine transplanting in Alivakkal village of Thanjavur.

With assistance from CSISA, the State Department of Agriculture has developed a DSR promotion and awareness video for Tamil Nadu. In total, 1000 copies of the videos have been distributed to the districts and village level extension workers for popularizing the technology. With an effective outreach campaign and full support from the government, DSR is poised to make strong in-roads in Tamil Nadu.

## BANGLADESH

The Cereal Systems Initiative for South Asia in Bangladesh project (CSISA-BD) is primarily funded through the USAID Bangladesh mission and works through 6 innovation hubs, of which 4 are in the FtF focal area of SW Bangladesh. Each hub represents an agro-ecological zone with distinct cereal system production problems. The hub system allows the CGIAR centers to develop integrated sets of technologies that produce s a more productive system than the sum of each component.

The **aquaculture** component of the project is good example of how a negative, excess monsoon rainfall, has been turned into a positive. Instead of trying to remove excess summer rain, the Gher system contains it in large ponds in which fish and prawns are raised in the monsoon and rice is cultivated in the dry season. This system can produce a gross margin exceeding $1,600/ha compared with less than $100 for rice production. Adoption of six simple technologies such as pond sanitation, using large fingerlings, and proper feeding can increase production by as much as eight times. Last year CSISA-BD trained 5,963 farmers of which 43% were women in the use of these simple production methods.

Another major focus of this year has been the creation of opportunities for farmers to grow a second or even third crop on the same land where previously only one or two crops have been possible. It is estimated that some 634,000 ha lie fallow in southwest Bangladesh during the Rabi season due to a combination of factors, with the principal ones being soil salinity and lack of access to fresh water.

Introduction of new boro season (dry season) rice varieties with tolerance to saline soils has permitted farmers to grow boro rice in areas where it would not previously have been possible. During the past year, 128,340 farmers received seed of salt tolerant varieties. The support given to the strengthening and development of the 120 seed associations and 3 large seed companies partnering with CSISA will help ensuring that the supply of seed initiated through this program is sustained after the initiative ends.

The introduction of crops that require less irrigation than boro rice such as wheat, maize and sunflower is another approach being taken by the project. Sunflower and one of the new wheat varieties tested this year by CSISA-BD have some tolerance to soil salinity. These crops have been introduced with a package of technologies to minimize farmers' costs, water use, and soil degradation. This package includes:

**Mechanization** using strip till or bed planter attachments to two

### *Embracing private sector partnerships to accelerate change in Bangladesh*

CSISA is breaking new ground in its new Mechanization and Irrigation initiative. The project is developing keystone partnerships with commercial agricultural businesses to encourage the rapid expansion of the availability of resource-conserving agricultural machineries to sustainably intensify production throughout the southwest region of the country.

On July 25, 2013 an agreement was reached that ACI will be leading the import, manufacture and commercial sales of several hundred bed planter and multi-crop reaper machines to local service providers. Bed planting saves irrigation by up to 50% and reapers accelerate the speed of harvests, facilitating quicker planting of the subsequent crop. iDE will support ACI in market development by developing sustainable business models for service providers. CIMMYT will provide technical backstopping to ACI for development of quality bed planters, as well as linking ACI to smaller manufacturers and engineers such as Junata Engineering that have technical expertise but limited working capital.

The agreement with ACI focuses on capitalizing upon the core competencies of the joint venture partners. This collaboration is anticipated to lead to more viable and technically efficient agricultural machinery markets that will ultimately benefit farmers at scale.

wheel tractors that allow for the seeding of crops into crop stubble without plowing. This reduces both the time taken to establish a crop and the cost of establishment. Farmers using these methods have saved $101/ha for maize and $90/ha on wheat production costs this year. Unlike some previous farm mechanization programs in Bangladesh, CSISA-BD has not procured and distributed machines to farmers for "testing" in isolation from the private sector. There has been a strong emphasis on engaging with machinery companies and dealers and sharing some of the start-up costs such as machine operator training and machinery promotion.

**Irrigation using axial flow pumps** uses two thirds of the fuel to pump water as conventional pumps. These have been tested this season and show promise as a low cost pump for pumping fresh water from ponds, lakes and canals.

**Sunflower** shows potential as a new high value oil seed crop with the advantage that it is drought and saline soil tolerant. It was successfully grown by 205 farmers who produced world class crop yields of 2.3 to 2.9 t/ha giving them an income of $113 from their 0.1 ha plots. Value chain analysis is being deployed so that more farmers can tie into the potential economic benefits of sunflower production in Bangladesh.

The experience gained from the mechanization and irrigation programs led to the creation of a new project the **CSISA- Mechanization and Irrigation project**. This $13million, five-year project, funded by USAID will be implemented by a partnership between CIMMYT and the enterprise development NGO, iDE. The project started on the 1st July and has already facilitated the import of 1,200 axial flow pumps by RFL / PRAN and several hundred planter seeder attachments for power tillers by ACI. These two Bangladeshi agro-business companies invested their own money, now exceeding $0.5 million, in these imports based on the technical advice proved by the project. They will be sold to local service providers through the company dealers.

The project now has very clear sets of technologies and implementation approaches that will allow farmers to very successfully grow **maize and wheat in southwest Bangladesh**. Scaling out these technologies to many thousands of farmers faces two main challenges: supply of seed of high yielding wheat varieties and hybrid maize and links to markets.

CSISA-BD implements technology scale-out programs through 34 NGO and private sector partners. Not only does this allow CSISA-BD to reach a large number of farmers, it also allows the core CSISA-BD staff to concentrate on technology testing and development.

## NEPAL

The CSISA-NP project began on August 15, 2012, with a mandate to provide agricultural technology and knowledge outputs for the FtF prime awardee (the KISAN project) to upscale and disseminate. FtF districts were characterized from secondary data sources to summarize socioeconomic and agronomic characteristics, and hub locations chosen for the Terai (Nepalgunj, Banke district) and mid-hills domains (Birendranagar, Surkhet; Dadeldhura Bazaar, Dadeldhura; Saphe Bagar, Achham) based

on these data, accessibility, proximity to a NARC agricultural research station and/or DoA office, and possibility for synergies with private sector and other projects and initiatives.

**Lentil:** On-farm lentil trials were conducted to assess farmer vs improved varieties, broadcast vs line sowing, and seed treatment with Mo and *Rhizobium* inoculum. Baby trials were also implemented to introduce farmers to newer varieties as they typically reported very low seed replacement rates, and to assess improved lentil varieties. The establishment and vigor of lentil regardless of the improved variety (IV) used could be consistently ranked until anthesis as follows (1 best, 5 worst): (1) Line sown IV (primed, inoculated) + fertilizer; (2) Broadcast IV (primed, inoculated) + fert; (3) Broadcast farmer variety (local mix; primed, inoculated) + fert; (4) Broadcast farmer variety + fert; (5) Broadcast farmer variety. However, unseasonal heavy rains soon after flowering decimated lentil across the Terai, with heavy losses due to root rot, and yields poor to non-existent. Bed planting of lentil in the Terai is being assessed this season as insurance against heavy rain.

**Spring maize:** G x E and varietal spring maize trials with short-duration hybrids were implemented in Terai and river valley sites in collaboration with 3 local seed companies to assess the performance of hybrids, line sown or broadcast (farmer practice), and with recommended vs. farmer nutrient management. Seed drill, mini-tiller, and jab planter demonstrations were held, and mini maize sheller, mini tiller, and diesel pump set trainings conducted for women farmers, with the maize sheller being received with great enthusiasm (as women typically shell maize by hand—a time-consuming job).

Preliminary analyses showed that the hybrids yielded significantly more than the short-duration OPV preferred by farmers, and also that the hybrids were responsive to irrigation, with a couple performing well at 4-5 irrigations in this very dry season. Yields of the OPV were lowest, but stable regardless of irrigation number—which is probably one reason farmers prefer it. Line-sown maize and recommended nutrient management were more productive than broadcast treatments or farmer NPK rates. Cost analysis is currently underway to enable profitability-based recommendations to farmers and the development of simple training modules to help them make good cost:benefit determinations.

Exposure visits were organized for farmers participating in Terai trials as well as those from surrounding areas, who ranked and discussed their preferences in the presence of DADOs, CSISA-NP and KISAN project staff, and seed and feed company representatives. Based on these trials, several farmers want to expand spring maize area, contingent on being able to irrigate 7-8 times. They also preferred line-sowing and recommended nutrient management to traditional practices. Feed companies expressed a commitment to buying Nepali maize, which would save the significantly higher expense and uncertainty of buying maize feed from India.

Greening the Terai is possible only with adequate and timely irrigation. CSISA-Nepal is working with the Department of Agriculture (DoA) and the Nepal Agriculture Research Council's (NARC) Agriculture Engineering Division (AED) to evaluate location-specific irrigation options. Timely supply of improved seed and hybrids as well as fertilizer is critical in decreasing spring fallows. CSISA-NP is working with the FtF KISAN project to (1) ensure that the appropriate market and governmental actors are aware of farmer preferences and constraints, and able to act on these, and (2) develop simple cost analysis training materials.

**Summer rice:** G x E and baby trials evaluated direct seeded rice (DSR) vs. transplanted rice (TPR) using improved varieties or hybrids and farmer varieties, with farmer practices vs. recommended nutrient management. Omission plots were established to validate the Nutrient Manager. Demonstrations/trainings—often with DoA and NARC—included: drum seeder, mechanical transplanting, and 2 and 4-wheel tractor seed drills, laser-land leveler, mini combine harvester, reaper, and threshers. The project works with local machinery dealers and facilitated their attendance to build service provision. This paid off, when several days after a wheat mini-combine harvester demo about 6 farmers approached the local dealer and offered to pay him to harvest their fields—which he did, and which made him consider service provision as a business model. In informal research and development (IRD), over 1200 farmers evaluated 12 rice varieties (9 self-pollinated and 3 hybrids) across 23 Agriculture Service Centers (ASCs) of 8 District Agriculture Development Offices (DADOs) in the far and mid west. In general, all three hybrids – DY18, DY69, and Prithvi were preferred, with DY69 being the most popular.

Exposure visits were arranged with farmers, KISAN project staff, DADOs, NARC, rice processors, agro-vets, and machinery dealers. Most farmers preferred the hybrid DY69 or improved varieties to the generally decades-old varieties they often used. Farmers were enthusiastic about DSR, stating that the practice saved labor, and allowed earlier rice planting and sowing of the following crop. Line sown DSR was preferred to broadcast DSR. Farmers expressed a desire to use recommended nutrient management practices as demonstrated in CSISA-NP trials, but identified timely fertilizer availability and reliability as primary constraints.

**Summer maize:** Summer maize GxE trials in the mid-hills compared hybrids and medium duration OPVs with farmer varieties, line establishment with broadcasting, or dropping seed behind the plough, and recommended nutrient management with farmer practice. Omission plots were also established. Farmers were enthusiastic about maize hybrids, and acknowledged that OPV yield with good nutrient management was good, but expressed a preference for short-duration varieties.

To further ensure sustainability, CSISA-NP will intensify work with its primary GoN partners, DoA and NARC, and continue working with private sector actors (such as machinery dealers, micro-credit companies, agro-vets, seed companies, community-based seed producing groups).CSISA-NP will continue to learn from and apply successful models from CSISA II hubs in India and Bangladesh, and collaborate on the joint development and use of CSISA training modules. CSISA-NP will also collaborate with other projects (e.g., the USAID-funded IPM-IL) to leverage their work (e.g. assessing utilizing the IPM-IL collection centers for consolidating hybrid spring maize production for purchase by feed companies).

## CROSS-CUTTING OBJECTIVE 1 ACTIVITIES

CSISA has strengthened its team to include specialists from different disciplines to support decision-making tools, build partnerships, improve post-harvest technologies, increase mechanization, and facilitate livestock-related business opportunities for women. Activities described below highlight some of the progress on themes and activities that transcend the hub and country locations.

***Reducing PH losses through improved technologies and business models:*** CSISA helps raise awareness on post harvest issues faced by farmers in the primary processing of cereals. Stakeholders are trained on how to implement tools for post-harvest value chain assessments. These tools help local partners understand post-harvest practices and technologies and identify entry points for innovation, including:

In Bihar, Odisha, and Bangladesh, most smallholder farmers rely on manual harvesting practices for rice that cause significant in-field and storage-related grain losses, raise production costs, and increase the turn-around time between rice harvest and the establishment of the winter-season. The latter is a crucial production constraint for crops like wheat in the stress-prone production ecologies of the Eastern IGP. Business models for **mechanical threshing** are being piloted for the current rice harvest to efficiently and sustainably extend cost-effective services to large numbers of farmers. This also has potential to reduce post-harvest drudgery for women farmers. Technology options include pedal, drum, and axial-flow threshers that each will likely have a different niche depending on farm size and the existing degree of mechanization.

Many projects make the mistake of promoting storage technologies without fully understanding that **sub-optimal drying** is a major cause of PH losses in storage.Drying and storage need to be addressed in tandem to reduce losses. Currently, farmers and processors at household and commercial levels lack capacity to dry and store paddy effectively, resulting in preventable losses and a poor quality of milled rice. Best practices in sun-drying are being promoted for the next season. Flat bed dryers are also being evaluated in Bangladesh and Odisha.

***Livestock activities:*** ILRI aims to improve the crop-livestock farming systems among small and marginalized farmers by 1) efficient use of resources for livestock feed, especially crop residue; 2) increasing awareness of the nutritional benefits of underutilized residues (maize and wheat in Bangladesh and Nepal); 3) to disseminate knowledge on livestock feeding in coordination with national partners; and 4) to improve the market-based distribution systems for quality feeds.

**THE POWER OF PARTNERSHIP:** In Bihar, a formal agreement has been reached with the Bihar Agricultural and a number of Self-Help groups (SHG), mainly run by women, have become very active in improving dairy production. In Odisha, the Odisha University of Agriculture and Technology (OUAT) is

collaborating in developing locally appropriate mineral mixtures and concentrate feeds. The Odisha State Milk Producers' Federation Limited (state dairy co-operative), Milk Mantra (private dairy company) and Lutheran World International are collaborating on training and evaluation of dairy feeding activities.In Nepal, the Forum for Rural Welfare and Agricultural Reform for Development is the major implementing partner for CSISA's livestock activities. In Bangladesh, the Bangladesh Livestock Research Institute is continuously supporting CSISA's livestock activities through technical backstopping.

**OPTIMIZING FOOD AND FODDER WITH SUPERIOR DUAL-PURPOSE CULTIVARS**: In Phase II, investigations for rice and maize cultivars with superior grain and straw/stover yield is focused on cultivars that are already released or are so-called pipeline hybrids in the final stages of release, and which are available for larger scale participatory testing and promotion. During the reporting period two maize promising private sector maize cultivars one released and one pipeline hybrid have been identified and stover from the released cultivar was tested with a commercial dairy producer to challenge the widespread perception that maize stover is not suitable as livestock fodder. In fact the selected maize stover outperformed sorghum stover. The project is using these findings to promote **maize stover with fodder traders** and dairy producers.

For wheat, 12 varieties consisting of three different fodder quality classes have been tested for differences in voluntary feed intake, digestibility, nitrogen balance and weight gains. This work address several objectives: 1) to better understand the rational for different wheat straw pricing occurring the same place and time because of perceived straw quality differences, 2) understand how much of wheat straw quality differences are cultivar dependent and how much are related to different harvesting procedures; and 3) estimations of economic benefits from improved wheat straws.

BUSINESS DEVELOPMENT: Small-scale business development is seen as essential for the sustainable intensification of small-holder livestock production through improved animal nutrition, and CSISA has supported the establishment of **chopping services** (e.g. in Bangladesh and Odisha) and **small feed mixing units** (e.g. in Bihar) as essential step to increase the adoption of these technologies at scale. In Bangladesh several local service providers have taken up the provision of chopping services, both stationary within their villages as well as with mobile units. While the stationary machines offer women the opportunity to engage in this business, the mobile machine offers far greater reach and potential returns. Collaboration with local machine manufacturers aims at providing improved mobile choppers to more local service providers. On the other hand, establishing small-scale feeding mixing units has proved to be more challenging than expected. The multitude of subsidy programmes for agricultural technology investments has led to expectations which a research programme cannot fulfil. It remains to be seen

whether the targeted self-help groups and entrepreneurial farmers can be convinced to invest without subsidies.

GENDER FOCUS: Although livestock production in South Asia is in itself already far more female-oriented than crop production, CSISA's livestock activities aim at improving the participation of women. This begins with trials (**50% female participation**) and trainings (**48% female participation**) but extends also to input provision where female-led self-help groups have been the major grass-root organisations involved in Bihar. Similarly, the provision of in-village chopping services in Bangladesh is dominated by women. Nevertheless, it remains a challenge to maintain gender equity where women are expected to collaborate with formal institutions and move far from their village.

***New models of outreach through strategic partnerships:*** The State Departments of Agriculture (DoA) are well-funded and powerful potential sources of change in India. Nevertheless, the scope of the challenge in states like Bihar and Odisha is enormous and the DoA increasingly recognizes that new models of outreach are required to better meet the needs of farmers and effectively scale new technologies and management approaches. The challenge too is to more effectively link with other government institutions with complementary strengths such as the network of Krishi Vigyan Kendra's (KVKs) that have scientific staff who are experienced with on-farm technical evaluations. In Odisha, CSISA has catalyzed a new partnership between Digital Green, the DoA (through the Village Agricultural Workers), and the KVK to embrace a video-based extension platform to facilitate farmer-to-farmer knowledge exchange with sound technical backstopping.

The pilot examines the **feasibility of integrating Digital Green's ICT-based extension model with the formal extension system** in Odisha and is being deployed in 20 villages with 800 households targeted.

The Digital Green - CSISA partnership in Bihar is ongoing. In collaboration with Jeevika (Bihar Rural Livelihoods Promotion Society), videos such as *the importance of early sowing in wheat* have been produced and screenings are ongoing.

***Decision tools for site-specific management:*** Across South Asia, blanket fertilizer recommendations are made over large regions, an approach that discounts all the different site and year-specific factors that govern economically optimal fertilizer usage. **Existing approaches to have lead to inefficient use of nutrients and, in cases, lower yield and profitability**. CSISA is working to refine, validate, and mainstream *Nutrient Manager* (NM) – an easily scalable ICT-based decision support tool for site-specific nutrient management (SSNM) for cereals.

In the past year, user testing and fine-tuning was conducted for the *Nutrient Manager for Tamil Nadu* during the *Thaladi* rice season. The results provide a more robust understanding of the contribution of organic fertilizer sources towards the fertilizer needs of the rice crop. Amore

precise inorganic fertilizer recommendation has been implemented that reduces the risk of fertilizer overuse while increasing profitability; *Nutrient Manager for Tamil Nadu* will be dissemination by the Kuruvai season 2014 on a mobile phone platform. In Bangladesh, the tools for rice and maize are in similar stages of deployment.

In Bihar and Eastern UP, a beta version of a tool developed for rice-wheat systems is currently under field evaluation. In this tool and others, simple agronomic management guidelines are also under development that will assist farmers achieve higher yields while making even more efficient use of fertilizer investments. In this fashion, a true *Crop Manager* framework is emerging.

To improve the science of site specificity, new efforts are being made to characterize and predict the dynamic nature of attainalbe yield in farmer's fields – a conceptual weakness of current approaches and a dominate term in the decision tool logic. This effort will integrate remotely sensed and weather forecast information to enable farmers to make in-season adjustments to management based on crop conditions.

***Business models and the dynamics of technology adoption:*** Two interlinked studies are in progress in Bihar that focus on **zero-tillage (ZT) service provision as a business opportunity** and on **ZT adoption patterns** and welfare impacts. The objectives of the two interlinked studies are to (1)assess the economic viability of ZT service enterprises and constraints to further business expansion; and (2) assess farmers'/service providers' resource endowment, risk exposure, and risk preferences as they condition willingness and ability to innovate. Results are being used to identify the factors that influence the emergence and expansion of ZT service provision entrepreneurs and, on the technology demand side, what factors compel ZT adoption. The impact of ZT adoption on farm households' income and food security are also assessed.

ZT adoption rates for wheat vary widely between the surveyed districts and also between villages within districts. Overall, two out of three sampled farmers who are aware of the technology chose to use it. But awareness of ZT is still limited, even within villages where the technology is already practiced.

Virtually every ZT seed drill now operating in Bihar and EUP is built for the four-wheel tractor and operation is less efficient on very small plots. This may partially explain why adoption of the technology is significantly biased towards larger farm sizes. Perhaps more importantly, awareness of the technology appears to be more pervasive among larger and better-educated farmers. On the other hand, there are ZT wheat adopters in the smallest farm size tercile who have fully adopted the technology. Hence, from a poverty alleviation perspective (ZT reduces production costs by \$200 $ha^{-1}$) it is desirable to also reach more small farmers with awareness raising activities and, at the same time, strengthening linkages with service providers. CSISA is deploying various social marketing tools to increase awareness, including videos distributed through the DoA.

Once farmers decide to use ZT technology, the majority adopts it on 100% of their wheat area. This is in line with our finding that ZT adopters are, on the average, very satisfied with the technology. The constraint most widely cited, namely that ZT services are not always available in a timely manner, is being addressed by CSISA with training activities geared towards increasing the number of ZT service

providers. These trainings increasing include a focus on 'business development services' and many are jointly implemented with the DoA and private sector partners.

***Training, spillover effects, and continuity of technology adoption:*** CSISA has conducted a study on factors that affect the **continuous use of DSR** in order to (1) assess the direct impact of CSISA trainings on rice production, (2) assess the spillover impacts of the CSISA-assisted service providers, and (3) identify adoption constraints and enabling factors for accelerating the expansion of DSR in Bihar and EUP.

The survey utilized a roster of 2,386 farmers who participated in DSR trainings provided by CSISA hubs in the four-year period between 2009 and 2012 and a list of farmers who contracted CSISA-assisted service providers for DSR. We selected 360 farmers by using a stratified sampling method. The survey finds that 61% of the sampled farmers applied DSR in 2012. Among non-adopters, the main reasons for not utilizing DSR in 2012 include delayed monsoon (50%), weed problem (23%), drought (12%), and non-availability of service providers (11%). Landholding size influenced the reasons for not using DSR, with about 20% of smallholders indicating that they did not use DSR because service providers were not available, while only 4.2 and 9.1% of large and medium landholders, respectively, citing this as a reason. This finding suggests that creative effort is required to more effectively link smallholders to service providers – a challenge, perhaps, when there are supply-side limitations in the number of seed drills in the many of the ecologies CSISA prioritizes in Phase II.

The survey finds that the total person days required per hectare on a DSR plot is 60 person days per ha, compared to 114 person days per ha for non-DSR plots. Thus, the **total labor use is about 46 person days lower** on DSR plots than on non-DSR plots. Labor markets have contracted remarkably in the last 4 to 5 years in Eastern India, and often farmers complain that labor is not available at any price with attendant implications for timely establishment and other crop management practices such as weeding. Labor shortages are anticipated to be the primary driver of DSR adoption in coming years.

Nevertheless, most farmers need to rely on service providers to implement DSR because they cannot afford their own seed drills. However, the number of service providers is still small. As was noted for the spread of ZT wheat, there is a great need to train more service providers to overcome supply-side bottlenecks that constrain adoption of capital-intensive innovations.

***Characterizing knowledge and social networks in CSISA districts in Bihar:*** Knowledge networks and social networks are the drivers for information sharing and they also play an important role in the diffusion of technology and related knowledge. Mapping these social and knowledge networks and understanding their role in supporting innovation is essential for achieving inclusive development. CSISA is undertaking a study to map the knowledge and social networks in selected districts of Bihar. We aim to identify the linkages between these networks and illuminate (1) how farmers are associated with these networks, (2) what information is delivered by the networks to the farmers, (3) what are the constraints to the functioning of these networks, and (4) what potential exists to use these knowledge networks to promote wider knowledge use.

***Investing in new analytical tools: strategic science partnership with AgMIP:*** Simulation tools are the best and, in cases, only method for studying complex processes included those that are significantly influenced by weather events. After a period of low investment in such tools, the Agriculture Model Inter-comparison and Improvement Project (AgMIP) was launched to evaluate and improve simulation tools for use in different production ecologies.

CSISA is collaborating with the Indo Gangetic Basin regional team of AgMIP, which is focusing on cereal crop production in the central and eastern Indo-Gangetic Basin. The team is working on strengthening simulation approaches for understanding, projecting, and managing climate risks in stress-prone environments across the central and eastern Indo-Gangetic Basin. The project team is using CSISA Karnal platform data for evaluating promising adaptation strategies, suggesting areas for model improvement, developing a qualitative summary of the non-climate drivers of change, and analyzing different policy scenarios by integrating an economic tradeoffs model with the crop simulation models.

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

In the process of participatory development and out-scaling of new technologies for sustainable intensification (Objective 1), problems as well as new opportunities emerge that necessitate rigorous, process-based inquiry. Strategic research is conducted at four platform sites representing distinct agro-ecologies: Karnal, Haryana; Patna, Bihar; Aduthurai, Tamil Nadu; and Gazipur, Bangladesh. Four cropping systems scenarios are explored at CSISA's research platforms: (Scenario 1) business as usual—conventional farmers' practices; (Scenario 2) established 'better-bet' management practices; (Scenario 3) labor-, energy-, and water-saving practices based on conservation agriculture; and (Scenario 4) diversified systems (CA 'plus').

***Karnal Research Platform***(Central Soil Salinity Research Institute, CSSRI-ICAR): Based on three-years evidence, key findings for the northwestern Indo-Gangetic Plains include:

1. Full adoption of CA-based practices for all components of the cropping system leads to **higher yield productivity** over time (12–14%) with **significantly less resource use** for irrigation water (33%) and energy (26%) while increasing profitability (US$ 394 $ha^{-1}$)
2. Dry seeded rice is a viable alternative to puddled transplanted rice to overcome the emerging constraints of labor, water, and energy while maintaining high rice yields
3. Maize can be profitably cultivated as a monsoon season alternative to rice with dramatic reductions in energy and irrigation water inputs
4. Benefits from CA-based management are likely to increase with time as further improvements in soil physical quality and reductions in weed populations continue to accrue.

***Patna Research Platform*** (Research Complex for Eastern Region, ICAR-RCER). Key findings for the Eastern Indo-Gangetic Plains are similar to those in Haryana. Full CA in rice-wheat systems resulted in improvements in wheat and rice productivity by 17% and 8% compared to conventional best practices. Other work suggests that DSR can reduce irrigation water application by 15–30% compared to conventionally transplanted rice that requires considerable water during the soil puddling process. Nevertheless, DSR is inherently more risky in the east where the threat of early flood inundation and stand loss is high. Additional research characteristics this risk and is identifying options for reducing it.

CSISA recognizes that the challenges of sustainable intensification require an **expanded focus that extends beyond research stations**. Examples of Objective 2's new strategic research activities include:

***Exploring the scope and implications of diversifying rice-wheat systems in the NW IGP:*** This study explores some of the critical 'unknowns' about the Government of India's new policy of promoting **Kharif maize as an alternative to rice in an attempt to arrest declining groundwater** tables in the NW. Interactions between demand projections, market and non-market risks to producers, and uncertainties about underlying hydrology processes including risks of secondary salinization in reclaimed soils. There are also significant feedback interactions between these factors that necessitate an integrative approach that unites socioeconomic, biophysical, and policy dimensions in order to best estimate the implications of diversification at the household to regional scales. A linked simulation model approach will be used for broadly establishing trajectories of change and multi-criteria outcomes under different policy investment, socioeconomic, and technological change scenarios.

***Developing options for improving water productivity at the field and command area scales:*** Water resources are generally under-developed in Eastern India, and cost barriers among relatively impoverished communities necessitates layered approaches that increase efficiencies and reduce costs in order to spur development. This research theme focuses on **productive and profitable uses of water** with technologies such as improved field design to decrease non-productive water losses, precise irrigation scheduling, methods that reduce conveyance losses, deployment of energy efficient pumps for water lifting, and adjustment to cropping practices based on agro-climatology and weather forecasting.

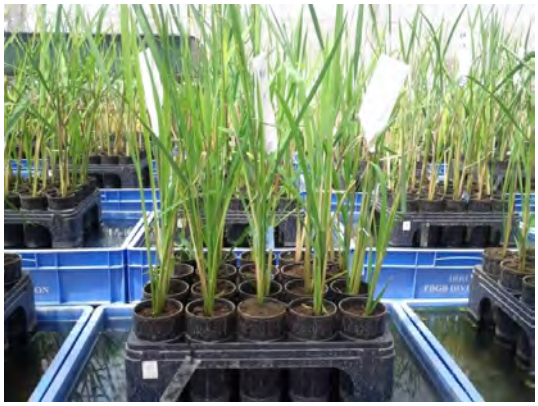
***Integrated weed management for complex flora and new agronomic practices:*** In general, **weed management is extremely poor in eastern India** leading to high yield losses – a situation that is intensifying as agricultural labor markets tighten. Moreover, weed management is one the greatest challenges to the wider adoption in CA-based practices as weed management is more knowledge intensive and difficult in these new systems. Integrated weed management strategies are being

developed that focus on manipulating crop-weed competition through both chemical and non-chemical approaches including residue management, cultivars, water, and nutrient management.

## 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.

In the wet season 2013, 30 entries in **early maturity** group and 28 entries in the **medium maturity** are being evaluated at 5 locations in India. In collaboration with ILRI, **straw quality** of 160 entries including hybrids, varieties and breeding lines were studied. In order to develop high yielding varieties with better straw quality traits (dual purpose),six contrasting parents were crossed to develop mapping populations. One hundred new IRRI breeding lines with **multiple disease resistance and high yield potential** are being evaluated in replicated trials in Nepal and Bangladesh.



During wet season 2012, three multi-location machine sown **dry direct seeded** trials were conducted.bPromising entries were identified for early maturity hybrids, medium-early maturity hybrids, and medium maturity hybrids. During the wet season of 2013, 36 entries of early and 32 entries each of medium early and medium duration are being conducted at 7 locations in India. Desired traits for DSR systems include plant types with **high grain yield potential**, tall stature ( > 100 cm),early stage seedling vigor, slow leaf senescence, prolonged grain filling duration, and biotic stress tolerance.

In order to develop varieties with **anaerobic germination (AG)** capabilities(a trait with particular importance to DSR systems),mega varieties such as Swarna were crossed with lines having QTLs (AG1) for AG. F2s were evaluated during wet season 2013. Because zinc and iron deficiency is a major problem in dry direct seeded conditions, 110 entries including hybrids were screened for Zn deficiency tolerance. One breeding line from IRRI (IR 06A150) and a few hybrids were found to be tolerant.

A **heat tolerance** MAGIC population is at S3 generation in 2013 wet season. In order to develop near-isogenic lines (NILs) with the N22 QTL region in a susceptible mega-variety and validate under controlled stress for heat tolerance at flowering,

Ninety-four $F_2$ populations, 3496 $F_3$ lines, 1026 $F_4$ lines, 393 $F_5$ lines, 285 $F_5$ MAGIC plus lines, and 651 $F_6$ lines were evaluated in the field for heat tolerance at flowering stage during 2013 dry season. Seventy six lines were advanced to first phase OYT and 76 lines for second phase OYT.

## Objective 4: High-yielding heat- and water-stress tolerant, and disease-resistant wheat varieties for current and future cereal and mixed crop-livestock 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; as well as adaptability to CA practices.

During the reporting period, **10 outstanding wheat varieties were released** in four countries. More than a dozen new varieties were either identified or proposed for release in respective countries and more than 500new lines were promoted to various stages of national and state trials.

**Table 4. Wheat new varieties released in four participating countries of South Asia in CSISA project**

| No. | Country | Variety | Pedigree | Location/ management |
|---|---|---|---|---|
| 1. | India | PBW 658 | CS/*Th.sc*//3*PVN/3/MIRLO/BUC/4/ MILAN/5/TILHI | I-TS; Punjab |
| 2. | India | DBW74 | WBLLI*2/BRAMBLING | I-TS; NWPZ |
| 3. | India | HD3059 | KAUZ//ALTAR84/AOS/3/MILAN/KAUZ/4/HUITES | I-LS-NWPZ |
| 4. | India | HI8713 (d) | HD4672/PDW233 | I-TS; CZ |
| 5. | India | UAS 304 | SERI/CEP80120//KAUZ / PBW 343 | PZ |
| 6. | Bangladesh | Bari Gom28 | CHIL/2*STAR/4/BOW/CROW//BUC/PVN/3/2*VEE#10 | I-TS; normal/saline soils |
| 7. | Nepal | BL3235 | NL872/ (CHIL/2*STAR)/NL868 | Hills, high hills; I, RS, RF |
| 8. | Nepal | BL3503 | BL1961/NL86 | Hills, high hills; I, RS, RF |
| 9. | Pakistan* | Pirsabak2013 | CS/TH.SC//3*PVN/3/MIRLO/BUC/4/MILAN/5/TILHI | I-TS |
| 10. | Pakistan* | Shahkar2013 | CMH84.3379/CMH78.578//MILAN | I-LS |

I-Irrigated; RF-Rainfed; RS-Restricted irrigation; TS-Timely sown; LS-Late sown; NWPZ –North western plains zone; NEPZ-North eastern plains zone; CZ-Central zone; PZ-Peninsular zone; d-durum; *Pakistan is associated to CSISA with funding from USDA

Seventy four nursery trials from CIMMYT were planted by collaborators in South Asia (Table 7). Superior lines selected for further evaluation in respective centers and countries. The 4th CSISA HT EM trial had 28 gentoypes and 2 checks and was grown in 10 locations (Table 7). The two checks included a local check, i.e., best locally adapted cultivar and a CIMMYT early maturing check 'Baj'. Several new genotypes outperformed the local checks and the CIMMYT check.

**Table 7. List of the sets of CIMMYT trials and nurseries planted by collaborators in south Asia (India, Nepal, Bangladesh and Pakistan) during 2012-13 cycle.**

| BREAD WHEAT 2012-13 | 33RD ESWYT*1 | 20TH SAWYT*6 | 7TH EBWYT | 4TH CSISA HT-EM | 4TH CSISA-SB | 2ND SATYN | 1ST WYCYT | TOTAL |
|---|---|---|---|---|---|---|---|---|
| **TOTAL NURSERIES** | 11 | 11 | 10 | 10 | 8 | 13 | 13 | 78 |
| INDIA | | | | | | | | |
| PAU, Ludhiana | 1 | 1 | 1 | 1 | - | 1 | 1 | 6 |
| IARI, N. Delhi | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 7 |
| UAS, Dharwad | 1 | 1 | 1 | 1 | 1 | 2 | 2 | 9 |
| IARI, Indore | 1 | 1 | 1 | 1 | - | 1 | 1 | 6 |
| UBKV, Coochbehar | - | 1 | - | - | 1 | - | - | 2 |
| BHU, Varanasi | 1 | 1 | 0 | 1 | 1 | 1 | 1 | 6 |
| DWR, Karnal | 1 | 1 | 1 | 1 | 0 | 1 | 1 | 6 |
| **Nepal** | | | | | | | | |

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| NWRP, Bhairahwa | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 7 |
| **Bangladesh** | | | | | | | | |
| Dinajpur/Gazipur/Jessore | 2 | 1 | 2 | 3 | 3 | 1 | 1 | 13 |
| Rajshahi | - | - | - | - | - | 1 | 1 | 2 |
| **Pakistan** | | | | | | | | |
| PARC Islamabad | 1 | 1 | 1 | 1 | - | 1 | 1 | 6 |
| WRI Faisalabad | 1 | 1 | 1 | 1 | - | 1 | 1 | 6 |
| RARI Bahawalpur | - | - | - | - | - | 1 | - | 1 |
| CCRI Pirsabak Nowshera KPK | - | - | - | - | - | - | 1 | 1 |

More than 1,100 crosses/backcrosses and segregating populations were exposed to selection in different locations of South Asia and Mexico. These crosses involved heat and drought tolerant, spot blotch and Ug99 resistant parents. Segregating ($F_3$/$F_4$) generations from South Asia were evaluated in Kenya for screening against Ug99 resistance. Seventy participatory varietal selection trials were planted in Nepal, India and Bangladesh and seed growers and farmer groups initiated seed dissemination of superior lines.

## 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. Objective 5 specifically 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. The two main research areas under Objective 5 are improved policies and incentives that encourage private investment and public–private partnerships in pro-poor technology development and delivery.

***Research continuing from Phase I:*** Research continuing from CSISA Phase I includes a study of **market segmentation** strategies for new technologies based on field experiments with laser land leveling in eastern Uttar Pradesh. This study informs the policy environment with respect to **subsidies** and other factors that can facilitate or impede the adoption of new agricultural technologies.

Also continuing from Phase I is a study on the impacts of the **National Rural Employment Guarantee Act** (NREGA) on adoption of resource-conserving technologies. While NREGA has the potential to provide substantial and reliable income for qualified rural households, it may also affect rural wages, with potential consequences for household labor and migration decisions, intra-household asset allocations, gender empowerment, and willingness to innovate for agricultural intensification.

***New research in progress:*** New research began in late 2012 using choice experiments to study farmers' preferences for **abiotic stress tolerance traits** embodied in different rice backgrounds. This study allows for in-depth exploration of **demand heterogeneity**, and will allow CSISA and its partners to improve strategies for reaching vulnerable farmers who stand to benefit from these traits. This study is meant to inform CSISA's breeding activities, private sector partnerships, and the public policy environment that enables such collaborations.

Additional research uses field experiments to study **farmers' attitudes toward risk and ambiguity**. These behavioural characteristics are important constraints to technology adoption, since there is often a great deal of uncertainty regarding the benefits of a new technology vis-à-vis conventional technologies. This study is meant to inform CSISA's efforts at promoting technologies by characterizing households who may face these additional constraints to adopting new technologies.

Research is being developed on the **substitutive and complementary effects of abiotic stress-tolerance traits in rice and weather index insurance** in Bangladesh. The broad aim of this study is to explore the impacts on household production, consumption, and risk management decisions of stress-tolerant cultivar adoption and weather index insurance uptake. One intervention is technological in nature: a drought-tolerant rice cultivar recently released in Bangladesh for cultivation during the aman rice-growing season but not yet widely cultivated in the country. The other intervention is financial: an index-based insurance policy that compensate for crop losses in the event of poor rainfall.

Research is being developed on the **impacts of shocks and vulnerability on input use and management** practices.The study aims to use household survey data to study how vulnerability constrains investments in new technologies that might otherwise improve farm livelihoods and, conversely, explore how different pathways for increasing resilience could lead to greater adoption of CSISA technologies.

Research is being designed to study differences in **learning patterns** among farmers in Bihar, both on an individual basis as well as in social settings. This study aims to use field-based experimental methods to study how individuals with different styles of learning process information and account for uncertainty in decision processes.  This information will be fed-forward into CSISA's out-scaling efforts.

## Objective 6: Project Management, Data Management, Monitoring & Evaluation and Communications

Governance and project management in CSISA Phase II are designed to (i) enable better linkages with national and regional stakeholders, (ii) simplify reporting and ensure clear lines of accountability, (iii) enable better teamwork and synergy across Objectives and CG partners, (iv) build a more inclusive model for outreach and research that leverages the strengths and addresses the needs of key partners. The section below highlights some of the key activities and advancements achieved under Objective 6 during the reporting period.

***Regional Governance: Executive Committee:*** The CSISA **Executive Committee** is composed of senior representatives of the CGIAR Centers in South Asia and chaired by the CIMMYT representative. Meetings are held quarterly. The primary roles of the Executive Committee include monitoring of project progress and work plan development, approval of fund allocation for regional investments, integration with other activities of the Centers/CGIAR Research Programs in the region, and harmonization of administrative processes and staff policies. The first in-person Executive Committee meeting was held in February 2013 in Dhaka, Bangladesh, and Executive Committee conference calls were held in May and November 2013.

***Country-level Governance: Management Team:*** A small **Management Team** has been composed in India and Bangladesh to lead strategy development, activity planning, and to provide comprehensive technical oversight for the non-breeding objectives of CSISA. The Management Team 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. In India, Management Team meetings have been held each month since July 2012 and have proven to be a helpful forum for discussing project details and issues, and promoting alignment and communication amongst the partners.

***State-level Governance: Advisory and Investment Committees:*** To reach CSISA development goals and to align the project with government priorities, policies and investments, and to provide new mechanisms for catalyzing partner-driven delivery activities at each hub, CSISA has created Advisory and Investment Committees for Bihar, Odisha, and Bangladesh consisting of NARES leaders and other representatives from the public, private, or civil society sectors. Advisory and Investment Committees have funds to allocate to partner-driven activities that are aligned with CSISA's goals[2]. Funds are allocated on a commissioned and a competitive grants basis, and are managed by the Advisory and Investment Committee in consultation with the CSISA management team.

During the first two Bihar Advisory and Investment Committee meetings held in April and May 2013, five potential areas for investment by the fund were proposed and technical working groups were formed around each topic. Areas for investment included: yield maximization, cropping systems optimization for timely wheat planting, yield potential and nutrient management, empowering women in agriculture, and facilitating innovation and entrepreneurship. Funds were subsequently awarded to KVK Jamui, KVK Ara, Banares Hindu University, and VASFA (a local NGO) for work related to these areas of investment.

An Advisory and Investment Committee has been formed in Odisha, and the majority of members participated in the 'Building Linkages' dialog that was held in Cuttack at the Central Rice Research Institute in May 2013. Working groups have been formed for post-harvest, nutrient management, rice mechanization, and maize agronomy interventions. These groups have been tasked with formulating proposals for support from the Advisory and Investment Committee for Odisha. A follow-up meeting has been scheduled for October 2013. A reconstituted advisory committee has been composed in Bangladesh, and had its first meeting in June 2103. Planning for prior meetings has been disrupted by the strikes and political turmoil that has plagued Bangladesh for several months.

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

***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 plan for the coming season's activities. Meetings are followed by staff work plans, proposals, and funding requests. The approval of activities and subsequent allocation of funds is done by the Management Team at the subsequent MT meeting. In 2013, planning and evaluation meetings were held by CSISA-India (Objective 1), CSISA-Bangladesh, CSISA-Nepal, Objective 2, Objective 4, and Objective 5. Whenever possible, management team members attend all of the planning and evaluation meetings in order to improve the sharing of ideas and strategy, and to improve integration and alignment across the project. Other mechanisms for increasing communication and integration include monthly calls between CSISA Phase II and CSISA-BD management, as well as monthly calls with the donors that not only provide updates from the project side, but also solicit helpful feedback from the donor perspective.

***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 have employed **Surveybe** software and portable netbook computers to improve field-based data collection, and to reduce the opportunities for error during data processing, as well as the time between data collection and analysis. The project is also developing mobile phone-based surveys using **Open Data Kit (ODK)** for regular activities such as trainings and short surveys with known groups of beneficiaries such as service providers. ODK Collect was developed, user-tested, and deployed—initially to document training events, service provision, and partner networks. Every sample point is automatically geo-referenced, and ODK can be synced to a server in real-time, and data easily mapped for quick visualization. Members of CSISA's M&E team are also developing standardized **data logbooks** for field-base partners, **standardizing templates** across hubs, generating **monthly reporting requirements**, and determining the project's needs for Access or cloud-based **data storage systems**. CSISA also made public its **Phase I baseline data** in May 2013 through Gates Foundation and USAID mechanisms, IFPRI's DataVerse, and the new CSISA web site. 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, Agricultureand Food Security (CCAFS), with eight current CGIAR partners. However, while the AgTrials database is powerful, the user interface could use 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. 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 will work 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. 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.

***Communication:*** CSISA is in the process of launching its **new web site**: http://csisa.cimmyt.org. This web site has been designed as a joint web site for CSISA Phase II, CSISA-Bangladesh, and CSISA-Nepal, and aims to provide a clear description of CSISA's goals, objectives, partners, geographies, activities, and outputs. The **CSISA Bulletin** has also been redesigned and is being launched with the new web site.The CSISA Phase II communications team has also designed a template for **CSISA Research Notes**, which essentially serve as briefs for the research coming out of CSISA (including Bangladesh and Nepal). Notes will be reviewed by a technical committee and an editorial committee, and then will be made public through the web site, the bulletin, and any other mechanisms that the relevant researchers choose. CSISA Phase II also has a **shared document repository** at cimmyt.box.com, which facilitates document sharing and storage. The communications team is also working on tools for improving internal communications across the CSISA team, and is drafting an **internal e-newsletter**.

***Monitoring and Evaluation:*** CSISA has nearly completed the staffing of its M&E team, and is streamlining its M&E processes, in line with the semi-annual and annual quantitative and qualitative reporting requirements of our donor agencies. IRRI's M&E Specialist has taken the lead for the evaluation discussions; CIMMYT's M&E Specialist based in Bihar has taken the lead for the Bihar and EUP data, the project's M&E plan, document standardization, and compiled indicator reporting; the Odisha M&E Specialist (expected to be hired before the end of the year) will be responsible for Odisha's data and the results framework; and the lead M&E Specialist will compile the semi-annual and annual technical reports.

CSISA is one of the first agricultural R for D projects the emerged after the food price crisis of 2007-8 to endeavor to achieve sustainable development at scale (i.e. outcomes focused). CSISA does not transfer assets, but rather seeks to play a catalytic and supporting role with other actors in the innovation system. As such, the geography and magnitude of success is difficult to predict *a priori* and difficult to measure *ex post*. Further, CSISA supports several major classes of technologies, all with distinct impact pathways. These factors necessitate non-classical and mixed methods approaches for assessing project-

supported impacts on the rapid timescales required to both make adjustments within the project as part of 'ME&L' as well as to give stakeholders updates on project progress on an annual or sub-annual basis.

One example of a **rapid and credible inference method** pertains to our work on zero-tillage that primarily reaches farmers through mechanized service providers. We've equipped each service provider supported by CSISA with logbooks so that we can record the number of farmers reached per season and the total land areas for which the technology has been deployed. By coupling this information with year-specific cost and returns studies on sub-samples of adopters, we can make reliable estimations of the major outcomes indicators of interest: number of farmers adopting, land under new technology, and the yield and economics benefits associated with the new technology.

## E. Key Challenges and Strategies to Address Them

The section below highlights some of the challenges CSISA has faced during the reporting period, with explanation of the strategies used to overcome the challenges specified.

### *Extreme weather in Bihar, Eastern UP, and Odisha*

**DROUGHT IN BIHAR:** During Kharif 2013, Bihar suffered a drought that lasted approximately 30-35 days, and resulted in rainfall falling 27-63% below normal monsoon levels up to September 2013. Instead of the monsoon lasting a normal 45-46 days, rains lasted for only 15 days. As the drought hit during the summer rainy season, the rice crop was badly affected. The drought during parts of June, July and August and heavy rains in mid-October due to the remnants of Cyclone Phailin negatively affected the direct seeded rice, mechanical transplanted non-puddled rice, maize and soybean fields in Bihar hub domain.

**CYCLONE PHAILIN:** High-velocity cyclone *Phailin* hit Odisha on October 12, 2013 and ensuing heavy rains have triggered massive floods in some of Odisha's main rivers. CSISA's districts – Puri, Bhadrak, and Mayurbhanj, are among the severely affected districts. Although precautionary measures such as a mass evacuation of Odisha residents, administrative arrangements, and awareness raising have saved many lives, the damage to agriculture, power, and the environment is immeasurable. The cyclone seems to have adversely impacted a large population dependent on agriculture, livestock and other allied activities due largely to high winds, flooding, and salt water inundation. Also, the cyclone damaged the power supply, communication & transportation infrastructure, and many other basic amenities.

In **Bhadrak**, CSISA sites were found not to be severely affected. In few cases, however there could be some extensive crop loss because of high wind speed and submergence and stagnation of fields for 2-3 days due to heavy rainfall and flood.

In **Mayurbhanj**, CSISA sites were relatively undamaged, perhaps because of their location and also because of late planting. But the sites which come under low-lying area are affected by submergence and will result in yield loss. Some farmers provided feedback that farms planted with mechanical transplanting under non puddled and puddled conditions better withstood the damage than the conventional fields. In case of the plateau regions even though there is not much damage, the pollination of paddy is going to be affected and may lead to chaffy grain. In case of the maize varietal trial by CSISA at KVK, Jashipur, the crops which were ready for harvesting of dry cobs have been lodged completely because of heavy storm. Further, the heavy rainfall increased the moisture level in the uplands that delays Rabi sowing also. Interestingly DSR fields have escaped from Phailin due to 10 days early maturity with compared to normal crop.

**Varietal testing at KVK, Jashipur** **Devastated forest at Similipal Plateau**

In **Puri**, in the CSISA project areas/blocks, the fields were affected by water logging due to heavy rainfall in all the locations such as Gop, Nimapara and Kakatpur. Though the water level had started receding at the time we visited the field (on 15$^{th}$ October), the drainage of water was problematic. In the paddy fields where the crop had reached the stage of panicle initiation or grain filling, the crops were seen to be completely lodged in the field due to high-speed wind along with water logging. In case of the fields

where the crop is still in the vegetative stage (which was found to be so in most of the cases as late transplanting or sowing of paddy was carried out in this particular district this year because of late arrival of monsoon), the crop were seen to be lesser affected in terms of lodging. However water logging was also seen in these types of fields. But there was no report of salinization/salt water inundation in the project areas.

The plots with omission plot trials and SSNM trials were flooded and there was overflowing of water from all across the field. So, the result from SSNM plots might not be as per our expectations. However, the mechanically transplanted fields were in a better condition. Due to delay in transplanting, these crops have survived the storm. In case of fields that had reached grain-filling stage, crop lodging was seen.

MT field with good crop stand

Affected DSR field because of water logging

Lodging of crop in mature crop in MT field

The DSR field in Gop is affected due to water logging and heavy wind flow. The crop has also affected with root rot disease and contains the same patchy look. The early transplanted crops at panicles developed were lodged in water.The effect of severe cyclonic storm was quite visible in the area, however the on field damage of crop was seen to be lesser than what was feared. However because of water logging, crop lodging and other effects, the crop yield is likely to be affected significantly in many of the areas.

***Hartals in Bangladesh:*** During this reporting period (October 1, 2012 to September 30, 2013) Bangladesh lost 46workdays due to Hartals (demonstrations, strikes, and road blocks), which constitutes about 20% of all possible workdays. Most lost days were between February and June, although 10 days were lost in October and November. At the time of report submission, the situation was expected to get worse due to the impending elections. During Hartals public transport and private vehicles can be attacked with stones and petrol bombs making it dangerous for staff to travel to and from work and for

project staff to travel in project vehicles while on work activities. Hartals are normally declared as nationwide activities but they can be confined to specific cities. In the data quoted above only days lost through nationwide Hartals are recorded. During a nationwide Hartal disturbances are not just confined to Dhaka but can occur in any provincial city. This year there have been severe disturbances in the Northwest (Rangpur, Rajshahi, and Bogra) and in the Southeast (Noakhali and Chittagong). There have also been violent disturbances in many of the focal areas on the CSISA-BD project in Southwest Bangladesh (Jessore, Faridpur, Khulna and Barisal).

Despite these hindrances most planned CSISA-BD activities have been completed. This has been due in most to the ingenuity and dedication of the CSISA-BD staff. Our policy has been to ask project staff to only attend work during a Hartal if they thought it was safe to travel and to find ways of completing work cancelled because of a Hartal on another day. In Dhaka most staff are not able to travel into the city during a Hartal. Only those living near the office are able to go to the office and this is normally by foot or rickshaw. For those in provincial centers most offices have used the Hartal day to catch up with office work such as accounts and M&E data entry. In many cases staffhave used local transport to work with farmers when crops have been harvested and data has had to be collected on a Hartal day. Although the project management is not encouraging this type of activity it equally acknowledges the dedication staff exhibit when they take these actions. Many staff also use the weekends to catch up with work lost during the week. As a result weekdays and weekends have become rather blurred.

***Bandhs in Nepal:*** The unstable political situation in Nepal results in frequent 'bandhs' or shutdowns of large swathes of the country—if not the entire country—sometimes for days together. Vehicular movement is blocked and businesses and institutions closed during such times, which makes planning, scheduling, and timely completion of activities and trainings a huge challenge. CSISA-NP has attempted to deal with this, and with the poor road infrastructure by adding two more ARTCs than originally planned, to minimize the need to travel long distances to project sites.

Aside from the bandhs, water is the single largest challenge to intensification in the 16 target districts of Feed the Future Nepal—including Terai districts. Groundwater is a relatively poorly tapped resource in the Terai, and reasonable sources of irrigation in the mid-hills are not common. CSISA-NP is attempting to focus a large amount of mechanization efforts on exploring the potential for axial flow pumps, and increased emphasis on tube wells, in conjunction with appropriate timing and application of irrigation water (e.g. alternatives to the commonly employed flood irrigation).

***Intellectual property rights issues for rice:*** Objective 3 reported that it faces challenges with intellectual property rights issues involved rice germplasm movement out of India, which has been very restricted in recent years. This issue is being taken up at higher levels by various CGIAR institutes in India. For the time being new breeding materials for Bangladesh, Nepal and Pakistan are being developed at IRRI,HQ, segregating materials and advanced materials are being sent to different countries formaking selections under specific conditions and for multi-location evaluation.

***Institutional Review Board restrictions:*** Objective 5 has noted that IFPRI's Institutional Review Board requires that all studies involving human subjects undergo review to ensure the highest ethical

standards in the study design and implementation. In 2013, IFPRI's Institutional Review Board has emphasized local approval of study design, even in countries where capacity for such ethical reviews is limited. Thislimited capacity in both Bangladesh and India has caused slight delays in study implementation. Similar delays have been experienced by collaborators at Jawaharlal Nehru University, where cited objections were beyond the scope of ethical review. Despite these challenges, continued adherence to Institutional Review Board requirements will be a hallmark of IFPRI's research agenda, and IFPRI will encourage its partner organizations in CSISA to establish similar mechanisms.

## *F. Sustainability and Scalability*

CSISA has leveraged a wide variety of partnerships to facilitate both the sustainability and scalability of its activities and interventions. In Bihar and Eastern UP, CSISA has leveraged its association with state department of agriculture (DOA) at the district level and through parastatals such as ATMA (Eastern UP) and Bihar Agriculture Management Education and Training Institute to institutionalize support for technological interventions such as machine transplanted non-puddled rice, zero till wheat and early wheat sowing. As a result of increasing government support for and promotion of these technologies, three private firms (VST, Kisan Kraft and Mand M) have entered the farm mechanization market in Bihar. State Agriculture Universities, KVKs, and NGOs, and private sector firms have been involved in the development and promotion of new technologies such as hybrids, new machines and new molecules. CSISA is also working to develop sustainable business models for technology dissemination and adoption, focusing on the central role of service providers in technology dissemination. CSISA trains service providers in various improved technologies and facilitates forward and backward linkages with farmers, credit organizations, government schemes, and dealers. In Haryana, strengthened partners, formation of farmers' cooperatives and refined research outputs help ensure sustainability.

In terms of how to scale up CSISA technologies, CSISA utilizes a few key tactics. CSISA **aligns its activities with national and state programs** so that government partners, which in many cases have substantial funds to spend on agricultural initiatives, can utilize CSISA's innovations in combination with their own funds to undertake large-scale interventions. Partnering with government bodies and initiatives also allows CSISA to influence key agricultural policies and extension messages, such as the state-recommended wheat planting time in Bihar, which was shifted two weeks earlier in 2013 in response to CSISA's encouragement. CSISA also partners with state agriculture universities, KVKs, NGOs, self-help groups, and CBOs as needed to improve the reach of CSISA technologies. In terms of training, CSISA focuses not just on training extension agents, but state officers, managers and staff of private sector companies, officials from national agricultural banks, agro-dealers and distributors, and women's groups. Finally, CSISA focuses on facilitating entrepreneurship, building up a cadre of service providers in all CSISA districts so that they can act as "change agents" and "scaling agents" within their farming communities.

## G. Major New Initiatives for Next Year

### *Objective 1*

For Objective 1 in India, Year 2 of CSISA Phase II is focused on scaling up of key technologies. It is expected that Early wheat sowing, zero till wheat, efficient weed management and new varieties in wheat will have major gains and that the support of the Department of Agriculture will be ensured. Direct-seeded rice, machine transplanted non-puddled rice, community nurseries, hybrid rice, stress tolerant rice, and efficient weed management will be scaled up. The number of service providers for machine transplanted non-puddled rice, zero till, post-harvest, and laser land leveling will increase substantially. CSISA will focus on promoting the intercropping of vegetables in maize, area expansion of Kharif maize, and better bet agronomy for maize, and bed planting in Rabi maize and wheat. Additional initiatives include increasing the collaboration with Digital Green as an extension methodology; further developing Nutrient Manager for rice, wheat, and maize; capacity building among local service providers and dealers and distributors will increase; and focus will increase on developing small-scale entrepreneurship opportunities for women.

### *Objective 2*

The below outline lists activities to be undertaken under Objective 2 during the 2013-14 Kharif and Rabi seasons in CSISA's hubs in India:

#### BIHAR AND EASTERN UP

- Development of crop manager/nutrient manager for rice-wheat systems of EUP and Bihar, a decision support tool for crop and site-specific nutrient management (Kharif 2013)
- Evaluation of different crop establishment methods in rice-wheat cropping system for yield maximization and resource use(Kharif 2013)
- Response of nitrogen and timing of application on grain yield of dry drill-seeded rice(Kharif 2013)
- Short-term changes in soil quality parameters and weed flora in cereal based cropping systems under conservation agriculture (Rabi 2013-14)
- Optimizing intensive cereal-based cropping system for yield maximization and resource use efficiency(Rabi 2013-14)
- Comparing Rabi maize productivity, resource use and economics under raised bed vis-à-vis zero-till flat system in Bihar(Rabi 2013-14)
- Evaluating mustard (*Brassica juncea*) cultivars of different maturity class for yield maximization and their effects on succeeding spring maize productivity(Rabi 2013-14)
- Evaluating wheat germplasm for early planting(Rabi 2013-14)
- Developing adaptive strategies against terminal heat stress in wheat(Rabi 2013-14)

#### ODISHA

- Maize hybrid maturity class and opportunities for cropping systems intensification in rainfed plateau ecologies(Kharif 2013)
- How much can we intensify maize productivity based on single and layered interventions? (aka 'decomposing yield gaps')(Kharif 2013)

- Development of crop manager/nutrient manager, a decision support tool for crop and site-specific nutrient management in rice and maize in Odisha(Kharif 2013)
- Evaluating rice cultivars for water stress conditions under different establishment methods(Rabi 2013-14)
- Optimizing irrigated rice based cropping system of Odisha by diversification/intensification for maximization of system yield and resource use efficiency(Rabi 2013-14)
- Optimizing weed management in dry drill seeded rice under Odisha conditions(Rabi 2013-14)
- Increase irrigation water use efficiency by reducing the conveyance losses and precise irrigation scheduling in irrigated rice of Odisha(Rabi 2013-14)
- How much can we intensify wheat productivity based on single and layered interventions in plateau ecologies? (aka 'decomposing yield gaps')?(Rabi 2013-14)

### HARYANA

- Improved irrigation systems for rice-wheat and maize-wheat systems for better irrigation and energy efficiencies. (Kharif 2013)
- Greenhouse gas emission measurement in conventional and CA-based cereal systems(Kharif 2013)
- Evaluating performance of maize hybrids on raised-bed and conventional flatbed during Kharif season.(Kharif 2013)
- Evaluating cultivars (hybrids and inbreds) performance under DSR(Kharif 2013)
- Screening new herbicide molecules for troublesome weeds of DSR and for post-emergence weed control in maize(Kharif 2013)
- Exploring the scope and implications of diversifying rice-wheat systems in a reclaimed salt affected soils of Northwest India(Rabi 2013-14)
- Screening new herbicide molecules for troublesome weeds of DSR and for post-emergence weed control in maize(Rabi 2013-14)
- Influence of planting dates and tillage and residue management on weeds, soil moisture, terminal heat stress, and crop productivity and profitability(Rabi 2013-14)

### TAMIL NADU

- Improved water use efficiency for the Cauvery Delta (Thalandi 2013-14)
- Early N dynamics under novel crop establishment methods (Thalandi 2013-14)
- Volunteer rice/weedy rice management using state seedbed technique (Thalandi 2013-14)

### NEPAL

- GxE and baby trials for lentil, maize, and rice will continue, influenced by the lessons learned in Year 1 (e.g., inclusion of bed-planted lentil in trials across the Terai and in river valleys).

- Collaborations with GoN and private sector on machinery and viable irrigation options will increase, with more demonstrations and trainings, and also facilitation of importer and dealer presence at national and regional events.

- CSISA-NP PhD Fellows from NARC and DoA will begin working on the project.

### *Objective 3: Rice breeding*

- Evaluation of at least 60 elite lines in multi-location trials and more than 300 new breeding lines in observational yield trials.
- Conduct physiological trait-based selection on diverse germplasm and elite lines for high yield potential (HYP) using high-throughput phenotyping platform. Design SNP assays and genotype for cloned yield-related genes/QTLs and initiate a breeding program for HYP. Identified primers will be used for trait-marker association analysis as well asfor tracking yield genes in the advanced breeding population to select breeding lines with high yield potential.
- Single plant selections for desirable plant types suitable for transplanted condition will be carried out in 22 F2,12 BC1F2 and 15 BC2 F2 populations
- Promising selections from F3,F4, F5 and BC1F3,BC1F4 and BC2F3 and BC2 F4 will be advanced to next generations
- In collaboration with NARES partners ,the work on straw quality will be intensified. The work on developing mapping populations for straw quality will be initiated.
- Population improvement program for enhancing genetic gain through recurrent selection will be intensified.
- Effectiveness of genomic selection for yield related traits will be studied and400 diverse group of entries will be phenol-typed for yield and yield related traits at3 locations in India.
- Genotyping work in the two mapping populations for early stage seedling vigor will be continued and advancement of generation to develop NILs and BILS will be taken up.
- Off-season nursery facility for advancement of breeding material will be provided to North Indian centers. RGA facility for quick development of fixed lines will be established.
- Multi-location evaluation of hybrids, varieties and new breeding lines under machine sown dry direct seeded conditions in India, Nepal and Bangladesh will be continued. More than 100 entries including hybrids will be evaluated at least 7-8 locations.
- More than 350 new breeding lines will be evaluated in observational yield trial.
- Single plant selections for desirable plant types suitable for dry DSR will be carried out in 50 F2,14 BC1F2 and 10 BC2 F2 populations
- Promising selections from F3,F4, F5 and BC1F3,BC1F4 and BC2F3 and BC2 F4 will be advanced to next generations
- The selected plant will be selfed to screen $F_3$ populations in the field by pedigree method at IRRI during 2013-2014 DS. Due to they all contain homo alleles of the two QTLs, no more segregations of target QTLs are expected. General morphology and agronomic performance will be evaluated. The $F_4$ seeds from the selected $F_3$ plants will be screened in low P and/or AG conditions.Swarna-Sub1-Pup1 $F_1$ and Swarna-Sub1-AG1 $F_1$ plants will be genotyped to select right crossing plants and will be backcrossed to develop $BC_1$ $F_1$
- Screening germplasm for deeper seed burial under flooding during germination, and development of QTL mapping population once donors are identified.

- NILs ofqHTSF4.1 ($BC_5F_2$) in IR64 background will be evaluated under temperature-controlled conditions and field conditions.
- Continue validating and fine mapping of qHTSF1.1, identifying candidate genes for qHTSF4.1 and reconfirm their impact towards reducing heat induced spikelet sterility and advancing MAGIC lines.
- Identify additional donors for early morning flowering and new mapping populations will be developed for high night temperature tolerance
- Quantify the respiratory losses due to high night temperature under field conditions
- More than 400 new breeding lines will be phenol-typed for reproductive stage heat tolerance at 3 locations in India and an array of new breeding lines will be developed.

### *Objective 4: Wheat breeding*

- Planting of trials and nurseries of the best advanced lines with best local checks
- Data collection, evaluation and characterization of new wheat lines for grain yield and other traits under diverse environments and varieties
- Identification of suitable lines for national, state and stations trials for release
- Advancement of segregating populations at various breeding sites after completing the selection
- Identification of spot blotch resistant varieties
- Analysis of spot blotch resistance in four RIL populations
- Dissemination of seed of outstanding lines to Hubs
- Analysis of physiological trait data collected across CSISA sites; writing of paper underway on 17SAWYT grown 2009/10 and 2010/11.

### *Objective 5: Policy research*

- Work will begin on the study of DT rice and weather index insurance in Bangladesh, including experimental design and protocol work.
- Work will begin on a study using field experiments to determine heterogeneity in learning heuristics.This study will provide valuable information regarding the different ways in which individuals process information from past experiences and use this information to modify expectations regarding, e.g., the benefits of a new technology, weather, etc.

### *Objective 6: Management*

- Finish staffing up our M&E team by placing an M&E Specialist at the Odisha hub
- Develop a system for more easily generating our indicator numbers as needed
- Standardize data collection forms as much as is practical and helpful
- Bring together the M&E teams of CSISA-Phase II, CSISA-BD, and CSISA-MI to learn from each other's M&E systems and communications tools
- Launch the new CSISA web site and implement a system for regularly generating new content
- Launch the CSISA Research Note to disseminate CSISA research findings to a wide audience
- Launch the revamped CSISA Bulletin and dispatch on a monthly basis

- Launch or deepen our collaborations with Oak Ridge National Labs and AgTrials
- Deepen cross-project integration, management, and alignment with national partners through strategic meetings at the hub, national, and regional levels

## Annex A: Success Stories

### CSISA helps mainstream climate-resilient management practices

Sowing wheat in late November or early December has been the normal practice in Bihar. However, sowing wheat this late makes the crop more vulnerable to late-season terminal heat stress, when temperatures rise above 35 C and crop productivity declines. After 3 years of extensive work, CSISA has demonstrated that the early sowing of wheat leads to an increase in wheat yield by avoiding terminal heat stress, and that a zero-till seed drills can facilitate early sowing. During 2012-13, CSISA collaborated in wheat planning workshops with District Agriculture Officers, providing machinery demonstrations and showing videos on the advantages of early wheat sowing and zero tillage. In Kishanwada Village, when an unprecedented 7.3 tons/ha grain yield of wheat was achieved by early sowing of wheat in 2012-13 season, the District Agriculture Officers were convinced. On-farm field trials in Bihar and eastern Uttar Pradesh conclusively demonstrate that wheat yield potential declines by more than 50% with late planting.

CSISA worked with the Bihar Department of Agriculture (DoA), Bihar Agriculture Management Education and Training Institute, District Agriculture Officers, and KrishiVigyanKendras (KVKs) to promote early sowing prior to the 2013 Rabi season. The Bihar DoA has now taken up the charge and is promoting early wheat sowing across Bihar through newspaper advertisements, and campaign workshops at district and block levels. The state previous guidance to sow wheat after November 15 has now changed to early wheat sowing before November 15 in 2013-14 (see photo). The shift in the focus towards early wheat sowing will give an unprecedented push in the wheat productivity in the times to come, and help protect this important crop against the effects of climate change.

## Farmers adopt mechanical transplanting of rice in Bihar

Tribhuvan Singh normally faces acute farm labor shortages during the rice-planting season, a scenario that he has avoided this year by adopting mechanical transplanting of rice. “This technology allowed me to transplant seedlings immediately after irrigating the field in an un-puddled condition, and thus helped me to save irrigation and fuel costs. The yield has also been exceptionally good.” Looking at Tribhuvan’s success, other farmers in his Rampur village near Patna are also convinced and enthusiastic about adopting this new technology.

CSISA has persuaded many farmers to adopt machine-transplanted non-puddled rice (MTNPR) as well as trained service providers to enter into the business. In Bihar, the cost of energy, labor and inputs has increased significantly in recent years. According to Dr. R.K. Malik, CSISA’s Objective 1 leader in India, mechanical transplanting of rice has a number of advantages, “labor resources are saved and there are savings on water. This also ensures higher productivity as compared to traditional methods. The elimination of puddling also leads to improved soil health, which is particularly important for winter-season crops like wheat.”

Farmers from Hasanpur village in Samastipur district have also observed good yields and savings in labor after switching to mechanical transplanting. Ranjit Singh from Hasanpur said, “the technology has resulted in higher yields than traditional methods of paddy cultivation”.

Newly transplanted rice seedlings: a mechanical transplanter in operation

Dr. Malik is optimistic that this technology will be successful in Bihar and eastern Uttar Pradesh. “Farmers of this region are often left with 50-days-old seedlings due to non-availability of farm labor during peak planting season,” Malik says, alluding to the fact that planting such seedlings guarantee that farmers will realize very low crop yields. “Machine transplanting will help address this issue while saving costs as compared to manual transplanting methods,” he said, estimating that the savings would be anywhere between 30 and 40%.

CSISA is working to educate farmers and service providers how to raise mat-type nurseries, field preparation for transplanting in un-puddled conditions, and weed management. “For harnessing the potential of this technology, we adopted the approach of community nurseries (photo), transplanted young seedlings, and shared our demonstrations and videos with District Agricultural officers (DAOs) and Bihar Agriculture Management Education and Training Institute. The Training Institute circulated these videos at the district level in the local language.” With a thrust on improving rice productivity and the use of mechanization, Bihar Department of Agriculture has now mainstreamed mechanized rice intensification as a regular part of their technical program.

*Satyadev Prasad in his machine transplanted paddy field*

Entrepreneurs such as Satyadev Prasad of Ratanpur Birta village in Bihar are taking note. This year he purchased a rice transplanter with the support from the schemes of the State Department of Agriculture in the form of subsidy on the purchase of agricultural machinery. With guidance and training from the CSISA team, he raised a mat-type nursery for paddy and used the transplanter on his own field and hired it to the neighboring farmers, thus making his venture profitable in its first season. He planted paddy on about 80 acres for 31 farmers. “On seeing the success of my business model, other farmers are also in the process of purchasing paddy transplanters,” he exclaimed.

Due to efforts of CSISA, the mechanized rice transplanting this year has increased to 360 acres in East Champaran district. Currently there are nine rice transplanters in East Champaran compared to two last year.

**Women's self-help groups raise income and ensure food security through maize cultivation in Odisha**

Badbil Rengalsahi is a typical remote village in the Mayurbhanj district of Odisha, with 85% tribal population. Maize cultivation is common in these parts, but yields are typically very low – less than 1.5 t/ hectares. They usually grow local varieties of maize in their backyards for household consumption and what little surplus is produced is sold as green cob in the local market. Yields are poor because of low quality seeds, traditional methods of sowing and lack of information on nutrient and weed management.

However, one case in Badbil village has been an exception this year. Women members of the *Johar Jaher Ayo* self-help group are reaping profits from a good maize harvest. Consisting of 11 members, the group decided to collectively grow maize on a 2-hectare plot of previously abandoned land after learning about new technologies and improved seeds from the CSISA team and the state agriculture officers. They bought the hybrid maize seeds (Pioneer-3501) and fertilizers from Large Sized Multipurpose Cooperative Society, Government of Odisha, and ploughed the field with tractors using their corpus fund. CSISA provided the group with the seed and fertilizer drill for precisely maintaining optimum plant population by sowing the seed in lines, and trained the members in better-bet agronomy practices. With an initial investment of 6,700 rupees, they have already earned 5,200 rupees by selling 8.6 quintals of green cob at six rupees per kg. They are expecting that they will earn more Rs 25,000-30,000 by selling dry grain from crop yields that are expected to surpass those achieved with traditional practices by a factor of four – even without irrigation. Kuni Murmu, President of this SHG, said, "sowing seed and fertilizer together in seed drill reduced the work burden of women as sowing and fertilizer application behind the country plough is the main activity of women". The women were also able to feed nutritious food to their children and family members during the 'lean' season from August to October before rice is harvest and stores from the previous year are depleted. Members also were able to distribute green cob to their neighbors besides satisfying their own household level need.

Three more women's SHGs in Matiagarh village of Mayurbhanj have also successfully adopted collective maize cultivation. Group members are poor and belong to scheduled caste (Dalit) community. With CSISA's encouragement, they took a fallow 8-hectare plot on lease from the village landlord to grow maize. They did line sowing using a fertilizer and seed drill provided by CSISA. To bring awareness about balanced fertilization and the existing nutrient status of soil, site-specific nutrient management (SSNM) trials were also planted in their fields by the CSISA team. Babirani Sethi from *Swarnalaxmi* SHG said, "line sowing with the seed-cum-fertilizer drill not only reduced our sowing cost, but also it was possible to cover more area in a short period and it was easy to do intercultural operation with less labor". Maize cake is their common breakfast and snacks for the family. With a good crop, these 24 women were able to feed maize cake to their children. During the green cob stage, *Dhabaleswari* SHG earned 16,000 rupees and *Swarnlaxmi* earned 3,000 rupees by selling green cob. Strong profits are also expected from the sale of dry grain.

**Direct Seeded Rice is a boon to rainfed farming in Odisha**

Kudarshai village in Mayurbhanj, one of the tribal dominated districts of Odisha state, is witnessing a change. At a time when erratic rainfall and poor agronomic practices are limiting rice productivity in this region, innovative farmers of Kudarshai are adopting new technologies to improve yield. Kaushalya Mohanta is one such farmer. She looks after the family farm while her husband manages a grocery shop and rents out a VST power tiller. Her family owns one hectare of land and she faces difficulty to cultivate it due to labor shortage during the peak season.

Kaushalya showed keen interest during the village-level orientation on direct seeded rice (DSR) by the CSISA team. She volunteered to demonstrate the new technology in her field along with two other women farmers. She established DSR on a 0.2 ha plot with a seed and fertilizer drill provided by CSISA, using their power tiller. Appropriate weed control measures were taken. During the long dry spells that periodically disrupt cropping in the dominantly rainfed systems of Mayurbhanj (including a full month without rain in 2013), the DSR crop withstood drought better than the traditionally broadcasted fields. The broadcasted fields turned yellow and were full of weeds. Kaushalya is glad that she adopted DSR using the seed drill method as it does not require manual ploughing, requires less seed (one third of the broadcasting method) and less labor. She said, “I had not harvested single crop from this field for last three years due to drought, I am very happy that this year I will reap a good harvest from this field”.

After seeing the good crop in her field, many farmers of her village as well as adjacent villages are now interested in adopting DSR. She wants to continue DSR with seed drill in all her rice fields next year and has been advising her neighbors to adopt this technology for next year as well.

**CSISA campaign aligns policies and entrepreneurship to benefit farmers in Haryana and Punjab**

Thanks to the integrated efforts of the Haryana State Department of Agriculture, enterprising farmers of Punjab and Haryana, and the CSISA team, direct seeded rice (DSR) is gaining popularity in northern India. Faced with the threats of depleting groundwater, shortage of farm labor, rising production costs and climate variability, more and more farmers are adopting this alternative method of sowing rice. It promises to be both environmentally friendly and cost-efficient.

Compared to the more widely used method where seeds are first established in a nursery and then manually transplanted to the fields, DSR involves sowing seeds directly in the fields with the help of a machine called a Multi Crop Planter. With technical backstopping from CSISA, India's Ministry of Agriculture has been promoting this technique through its two flagship programs, the National Food Security Mission and RashtriyaKrishiVikasYojna (RKVY).

DSR brings many benefits to farmers – it reduces cultivation costs by 5,100 rupees (78 USD) per hectare (ha), reduces irrigation water consumption by 25% and increases profitability up to 4,600 rupees (70 USD)/ha. "Moreover, when wheat is grown after a crop of DSR, wheat productivity has increased 8 to 10% more than when grown after a crop of conventional cultivated rice," said CSISA's Virender Kumar.

The State Agriculture Department, Haryana Agricultural University and the Farmer's Commission are now promoting the use of DSR in Haryana because of its benefits. Four years ago, only 226 ha of land were under DSR in Haryana. This has increased to 8,000 ha in 2012 and DSR is targeted to cover 20,000 ha in 2013. However, access to effective weed management and cost-effective herbicides still remain a challenge.

As with any new technology, building awareness, training and responding to farmers' concerns are integral to making DSR successful. CSISA launched a campaign in May to encourage farmers to adopt DSR in Haryana. The campaign included technical trainings on DSR for farmers and service providers, meetings with different stakeholders to identify and solve the problems of availability of inputs such as machinery and seed, and the use of radio and other mass media programs to build awareness and generate demand for service providers.

The campaign reached farmers at the field and village level for their direct feedback and to understand their problems. "Synergy between different public and private stakeholders, feedback from farmers and getting technical inputs to the farmers at the right time are necessary after a series of intensive trainings to make a transformation like direct seeded rice technology a success," stated CSISA's B.R. Kamboj.In collaboration with IFC-Dunar Foods Limited and the Haryana State Department of Agriculture, CSISA

organized a travelling seminar on 14 August to different villages of the Asandh block of the Karnal District to gain first-hand experience of farmer perceptions of DSR and what technical areas deserve further research.

**Farmers in western Nepal excited about new spring maize varieties by CSISA-Nepal**

Farmers in the mid and far-western Terai region of Nepal typically grow maize in their kitchen gardens, leaving most of their fields fallow. Production levels are low, mostly due to poor agronomic practices and low-yielding crop varieties. This year, farmers who participated in CSISA-Nepal spring maize trials more than doubled their production.

Farmers were initially skeptical about growing maize in the dry spring period, with one farmer's wife berating him for sowing maize on land she thought they should grow a fodder crop on. By about 2 months after planting, she was delightedly admitting being wrong, and showing visitors their maize field, with both the farmer's variety and a hybrid, both under farmer management and recommended nutrient and establishment practices.

All hybrids tested yielded at least 2 t/ha higher than the farmer's open pollinated variety (OPV), Arun-2, which also yielded over 1 t/ha more with improved management than under typical farmer management.

Yields of the Rajkumar hybrid that farmers voiced early preference for were often doubled, at over 10 t/ha with just 3 irrigations. Hybrid yields under farmer management were comparable to or better than the farmer's OPV yields under best practices. Several farmers want to expand spring maize area next year and plant the Rajkumar hybrid by line-sowing as introduced by CSISA-NP rather than the traditional practice of broadcasting. They said that although initial time for line-sowing might be high, applying irrigation and weeding were cheaper and easier in the line-sown plots.

Feed industry representatives invited to visit the plots were also pleased with the hybrid maize, and told farmers that they could guarantee the purchase of these farmers' hybrid maize at the same rates as they currently pay Indian producers if they could increase production, as currently purchase over 200 t of maize annually from India at NPR 24/kg to meet demand.

*Typical farmer spring maize in far-west: water-stressed, and poorly managed*

## Annex B: Results Framework

# CSISA PHASE II: RESULTS FRAMEWORK – KEY MILESTONES

| Key Milestones | | Period One | | Progress Narrative – October 2013 |
|---|---|---|---|---|
| | | *October 2012* | *May 2013* | |
| | **Baseline** *(if relevant and available)* | **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 to transition hubs while continuing to ensure impact of CSISA investments is developed and initiated. | | Transitions to other aligned projects completed in Nepal and Pakistan. Exit strategies defined for Haryana, Tamil Nadu, and Punjab. |

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| 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. | | In consultation with core partners, primary impact pathways defined and prioritized for action in order to accelerate the outscaling of key CSISA-supported technologies. | Impact logic mainstreamed into activities planning at twice-annual evaluation and planning meeting held at the country level in Bangladesh and India (started in Bangladesh in 2011). Concepts and implementation mainstreamed with the India hubs in January 2013. |
| **Sub-objective 1.2. Participatory technology testing and adaptation for sustainable intensification** | | | |
| 1.2.1.1. Crop 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. | Targets exceeded in priority hubs in Bihar, EUP, Odisha, and Bangladesh. Many assess labor-saving interventions that are particularly germain to women farmers. Most have been implemented with partner organizations, including KVKs, OUAT, DoA in the new CSISA hub in Odisha. |

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| 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. | Targets exceeded in priority hubs in Bihar, EUP, Odisha, and Bangladesh for crop production demonstrations and verfication trials. New partner (dairy) organisations in Odisha mobilize animal feed development groups through existing milk supplier networks. |
| | | 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 levelling, options for integrated weed management, and site-specific nutrient management. |
| 1.2.4.1. Strategies to overcome principal gender-differentiated causes of postharvest cereal losses in each hub domain. | | Gender-differentiated extent and prime causes of postharvest losses determined with men and women in at least four hubs. | PRA and key informant interviews completed in Bangladesh, Bihar, and Odisha to characterize PH losses and key intervention points. |
| 1.2.5.1. Strategies to overcome biophysical, socioeconomic, and policy-related constraints to farmer adoption of key production, livestock feed, and | | Constraints to the acceptance of key technologies documented in at least four hubs, and strategies | Adoption studies completed for ZT wheat, directly sown rice, maize intercropping, and laser land levelling. PRA and |

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| postharvest technologies. | | to overcome these identified. | key informant interviews completed in Bangladesh, Bihar, and Odisha to identify key entry points and potential bottlenecks for crop production, post-harvest, and livestock innovations. |
| **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. | | Requirements and interest of men and women farmers for real-time and site-specific information on agronomic best practices assessed within the context of technical feasibility along with ex-ante and ex-post evaluations. | User testing of the Crop Manager tool for rice in Bangladesh conducted in kharif 2013, and will be extended in the boro seaon. Field testing in India initiated in rabi 2013-14 with beta version release of rice-wheat tool. |
| | | Nutrient management software validated for different crops, cropping systems, and regions (Web and mobile-phone applications), and Crop Manager application designed based on user requirements. | V.1.0 rice and maize tools released in Bangladesh; rice tool released in Tamil Nadu. Beta testing of rice-wheat tool in Bihar and EUP ongoing for rabi 2013-14 season. |

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| 1.3.2.1. Strengthened and diversified dissemination pathways for agricultural knowledge and technologies using traditional approaches and ICTs. | | At least 6000 farmers and partners exposed to new technologies through community-based demonstrations, trainings, and at least 10 cross-hub exposure visits. | Targets exceeded in India alone with 9,401 famers receiving short-term training, including 2,131 women. |
| | | Instructional videos developed and deployed to more than 250 villages; uptake following exposure to videos assessed. | 332 village reached in Bangladesh alone for 'Save More, Grow More' video, with an ex post assessment of efficacy and how to layer communication and training approaches recently completed. Videos distributed through intermediaries in Bihar, EUP, and Tamil Nadu have reached hundreds more. |

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| | | User assessment performed, and CKB design/content plan refined based on assessment; at least 10 new entries incorporated, and at least 10 hub staff and partners in each hub introduced to/updated on CKB. | CSISA calendar for 2013 produced and distributed. Reprints of other useful material being ordered. Knowledge mapping exercises for Odisha initiated and completed for one district in Odisha. Partnership mapping exercises for content development and dissemination completed for Odisha, planned for Bihar. Pilot for video content production with Digital Green initiated in Odisha, ongoing in Bihar. 2 video produced in Bihar, 5 planned for Bihar and 10 for Odisha |
| 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. | | Released or near-release rice, wheat, and maize lines/ hybrids with superior 'dual purpose' traits identified, characterized, and matched to prioritized production ecologies. | Progressing as planned. |
| | | At least 30 promising rice lines/hybrids in multi-location replicated yield trials evaluated for straw fodder traits. | Progressing as planned. |

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| | | Promising heat and disease-resistant maize cultivars tested in hub domains with partners, including breeders from national programs. | | Progressing as planned. |
| 1.3.5.1. Business models targeting men and women entrepreneurs for sustaining change through private enterprise and investment. | | Gender-based and other constraints to the initiation of agricultural businesses evaluated, and at least 5 business models developed or strengthened that incorporate technologies recommended by CSISA. | | Progressing as planned with service provider business models assessed for ZT, mechanical transplanting, axial flow pumps, reapers, and threshers. New businesses for small tools (e.g. fertilizer spreaders, hand seeders) under assessment. |
| **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. | | Technical Working Groups (TWGs), Advisory + Investment Committees constituted; meetings held in each hub. | TWG, Advis. & Invest. Cmte meetings held in each hub to revise workplans in light of learning and new partnership opportunities. | Advisory and Investment Meetings held in Bihar, Odisha, and Bangladesh. TWG concept has been revisited, and constituted as on-going interactions with specific partners for specific technical themes rather than a general standing committee. |

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| | | At least 5 major partnerships established or strengthened each year in the priority hubs with support from the TWG/Advis. & Invest. Cmte. | Targets exceeded with a strong mix of public (e.g. JEEViKA, State Departments in India), private (e.g. RFL in Bangladesh), and NGO (e.g. Digital Green in Odisha) partners. Crucially, we are also catalyzing partnerships among our core partners. |
| **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. | | 'Training of trainers' (ToT) course for senior and junior CSISA hub staff and selected partners, including social and gender issues developed and conducted. | Initial focus has been on increasing the technical competencies of new staff. ToT has been reframed as a second-order priority. |
| | | 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 event is planned for Bihar in December 2013. |

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| | | Training course with modules covering at least 5 animal husbandry topics prepared and conducted for staff and partners at prioritized hubs. | Efforts to harmonise and document current training activities are on-going. Links between farmer groups and existing training institutions (e.g. NDRI) are being developed. |
| | | Demand-driven trainings developed and 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 750 service providers trained in Bihar and EUP alone. BDS aspects in the process of being strengthened. |
| | | Dealer training programs and certification examinations designed, agronomy extension leadership program piloted in two hubs, and program requirements and business plan developed. | Dealer training program launched in Bihar and EUP. Decision on certification still pending partner feedback. Extension agent training program initated in Bihar and EUP, with over 1,300 extension personnel trained in India in 2013. |
| 1.5.3.1. Next generation of cereal systems scientists and development professionals, especially women, strengthened. | | | Student recruitment on-going. |

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| | | Training modules developed and short-term advanced courses conducted for hub staff (including animal husbandry) and at least 75 young male and female scientists. | Training modules develop for DSR, seeder maintenance, mat nursuries, and the fundamentals of site-specific nutrient management . |
| | | At least 30 interns (30% female) placed in CSISA hubs and partner institutions. | 15 interns were place in 2013, including three females. Additional recruitment is ongoing with an emphasis on attracting more women candidates. |
| **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 established, strengthened, or continued with new and on-going experiments that address key opportunities to optimize sustainability and profitability based on feedback from farmers and hub-based socioeconomics and biophysical scientists. | New and on-going experiments conducted in Bihar, Bangladesh, and Haryana. Platform activities in TN continued through March 2013. |

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| | | In collaboration with NARES partners, identify and communicate constraints associated with CA-based systems and develop hypotheses to inform process-based research trials that will lead toward system refinements. | New experiments devised in Haryana, Bihar, Tamil Nadu, and Bangladesh on topics such as managing secondary salinization with CA and precision water management under crop diversification scenarios. |
| 2.2.1. Models for assessing cropping system performance under different agro-ecological conditions and climate-change scenarios. | | Evaluate and improve modeling tools such as APSIM, DSSAT, ORYZA 2000, and DNDC | CSISA has joined the AgMIP (model intercomparison and improvement) initiative and is working with the APSIM, DSSAT, and TOA-D development teams to assess and improve simulation performance at locations across the IGP. |
| 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 Objective 2 meeting held in October 2012 and September 2013. Integrated planning with Objective 1 conducted in Haryana, Bihar/EUP, and Bangladesh twice annually. |
| **Objective 3. High-yielding, heat- and water-stress-tolerant rice varieties for current and future cereal and mixed crop-livestock systems.** | | | |

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| 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 through public- and private-sector breeding network, dissemination of superior dual-purpose breeding lines and hybrids facilitated through breeding networks, farmers, and fodder traders. | Fifty breeding lines were evaluated in multilocation trials conducted during the wet season 2012. Six promising lines along with 60 new breeding lines will be evaluated in MET during Kharif season 2013. |
| 3.2.1. Rice for mechanized direct seeding and water-saving irrigation practices developed and released. | | At least 25 new lines/hybrids in different maturity groups tested under mechanized DSR and CA at 4-6 locations; at least 10 new hybrids/breeding lines entered in national varietal testing programs. | Ninety entries involving breeding lines and hybrids were evaluated in MET conducted during wet season 2012.Nine promising entries were identified for second year of testing in 2013. |
| 3.3.1. At least two heat-tolerant rice varieties nominated for national varietal testing. | | Reliable field phenotyping facilities and protocols established in CSISA hubs; | Established field phenotyping facilities and protocols for heat tolerance/avoidance in CSISA hubs across hot-dry (Hyderabad and Ludhiana in India) and hot-humid (Tamil Nadu in India and Joydebpur in Bangladesh) regions |
| **Objective 4. High-yielding, heat- and water-stress tolerant, and disease-resistant wheat varieties for current and future cereal and mixed crop-livestock systems.** | | | |

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| 4.1.1. Improved early, medium, and normal-maturing bread wheat varieties for heat- and water-stressed environments. | | 30 lines each of early, medium, and normal-maturing HYP wheat that is heat, drought, and disease-tolerant tested; at least 200 segregating breeding populations selected; new crosses made at CIMMYT and by NARES; 5 best lines evaluated in multilocation yield trials. | Achieved as planned, including 64 different bread wheat nurseries planted across South Asia in 2012-13. |
| 4.2.1. Spot blotch-resistant wheat germplasm and molecular markers for resistance to the disease. | | Resistance to spot blotch characterized through annual screening in Mexico and hot-spots in South Asia; capacity of spot blotch screening in Mexico and hot spots of S. Asia enhanced. | Around 1000 genotypes planted at Agua Fria (Mexico) for evaluation. In addition, around 2000 lines are being evaluated by collaborators in India. |
| 4.3.1. Improved heat and drought tolerance in wheat. | | Physiological and environmental limitations to yield established; conceptual models for heat- and drought-adaptive traits refined to increase yield potential; phenotyping manual developed and trainings conducted for hub staff and partners. | Progress as planned. |
| **Objective 5. Improved policies and institutions for inclusive agricultural growth** | | | |

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| 5.1.1. Improved policies and incentives that encourage private investment and public-private partnerships in pro-poor technology development and delivery. | | Concrete strategies developed to: a) achieve the policy changes required for improved delivery of seeds and other inputs b) unite public and private partners in delivery of CSISA technologies, including specification of appropriate incentives for market segmentation and implementable agreements for Public/Private Partnerships. | Strategies under development, in publication, and under discussion; continuing communications efforts planned to bring public and private partners together. |
| 5.2.1. Improved policies and incentives that address changing labor, gender, assets, and migration dynamics related to pro-poor technology development and delivery. | | Study methodology developed to assess gender-differentiated access to and control of key assets, the role of women in agricultural technology adoption decisions, and the role of rural employment schemes on adoption of resource-conserving technologies. | Efforts still ongoing: Specific study objectives and methodologies under development. |
| **Objective 6. Project management, data management, communication, evaluation, and decision support.** | | | |
| **Sub-objective 6.1. Project management** | | | |

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| 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. | Country-based 'MT' and project-wide 'EC' meetings conducted as planned. Regional forum deferred while country-specific consultations with NARES partners are prioritized. |
| **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 for data collection optimized and data training held, agronomy module designed for Integrated Breeding Platform (IBP), AgTrials, DataVerse customized, Surveybe, OpenDataKit operational, Google Fusion implemented for analysis, visualization, mapping. Minimum meta-data requirements implemented by 12/2012 by CSISA-funded partners. | Data standardization protocols completed; good progress on developing and deployingelectronic mobile data collection platforms in ODK and Surveybe; data portals with strong meta-data standards and open public access supported and utilized. |
| 6.2.1.2 Key CSISA datasets made widely available through public access data repositories. | | Regionally and globally important datasets from Phase I of CSISA (i.e. strategic research, socioeconomic studies, and multi-location screening trials) are made publically available in well-documented formats. | Data from experimental platforms uploaded into AgTrials. CSISA HH survey baseline data released on IFPRI's dataverse instance during Q2 2013. |

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| 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. | | CSISA Wiki/group communication platform created; project personnel and hub staff trained to add project documents and materials; CSISA Web site created, tested, refined, and frequently updated. | Beta launch of new website in Q3 2013. Internal communications platform established and functional. |
| **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. | | Implement M&E system, collect and upload disaggregated (by hub, gender) data for outputs that are tied to intermediate outcomes | New inference techniques devised and implemented to assess progress towards intermediate outcomes for Rabi 2012-13. Techniques have been customized and matched to different project interventions. |

## Annex C: USAID Indicators

| Current Selection | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| Reporting Organization : USAID | | | | | | | | | |
| Indicator / Disaggregation | 2013 Deviation Narrative | 2013 Comment | Baseline Year | Baseline Value | 2013 | | | 2014 | 2015 |
| | | | | | Target | | Actual | Target | Target |
| | | | | | PPR | Updated | | | |
| 4.5.2(2): Number of hectares under improved technologies or management practices as a result of USG assistance | | | | | | | | | |
| Technology type | See below | See below | | | 30,000 | | 66,682 | 120,000 | 250,000 |
| crop genetics | | | | | | | 896 | | |
| pest management | | | | | | | | | |
| disease management | | | | | | | | | |
| soil-related | | | | | | | 64 | | |
| irrigation | | | | | | | 22,534 | | |
| water management | | | | | | | 784 | | |
| post-harvest handling and storage | | | | | | | | | |
| processing | | | | | | | | | |
| climate mitigation or adaptation | | | | | | | 7,780 | | |
| other | | | | | | | 34,624 | | |
| total w/one or more improved technology | | | | | | | | | |
| Disaggregates Not Available | | | | | | | | | |
| New/Continuing | | | | | 30,000 | | 66,682 | | |

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| New | | | | | | | 35,368 | 63,320 | 148,000 |
| Continuing | | | | | | | 31,314 | 56,680 | 102,000 |
| Disaggregates Not Available | | | | | | | | | |
| Sex | | | | | 30,000 | | 66,682 | | |
| Male | | | | | | | 21,152 | 36,000 | 75,000 |
| Female | | | | | | | 711 | 6,000 | 12,500 |
| Association-applied | | | | | | | 42 | | |
| Disaggregates Not Available | | | | | | | 44,777 | 78,000 | 162,500 |

**Deviation Narrative:**

CSISA significantly exceeded its hectarage targets in FY13 by embracing its catalytic role with the public and private sector. For the former, strategic partnerships in Haryana and Bihar have accelerated the adoption of resource-conserving technologies such as laser land levelling and zero-till wheat. For the latter, strategic partnerships in Bihar and EUP have greatly expanded market access to efficient and effective weed control methods as well as facilitated the adoption of hybrid maize as a diversification option in stress-prone rice ecologies.

**Notes:**

This is an Objective 1 indicator and includes data from Bihar, Eastern UP, Odisha, Tamil Nadu, Haryana, and ILRI's cross-cutting work.

| Current Selection | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| Reporting Organization : USAID | | | | | | | | | |
| Indicator / Disaggregation | 2013 Deviation Narrative | 2013 Comment | Baseline Year | Baseline Value | 2013 | | | 2014 | 2015 |
| | | | | | Target | | Actual | Target | Target |
| | | | | | PPR | Updated | | | |
| 4.5.2(5): Number of farmers and others who have applied new technologies or management practices as a result of USG assistance | | | | | | | | | |
| New/Continuing | See below | See below | | | 19,800 | | 285,574 | 500,000 | 1,000,000 |
| New | | | | | | | 99,457 | | |
| Continuing | | | | | | | 186,117 | | |
| Disaggregates Not Available | | | | | | | | | |
| Sex | | | | | 19,800 | | 285,574 | | |
| Male | | | | | 15,804 | | 14,254 | | |
| Female | | | | | 1,756 | | 568 | | |
| Association applied | | | | | | | 5 | | |
| Disaggregates Not Available | | | | | | | 270,747 | | |

**Deviation Narrative:**

CSISA significantly exceeded its hectarage targets in FY13 by embracing its catalytic role with the public and private sector. For the former, strategic partnerships in Haryana and Bihar have accelerated the adoption of resource-conserving technologies such as laser land levelling and zero-till wheat. For the latter, strategic partnerships in Bihar and EUP have greatly expanded market access to efficient and effective weed control methods as well as facilitated the adoption of hybrid maize as a diversification option in stress-prone rice ecologies.

**Notes:**
This is an Objective 1 indicator and includes data from Bihar, Eastern UP, Odisha, Tamil Nadu, Haryana, and ILRI's cross-cutting work.

| Current Selection | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| Reporting Organization : USAID | | | | | | | | | |
| Indicator / Disaggregation | 2013 Deviation Narrative | 2013 Comment | Baseline Year | Baseline Value | 2013 | | | 2014 | 2015 |
| | | | | | Target | | Actual | Target | Target |
| | | | | | PPR | Updated | | | |
| 4.5.2(7): Number of individuals who have received USG supported short-term agricultural sector productivity or food security training | | | | | | | | | |
| Type of individual | See below | See below | | | 20,000 | | 12,126 | 15,000 | 15,000 |
| Producers | | | | | 7,079 | | 9,401 | | |
| People in government | | | | | 2,360 | | 1,372 | | |
| People in private sector firms | | | | | | | 243 | | |
| People in civil society | | | | | | | 911 | | |
| Disaggregates Not Available | | | | | | | 199 | | |
| Sex | | | | | 20,000 | | 12,126 | | |
| Male | | | | | 8,449 | | 9,995 | 11,250 | 11,250 |
| Female | | | | | 990 | | 2,131 | 3,750 | 3,750 |
| Disaggregates Not Available | | | | | | | | | |

**Deviation Narrative:**
CSISA has fully embraced its role in training intermediaries, who in turn reach large numbers of farmers, which is reflected in our impact indicators. We will continue to prioritize training of intermediaries, and have revised our FY14 and FY15 training numbers downward accordingly. Training lead farmers remains a priority, but is not our primary mechanism for reaching CSISA's goals.

**Note:**

This is an Objective 1 indicator and includes data from Bihar, Eastern UP, Odisha, TN, Haryana.+ ILRI.

| Current Selection | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| Reporting Organization : USAID | | | | | | | | | |
| Indicator / Disaggregation | 2013 Deviation Narrative | 2013 Comment | Baseline Year | Baseline Value | 2013 | | | 2014 | 2015 |
| | | | | | Target | | Actual | Target | Target |
| | | | | | PPR | Updated | | | |
| 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 | | | | | | | | | |
| Type of organization | See below | | | | 20 | | 919 | 1,200 | 1,500 |
| Government organization | | | | | | | 30 | | |
| Private enterprises (for profit) | | | | | 2 | | 820 | | |
| Producers organizations | | | | | 2 | | 6 | | |
| Water users associations | | | | | 2 | | 0 | | |
| Women's groups | | | | | | | 35 | | |
| Trade and business associations | | | | | 2 | | 4 | | |
| Community-based organizations (CBOs) | | | | | 2 | | 24 | | |
| Disaggregates Not Available | | | | | | | 0 | | |
| New/Continuing | | | | | | | 919 | | |
| New | | | | | | | 607 | | |
| Continuing | | | | | | | 312 | | |

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| Disaggregates Not Available | | | | | | | 0 | | |

**Narrative:**
This is an Objective 1 indicator and includes data from Bihar, Eastern UP, Odisha, Tamil Nadu, and ILRI's cross-cutting work. The number of private enterprises is high because we assist many sole entrepreneurs (such as service providers) in the prioritized ecologies of Bihar and EUP. We have revised our FY14 and FY15 targets accordingly.

| Current Selection | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| Reporting Organization : USAID | | | | | | | | | | |
| Indicator / Disaggregation | 2013 Deviation Narrative | 2013 Comment | Baseline Year | Baseline Value | 2013 | | | 2014 | 2015 | 2016 |
| | | | | | Target | | Actual | Target | Target | Target |
| | | | | | PPR | Updated | | | | |
| 4.5.2(12): Number of public-private partnerships formed as a result of FTF assistance | See below | | | | 6 | | 29 | 6 | 6 | |
| Agricultural production | | | | | | | 17 | | | |
| Agricultural post harvest transformation | | | | | | | 1 | | | |
| Nutrition | | | | | | | | | | |
| Multi-focus | | | | | | | 11 | | | |
| Other | | | | | | | | | | |
| Disaggregates Not Available | | | | | | | | | | |

**Deviation Narrative:**
CSISA formed more PPPs than expected this year.

**Note:**
This is an Objective 1 indicator and includes data from Bihar, Eastern UP, Odisha, Haryana, and Tamil Nadu.

| Current Selection | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| Reporting Organization : USAID | | | | | | | | | |
| Indicator / Disaggregation | 2013 Deviation Narrative | 2013 Comment | Baseline Year | Baseline Value | 2013 | | | 2014 | 2015 |
| | | | | | Target | | Actual | Target | Target |
| | | | | | PPR | Updated | | | |
| 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) | | | | | | | | | |
| Sector | | | | | | | 10 | | |
| Inputs | | | | | | | 7 | | |
| Outputs | | | | | | | | | |
| Macroeconomic | | | | | | | | | |
| Agriculture sector-wide | | | | | | | 2 | | |
| Research, extension, information, and other public service | | | | | | | | | |
| Food security / vulnerable | | | | | | | | | |
| Climate change adaptation or natural resource management | | | | | | | 1 | | |
| Disaggregates not available | | | | | | | | | |
| Stages of Development | | | | | | | 10 | | |
| Stage 1 of 5 | More policies were analyzed than anticipated. | | | | 3 | | 7 | 3 | 3 |
| Stage 2 of 5 | | | | | 1 | | 1 | 1 | 1 |
| Stage 3 of 5 | | | | | 1 | | 1 | 1 | 1 |
| Stage 4 of 5 | | | | | 1 | | 1 | 1 | 1 |
| Stage 5 of 5 | | | | | 1 | | 0 | 1 | 1 |
| Disaggregates Not Available | | | | | | | 0 | | |

**Note:**
This is an Objective 5 indicator. Data are provided by IFPRI.

| Current Selection | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| Reporting Organization : USAID | | | | | | | | | |
| Indicator / Disaggregation | 2013 Deviation Narrative | 2013 Comment | Baseline Year | Baseline Value | 2013 | | | 2014 | 2015 |
| | | | | | Target | | Actual | Target | Target |
| | | | | | PPR | Updated | | | |
| 4.5.2(39): Number of new technologies or management practices in one of the following phases of development: (Phase I/II/III) | See below | | | | | | | | |
| Phase 1 Number of new technologies or management practices under research as a result of USG assistance | | | | | 13 | | 47 | 35 | 30 |
| Phase 2 Number of new technologies or management practices under field testing as a result of USG assistance | | | | | 25 | | 80 | 87 | 94 |
| Phase 3 Number of new technologies or management practices made available for transfer as a result of USG assistance | | | | | 26 | | 55 | 60 | 65 |
| Disaggregates Not Available | | | | | | | | | |

**Deviation Narrative:**

The way that technologies are counted has changed in the FTF system, which has resulted in more technologies being in all of the phases of development. We have revised our FY14 and FY15 targets accordingly.

**Note:**

This indicator includes combined data from Objectives 1 and 2, and from the breeding Objectives 3 and 4.

**4.8.2 (26) Number of stakeholders with increased capacity to adapt to the impacts of climate variability and change as a result of USG assistance**

| Current Selection | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| Reporting Organization : USAID | | | | | | | | | |
| Indicator / Disaggregation | 2013 Deviation Narrative | 2013 Comment | Baseline Year | Baseline Value | 2013 | | | 2014 | 2015 |
| | | | | | Target | | Actual | Target | Target |
| | | | | | PPR | Updated | | | |
| 4.8.2 (26) Number of stakeholders with increased capacity to adapt to the impacts of climate variability and change as a result of USG assistance | See below | | | | | | | | |
| Implementing risk-reducing practices or actions to improve resilience to climate change (such as water-saving strategies to deal with increasing water stress and adjusting farming practices like soil management, crop choice, or seeds, to better cope with climate stress) | | | | | 15,000 | | 172,017 | 300,000 | 600,000 |
| Using climate information in decision making | | | | | | | | | |

**Deviation Narrative:**
Most of CSISA's prioritized technologies lead to increased adaptive capacity. Given our success in scaling various technologies, our numbers for this indicator have risen accordingly. We have therefore revised our FY14 and FY15 targets.

**Note:**
This is an Objective 1 indicator and includes data from Bihar, Eastern UP, Odisha, Tamil Nadu and Haryana. Number of beneficiaries is calculated based on the average landholding in the areas where our technologies were implemented.

## Annex D: Environmental Monitoring and Management Plan

This Environmental Monitoring and Management Plan (EMMP) is submitted for the USAID India – CSISA Grant BFS-G-1100002. It was developed in conjunction with the Performance Monitoring Plan and is briefly updated herein for the purposes of the annual report. This EMMP provides a framework within which CSISA will address environmental mitigation and monitoring as the project evolves over time.

This EMMP builds upon the Initial Environmental Examination (IEE) and Environmental Threshold Decision (ETD), and defines in practical terms how CSISA will implement the conditions of the IEE in order to mitigate and monitor environmental impacts. Given the structure and content of the IEE, it is worth noting the following impacts on the development of this EMMP:

- CSISA was included in the IEE approval process which was approved on September 15, 2012.
- The IEE/ETD included both (i) Categorical Exclusion (CE) and (ii) Negative Determination with Conditions (NDw/C), the "conditions" were not tied to broader "activities." As a result, the development of the EMMP first analyzed all CSISA activities to determine which should be subject to a CE or an NDw/C. In keeping with USAID guidance on the development of EMMPs, only those activities assessed to receive an NDw/C were included in the subsequent EMMP tables.

Section 1.0 of this EMMP provides an overview of the CSISA, including the environmental compliance-related contractual requirements, and defines environmental mitigation and monitoring.

Section 2.0 presents the general roles and responsibilities of CSISA staff for ensuring environmental compliance.

Section 3.0 presents all the project activities and the determinations assumed in the development of this EMMP.

Sections 4.0 describes the potential environmental impacts and define mitigation measures and monitoring requirements.

Future updates of the EMMP will be conducted concurrently with the Annual Work Plans and PMPs. This coordination will ensure that environmental mitigation and monitoring are actively considered and integrated as the direction of CSISA evolves and specific activities begin to take shape.

The EMMP provides a framework for monitoring environmental impact regardless of the final selection of sites and definition of concrete activities, however based on identified activities, key commodities and approach. Therefore, this document covers a broad description of project components, tasks, activities and deliverables or outputs and the environmental risks contained within. The general premises and tools contained within the EMMP apply across all potential pilot activities.

**Environmental Compliance:** The structure and content of this EMMP are based on the requirements stipulated in the CSISA grant**,** corresponding USAID regulations, and the Initial Environmental Examination (IEE)/ Environmental Threshold Decision (ETD). The IEE/ETD defined certain activities as "a negative determination with conditions (NDw/C)" and therefore triggers the requirement for this EMMP. In addition, Quarterly and Annual Performance Reports will include a section dealing with Environmental Compliance that provides details on indicators, mitigation efficacy, and unintended environmental consequences of activities. The key implementing partners participating in these activities must also comply with host country environmental regulations unless otherwise directed in writing by USAID.

**Environmental Monitoring AND MANAGEMENT Plan:** The goals and processes for environmental mitigation and monitoring have been clearly defined by USAID. This document, including all definitions, builds directly upon USAID's most up-to-date guidance on the development and implementation of EMMPs.[3]

Environmental mitigation, defined as *the implementation of measures designed to reduce the undesirable effects of a proposed action on the environment*, is central to the environmental compliance process, and is essential to achieving environmentally sound activity design and implementation.

Mitigation can reduce impacts in three ways:

1. Prevention and control measures,[4]which fully or partially prevent an impact/reduce a risk by:
   - Changing means or technique;
   - Changing the site; or
   - Specifying operating practices;
2. Compensatory measures, which offset adverse impacts in one area with improvements elsewhere; and
3. Remediation measures, which repair or restore the environment after damage is done.
   Prevention of impacts by changes to activity design, site, or technique is the most reliable approach to mitigation.

Environmental monitoring is defined as:

- *The systematic measurement of key environmental indicators over time, within a particular geographic area*; and
- *The systematic evaluation of the implementation of mitigation measures*.

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[3] Recent guidance documents include: "Environmental Procedures Training Manual,""Introduction to Environmental Mitigation and Monitoring Plans," and"Environmental Guidelines for Small-Scale Activities in Asia."

[4] Prevention of impacts by changes to activity design, site, or technique is the most reliable approach to mitigation; as such, this EMMP gives preference to prevention and control measures.

Environmental monitoring is a necessary complement to mitigation, and should be a normal part of monitoring project results. This EMMP defines environmental mitigation and monitoring for the CSISA, and builds directly on the IEE dated September 15, 2010.

In terms of mitigation, this plan defines

- What and Why:
  - What are the significant impacts that need to be mitigated?
  - For each significant impact, what are the proposed mitigation measures?
- Who:
  - Who carries out mitigation measures? Who manages or verifies?
- When:
  - At what stage in the project cycle is each measure implemented?
  - Is there adaptive mitigation?

In terms of monitoring, this plan defines

- What:
  - What are the indicators?
- Why:
  - Why each indicator—what is the purpose of each indicator?
- When and How:
  - When and how will indicators be measured? How will the information be analyzed?
- Who:
  - Who monitors? Who analyzes? Who reports? Who receives the information?

Mitigation and monitoring are a critical part of environmentally sound design and implementation. Mitigation minimizes adverse environmental impacts. Monitoring assesses whether the mitigation measures are sufficient and effective.

To be effective, mitigation and monitoring must be:

- **Realistic**: Mitigation and monitoring must be achievable within time, resources, and capabilities.
- **Targeted:** Mitigation measures and indicators must correspond to impacts.
- **Funded:** Funding for mitigation and monitoring must be adequate over the life of the activity.
- **Considered Early:** Preventive mitigation is usually cheapest and most effective form of mitigation, but prevention must be built in at the design stage.

## Roles and Responsibilities

CSISA proposes the following personnel to meet USAID environmental compliance requirements:

1. Chief of Party (CoP) : Dr. Andrew McDonald (Project Leader)
2. Senior Technical Advisor (STA/M) : Dr. Virender Kumar (Objective 2 Leader)
3. Operations Manager (OpM) : Dr. RK Malik (Objective 1 Leader)
4. Project Partners : The project partners will comprised of farmers, research institutions, agribusiness companies, civil sector NGOs, community based organizations brought together as a Technical Working Group (TWG). This would be complemented through independent Advisory and

Investment Committees (AIC). Activities implemented through CSISA will include EMMP tasks and reporting in their scopes of work.

## SUMMARY ENVIRONMENTAL REVIEW OF CSISA ACTIVITIES

**Table 1: Proposed Partnership in Agriculture and Food Security (PAFS) and Recommended Threshold Decisions by Components (Source: IEE September 15, 2010)**

| Project No. | Activities | Effect on Natural/ Physical Environment | Threshold Decision and Reg.216 actions required |
|---|---|---|---|
| 1 | All activities that don't have an effect on the natural or physical environment. This includes education, technical assistance, consultations, participant training, document transfer, as well as information dissemination, analysis, studies, research & workshops, and training programs except to the extent such programs include activities directly affecting the environment (such as construction of facilities, assistance in use of crop protection products etc.)<br>Specifically, this might include:<br>-identification of local partners, education and research institutions;<br>- performing partnerships, needs assessments training & action plans;<br>- Working with training programs & educational institutions on their curricula;<br>- improvement in business regulatory environment, facilitating access to consulting and extension services;<br>- development and implementation of their course materials;<br>- developing information networking, grants to associates and others to support policy work and networking. | No effect | **Categorical Exclusion: no action required** |
| 2. | All activities in which no potentially significant adverse effect are expected. No special mitigation measure is needed; | | **Negative Determination with conditions** |

| Project No. | Activities | Effect on Natural/ Physical Environment | Threshold Decision and Reg.216 actions required |
|---|---|---|---|
| | activities are implemented with conditions.<br><br>a) Identification of communities with activities with potentially significant adverse effects on environment (all Activities). | Insignificant effect | a. The activity can go forward after the implementer develops selection criteria including environmental compliance criteria to be reviewed and approved by the MEO in consultation with the REA. |
| | b) Facilitate farmers' access to finance (Activities 3, 5, 6 &9) | Insignificant effect | b. The implementer is required to review the adequacy of the environmental capabilities of the partnering financial institutions to be involved. Implementer will ensure that appropriate environmental standards are developed (e.g. Environmental Review Manual) and followed by the partner institutions in the use of USAID-supported funding. |
| | c) Procurement of electronic and electromagnetic electro-magnetic equipment, commodities and materials (under all activities) | Insignificant effect | c) The implementer will ensure that all equipment, commodities, and materials are procured from certified retailers; environmental safety and quality certificates conforming with national and/ or international standards are available; equipment and materials are used in an environmentally sound and safe manner; are properly disposed of; when applicable, at the end of their useful life in a manner consistent with best practices |

| Project No. | Activities | Effect on Natural/ Physical Environment | Threshold Decision and Reg.216 actions required |
|---|---|---|---|
| | | | according to Indian standards or, in their absence, USG, European Union or equivalent standards. |
| 3. | a) All project activities and procurement of services and commodities that normally don't have a significant effect on the environment, such as, for example:<br>• Small scale agricultural production, natural resource including water management projects;<br>• Small-scale irrigation and drainage system rehabilitation;<br>• Creation of small agro-processing enterprises;<br>• Greenhouse construction;<br>• Vaccination of cattle, veterinary services;<br>• Set-up of instructional farm or demonstration plots;<br>• Assistance to laboratories (might include certification, or standardization);<br>• Small-scale rehabilitation/ construction;<br>• Procurement of equipment and machinery, technologies, materials, services that may have a potential for hazardous environmental impact;<br>• Conducting works at a site with a historic, archaeological, cultural, or social importance, or with a unique habitat or natural resources; and | Potential for a significant adverse effect of one or more activities | a) Environmental Due Diligence (EDD) review is required to identify environmental effects; Develop Environmental Mitigation and Monitoring Plans, confirm/ do not confirm a potentially significant adverse effect. If confirmed, a Scoping Statement (SS) and Environmental Assessment (EA) will be done by the implementer prior to start of the activities.<br><br>Terms of Reference (TOR) for the Scoping statement and EA Report will be reviewed by MEO and approved by Asia BEO. For reference please see section "Implementer procedures". |
| | b) Crop protection trainings as part of trainings for agricultural producers, and related value chain actors in agribusiness<br><br>• Agricultural inputs procurement and use (seeds, fertilizer, pesticides); | Potential for a significant adverse effect of one or more activities | **b) Negative Determination with a condition** that a Pesticide evaluation report and Safe Use Action Plan (PERSUAP) is prepared by BEO approved PERSUAP professional and is approved by BE Asia. |

**Recommended Action:**

(IEE Sep 15, 2010) **Categorical Exclusion**: Pursuant to 22 CFR 216.2(c) (3). The originator of the activities has determined that "core" program activities under all PAFS program's component (Section 1 of Table 1) which include technical assistance, participant training, information dissemination and other similar types of environmentally neutral actions consist of types of interventions entirely within the categories listed in 216.2(c) (2) and are therefore recommended to be categorically excluded by falling under the following classes of action:

a. Education, technical assistance, training program, except to the extent such programs include activities directly affecting the environment {22 CFR 216.2(c) (2)(i)};

b. Analysis, studies, academic or research workshops and meetings {22 CFR 216.2(c) (2)(iii)};

c. Document and information transfer {22 CFR 216.2(c) (v)};

d. Studies, projects or programs intended to develop the capability of recipient countries and their institutions to engage in developmental planning, except to the extent designed to result in activities directly effecting the environment {22 CFR 216.2 (c )(2)(xiv)}.

**Negative Determination with Conditions**: For activities involving grants, when following normal good practices, engineering methods and standard instructions will help avoid potential environmental problems (Section 2 of Table 1). This includes facilitating access to finance, procurement of computers and other electric and electronic equipment, commodities and materials. The proposed action is that the Implementer should provide evidence that equipment and materials are procured from certified retailers; environmental safety and quality certificates conforming to national and/or international standards are available; equipment and materials are used in environmentally sound and safe manner consistent with best management practices according to the standards of the Government of India or, in their absence, those of the USG, the European Union or equivalent standards.

**Negative Determination with Conditions**: For activities that have a potential for an adverse impact on the natural or physical environment. The originator of the action has determined that pursuant to 22 CFR 216.2(d)(2), such activities as small scale construction activities, rehabilitation of irrigation and drainage network, introduction of improved agri-business practices as listed in Components 2,4 & 5 (ref. Section 3 of Table 1) may have potential for significant adverse environmental impacts. For each type of these activities the Implementer will conduct an Environmental Due Diligence (EDD) review to document existing environmental concerns and foreseeable environmental effects resulting from the activity and develop an Environmental Manual (EM) and Framework Environmental Mitigation and Monitoring Plan (FEMMP). The EM and FEMMP will be approved by the MEO, in consultation with the Asia Regional Environmental Advisor (REA) and will be adapted to a specific site before the activity is implemented. If EDD results in a finding that significant adverse effect is confirmed, a Scoping Statement (SS) and Environmental Assessment (EA) will be done by the implementer prior to the start of the activities.

Terms of Reference (TOR) for SS and EA report must be reviewed by the MEO and approved by the Asia BEO.

**Revisions:**

Pursuant to 22 CFR 216.3(a)(9), if new information becomes available which indicates that activities to be funded by the PAFS might be "major" and the their effect "significant," these determinations will be reviewed and revised by the originator of the project and submitted to the BEO/Asia for approval and, if appropriate, an environmental assessment will be prepared.

**Potential Environmental Impacts/Issues & Mitigation Responses:** CSISA was designed to work at the confluence of research and development – promoting adoption and scale up of research outputs through partners across underserved geographies in close collaboration with partners with outreach capabilities to address development requirement of poor farming households.Like all development activities, CSISA has the potential to result in adverse environmental impacts. In this section of the EMMP we describe the potential negative environmental impacts associated with each activity, identify other issues that warrant special attention in the design and implementation of the activity, and discuss mitigation measures.

| CSISA Technology | Addressing production challenges | Potential environmental impacts | Scale and severity | Proposed mitigation |
|---|---|---|---|---|
| Machine transplanted rice into non-puddled soil | Soil physical degradation and high irrigation requirements with puddling.<br>Labor bottlenecks at planting<br>Uneven plant establishment and spacing. | Higher fuel consumption with mechanical transplanting counter balanced by eliminating fuel consumption for soil puddling. | N/A | N/A |
| Directly-sown rice | Drudgery of transplanting<br>Non-availability oflabor<br>Delayed onset of inundating rains | Higher weed infestations may prompt more herbicide use, which brings concerns for worker safety and the evolution of herbicide-resistant weeds. USAID/India funds will not be used to procure herbicides. | Local to regional<br>Small | CSISA will ensure that proper handling, safe molecules, and integrated pest management strategies are utilized in all project-supported |

| CSISA Technology | Addressing production challenges | Potential environmental impacts | Scale and severity | Proposed mitigation |
|---|---|---|---|---|
| | | | | trainings and demonstrations. These messages will also be shared more broadly through the state extension systems and through agro-dealer networks. |
| Use of herbicide mixtures for weed control integrated with cultural techniques such as stale beds | Labor shortages and MNREGA limiting the efficacy and frequency of manual weed control<br>Complex weed flora,<br>MNREGA affecting manual weeding,<br>herbicide mixtures, Spray techniques | Accelerating labor problems may increase demand for herbicides. | Local to regional<br>Small | See above. IPM approaches will ensure that over-reliance on herbicides is avoided.<br><br>CSISA will ensure that USAID/India funds are not used to procure/purchase herbicides. |
| Rice hybrids | Yield potential of conventional varieties has not markedly increased since the 1970s.<br><br>Agronomic nitrogen use efficiency can be higher with hybrids, which is particularly important in regions of eastern India where fertilizer use is low. | None | N/A | N/A |

| CSISA Technology | Addressing production challenges | Potential environmental impacts | Scale and severity | Proposed mitigation |
|---|---|---|---|---|
| Timely sowing | Late planting in December cause a reduction in wheat yield potential by approximately 50% due to terminal heat and reduced growing season duration. | None | N/A | N/A |
| Zero tillage | Facilitates earlier planting.<br>Reduces P. minor weed infestations<br>Increase water productivity and can arrest / reverse soil quality decline. | None – preponderance of evidence suggests net ecosystem benefits with ZT with respect to GHGs, water quality, erosions, energy intensity, etc. | N/A | N/A |
| Long duration and high yielding varieties | Replacement of current varieties (e.g. UP 262, PBW 154, PBW 373, PBW 343) with varieties like HD 2824, HD 2733, PBW 502, and DBW 17 | None | N/A | N/A |
| Integrated weed management for wheat and maize | Complex weed flora,<br>MNREGA has affected labor availability,<br>Faulty methods of herbicide application are prevalent | Higher weed infestations may prompt more herbicide use, which brings concerns for worker safety and the evolution of herbicide-resistant weeds. | Local to regional<br>Small | CSISA will ensure that proper handling, safe molecules, and integrated pest management strategies are utilized in all project-supported trainings and demonstrations. These messages will also be shared more broadly through the state |

| CSISA Technology | Addressing production challenges | Potential environmental impacts | Scale and severity | Proposed mitigation |
|---|---|---|---|---|
| | | | | extension systems and through agro-dealer networks.<br><br>CSISA will ensure that USAID/India funds are not used to procure/purchase herbicides. |
| Better-bet irrigation | Farmers don't understand the value of post-anthesis irrigation and it is not typically given. Yield reductions are common, especially in years when the risk of terminal heat is high. | Groundwater decline in areas where abstraction is high. | Local to regional<br>Small | CSISA will promote precision irrigation scheduling and efficient conveyance methods that will improve crop performance without markedly increasing the volume of irrigation water used for crop production. |
| Zero tillage lentil | Late draining Tal areas of Bihar do not permit full-season cereal crop or conventional ploughing | None | N/A | N/A |

| CSISA Technology | Addressing production challenges | Potential environmental impacts | Scale and severity | Proposed mitigation |
|---|---|---|---|---|
| Laser land leveling | Uneven field require more irrigation water and often have lower yields with lower fertilizer use efficiencies. | None – initial energy investments leveling are more than compensated by subsequent saving from gains in irrigation efficiency and more productive use of fertilizers | N/A | N/A |
| Intensification through triple cropping and inter-cropping | Little room for area expansion<br>Triple and intercropping can maximize resources capture and economic returns per unit area | None – positive ecosystem benefits expected due to less pressure placed in marginal lands such as hill slopes. | N/A | N/A |
| Bed planting | Gravity irrigation without beds can be both inefficient (ca. 25% more water requirement to reach the farthest point of the field) and reduce crop growth from excess water in low spots, especially on heavier textured soils. | None | N/A | N/A |

## Summary

CSISA commits itself to ensuring that the vast majority of project activities will have a positive or neutral impact on environmental quality; due vigilance and caution will be exercised to ensure that any negative aspects are nominal and appropriately mitigated.

## Annex E: Publications and important links

### *Objective 1 papers*

U. Schulthess, J. Timsina, J.M. Herrera, A. McDonald, Mapping field-scale yield gaps for maize: An example from Bangladesh, Field Crops Research, Volume 143, 1 March 2013, Pages 151-156, ISSN 0378-4290, http://dx.doi.org/10.1016/j.fcr.2012.11.004.

Tek B. Sapkota, Kaushik Majumdar, M.L. Jat, A. Kumar, Dalip K. Bishnoi, A.J. McDonald, Mirasol Pampolino, Precision nutrient management in conservation agriculture based wheat production of Northwest India: Profitability, nutrient use efficiency and environmental footprint, Field Crops Research, Volume 155, January 2014, Pages 233-244, ISSN 0378-4290, http://dx.doi.org/10.1016/j.fcr.2013.09.001.

### *Links from Objective 1: Presentations from Mechanization workshop in Bangladesh*

Rural Mechanization: Status and Issues in Bangladesh, M. A. SattarMandalhttp://dl.dropbox.com/u/101834755/BanglaMechWS_PPT/RuralMechanization_StatusIssuesBangladesh_SattarMandal.pdf

The Status of Agricultural Machinery Manufacturing in Bangladesh, Md. MonjurulAlamhttp://dl.dropbox.com/u/101834755/BanglaMechWS_PPT/Agri-machineryBangladesh-Monjurul%20Alam.pdf

The Status of Farm Mechanization in West Bengal, Dr. VK Tiwarihttp://dl.dropbox.com/u/101834755/BanglaMechWS_PPT/Farm%20MechanizationWestBengal_VKTiwari.pdf

Gender Dimensions of Labour Supply, Employment Dynamics of Wage Labour and Out Migration: Implications for Farm Mechanization, WMH Jaimhttp://dl.dropbox.com/u/101834755/BanglaMechWS_PPT/GenderWageLaborEmploymentOutmigrationDynamicsinFarmlMechanization_Jaim.pdf

Farm Mechanization in Bangladesh: Evidence from IFPRI National Household Survey,Akhter Ahmed http://dl.dropbox.com/u/101834755/BanglaMechWS_PPT/IFPRISurveysEvidenceofMEchanizationininBangladeshAkhterAhmed.pdf

Nature and Impact of Agricultural Mechanization in Bangladesh: Insights from Farm Level Surveys Mahabub Hossain, Mahfuz Rahman, Sudhir. C. Nath, AlamgirChowdhuryhttp://dl.dropbox.com/u/101834755/BanglaMechWS_PPT/NatureImpactMechanizationinBangladeshocalLevelSurveys_MahabubHossain_RahmanNathChowdhury.pdf

Review of Research and Extension in Farm Power Issues Project*: Findings and Impacts* Professor Dr. R.I.Sarker Gerard

Hendriksenhttp://dl.dropbox.com/u/101834755/BanglaMechWS_PPT/ResearchExtensionFarmPowerIssues_SarkerHendriksen.pdf

Productivity and Efficiency of Rice Milling System in Bangladesh M. Asaduzzamanhttp://dl.dropbox.com/u/101834755/BanglaMechWS_PPT/Rice%20Milling_Presentation_Asaduzzaman.pdf

Solar Energy in Rural Mechanization, NazmunNaharhttp://dl.dropbox.com/u/101834755/BanglaMechWS_PPT/Rural%20Mechanization%20by%20Solar%20PV%20Nazmun%20Nahar.pdf

Rural Mechanization in Nepal: Technological Options and Policy Issues,D. Gauchanhttp://dl.dropbox.com/u/101834755/BanglaMechWS_PPT/Rural-Mechanization-NepalDGauchan.pdf

Commercialization of Selected Agriculture Machineries – Study Findings, R. Pradhanhttp://dl.dropbox.com/u/101834755/BanglaMechWS_PPT/Study_CommercializationofSelectAgriMachineryMarketSurveyPradan_et_al.pdf

Rural Mechanization: A history of the spread of smaller scale technology in some Asian countries, S. Biggs and S. Justice http://dl.dropbox.com/u/101834755/BanglaMechWS_PPT/HistorySpreadofMechanizationinSomeAsianCountries_BiggsJustice.pdf

### *Publications emerging from Objective 2: Publishing CSISA Phase I strategic research results*

Tirol-Padre A, M. Rai, M.K. Gathala, S. Sharma, V. Kumar, P.C. Sharma, D.K. Sharma, R. Wassmann, J.K. Ladha. 2013. Assessing the performance of the photo-acoustic infrared gas monitor for measuring $CO_2$, $N_2O$ and $CH_4$ fluxes in two major cereal rotations. Global Change Biology. doi: 10.1111/gcb.12347

Gathala, M.K., V. Kumar, P.C. Sharma, Y.S. Saharawat, H.S. Jat, M. Singh, A. Kumar, M.L. Jat, E. Humphreys, D.K. Sharma, S. Sharma, J.K. Ladha. 2013. Optimizing intensive cereal-based cropping systems addressing current and future drivers of agricultural change in the northwestern Indo-Gangetic Plains of India. Agriculture, Ecosystems and Environment 177: 85-97.

Kumar, V., Samar Singh, R.S. Chhokar, R.K. Malik, D.C. Brainard, and J.K. Ladha. 2013. Weed management strategies to reduce herbicide use in zero-till rice-wheat cropping systems of the Indo-Gangetic Plains. Weed Technology 27: 241-254.

Singh K., V. Kumar, Y.S. Saharawat, M.K. Gathala, J.K. Ladha, B.S. Chauhan. 2013. Weedy Rice: An Emerging Threat for Direct-seeded Rice Production Systems in India. Journal of Rice Research 1:106. doi: 10.4172/jrr.1000106

Alam, M. M., Md. R. Karim, J.K. Ladha. 2013. Integrating best management practices for rice with farmers' crop management techniques: A potential option for minimizing rice yield gap. Field Crops Research 144: 62-68.

## *Objective 4 publications*

Chand R., O.P. Yadav, B. M. Bashyal, L.C. Prasad and A. K. Joshi (2013) Technique for the maintenance of heterokayotic isolates of *Bipolarissorokiniana* under ordinary conditions. Indian Phytopath. 66 (1) : 61-65

Kumari M, R.N. Pudake, V.P. Singh, and Arun K. Joshi (2012) Association of staygreen trait with canopy temperature depression and yield traits under terminal heat stress in wheat *(Triticumaestivum* L.). Euphytica(DOI 10.1007/s10681-012-0780-3)

M. Eisa, R. Chand, A.K. Joshi(2013) Biochemical and histochemical factors associated with slow blighting to spot blotch in wheat. Lithuanian journal of agriculture (In press)

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## *Objective 5 publications*

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