EXTERNAL SUPPLEMENTARY REVIEW OF PROJECT CSE/2011/077

SUSTAINABLE AND RESILIENT FARMING SYSTEMS INTENSIFICATION (SRFSI)

ACIAR

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1 CONDUCT OF REVIEW / METHODOLOGY

This review was conducted in February 2018. All relevant extant documentation was made available to the review team from late January onwards. The team leader (Reeves) engaged in two telephone hook-ups with Drs Dixon and Huttner of ACIAR, in early February and all members of the review team subsequently corresponded by email in the ensuing weeks. This dialogue provided an appropriate and solid foundation for the review meeting held at Jalpaiguri, West Bengal from 17 to 21 February 2018. The standard ACIAR draft TOR was also shared with project management for comment in advance of the mission. The review team commends all parties on the efficient and timely provision of reports and other documents and on the very good organisation and conduct of the review meeting at Jalpaiguri, which included an outstanding field visit to the SRFSI out-scaling node at Ghughumari, Cooch Behar, West Bengal.

A wide range of stakeholders was consulted (details attached in Appendix X). The MTR team met with nearly all of the 21 SRFSI partner coordinators; invited written observations from the partners and discussed progress, constraints and appropriate changes with the SRFSI project management team (Drs T P Tiwari and Mahesh Gathala) and with the Project Steering Committee, now chaired by Dr Raj Paroda (former DG ICAR and Secretary DARE).

Before departing Jalpaiguri, the review team met for several hours to discuss major findings and determine the standing and effectiveness of key aspects of the SRFSI project. The completion of this report was finalised remotely with each review team member substantially contributing to the final report.

2 BACKGROUND / INTRODUCTION

SRFSI is a regional four-year multi-partnership project (May 2014 – June 2018) funded by DFAT and ACIAR as part of the Sustainable Development Investment Portfolio in South Asia. The project, managed by CIMMYT, aims to reduce poverty in the Eastern Gangetic Plains (EGP: India - Bihar and West Bengal; North-West Bangladesh; and the Eastern Terai of Nepal) by improving productivity, profitability and sustainability of small farmers while safeguarding the environment. The main – but not the only – entry point of this research project is to establish the contribution of Conservation Agriculture (CA) practices to Sustainable Intensification (together referred to as CASI) in smallholder farming systems where future productivity gains will be dependent on, inter alia, water productivity and labour productivity. In SRFSI the CASI approach is interpreted broadly to include increased and sustainable agro-ecosystem management, increased input use efficiency and increased biological and economic productivity based on the CA principles of minimizing soil disturbance and ensuring soil cover and diversification through rotations – for example including improved varieties, better irrigation practices and improved crop management. The two constraints of water and labour are directly linked to energy through mechanisation (diesel), water pumping costs (electricity, solar) and water use (hydropower and irrigation): the Food-Water-Energy (FEW) nexus.

ACIAR and others have produced convincing evidence of the potential productivity benefits of CA in a wide range of environments globally over the past 2 decades; for example, in Western India, North Africa and Northern Iraq. However limited information was available for the low productivity, mostly irrigated, rice-based systems of the EGP. During the consultations leading up to the India-ACIAR Country Strategy 2011-16, the ICAR requested ACIAR to assist with the

transfer and adaptation of the experience with CA from NW India to eastern India. Furthermore the adoption at scale of proposed technologies would be driven by rapid changes in gender norms and practices, improving infrastructure, and a growing private sector in the region. Initial work from ACIAR Projects and from the Cereal Systems Initiative of South Asia (CSISA) suggested the potential of some CA methods for SI in parts of the EGP, for example: Rice-maize project CIM-2007-122 (no-till maize after T. aman rice); Development and adoption of conservation agriculture in diversified rice-based cropping in Bangladesh LWR-2010-080 (unpuddled rice transplanting, adapted machinery). These early projects showed the need for adaptive research to broaden the CA options and to ensure technical effectiveness in the diverse target areas as well as the need for socio-economic and gender research to determine the drivers of adoption, and evaluate options for a private sector-based impact pathway.

The project design included a range of pre-project activities:

- Scoping mission to Eastern India with (then) AusAID, 2011
- SDIP established, co-funding agreement (ACIAR AUD 1.6m, DFAT AUD 11 m), 2012
- DFAT South Asia - ACIAR Partnership Agreement, 2013
- Training future project partners in Innovation Platforms (IP) in Patna, 2013
- Formulation workshops, team building activities, private sector engagement, 2013-14
- Pilot field research activities, paving the way for the prompt establishment of research nodes once the project was approved, 2013-14.

The result of these activities led to the formulation of SRFSI, as one of the components of SDIP. SRFSI is positioned to: (1) understand in the EGP the Food-Water-Energy nexus at the level of the farming systems, complementing the basin and regional scale physical and socio-economic analysis delivered by the other SDIP partners; (2) design, test and validate effective and adoptable interventions in farmers' fields; (3) design, test and evaluate mechanisms to scale out those interventions with a main focus on the private sector; and (4) initiate the scale out of the most effective mechanism for each area of the project.

The research strategy comprised:

- The choice of 40 research nodes covering, at 8 locations (districts) over the 3 countries, the key agro-ecosystems and farming systems of the EGP where CASI is likely to deliver the desired outcomes.
- Partnership with a wide range of local institutions (universities, private sector, government and non-government) as implementers on the ground, to ensure from the onset buy-in, research sustainability, and direct path to impact, in each node.
- Predominantly farm-based research activities (field-based and socio-economic surveys and analysis) but associated with some research station experiments (to ensure rigorous assessment of some biophysical constraints and opportunities) and national program and policy maker engagement to identify opportunities for scaling SRFSI results through convergence with national programs.
- Linkage with other members of the SDIP program, building on their results, and contributing field-based results to their analysis of large scale physical, economic and policy constraints and drivers of sustainable development.
- Focus on gender as a key driver of the research and scaling.
- Involvement of the emerging private sector in early attempts to scale out results and successes.
- Complementing the broad technical and management skills of CIMMYT (the

organisation commissioned by ACIAR to lead the project) with specific Australian expertise as required.
- Committing about 30% of the overall budget to scale-out exploratory activities in the later part of the project, to be informed by the earlier results.

Following pre-project activities and project approval, the Inception Workshop was held in August 2014. Since the start, the project has held two review and planning meetings per year, conducted two field monitoring visits per year to each site and one meeting of the high level Steering Committee per year. As results were obtained and the opportunity arose, the project entered additional sub-agreements with new partners. SRFSI regularly invited a variety of SDIP, ACIAR and CIMMYT projects to participate in the review and planning meetings.

The project has completed 4 years of activities. Thanks to pre-project activities, field trials covering four kharif (monsoon/rice) seasons (2014; 2015; 2016; 2017) and three rabi (winter) seasons (2015-16; 2016-17; 2017-18) have been (almost) competed and the data are being assembled and analysed (more on this later). The timing of this review was strategic, as it focused on Objectives 1, 2 and 3 with particular attention to scientific, technical and research quality, as an underpinning component for the final review of the SRFSI project to be held in 2019, when all project objectives will be reviewed, particularly Objective 4 – 'Facilitate widespread adoption of sustainable, resilient and more profitable farming systems'. Whilst the current external supplementary review noted progress to date with adoption – ranging from outstanding to very moderate, according to location – the fact is that SRFSI is now entering a phase of projected exponential growth in adoption of the CASI technologies and assessment of the extent and success of this in 12 months time will be much more appropriate.

Nevertheless, one of the high priorities for the current review is to identify and analyse the 'lessons learned' for the marked differences in progress to date with the out-scaling of CASI technologies. This is a key part of its mission to identify further opportunities and needs for future research emerging from the findings to date and arising as a result of rapid and widespread adoption across different bio-physical and socio-economic environments in the coming years. A matrix and discussion around 'lessons learned' is presented in the 'Project Impacts' section of this report.

3 EXECUTIVE SUMMARY and RECOMMENDATIONS

The review team has based its comments and recommendations on the TOR for this external supplementary review, providing a detailed assessment for each of Objectives 1, 2 and 3 – and comments on linkages and ramifications for Objective 4. The major findings are presented herewith under the headings from the TOR.

Major findings

The specific details of the responses to each of the planned activities are provided in the log frames shown later in this report. A synthesis and overview of the review team's assessment and analysis of progress and achievements under each objective is provided here.

OBJECTIVE 1 - Understand farmer circumstances with respect to cropping systems, natural and economic resources base, livelihood strategies, and capacity to bear risk and undertake technological change

The project site is in the Eastern Gangetic Plain (EGP), encompassing parts of India, Bangladesh and Nepal, and is home to the greatest concentration of rural poor in the world. The project

starts with developing an in-depth understanding on where the farmers are, rather than starting with the aspirations of the researchers on what they want them to be. To the review team, this is an excellent beginning and the humility of the researchers to mix with the farmers and probe deeper on the different human conditions (physical, economical, social, psychological, political and overall cultural settings) has greatly enhanced the efficacy of the project. During the review the team could understand that there is a genuine willingness on part of the researchers to understand the adaptive capacity of the farmers, both women and men and this has created a great conducive and collaborative environment to contribute and learn from each other. The several interactions with the farmers (through community surveys and key informant interviews conducted in the summer and fall of 2012) have helped to identify the factors contributing to low adaptive capacity of the farmers as given below:

- Small size of fragmented landholding (typically < 1 ha) with variable soils
- Farmers have little access to assured irrigation, credit, quality seeds, fertilizers, or demand-driven extension services
- Reliance is to a large degree on local and informal advice and knowledge sharing mechanisms
- Relatively high uptake and good responses to profitable crops and technologies
- Prone to flood and drought

The other uniqueness of the project is a proactive approach to investigate the huge variability in terms of social structure, farm typologies, farming and cropping systems, land topography, crop yields, infrastructure, market networks, local policies and governance. Based on these findings, six farming system zones were characterized. Also this node characterization helped the researchers to understand the specific strengths and weaknesses and the problems that needed to be addressed, for each of these nodes.

There were efforts to characterise the existing water development and management institutions in these national jurisdictions and districts. These efforts resulted in the production of the document "Groundwater irrigation and machines in agriculture in Eastern Gangetic Plains: identifying constraints to the Green Revolution in Eastern India". A huge number of formal and informal socio-economic surveys were conducted using focus group discussions (FGDs), literature reviews, and farmers' and other stakeholders' interviews, etc. to select, establish and characterize various nodes, and characterize farming systems and farmers' socio-cultural settings and requirements within each district. Such characterizations helped identifying, designing, and implementing project activities. Surveys, FGDs and literature reviews were conducted to quantify and characterize the existing groundwater and surface water resources and their demands for irrigation and to identify irrigation and water management constraints for marginal and tenant farmers in the EGP. Groundwater tables and surface water depths were monitored in each node. So overall the review team believes that Objective 1 is very efficiently fulfilled.

<u>*Opportunities and needs for further research on water resources*</u>

- *During the field visit, Abdus Salem and Abdur Razzak talked about the problems of insufficient irrigation water. Further study could be done to assess household access to different government programs on irrigation and to identify the constraints. For example, in India, linkage to Government programs such as "Mahatma Gandhi National Rural Employment Guarantee Act"(MGNREGA) & West Bengal Accelerated Development of Minor Irrigation Project (WBADMIP) could be advantageous, as both are directly - the*

latter, which also has World bank funding has an irrigation focus - or indirectly, the former – which provides employment opportunities that favour water/irrigation projects

- *Further study on the ownership and management pattern of the Water Extraction Mechanism (WEM) and access to water resources and decision making processes for their distribution, may also help to reduce uncertainties around access to irrigation. This acknowledges the work already conducted by IFPRI, IWMI and others*

OBJECTIVE 2 - Develop with farmers more productive and sustainable technologies that are resilient to climate risks and profitable for smallholders

The review team is of the very strong view that with regards to Objective 2, further **analyses and modelling** of the data already gathered and well documented in the latest 'Research Synthesis Report CSE/2011/77' (February 2018) and elsewhere is of the highest priority for the project in the coming months. The modelling work to date is to be commended, as a significant portion has been conducted in-region. As a result there has been good participation and capacity building for local scientists and important calibrations and validation of APSIM have been achieved for a number of locations and these need to be completed as soon as possible. The urgent requirement now is for future projections/scenarios - c2030 - to be developed for all locations and relevant farming systems. For scientific and technical purposes, projections under the various farming systems and climate change scenarios, of crop yields and variability with related economic projections will of course be very important. However, future projections and scenarios around soil fertility trends; weed, pest and disease incidence/management; and environmental impacts are also of great technical importance. In addition, particular thought needs to be given to those additional projections/scenarios that will be critical to gain the attention, and hopefully support of high level policy and decision makers. These would include consideration of socio-economic factors such as: food and nutritional security; food availability and costs; roles and employment of women and men farmers/workers; mechanization; marketing. In addition, future projections and scenarios around key environmental impacts could also be very important for this high level cadre and could include those on – water and energy use; greenhouse gas emissions and other air pollution factors; pesticide usage; and food losses and waste management. It is recommended that a broad range of potential end-users are gathered to meet with the scientists to determine what is required and what can feasibly be delivered; such a meeting should include the use of a capable facilitator to ensure an efficient and effective interchange of ideas. This is a very important aspect of Objective 2.

SRFSI's **major technology platform** is based on Conservation Agriculture and Sustainable Intensification (CASI) principles and practices. These are well described at the global level in the FAO publication 'Save and Grow in practice: rice, maize and wheat' (2016) as follows:

"Conservation Agriculture (CA)

By minimizing soil disturbance and using surface mulch and crop rotation, maize and wheat growers are reducing costs, boosting yields and conserving natural resources. Farmers in irrigated rice systems are shifting to dry-seeding without tillage. To increase their incomes and build resilience to climate change, cereal growers are diversifying crops and integrating trees, livestock and aquaculture into their production systems.

Healthy soil

Conservation agriculture practices are improving the organic matter content and physical properties of the soil, which reduces erosion and enhances water-use efficiency. Nitrogen-fixing legumes improve soil fertility and reduce the need for mineral fertilizer. Matching crop nutrient demand and supply helps farmers to reduce fertilizer applications and harmful losses to the environment.

Improved crops and varieties

Save and Grow systems use diverse, complementary groups of crops, and their improved varieties, to achieve higher productivity and strengthen food and nutrition security. Cereal varieties that are more resistant to biotic and abiotic stresses are now grown in farmers' fields. The development of more productive and nutritious cereals needs to be matched by systems for the rapid multiplication of quality seed.

Efficient water management

To produce 'more crop per drop', many rice farmers have reduced the flooding of fields, which also lowers methane emissions. Growing rice without flooding cuts water use by up to 70percent. Supplemental irrigation of wheat, using stored rainwater, has quadrupled water productivity. Furrow-irrigated, raised-bed planting saves water and produces higher yields of wheat and maize.

Integrated pest management

The first line of defence against pests and diseases is a healthy agro-ecosystem. Rice farmers trained in IPM have greatly reduced insecticide applications – with no loss in yield. Planted together with maize, legumes help to smother weeds. Wheat growers have overcome rust epidemics with resistant varieties, and fight insect pests by rotating crops.

While each of those components contributes to sustainability, the maximum benefits will only be realized when all of them are integrated fully into Save and Grow farming systems"

(FAO 2016)

These FAO CASI practices provide an appropriate framework of contemporary global best practice to benchmark the achievements in Objective 2 ' of the SRFSI project '…to develop more resilient and sustainable technologies…' Dealing with each of the practices in the order presented above it can be seen that there has certainly been substantial progress and success in the development of CASI technologies.

Presentations made at the review workshop by collaborating partners covering all of the research nodes, clearly described successful development of the first component for CASI **- CA systems** appropriate to the local conditions, thereby providing the foundations for the adoption of these technologies by farmers in each region. In particular, the review team was able to see for itself the progress with CA technology development during the field day held at Ghughumari, where arguably the greatest gains have been made. Even there, the review team is of the opinion that much remains to be done to better adapt CA to local conditions and to meet arising issues as the technologies are scaled-out. Issues around crop establishment; uneven soil surfaces; patchy crop growth; surface residue management; weed control; and nutrient management were all evident.

Opportunities and needs for further CA research:

- *Investigate alternative seeder points to facilitate separation of seed and fertilizer applications at sowing, particularly for successful establishment of maize*
- *Investigate further options for soil surface residue management including treatment of rice stubbles – cutting, chopping, mulching - and the potential for cover cropping and green/brown manuring*
- *Increase emphasis on reduced tillage and reduced water-use systems for rice, as whilst complex the economic, social and environmental impacts from success could be very large. The successful approaches to the DSR system achieved through ACIAR's project CSE/2004/033 collab.aciar.gov.au could be readily transferred and developed in SRFSI*

The second factor recognised globally as of fundamental importance to the success of CASI practices relates to **soil health**. The review team considers that there is a major opportunity to make more progress in this crucial area of development. Some important soil constraints have already been identified by very good research to date and these include extremes of soil pH – both very low and very high – and associated toxicities/deficiencies; low organic carbon levels; trace element deficiencies including zinc, copper and boron; and soil structural problems. However, little has been done to address these soil health issues, as resources have not been available for this purpose.

Importantly, the cumulative soil health benefits recorded globally, as a result of longer-term adoption of CA practices, have yet to be demonstrated in this project and could remain unrealised until the damaging effects of soil puddling for *kharif* rice production are minimised - hence the call by the review team for increased emphasis on the new systems for rice production, such as DSR (see above).

Opportunities and needs for further soil health research:

- *Investigate use of lime and/or trace elements to address soil pH barriers to economically viable crop and forage production*
- *Investigate opportunities to enhance soil organic levels through better management of soil mulching*
- *Give greater emphasis to the development of site specific soil nutrient management particularly for rabi crops*
- *Investigate the opportunities for an increased emphasis on the production of biologically fixed nitrogen through the greater use of legumes and pulses*

The third key component of successful CASI systems is the **use of improved crops and varieties.** It is the opinion of the review team that the SRFSI project has made significant progress on this aspect with the introduction of improved wheat varieties; new maize varieties; mustard; and a number of pulses.

Opportunities and needs for further research on improved crops and varieties

- *There will be an important continuing need to evaluate new varieties of the current crops and new crop species to add to the farming systems in order to make them more diverse and more resilient to both future economic and bio-physical perturbations. Vegetables, including potatoes should be part of this diversification effort. Close collaboration and liaison with Government breeding and selection programs will be paramount to achieve this efficiently and effectively*

- *More attention should be given to the introduction of enhanced legume and pulse germplasm into the CASI systems to help diversification; add biologically fixed N – a topic where this is little experience to date in EGP; and enhance nutritional security*
- *Continuing access to improved varietal material, efficient seed production and seed systems generally will require enhanced attention and resourcing as demand increases*

The fourth component of successful CASI systems is **efficient water management** and this is particularly pertinent to the SRFSI project given its presence in regions where water availability is variable, with sporadic extremes and which are also prone to future climate change and increased variability. The project has made some important progress on greater water use-efficiency with the establishment of CA technologies, but there is considerable scope for further improvements and probably the greatest of these would arise from successful adoption of the transformational 'one-pass dryland till and wetting' rice production systems. The success to date, noted during the field visit is very encouraging and if widespread adoption of this radical new technology could be achieved in farmers' fields it could potentially elevate the impacts of the project to the very highest levels in terms of water savings and efficient on-farm water management. However, it will also be important to determine if weeds can be effectively managed and that suitable mechanical rice-transplanters are available.

Opportunities and needs for further research on efficient water management

- *Greater emphasis given to water - and soil – saving technologies particularly for rice production. All practical options should be explored including enhancement of laser levelling; early transplanting of seedlings (both already being evaluated); dry seeding with zero tillage; alternate wetting and drying; raised bed planting; and intermittent irrigation, where appropriate. ACIAR project LWR/2012/079 should be an important source of data and information that could be incorporated into SRFSI*

The final component of successful CASI systems is **integrated pest management** and it appears to the review team that there has been little attention given to this aspect, apart from the important introduction of crops and varieties with greater resistance to/tolerance of crop diseases and pests. Integrated weed management (IWM) could well have an important role to play as the emerging farming systems develop new and more complex weed problems. An example of such a development was the presence of weeds in the seeding rows of the maize planted at the Ghughumari field site. Soil disturbance was clearly implicated in the stimulation of weed seed germination and emergence, as there was virtually no presence of weeds in the interrow spaces. This disturbance was exacerbated by the need to make two parallel openings for each sown row – one to apply seed - and the other to apply N fertilizer away from the seed, so as not to reduce crop germination and emergence. A more suitable seeding opener for the drills could allow simultaneous placement of seed and fertilizer with no crop damage and with significantly less soil disturbance and as a result, fewer weeds. Australia has high-level expertise in seeding openers for CA – both at the researcher and farmer levels - and this could be readily tapped for the benefit of farmers in the SRFSI catchment areas.

A further important aspect of IPM in CA systems globally, particularly for smallholder farmers, is the use of cover crops and mulching to suppress weed growth and allow for reduced use of herbicides. Such an approach has a range of potential benefits and these include: lower costs; reduced problems with herbicide resistant weeds; benefits to soil fertility. The global knowledge 'regional' centre for mulching technologies is based in Latin America – particularly, Argentina, Brazil and Paraguay – and if further development of SRFSI is contemplated, then

serious consideration should be given to arranging a visit from a senior expert from that region.

Opportunities and needs for further IPM research

- *Improved IWM through use of better seeding openers and use of cover crops/mulches*
- *Continued evaluation and selection of crops and varieties with resistance/tolerance to biotic stresses*
- *New investigations on IPM for better insect and pest control with consequently more judicious usage of pesticides*

In conclusion, much technological progress has been made in Objective 2 to date and the researchers and farmers should be commended on such outstanding progress over a relatively short time frame. However, it is unrealistic to think that all of the technological development and refinement required has been achieved, as experience would show that in many ways, 'the surface has only been scratched'. The opportunities/needs for further research outlined above, provide some strong guidance on what is still required. In addition, the very substantial scaling-out that is a major feature of the remainder of this project will certainly create new technological (and other) challenges – associated with different soil types; 'new' weeds, pests and diseases; water management; and agronomic management. In this context, it is perhaps worth pointing out that in Australia, CA/direct drilling is celebrating 50 years of existence and its use has averaged around 70% of the sown cropping area for over 20 years. However, GRDC is still funding millions of dollars worth of research on the topic every year to address emerging problems and opportunities, with both the technology and its related systems. It would therefore be unrealistic to believe that the investments to date in the EGP, excellent though they have been, are anything other than a very promising and encouraging start. Much more needs to be done to capitalize on the progress to date.

OBJECTIVE 3. Catalyse, support and evaluate institutional and policy changes that establish an enabling environment for the adoption of high-impact technologies from Objective 2

SRFSI's strategy is to create an enabling environment for up-scaling adoption of the high impact promising CA technologies emerging as a result of activities in Objective 2. This is fulfilled through institutional and policy changes in relation to a number of interrelated activities as follows:

Innovation platforms

SRFSI support to and use of innovation platforms (IP) has proved quite useful at community level for exchange of ideas and gathering farmers' perceptions and feedback on new CASI technologies. This seems to have generated a lot of ideas of common interests among the participating stakeholders while the IPs have also contributed to useful information flows and sensitization about the opportunities for and constraints to CASI technologies, although this is still at a limited scale. The development and application of IP models and IP field guidelines based on FGDs and farmers perception surveys about farmers' decision making process, has helped developed both design and implementation plans for introduction of appropriate CASI technology packages in varying bio-physical and socio-economic environments. This has been confirmed during field visits and interactions with Satmile club members in Cooch Behar. The project has led to improved understanding of the strategic principles of conservation

agriculture (CA) i.e. three R's of CA - reduction of tillage costs, rotation of crops and retention of soil fertility in the land, water and energy scarce small holder farming situations of EGP. The development and application of IP models and IP field guidelines is also a notable contribution. One extraordinary achievement is that the field demonstrations of the project have clearly proved to the farmers that CA practices have not only improved soil health and reduced drudgery and production costs, but as importantly they have also increased crop yields and incomes. The inclusion of other stakeholders in the development and activities of the IPs – such as agricultural banks, NGOs, grain traders, insurance companies, IT service providers and extension agents – could also be very useful.

Service providers

Evaluation of service provision models through well conducted field studies and FGDs in association with collaborating SRFSI partners, brought out useful insights about farmer's needs, especially in understanding linkages between women farmers and service providers. Currently, women's involvement seems to be mainly in the form of receiving training, participating in group meetings, and supervising and monitoring application of CA technologies in their fields. Whilst the retailers of seed, fertilizers, pesticides, irrigation and other equipment are the commonly used service providers in the project, there would be merit in also encouraging new entrepreneurs such as: providers of seedlings suitable for the mechanical rice transplanters; plant nursery owners; compost suppliers (including women who produce vermi-compost, for example in Bangladesh). In addition, local machinery service providers and rural mechanics will be essential for sustainable transformation to CASI technologies. Further opportunities for value addition to the service provision models and approaches is possible through development of typologies of women farmers, such as identification of actual field activities carried out by women, their involvement in homestead agriculture, household processing of crops, small trades in inputs and product marketing.

Linking service providers to the local government information centres is currently an untapped opportunity. For example, the Department of Agriculture in Bangladesh provides technology and market information through its agricultural information centres located at the parishad level.

Irrigation business

The development of irrigation business development models is one of SRFSI project's over arching activities, which has actually put in practice the concerns and recommendations for groundwater development for the rural poor in the region (Ref: World Bank, 1993: Groundwater Irrigation and the Rural Poor- Options for Development in the Gangetic Basin). In addition, the review team commends the developments in supporting custom hiring services for irrigation and other CASI machines, involving about 30% women farmers; providing exchange visits and training; and promoting Community Business Facilitators (CBF) through iDE engagement. Training courses and curricular modules need continuous refinement and adjustment using project insights and field demonstration results, also keeping in view movement of water pricing under various contractual arrangements, energy supplies and prices, production and price risks, in the different local market situations. In WB, where deferring of private investment in expectation of the subsidized delivery of irrigation pump systems, is construed to be in the socio-political value system, the consequent development of competitive water markets is very limited.

Market development

Various efforts towards market development i.e. listing local agro-dealers, delivery of CASI machines, exposure visits by farmers, are all commendable contributions from the project, although a large part of the market improvement and linkages initiatives, also needs to be conducted by the local government and infrastructure development authorities. While the SRFSI project appears to have developed seed, fertilizers, chemical and machinery input delivery reasonably well, it has yet to do more on irrigation supplies and machine operation and rural mechanic services. Indeed, this probably has a lot to do with liberalizing machinery imports and supporting private sector actors to deliver CASI friendly equipment at an affordable cost.

Following on from this, it is a logical and commendable approach for the SRFSI project to stimulate the supply of seed of improved wheat and maize varieties; however, making further provisions for training in seed treatment and storage would not only improve crop yields, but also contribute to farmers' capacity building. Providing greater support to the local processing of crops would be another useful market development activity. (For example, in Bangladesh supporting women entrepreneurs with machines for chopping maize stover – CSISA BD – and promoting maize-wheat flour mixtures, are two promising business developments).

Policy roadmaps

SRFSI project has devoted significant efforts towards developing policy roadmaps for sustainable use of water resources, but these have, more recently, been limited to irrigation and mechanization studies by IFPRI and organizing a number of policy dialogues at the regional levels. (The earlier work of IFPRI 2012-15 on policies for sustainable agriculture is however noted). While IFPRI conclusions about low competitiveness of groundwater irrigation market and hence its recommendations are generally true for WB and Bihar, where subsidies are more common, these are not that relevant to Bangladesh where unsubsidized - largely diesel run pump irrigation - has been fairly competitive, with reasonably positive equity implications in terms of access to irrigation by smallholders. Preparation and circulation of policy briefs by SRFSI on scaling CASI in South Asia is an important step forward. Development of policy road maps do however need further delineation of action points by the government and other stakeholders e.g. reforming inputs and machinery import policies; creating spaces for the private sector; subsidies/ incentive packages; regulation/ deregulation of chemical uses; integration of productivity gains with broader nutrition issues, etc.

The three country comparative analysis of groundwater irrigation in EGP by the project has generated potential empirical insights, which has helped in devising appropriate policy roadmaps. In addition, the contributions from SRFSI IFPRI in relation to water balances in the 8 project districts have also been very useful. The academic discourses through special sessions on energy - irrigation nexus and proposed publication of outcomes is another helpful initiative. The major conclusion that pump irrigation has spread in the region and that irrigation efficiency and competition have not equally gained in different locations has important policy implications to be addressed in the scaling out of CASI technologies.

The SRFSI project has also succeeded in articulating regional dialogue and communications with policy makers on regulating farm equipment market. These are helpful and create grounds for expanding spaces and opportunities for anchoring the consultation and dialogues with academia and agency level practitioners, with higher level policy makers i.e. in ministries and with parliamentary members.

Opportunities and needs for further research in Objective 3

SRFSI project has generated significant field-based understanding and knowledge about farming communities' decision-making processes. As a result this has created scope for further research and investigation, as follows:

- *How important are the legal aspects of contracts between service providers and farmers? What happens if there is any breach of agreement?*
- *How do the IPs address multi-stakeholders interests when crops fail, input prices rise and output prices fall? How best to manage conflicts of interest?*
- *How gender friendly are the IPs? Do the women gain empowerment only through their membership participation in IPs or can they gain more from their occupational diversification facilitated by IPs?*
- *How competitive and inclusive is the market for inputs, equipment and output? Who are the major actors and who gains and who loses how much, from the market interventions by the project?*
- *How can the local entrepreneurs be attracted to invest in irrigation business and custom hiring services for CASI machines that will be fairly competitive and equitable?*
- *To what extent can provision of agricultural credit and subsidies promote business models? Or would more public private partnership in energy supplies and road infrastructure with information technology support, be more useful and sustainable?*
- *What are the entry points for effective policy dialogues? How can the policy recommendations/prescriptions be made more effective? How can the communication and dialogue be extended from occasional meetings with implementing practitioners, to potential interactions with high-level political entities, for accelerating CASI technology adoption?*

OBJECTIVE 4 Facilitate widespread adoption of sustainable, resilient and more profitable farming systems

This objective was not a specific priority for this review and therefore the review team has not provided any detailed evaluation in relation to objective 4. It has however referred to this objective when making recommendations about opportunities and needs for future research in the report sections above. In general terms the review team has the following comments:

- *Adoption of CASI technologies to date has ranged from outstanding – perhaps world leading over the short time frame – at some locations e.g. Ghughumari/Cooch Behar to less than expected at some other locations. There was a good discussion of the likely factors involved in these different rates of progress, both at the review meeting and also at the meeting of the Project Steering Committee. It is important to note that major activities to support adoption and scaling-out are only just now being put into place and progress to date is potentially not indicative of future achievements.*
- *The review team endorses the planned scaling-out and the aspirational targets sets for this. The urgency around future food and nutritional security warrants nothing less and*

the project team needs all the support it can get to enhance rapid, efficient and effective adoption of CASI practices and the associated policy, social and logistical arrangements.

- *A special emphasis of the review team has been to conduct a 'lessons learned' study of the progress to date at all locations and details of this are included below in the section 'Project Impacts'.*

RECOMMENDATIONS

A For the partner countries

1. *Cross-location learning. The rich but different experiences around CASI technology development and adoption should be used as a learning platform for project personnel and importantly leading farmers. 'Seeing is believing' is most apposite when developing new technologies that are transformational in their nature, such as CA replacing decadal traditions of extensive cultivation. Experience has demonstrated that being able to see what other farmers have successfully achieved has often lessened or removed the barriers to development and adoption of new technologies elsewhere. SRFSI has made very good progress to date with cross-location regional learning but renewed and enhanced approaches should continue to be developed and implemented.*
2. *Scaling-out. The project is about to enter a phase of massive expansion from the few thousand farmers currently involved to 1.5m households by 2021 – only three years away. Business and resource allocation planning by partner countries needs to continue in a timely manner to ensure that the required resources can be mobilized for both the scaling-out phase and almost simultaneously those required to address the issues and challenges – bio-physical; social; economic; and environmental – that will arise as a result of the extensive scaling-out.*
3. *In relation to issues around irrigation expressed at the review meeting, further studies could be done to assess household access to different Government programs on irrigation and to identify the constraints. For example in India, linkage to Government programs such as "Mahatma Gandhi National Rural Employment Guarantee Act"(MGNREGA) & West Bengal Accelerated Development of Minor Irrigation Project (WBADMIP) should be considered. In addition, ACIAR has four additional projects focused on various aspects of irrigation water management, access and policies in India and Bangladesh that should provide an important resource for governments.*
4. *A study on the ownership pattern of the water resources and decision-making process for distribution may also help to reduce issues around access to irrigation.*
5. *Innovation platforms (IPs). It is recommended that the following issues be addressed, if this has not already occurred:*
    - *In regards to the legal aspects of contracts between service providers and farmers, what happens if there is any breach of agreement?*
    - *How do the IPs address multi-stakeholders interests when crops fail, input prices rise and output prices fall?*
    - *How gender friendly are the IPs? Do the women gain empowerment only through their membership/participation in IPs or can they gain more from the occupational diversification facilitated by IPs?*
6. *Marketing, services, credit. It is recommended that the following questions be addressed:*
    - *How competitive and inclusive is the market for inputs, equipment and outputs? Who are the major actors and who gains and who loses from the market*

interventions by the project?

- *How can the local entrepreneurs be attracted to invest in irrigation business and custom hiring services for CASI machines in ways that will be fairly competitive and equitable?*
- *To what extent can provision of agricultural credit and subsidies promote business models? Or would more public private partnership in energy supplies; road infrastructure; information technology support; be more useful and sustainable?*

7. *Policy advice and influence. It is recommended that the policy dialogue around the project be made more effective. Specifically, the current communications and dialogue should be extended from occasional meetings with implementing practitioners, to potential interactions with high-level political entities in order to accelerate CA technology adoption. As the project out-scales this will become even more important.*
8. *Technological improvement. It is recommended that all partners fully participate in developing the enhanced technologies that are critical to further progress with SRFSI and the successful adoption of CASI technologies. These are detailed in the text of this report and outlined in the recommendations for the project team (below). They include better seeding/fertilizer placement; better management of soil mulches; greater emphasis on IPM/IWM methods for pest, disease and weed management; enhanced water management particularly for rice systems; soil fertility research with particular regard to related sustainability challenges arising from deficiencies and toxicities.*

B For the project team

1. *Modelling and future projections/scenarios. The strong basis of the modelling activities to date now needs to be urgently used to develop projections and scenarios to 2030 or similar. The scenarios developed should follow from intensive consultation between all key stakeholders, particularly end-users as a major use for these scenarios will be to convince decision makers and investors of the worth of further investment in this high priority work for the resource-poor in the EGP.*
2. *Soils research and management. Research to date has provided data on soils in the project areas and identified some significant soil constraints to the future productivity, profitability and sustainability of farms in the targeted regions for adoption and scaling-out of CASI technologies. Urgent attention needs to be given to studies on the potential roles of lime, trace elements and other soil ameliorants – and the work of ICAR (lead by Dr S K Chaudhri) on the Indian Soil Health Card system needs to be taken advantage of by SRFSI, especially following the recent launch of the redesigned cards to address farmers' concerns. www.soilhealth.dac.gov.in*
3. *Seeding and fertilizer operations. The technologies evaluated and adopted to date, whilst successful in some locations, need further refinement to overcome problems with fertilizer placement; stimulation of weed seed germination and emergence; nutrient management, especially for maize.*
4. *IPM and IWM. As the CASI technologies are more frequently used and more widely used it is highly likely that pest, disease and weed management issues will also increase in scope and complexity. More detailed development of IPM/IWM technologies should be carried out, as these will generally be more appropriate for usage on small farms, compared to widespread pesticide usage. Break crops, cover crops, mulching and diversification all have important roles to play.*
5. *Gender considerations. Mainstreaming of gender considerations must remain at the*

forefront of all project endeavours; whilst good progress has been made, much more needs to be done particularly around technology use; diversification for landless women and men workers; mechanisation strategies; occupational health and safety in a rapidly changing work environment; group decision-making and joint 'ownership' of resultant actions by both women and men.

6. *Sustainability. There are two pillars for CASI systems – the simultaneous achievement of increased productivity AND enhanced eco-system/environmental health, in other words 'sustainability'. The review team recommends that more attention be given to sustainability factors, as the emphasis to date appears to have been more focused on productivity/short term economic returns. Soil health is one of the aspects of sustainability that requires more attention.*
7. *Policy inputs. Whilst the policy support inputs from IFPRI were useful and interesting, the review team considers that IFPRI efforts would be better focused on food and nutritional security issues rather than their current work that appears to overlap and perhaps duplicate other project activities.*
8. *Lessons learned. The broad range of interesting and stimulating experiences seen in the project to date, if properly used can provide valuable information on key success factors and also on things that did not work and maybe should not be used in the future. The review team believes that clear evidence of 'lessons learned', that is well thought out, analysed, synthesised and documented, will be fundamental to any further investment in SRFSI or related initiatives. The matrix presented in this review report (see later) is a good initial basis for further discussion and debate.*
9. *Communications and publications. The progress to date with the research synthesis report has been very good. However, there remain a number of high priority tasks: preparation of scientific papers for peer-reviewed journals/books; production of very concise, technically sound, but easy to read guides for policy makers and other key stakeholders. (Some attempts have already been made, but those seen by the review team had too much scientific detail and did not meet the crucial 'easy to read' criterion). In addition, effective communications within and between farmer groups needs to be further enhanced.*
10. *Patient, longer-term investment in CASI. In relation to consideration of future investment in CASI research and development, it is worth noting that in Australia CA/direct drilling is celebrating 50 years of existence and its use has averaged around 70% of the sown cropping area for over 20 years. However, GRDC is still funding millions of dollars worth of research on the topic every year to address emerging problems and opportunities, with both the technology and its related systems. It is therefore unrealistic to expect that successful establishment of CASI in EGP will not require further patient investment.*

C For ACIAR

1. *Tightened focus or address the challenges of 'poorer' sites? This is an outstanding project by most measures, but the level of response and impacts varies considerably between locations (see matrix under "Project Impacts' section). ACIAR needs to consider how it should respond to such differences – should it give greater focus to the 'more successful' sites and thereby accelerate adoption and beneficial impacts, or should it keep investing at all sites in order to potentially broaden its impacts? Is ACIAR's modality of 'research for development' applicable and appropriate for all sites*

or are some other modalities more suitable at sites where less progress ahs been made? The decision to transfer the sites with the least progress to date, to national partners is supported. NB Whilst these comments on 'focus or persist' refer specifically to SRFSI, the underlying principle has broader applications for ACIAR's global work.

2. *Same project, different presentation. Following on from the comments made in 1 above, ACIAR could consider a more targeted approach to each site rather than a 'one size fits all' methodology. For example, the emphasis on CASI development has worked outstandingly well across a number of locations but not so successfully at others. Without significantly changing the activities carried out, could a simpler focus be more successful at sites where adoption to date has been lower? For example, if the focus at some of these locations was simply 'Maize production', albeit using CASI technologies, could this simplify and clarify the message such that greater progress would be achieved? Rice would be another high priority crop given the limited progress to date and this more focused approach should build on the successful DSR work in N W India. In other words, the same technologies, but a simpler targeted focus. These considerations – presented here and in 1 above – should be given serious consideration for any future similar projects.*
3. *Education and training. Much has been achieved in terms of the training of scientists, farmers and support staff and this is commendable. However, if CASI technologies are to be widely adopted in a timely manner – as they urgently need to be – the education focus needs to be strengthened. School, college and university curricula need to be re-written to ensure that CASI is taught wherever agricultural, food and environmental components are part of the curriculum. This will require dialogue with academic administrators. For children and young adults to see what is happening in the project, but still be taught that cultivation and 'puddling' systems are the only ways to produce crops, can be both confusing and discouraging. There needs to be cohesion across all educational and training materials and this is not the case to date.*
4. *Private sector. The project has significantly opened up the opportunities for greater private sector involvement that will be essential for sustainability of progress. ACIAR should consider how best to stimulate greater private sector engagement including through 'incubators' and/or the conduct of business forums.*
5. *CIMMYT high-level engagement. The Project Steering Committee expressed its displeasure that there had been no recent visits to the project by any of CIMMYT's senior management team. Given the high profile and substantial success of this project to date, the scaling-out foreshadowed; and potential considerations of the opportunities and needs for future research, the review team recommends that ACIAR take up this concern with the DG CIMMYT.*
6. *Sustainable Development Investment Portfolio 2. ACIAR should carefully consider if and how it should position further work on CASI/SRFSI amongst priorities for SDIP2.*

4 PROJECT OUTPUTS

a) Project outputs are detailed in the log frames:

Objective 1: Understand farmer circumstances with respect to cropping systems, natural and economic resources base, livelihood strategies, and capacity to bear risk and undertake technological innovation.

No.	Activity	Outputs/Milestones	What has been achieved?	REVIEW TEAM COMMENTS
1.1	Identify representative communities, farming systems and farmer requirements in the target districts to orient project activities.	*1.* Survey results presented at inception workshop. *2.* Project communities identified in each District. *3.* Working document characterizing farming systems, institutional support and farmer problems in each District. *4.* Synthesis document comparing and summarising farming systems, institutional support and farmer problems across the 8 districts	• Survey results (as part of SRA) presented at the Inception Workshop in Jul 2014 in Kathmandu, and also in Dhaka during SE workshop in Feb 2015. • 40 nodes in 8 districts in 3 countries have been identified based on farming systems characterization and problems were assessed through FGDs (female and male separately and jointly) and documented. A synthesised SE (socio-economic) report prepared and circulated for use. • Institutional linkages and a list of key stakeholders were prepared by CRISP; a separate report is available from CRISP. • Farming systems were identified, documented through focus group discussion in each communities and their problems and intuitional support in each were listed through CRISP and FGD.	* The results of the scoping study on socio-economic and biophysical survey were presented at inception and planning meeting, Sept 2014 at Dhulikhel, Nepal. * Depending on the results of this survey and FGDs, 40 nodes were identified/established * Submitted reports (Institutional Analysis for Agriculture Innovation: Synthesis, CSIRO & CRSIP; Project Node characterization (2015)). * All milestones completed, presented, and documented; a final report shared with all partners.
1.2	Evaluate and document factors influencing household access to irrigation water	1. Surveys conducted in all 8 Districts 2. Synthesis working document published	• IWMI produced final report and circulated for its use. • Summary of major findings is also presented in SRFSI Annual Report 2016 (Appendix 2) and 2017.	* All milestones completed: Reports (Groundwater Irrigation in EGP. A Comparative Study of Bangladesh, India and Nepal (2016), IFPRI; Irrigation and Water Management Constraints for Marginal and Tenant Farmers in the EGP (2016), IWMI) submitted to ACIAR.

1.3	Characterise and quantify local water resources in the project target areas.	Working document on water resources in the project communities produced.	• A separate report produced by IWMI through ACIAR-IWMI contract and circulated for its use. • Factsheets prepared for each districts and shared among relevant stakeholders	* Report (Assessment of Water Resources and Demand for Irrigation in the EGP (2015), IWMI); Factsheets by IWMI submitted to ACIAR and circulated to relevant partners * Most of the project outputs have been achieved
1.3.1	Assess local water balances, depth of water table, and estimates of ground water availability.	1. Reports on water table and groundwater availability prepared for each node. 2. Data on ground water and water table levels shared with IWMI/LWR2012/079	* Factsheets (as above) * Groundwater table monitoring initiated from September, 2015 and is continued on monthly basis for up to December 2016. IWMI reported ground-water table for all SRFSI districts * Rain gauges established in each node for rainfall measurement. * Rainfall data are received from partners from Jan 2015 to November 2017. Will continue measuring/collecting data until June 2018	* Groundwater-table monitoring initiated from September 2015 and is continued on monthly basis. * The milestones have been achieved though the rainfall data needs to be analysed in relation to variability and reliability
1.3.2	Quantify surface water resources,	Quantity of surface water each month outside the monsoon documented for each node (2+ years data) (part of 2014; 2014/15; 2015/16	* See sections 1.3, 1.3.1 (above). Results suggest that there is no enough surface water across working locations. * Data are being used for results interpretations, etc. and available for further use.	* Rain gauges established in each node for rainfall measurement and surface water is being monitored. * The project milestones have been achieved

Objective 2: Develop, with farmers more productive and sustainable technologies that are resilient to climate risks and profitable for smallholders.

No.	Activity	Outputs/Milestones	What has been achieved	REVIEW TEAM COMMENTS
2.1	Assess and document bottlenecks and entry points for the establishment of CA systems through farmer consultations and participatory technology evaluations.	1. Presentation on bottlenecks and entry points at Inception Workshop 2. Draft working document on bottlenecks and entry points in each District available by first local E&PM[1]. 3. Published paper on CA bottlenecks and entry points in the EGP before the end of the project.	* Bottlenecks identified and prioritized; entry points for technological interventions have been determined, and systems intensification and diversification, etc. activities designed and are being implemented. * Farm typologies, cropping systems, farming systems zones characterization, constraints, and problems were identified and documented. * What is working well and what is not (constraints/bottlenecks) are assessed, presented and discussed in each evaluation and planning meetings from each state/country	* The team was satisfied that significant progress ahs been made in each of these achievement areas * The highly commendable 'Research Synthesis Report' (February 2018) provides an excellent record of all project achievements and should give confidence to investors, participants and other external stakeholders

[1] *Local E&PM = Evaluation and Planning Meetings held each season covering both districts of each state (India) or country (Bangladesh and Nepal)*

No.	Activity	Outputs/Milestones	What has been achieved	REVIEW TEAM COMMENTS
2.2	Evaluate costs, benefits, and climate resilience of current and innovative management technologies (e.g. CA, site-specific nutrient management, supplementary irrigation) for different farmer groups through on-farm evaluations and simulation models.	1. Trial and demonstration protocols developed at each local E&PM. 2. Planned trials and demonstrations established on farmers' fields each season in all communities. 3. Summary report from each node at the end of the project, together with all data, curated and in electronic format. 4. Working document on costs, benefits and climate resilience of at least three technologies across the EGP prepared by project end.	* Protocols standardised for all on-farm and on-station trials and data meta-sheets developed, reviewed and shared among partners each year. Data for up to 2016/17 winter cleaned/curated, stored and reported. * Data meta sheets received up to Rabi 2016-17 from all partners. Data cleaned/curated, stored and available for use. * Almost 360 each for rabi and kharif replicates (Farmers) for long term on-farm systems trials established each year and maintained until June 2017 with modifications, as needed. * Over 150 farmer's participatory trials as part of crop diversification and intensification is established each year in order to understand potential benefits over conventional systems in terms of economic profits, water, land and resources use efficiencies. These trials mainly focused on upland dry rabi season (October-May). They are reviewed in each year during review and planning meeting. * Over 300 on-farm opportunity trails conducted in order to address site specific issues like land type, water access and nutritional security, etc. established (mainly rabi season), results presented and reported each year. Encouraging results have been observed from intercropping interventions and encouraging women participation that they will have an additional income and nutritional security. * About 35-learning modules trials were established to fill the gaps in weed management for rice, wheat and maize, judicial water use, new stress tolerant and short maturing varieties screening, fertilizer management and APSIM model validation. * Results and progress by partners are presented each year during review and planning meeting and incorporated in SRFSI reports (SAR and AR Reports).	* 750 on farm participatory trials established in approx 368ha plus 34 on-station trials comparing CASI technologies with CT. * Site specific nutrient management and supplementary irrigation included at some sites. * Comprehensive data collected at each site and reported. * Data being used for modelling and further analyses.

No.	Activity	Outputs/Milestones	What has been achieved	REVIEW TEAM COMMENTS
2.2.1	Develop with farmer participation profitable options for the efficient management of CA systems, including site-specific nutrient management and system intensification, especially in the winter.	Report on previous seasons trial results prepared and presented at each local E&PM	• Also see 2.2 (above) * Results were presented in AR&PM meeting each year. New trials and research priorities identified to fill the research gaps. Existing cropping systems and opportunity trials were adjusted as per local needs. * In all on-farm trials, the best crop management practices (CA) coupled with new varieties/hybrids seeds, weed and irrigation managements followed. • SSNM through decision support tool have been dropped from SRFSI, the output from CSISA will be used wherever possible.	See above
2.2.2	Assess the options for increasing system productivity and resilience through strategic supplementary irrigation, and assess the feasibility for different groups of farming households.	1. Report on previous seasons trial results prepared and presented at each local E&PM, especially those for the winter season. 2. Socio-economic assessment of irrigation feasibility for representative smallholder farm households reported by August 2015. Updated each year. 3. Working paper on the feasibility of smallholder supplementary irrigation in the EGP prepared by project end.	* On-farm trials related to CASI technologies are addressing in increasing the productivity crop and water) thereby reaping profitability and resilience. * Cropping systems trials (diversification and intensification) provided opportunity for farm communities to understand the water saving and more profits over unsustainable traditional systems (e.g. rice-rice). * Farmers already have been exploring all possibility of supplementary irrigation if exist. We are looking forward for alternate options using renewable energy like solar pump that are established in SRFSI communities by other agencies. As a pilot activity one solar pump in Cooch Behar has been established by the project. * Report submitted: Assessment of Water Resources and Demand for Irrigation in the EGP (2015), IWMI; Factsheets also produced and circulated.	All work seems to have been satisfactorily completed and reported

No.	Activity	Outputs/Milestones	What has been achieved	REVIEW TEAM COMMENTS
2.2.3	Monitor soil quality in on-farm trials to assess the environmental impact and sustainability of technological options.	1. Initial report on soil status available for parameterisation of the APSIM model. 2. Final report on the effect of key technological options on soil quality.	* The key soil parameters (C and N, Soil pH, Nutrient balance) are being used for APSIM modelling * Baseline soil analysis is completed for all the nodes. For example, soil pH data suggest that 15-20% of the sites in Coochbehar, Rangpur and Sunsari require lime application due to highly acidic pH<5.5 and another 30-45% sites require monitoring of soil pH (5.5-6.5) having moderately acidic soils. * At least in four nodes of Madhubani district in Bihar, the soils are very acidic throughout the profile (0-90 cm) and require lime application as a matter of urgency. * Dataset from past experiments for conventional vs CA practices have been collected from each of the four regions for simulating the performance of the CA interventions from perspective of crop production and soil sustainability.	* The presentation by Dr Ram Dalal was informative in two ways. It provided an initial description of the various soil types and soil factors likely to impact on successful adoption of CASI systems, as described under achievements. * Treatment differences in soil organic carbon and pH have been investigated, some deficiencies and toxicities identified and some nutrient balance work completed. * However, it also demonstrated that very little has yet been done in terms of addressing sustainability challenges. * There is a need for further work on soil quality, particularly in view of the vast scaling-out proposed

No.	Activity	Outputs/Milestones	What has been achieved	REVIEW TEAM COMMENTS
2.2.4	Evaluate costs, benefits, risks and resilience of researched technology options with simulation models	Results on model validation and benefits, risk and resilience of technology options reported at all local E&PM from April 2015.	* On station experiment and selected on farm trials identified and designed for APSIM modelling. * A detailed experimental field protocol was written by Don Gaydon and Ram Dalal (UQ) to guide field staff in collection of good quality field data throughout the SRFSI project. * APSIM training for the entire SRFSI modelling team was conducted at BAU by Don Gaydon and Alison Ling in January 2015. Continuous guidance and orientation have been provided periodically for individual location/jurisdiction. * There is modelling focus in order to develop production forecasting scenarios for each districts. A preliminary draft report based on available data have been prepared in Feb 2017 (MTR). However, finalisation of APSIM calibration and validation at each on-farm node is continuous. The nodal APSIM calibration and validation delay will not cause a corresponding delay in delivery of milestones for 2.3.3 (decision support tools from modelling outputs). * Workshops and meeting have been conducted as per plan. A summary of progress was presented during MTR meeting in February 2017 in Coochbehar and AR&PM in Rangpur in Sep 2017.	* There has been significant and commendable progress with modelling, but important tasks remain and must be given high priority. * Again commendably, there has been good training of S Asian researchers, in-region. * Data collection, paramaterisation, calibration and validation activities have been achieved in a largely timely manner. * Scenario development has commenced but there is an urgent need to now focus on future – 2030 – scenarios (see text).

No.	Activity	Outputs/Milestones	What has been achieved	REVIEW TEAM COMMENTS
2.2.5	Evaluate farmer appreciation of costs, benefits, risks and resilience.	Reports of results of FGD at each local E&PM from April 2015	* Protocol for farmer appreciation of costs, benefits, risks and resilience - Done (Sept 2015) * Protocol for FGD for 4 visits/ year completed) – Done (Sept 2015 & Sept 2016) * The FGD protocol and FGD guide for pre-Kharif and pre-Rabi have been developed and distributed to all members and are now being used by all while conducting FGDs * All districts have conducted FGDs. FGD protocols and guides developed by Curtin University in collaboration with partners were used to standardise data gathering. * FGD Reports completed and submitted to ACIAR and partners that includes - Mainstreaming Gender in SRFSI Project: A gender Strategy (2015); Impacts of CASI technologies: Stories of Change in the EGP of SA (2016); Benefits, Advantages, Disadvantages, Key Decision Processes on CASI Adoption in SA: Results of FGDs (2017).	* The gender program and its intent are commendable and some real progress has been made. * Any further SRFSI work must continue to mainstream gender considerations, as much is still required to be done. * In relation to mechanisation, it appears that this is mainly 'owned' by the men at present (not dissimilar to most Australian farms) but impacts of its greater use for women and children requires attention, including OH&S particularly for women and children.
2.3	Adapt ICT-based decision frameworks for crop and nutrient management in the target regions for maize, rice, and wheat.	See sub-activities.		* The review team has cast some doubts on the value of ICT based decision frameworks and tools unless the real end-users are well targeted. Experience indicates that those end users are highly unlikely to be farmers.
2.3.1	Develop and refine ICT-based decision tools for nutrient and crop management.	Removed		
2.3.2	Access information to establish the methods and value of integrating remotely-sensed information and weather forecasts into decision frameworks for crop selection and optimal nutrient management within the farming system.	Removed		

No.	Activity	Outputs/Milestones	What has been achieved	REVIEW TEAM COMMENTS
2.3.3	Develop decision support tools through crop and soil simulation modelling	1. First approximation decision tools for winter crop choices and at least two winter crop management options available for four districts by local winter E&PM in 2015. 2. Decision tools for winter crop choice and at least two management options used to establish validation trials in all districts in 2016/2017. 3. Report on decision support tool validation prepared by three months after the end of the project.	* The modelling team worked on the first approximation on decision tool format for winter crop choices during the 3rd APSIM training workshop in Cooch Behar, Nov 2015. * CSIRO and CIMMYT discussed in early June 2016 to progress this activity. Strategies for comparing management options was compared and advised to the broader SRFSI project on an agreed approach to move forward. * A process of developing Decision Support Tool was presented and discussed at the SRFSI mid-term review meeting in Feb 2017 and AR&PM in Sep 2017. There were discussion about (1) Who would use the tool, (2) what are the decision points, (3) what information would help them with decisions, (4) what delivery format, and (5) scope: specific or general and also the utility of model. Commencement on actual APSIM scenario simulations feeding data into the support tool framework was delayed due to delay in receiving the data from partners.	See comments above.

No.	Activity	Outputs/Milestones	What has been achieved	REVIEW TEAM COMMENTS
2.4	Adapt and evaluate CA implements for small tractors.	New prototypes produced by regional manufacturers and purchased for the project.	* New prototypes of 2-wheel tractor operated bed planter exported from Bangladesh to West Bengal. UBKV team evaluated and tried to multiply locally. * Two wheel tractors operated happy seeders imported from North West India to Bangladesh for further evaluation and need based local modification organised. * Laser land leveller (LLL) supplied from India to Bangladesh and Nepal for testing and validation at farmer's field continuous. * One potato planter imported from Punjab and supplied to Sunsari, Nepal for testing. * Rice transplanters provided to all project jurisdictions (4- row for Nepal and Bangladesh and 8-row for India) and demonstrated. * A high level delegates meetings at Ministry of agriculture showed the interest for happy seeder and mechanical rice transplanter in West Bengal. Private sector is promoting them with NARES support.	* The review team believes that good progress has been made but that more needs to be done. * Arranging a visit by machinery manufacturers from NW India and other appropriate regions, could stimulate greater private industry buy-in and arrangements with local providers.

No.	Activity	Outputs/Milestones	What has been achieved	REVIEW TEAM COMMENTS
2.4.1	Acquire promising equipment and new prototypes for evaluation	1. Equipment purchased for CA trials and demonstrations before the first summer season 2. New prototypes acquired as produced by regional manufacturers.	• Equipment/implements are in place in all communities (e.g. planters, sprayers, multiple nozzle booms, GPS, Rain gauges, and other small scientific instruments) (Annex 4.3, AR 2016-17) * Motorbikes for partners of each districts purchased and handed over to them.	See above.
2.4.2	Conduct participatory machinery evaluation events	At least one participatory (farmers, manufacturers, project personnel) CA equipment evaluation conducted and reported in each District each season	* Participatory equipment evaluation has been conducted in all nodes with farmers and other stakeholders, which is a part of on-going activity. Machinery manufacturers have been involved for machine set-up and calibration and required modification in some jurisdictions. * Dealership network initiated and established in some jurisdictions (Nepal, West-Bengal and Bangladesh) and continue establishing new and existing strengthened. * Nepal: 9 tractor dealers (6 in Dhanusha and 3 in Sunsari) started selling both large and small size tractors, one tractor dealer each in Dhanusha and Sunsari, identified for selling ZT. 20 tractor operators trained on ZT service so far and effort is continuous. * India: 1 tractor dealer in Madhubani and 1 in Purnea identified and linked with concern stakeholders. 1 ZT dealership network established to sale ZT machines in Coochbehar. * Bangladesh: Small manufacturers and suppliers identified and linked with concern stakeholders. * There is a huge attraction particularly on ZT/ST, Mechanical Rice Transplanter, LLL technologies.	* The review team was impressed with the work to date that should now be used as a solid foundation for further commercialization. * Options for sub-dealerships and franchises should be explored in the pursuit of sustainability.

No.	Activity	Outputs/Milestones	What has been achieved	REVIEW TEAM COMMENTS
2.4.3	Support machine development and manufacturing activities.	New machines based on testing in the EGP are produced in South Asia.	• Participatory new prototype testing and required modifications of existing machineries is an ongoing activity, which will continue. • The need based local modifications has been made by manufactures after feedback from farmers and operators.	See above.
2.4.4	Test and demonstrate the efficiencies of laser levelling on small fields.	1. Results of field tests of laser levelling documented. 2. Bulletin produced on the efficiencies allowed by laser levelling of small fields.	• Laser land leveller (LLL) testing and demonstration initiated in Nepal, Purnea-India and Bangladesh through iDE, Agrevolution and CIMMYT respectively. LLL is gaining popularity in Nepal and Purnea-Bihar and creating demand for larger scale adoption. Stakeholders enthusiastically observed the demo and motivated to adopt technology. Service providers also showed interest to purchase LLL. In both countries hands on training on LLL use was organized in presence of research and development leaders including policy makers. The agreement initiated with service providers for LLL for custom hiring in Nepal and Bangladesh. LLL work is also initiated in Bihar through JEEViKA.	
2.5	Evaluate pumps including those using alternative energy sources, and water distribution systems adequate for smallholders and service providers in the EGP	1. Tests of low-cost pumps suitable for smallholder farmers comparing mechanical and fuel efficiency documented. 2. Participatory (farmer and service provider) evaluations of suitable pump options for smallholders conducted in at least two communities in each district. 3. Reports on participatory (farmer and service provider) testing of suitable pump options.	• Opportunities for the use of surface irrigation water in most of working communities explored and report suggest (IWMI and IFPRI) there is no enough source of surface water available for irrigation that could be potentially exploited. Effort is continued for low-cost, energy efficient and accessible pumps for groundwater pumping. • Shallow tube-well pump sets were supplied in Madhubani Bihar that was needed for landless and marginal farmers. • Installed a solar pump for pilot testing in Coochbehar in 2017.	* There is considerable scope to increase this work but in collaboration with other organisations who have this work as mainstream activity.

Objective 3: Catalyse, support and evaluate institutional and policy changes that establish an enabling environment for the adoption of high-impact technologies from Objective 2.

No.	Activity	Outputs/Milestones	What has been achieved?	REVIEW TEAM COMMENTS
3.1	Assess and document farmer decision processes for investing in key climate-resilient technologies, including the role of risk and perceptions.	1. Report from RRA and surveys on farmer perceptions of the agronomic and institutional feasibility of available rice and wheat technologies, and supplementary irrigation. 2. Results of FGD on technology acceptability and institutional feasibility presented at local E&PM for the 2016 winter season. 3. Survey in project communities and synthesis report on early adopters and non-adopters of project-promoted system enhancing technologies. 4. Synthesis report on farmer decision making processes in 8 districts of the EGP.	• Report from FGDs about farmers' perceptions on CASI technologies was presented at Sept 2016 AR&P meeting in Darjeeling. • Reports submitted by CU: Participation of Men and Women in SRFSI activities (2016); Benefits, Advantages, Disadvantages and Key Decision Process on CASI adoption in SA: Results of FGDS, (2017); Impacts of CASI technologies stories of change in the EGP of south Asia (2016). • CSIRO presented the Smallholder ADOPT at the AR&P meeting in Sep 2016. A pilot assessment was conducted on DSR in Sunsari (Nepal) to explore the utility of model. • Smallholder ADOPT is available for use and support is available from CSIRO, if required	* SRFSI project has properly assessed small and marginal farmers' decision making processes through FGDs and farmers perception surveys in varying biophysical and socioeconomic environments, and extensively produced reports to document results. * This has helped design an implementation plan for introduction of appropriate CASI technology package following the underlying concepts of conservation agriculture (CA).

3.2	Initiate and establish innovation platforms in each project district incorporating farmers and agents representing many of the principal components of the main agricultural value chains.	Discussion groups of farmers and value chain agents held in each node in each season. Issues and decisions on institutional and technological problems (and possible solutions) documented, including timetable for future meetings.	* There was a strong focus on further support and evaluation of IPs during this reporting period. * Darbas & Brown ran Structured Training Workshops" (May/Jun 2016) in Bihar and West Bengal (with participants from India, Nepal and Bangladesh attending to support/promote cross-country learnings), * Summarised the implementation of IPs (34 Node and 4 District IPs established (Trip report, Aug 2016), * Conducted field visits and supported for IPs establishment in Terai, Nepal, Sep 2016. * Analysed IPs for policy implications, and drafted an IP field guide, Report included in annual report (2016) * Lesson learned from the experience in SRFSI that a sustainable and more vibrant model can only be expected when the existing multi-stakeholder forums such as farmers' clubs/school/federation and self-help groups, etc. are trained and strengthened. * Darbas drafted a IP field guide and received comments and suggestions, but yet to finalise and circulated for wider use. * CSIRO conducted an IP Review Workshop in Sep 2017, and reviewed what is working well and what is not. Also discussed what are the major ingredients to become a successful IP. * Single window service provision model established in Coochbehar is functioning well. It will be replicated in other similar (with respect to bio-physical and socio-economic) communities and based on available resources will continue strengthening them.	* Supporting innovation platforms (IP) proved to be a useful vehicle for involving community level actors in discussion about CASI technology. Inclusion of other strategic partners would strengthen IPs. * The IPs contributed useful information flow and sensitization about the opportunities for and constraints to CA technology, but this needs to be better targeted and more intensified.

3.3	Evaluate service provider models and systems for different farmer groups, especially women farmers.	Effectiveness of linkages between women farmers and service providers assessed through key informant surveys in at least four districts.	* Evaluated the service provision models in West Bengal, Nepal and Bangladesh and continuously advocating for an individual and/or community/clubs based service provision models. Assessed in seven districts (Sunsari and Dhanusha in Nepal; Malda and Coochbehar in West Bengal, India; Purnea and Madhubani in Bihar, India and Rangpur in Bangladesh). Draft reports submitted. * Feb 2016 – Curtin University researchers with iDE and NARES partners conducted FGDs and field interviews with farmers and service providers using iDE model. Draft report for the service provider models for Nepal was submitted in 2016. * Sept 2016 – Curtin University researchers with UBKV partners conducted FGDs and field interviews with farmers and service providers using farmer group model. Draft report for the service provider models for West Bengal was submitted in Feb 2017. * February 2017- Curtin University researchers with BAU partners and RDRS conducted FGDs and field interviews with farmers and service providers using farmer group model. Draft report for the service provider models for Bihar and Rangpur, Bangladesh was submitted in June 2017.	* Evaluation of service provision models through field studies and FGDs by Curtin University in association with collaborating SRFSI partners seems well conducted in a participatory fashion. * These generated knowledge about linkages between service providers and farmers, especially women farmers. * Further validation of the models is needed to identify actual work portfolios of field activities by women farmers.

3.4	Strengthen CA and irrigation business models for service providers to efficiently address the needs of different farmer groups, especially women farmers, through support and training by both the public and private sectors.	1. Women farmers in four districts effectively linked to service providers with the skills to negotiate prices, understand the value of key technologies, etc. 2. Syllabus and training modules for technical and business development services formalized in consultation with partners. 3. At least one course on Technical and business development services conducted for service providers in four districts.	• All CA equipment are placed with SHGs (in Nepal and India) to take ownership for developing custom hiring service. • iDE facilitated for developing the CA based service mechanism including women farmer group. • Exposure visits and trainings conducted where a significant number of women farmers (28.4) participated (See section 4, Annex 4.1a&b) during reporting period. • Almost 30% women farmers are involved in on-farm activities where they effectively linked with service providers through farmers clubs, societies, cooperatives and self-help groups (SHGs) in all communities. • Community Business Facilitator (CBF) created in Nepal through iDE for self-sustained business through communities, service providers, and agro-vets. 18 CBFs were trained and working in project areas to scale-out technologies within and beyond SRFSI nodes. • Courses on technical and business services have been conducted by iDE in 4 districts (2 each in Nepal and India). However, because of shortage of resources this was not conducted in Bangladesh.	* Support to custom hiring services for irrigation and use of machines is in a proper direction. * Training courses and curricular modules are reportedly as needed, but these demand continuous refinement and adjustment using new insights and results from the fields.

3.5	Develop markets for inputs and services in the target areas.	1. Backward linkages in input chains strengthened by providing market intelligence to private companies and through exposure visits linking private companies to newly developing commercial pockets. 2. New approaches for marketing and demand aggregation implemented to ensure that smallholders have improved access to mechanized service provision.	* In Nepal, project conducted one participatory (project staff, farmers and service providers) exposure visit to Nawalparasi, Rupendehi, Chitwan, and Bara districts. The team observed LLL operation, ZT-Lentil production field, ZT machine operation, Chinese seed drill and reaper and a rural vegetable collection centre at Piperahiya in Nawalparashi. This joint visit developed linkage between farmers and service providers, and raised awareness among private entrepreneurs about the feasibility of agriculture mechanization and development of rural collective marketing. * List of local agro-dealers prepared in all districts and linked with large private distributers and manufacturers. * Project team set-up hoarding boards with technological information in key locations i.e. cross roads, local markets in most districts, which is creating awareness. * The purchase of machinery through local distributors helped to disseminate/promote CASI technologies through increased demand and sell for equipment and services. * Commercial pockets for marketing and demand aggregation initiated in Nepal, Bihar and West Bengal * New dealership initiated and established through IP in Nepal and West Bengal for the promotion of CA based machineries at local level. * High level policy meetings /interactions were organized in all three countries to promote large scale scaling of CASI technologies.	* Listing local agro-dealers, delivery of CASI machines, exposure visits are commendable. * While the SRFSI project appears to have developed seed, fertilizers, chemicals and machinery input delivery reasonably well, it has yet to address the need for reliable irrigation and machine services, with positive equity implications.

3.6	Develop policy roadmaps for the sustainable development and use of water resources along with increased market-based access to scale-appropriate agricultural machinery.	Discussions held with stakeholders, including policy makers at the local, regional and national levels of policy to develop options to enhance the profitability and sustainability of smallholder agriculture in the EGP.	* Reports on mechanization and irrigation policies have been prepared and circulated to partners by IFPRI. * The policy roadmaps for sustainable water use and scale-appropriate mechanization was discussed in two stakeholder dialogues organized on 20th-21 July, and 9th and 10 October, 2017 in New Delhi, organized by IFPRI. Outcomes from both events will be published as edited volumes and policy briefs with recommendations will be shared with concerned policy-makers and other stakeholders, including private players active in the sector. * A regional policy dialogue on scaling conservation agriculture for sustainable intensification in South Asia was held in Dhaka on September, 2017. On the basis of this dialogue, policy brief; and proceedings and recommendations have been prepared and circulated. * Discussed at regional level via SAARC with CIMMYT Nepal (CSISA) and series of discussion and joint events were organised between CIMMYT and SAC (SAARC Agricultural Centre) in relation to CASI promotion in Bangladesh and the region.	* Activities for policy roadmaps towards sustainable use of water resources are satisfactory, although these have been limited to organizing a number of policy dialogues at the regional levels. * IFPRI conclusions about low competitiveness of groundwater irrigation market are generalized for the entire EGP region; these need further evaluation by locations. * Preparation and circulation of policy briefs on scaling CASI adoption is an important step forward.

3.6.1	Develop policy roadmaps for the sustainable development and use of water resources.	1. Working document published on policy options for the sustainable use of water resources in the eight (SRFSI) districts of the EGP. 2. Policy brief prepared on options for the sustainable use of water resources in the EGP.	• Submitted report on Groundwater Irrigation in EGP: A comparatives study of Bangladesh, India and Nepal (2016), IFPRI. • IFPRI prepared policy brief on how to use groundwater irrigation to make agriculture more resilient in Bihar. Another policy brief focusing on the entire EGP region is yet to be produced and circulated. • IFPRI organized a special session on energy-irrigation nexus in eastern Gangetic plains in a major conference on Bringing Green Revolution in Eastern India on 9th-10th October 2017. This session focused on research findings and policy recommendations emerged from work done under SRFSI. The SRFSI work will also be published as a book chapter in a peer reviewed book and will form a key component of policy recommendations shared with top policy makers in EGP states/countries and Government of India	* Report on the three-country comparative analysis of groundwater irrigation in EGP is a good strategic step by the project. * Interactions and sharing of knowledge on energy-irrigation nexus is another pertinent initiative.
3.6.2	Assess policies regulating the market availability of small farm equipment and explore with stakeholders options to overcome bottlenecks in equipment availability.	1. Document published on the policies regulating the markets of small farm equipment in the EGP. 2. Reports of stakeholder discussions on overcoming policy and institutional bottlenecks in equipment availability in districts where this is an identified problem.	• Document completed for three countries and shared for comments, which was also presented in July 2017. Agriculture mechanization dialogue in Delhi. • IFPRI organized a Regional Dialogue on Agricultural Mechanization for Sustainable Intensification of Agriculture in Eastern Gangetic Plains on 20th-21st July, 2017 in New Delhi, India, which will help to refine policy briefs related to agri. Mechanization in the EGP. • Policy briefs on Scaling out Conservation agriculture based sustainable intensification approaches for smallholder farmers and supporting conservation agriculture based sustainable intensification for improved rural livelihoods have been prepared.	* Documentation of regional agricultural mechanization dialogues and communications with policy makers with policy briefs on CASI approaches is commendable. * This process needs scaling up to higher political policy levels.

Objective 4: Facilitate widespread adoption of sustainable, resilient and more profitable farming systems.

No.	Activity	Outputs/Milestones	What has been achieved	REVIEW TEAM COMMENTS – reported comments only
4.1	Establish on-farm technology validation and learning modules and use these to help build stakeholder capacity.	1. Document describing the objectives and conformation of the learning modules discussed and finalised at the Inception Workshop. 2. Protocols for learning modules prepared in each district at the 2014 summer planning meeting in each state/country. 3. Learning modules established in each node each season 4. Technical bulletin prepared with results and discussion of learning modules	• 3,033 on-farm participatory trials established in the region for validation, awareness creation and widespread adoption which covered 368 ha with different CASI technologies/practices that lead to benefit additional 1,043 farmers. • SRFSI activities are linked with the flagship and mission program of India & Nepal and has helped better convergence for larger scale adoption of CASI technologies. • The learning modules for direct seeded rice and no-till maize weed management options developed with clear objectives are established in all 8 districts. • New Rabi season learning modules as per identified problems during AR&PM at Darjeeling for Lentil weed management, supplemented fertilizer (superimposed) treatments in core trials of maize and wheat were established and data are compiled and reported. • Nutrient sufficiency and deficiency learning modules for rice, wheat and maize were established in all nodes.	<u>The following things have been reported to the review team:</u> 2,253 on-farm participatory trials (from rabi 2014-15 to kharif 2016) established in the region for validation, awareness creation and widespread adoption which covered 247.3 ha with different CASI technologies/practices that lead to benefit additional 1,043 farmers. SRFSI activities are linked with the flagship and mission program of India & Nepal and expected to have convergence that likely to have larger scale adoption of CASI technologies. The learning modules for direct seeded rice and no-till maize weed management options developed with clear objectives are established in all 8 districts. New rabi season learning modules as per identified problems during AR&PM at Darjeeling for Lentil weed management, supplemented fertilizer (superimposed) treatments in core trials of maize and wheat have been established. Nutrient sufficiency and deficiency learning modules for rice, wheat and maize were established in all nodes. Information are communicated to concern stakeholders. The review team feels that the technology has been appropriately validated Future scope: More focussed attention to pin point the node wise learning capturing its variability

5 PROJECT EXECUTION

- The approaches followed in selecting partner countries, project sites, locations, nodes and partners are scientific and logically sound. Huge data sets have been handled and interpreted competently using smart analytical techniques i.e. component analysis, gross margins, APSIM. Based on scientific design i.e. scoping study, co-funding agreement, training of project partners, team building, business focus with private sector engagement and piloting field research, this cross-country project has been implemented with clear vision and scientific rigor for adoption of CA technology.
- The quality and soundness of the research undertaken has generally been of a high standard, particularly at the research stations. Where there has been lower research quality this has been well recognized by the project team and adjustments in interpretation and use of the results obtained carried out accordingly. Overall, great confidence can be placed in the research results.
- The formal documentation of reports, publications and policy briefs is considered very rich and diverse. While the soft and hard copies of formal publications are easily accessible, occasional reports, policy briefs and communications of CIMMYT and partner organizations have been widely circulated.
- The management of the SRFSI project seemed to be very prompt and particular in communication, reporting and transparent financial administration. As with every project, continuous attention needs to be paid to containment of overhead costs to ensure that the maximum proportion of funds is available for the high priority field operations that are crucial to project success.
- The project has succeeded in facilitating collaboration and cooperation between the partner institutions/ agencies in the three countries. Cooperation amongst partners within the participating countries (extension department, university, research institute, NGO, private sector) also appeared very good, although intensity varied between locations without affecting project implementation.
- Overall, the review team believes that the planning and execution of this project is generally of the highest order and all parties should be commended. CIMMYT has provided good leadership, whilst facilitating genuine partnerships and participation, resulting in a real sense of 'ownership' by all stakeholders.

6 PROJECT IMPACTS

The review team is of the strong opinion that whilst there are good reasons to consider the impacts of the project as a whole – as indicated in the TOR – it also believes that an attempt to consider the variation in impacts across the various locations and sites of the project has considerable merit. The review team therefore developed the matrix shown below in consultation with the project team.

In addition, the review team also recommends that the 'lessons learned' as a result of carefully analysing and digesting the variability displayed in the matrix, would be of great benefit to the remainder of this project and invaluable in designing and developing any future related investments. Appropriate questions could include:

- Why was this score given?
- What could have been done differently?
- What can be done now?
- What needs to be done in the future?
- How could this score have been improved?

The review team does not have the knowledge or resources to deliberate on every individual score, but draws attention to some particular observations, as follows.

- There is as much variation in scores within countries as there is between countries
- Impacts to date at all sites range from 1 to 5 clearly demonstrating the variability
- Highest overall scores were given to Cooch Behar and Malda
- Lowest overall score was given to Dhanusha
- The most frequently highest scoring criterion was 'Contact/communication with end users including farmers'
- The most frequently lowest scoring criterion was 'Alignment with government policies'
- There appears to be a positive association between high 'Research quality' and favourable scores for other criteria
- Almost invariably there are high scores for the criterion 'Community response/ownership'
- Research quality (summary) scores ranged from 3 to 4.5 across all locations
- Overall, despite the clear differences the project has performed/been scored very well

Location	Research quality	Effectiveness of collaboration/ partners	Contact / communication with end users inc farmers	Alignment with government priorities / policies	Community response / ownership	Impacts to date (NB Not future impacts)
BANGLADESH						
Laxipur (Nachole), Chapiaganj	3	3	4	2	4	4
Nabinagar	3	3	3	2	3	3
Premtoli	4	4	5	3	4	5
Baduria (Charghat)	4	4	5	2	5	5
Dharampur (Durgapure)	4	4	5	2	5	4
RAJSHAHI (Overall)	**3.5**	**3.5**	**3.5**	**3**	**4**	**4**
Mohanpur (Birganj), Dinajpur	5	5	5	4	5	5
Kolkondo (Gangachara)	4	4	5	3	4	4
Lokhitari (Gangachara)	5	5	5	3	4	4
Durgapure (Mithapurkur)	4	5	5	4	5	5
Badodargah (Pirganj)	5	5	5	4	5	5
RANGPUR (Overall)	**4.5**	**5**	**5**	**3.5**	**4.5**	**4.5**

Location	Research quality	Effectiveness of collaboration/ partners	Contact / communication with end users inc farmers	Alignment with government priorities / policies	Community response / ownership	Impacts to date (NB Not future impacts)
INDIA						
Falimari (Satmile)	5	5	5	5	5	5
Patchara	5	5	5	5	5	5
Durganagar (Dinhata)	5	5	5	5	5	5
Ghugumari	5	5	5	5	5	5
Mansai (Tufanganj)	3	4	5	4	5	4.5
COOCH BEHAR (Overall)	**4.5**	**5**	**5**	**5**	**5**	**5**
Kalinagar (Gazole)	5	5	5	5	5	5
Gourangpur (Gazole)	5	5	5	5	5	5
Ugritola (Manikchak)	4	4	5	4	5	5
Bidyanandapur (Chanchal-II)	5	5	5	5	5	5
Mahadipur (Chanchal-II)	4	5	5	5	5	5
MALDA (Overall)	**4.5**	**5**	**5**	**5**	**5**	**5**
Nanore (Andrathari)	2	2	3	2	1	2

Location	Research quality	Effectiveness of collaboration/ partners	Contact / communication with end users inc farmers	Alignment with government priorities / policies	Community response / ownership	Impacts to date (NB Not future impacts)
Korahia (Jainagar)	4	3	4	2	4	4
Mauahi (Babubarhi)	2	2	3	2	2	2
Sukhet (Jhanjharpur)	3	2	3	2	4	4
Khairi (Lakhnaur)	3	2	4	2	3	3
MADUBHANI (Overall)	**3**	**2**	**3**	**2**	**2.5**	**3**
Kathaili (Jalalgarh)	4	4	5	4	4	5
Dogacchi (Kasba)	3	3	4	5	4	4
Tikapati (Rupauli)	3	3	4	4	5	5
Udianagar (Srinagar)	4	4	5	4	5	5
Dakua (Dhamdaha)	3	4	4	5	5	5
PURNEA (Overall)	**3.5**	**3.5**	**4**	**4.5**	**4.5**	**4.5**
NEPAL						
Lalgarh	3	2	4	2	3	2
Sinurjoda	3	2	4	2	4	3

Location	Research quality	Effectiveness of collaboration/ partners	Contact / communication with end users inc farmers	Alignment with government priorities / policies	Community response / ownership	Impacts to date (NB Not future impacts)
Fulgama	2	2	3	1	2	1
Raghunathpur	4	3	5	2	5	5
Gidha	4	3	4	2	4	4
DHANUSHA (Overall)	**3**	**2.5**	**4**	**2**	**3**	**3**
Shalbani (Mahendranagar)	4	3	4	2	5	5
Simariya	4	4	4	2	5	5
Bhaluwa	3	3	4	2	3	3
Kaptanganj	4	4	4	2	4	5
Bhokraha	4	4	5	2	5	5
SUNSARI (Overall)	**4**	**3.5**	**4**	**2**	**5**	**4.5**

5 = STRONG – performing at 'contemporary international (or national, where more appropriate) best practice'; of the highest standard.

4 = FAVOURABLE – performing at a high level but with one or two aspects for improvement.

3 = BENCHMARK – operating at a level that meets expected requirements but does not exceed them, nor fall below them.

2 = UNSATISFACTORY - operating at a level that is below expectations with one or more major deficiencies

1 = POOR – falls well below expected requirements and requires immediate attention.

(i) *Community impacts (social, economic and environmental)*

The project has contributed hugely in enhancing the knowledge and skills of the participating communities. This was quite evident from several interactions during the field visits as well as at the review workshop. The farmers are very confident about the usefulness of the new technologies and want to scale up. The service providers also seemed to be very much determined to provide quality services to the farmers.

It was quite evident that the project could build a high quality social capital in the communities involved. The community appears to be ready as a cohesive unit to disseminate the technology to other farmers

During the field visit it was quite evident that the farmers, both women and men, are very sure about the economic gains. Now together they are aspiring to replicate the technology and enhance their standard of living. Ayesha Bibi from Cooch Behar told us her stories of buying a motorcycle for her husband and she is now aspiring to give quality education to her daughters. These were inspiring real-life stories.

ii *Capacity-building impacts*

The SRFSI project has substantially increased knowledge and skills of participating researchers in CA technology development and dissemination through inter and intra-country field visits and by way of intensive CA training workshops. For example, CA training in Punjab, India provided the participant scientists from partner countries useful applied training on CA practices, machines and devices, agronomy, weed control and CA based water management, which contributed to gaining new knowledge and sharing individual country experiences amongst the scientists. The cross-country experience also improved their research management skills and confidence to conduct field research in varying biophysical and socioeconomic conditions.

The project has also demonstrably contributed to enhancement of institutional capacity in terms targeting focus on CA research and technology development (e.g. BARI has been involved in field research on soils and agronomy with collaboration from ACIAR with Murdoch University, and it could also draw on the Ministry of Agriculture's project on CA machinery development i.e. zero till seeder with CIMMYT support). Besides, the project has improved access and capacity of academic scientists (e.g. those from BAU, Bihar) to build functional linkages with agricultural extension department and interested farmers through field demonstration of CA practices and machineries.

iii Environmental Impacts

The analyses carried out by the project team at each of the long-term trial locations have shown that the use of CASI based crop management practices reduced both, water-use and energy requirements, as well as reducing GHG emissions. For example, for rice production in R-M and R-L rotations, CASI technologies used slightly less water. However, for wheat in the R-W systems irrigation water-use was reduced from 20-34% and similar reductions were reported for maize in R-M systems. The use of CASI technologies compared to conventional tillage and sowing for wheat, maize and lentils during the *rabi* season, required less time to pump groundwater and resulted in reduced irrigation costs.

Similarly, energy use reductions of from 5-25% resulted from the use of CASI technologies for maize, wheat and lentil production across all sites.

GHG emissions were reduced from 1-30% through the use of CASI technologies. These results are very encouraging and in line with international findings, for example: T Lumpkin and K Sayre (2009) http://www.fao.org/ag/ca/doc/wwcca-leadpapers.pdf and from Australia, NANORP http://www.n2o.net.au/repository/ However, if reductions in GHG emissions as a result of the adoption of CASI technologies are to be used as a policy lever, then more detailed work will be required to definitively demonstrate that the findings in SRFSI are in line with expectations from similar studies elsewhere.

d) Specific topics identified by ACIAR

i Gender considerations

The project has seen a huge participation of women. In the year 2015-16, 33% women participated, in the next year it was 53% and in 2018 it has reached 62%. There were well-articulated strategies towards empowerment of women and the appointment of a designated gender focal person is a great idea. During the field visit when the review team asked the participants 'who of you present are the farmers'? – it was overwhelmed to see 100% of the women raise their hands! The review team also observed that all the women have participated with lots of energy and also believes that a lot of advancement has happened as far as gender empowerment is concerned.

Opportunities and needs for further work on gender considerations

- *Women's Empowerment in Agriculture Index (WEAI) could be used to monitor empowerment*
- *Separate impact assessments should be done only with women, as earlier studies were with a mixed group*
- *There is huge variation of women's participation across districts in trials, farmer field days, exposure and training and workshops. Efforts to understand why this is the case, what the constraints are and adoption of a more gender sensitive strategy would be important*
- *Conducting a large scale sensitization program on Gender Equality is recommended*

ii Private sector engagement

Private sector engagement has remained limited. Active involvement of local manufacturers and suppliers of CA machines, rural mechanics, irrigation water sellers, credit suppliers, insurance companies, grain traders and product processors is largely yet to take place. One of the most important steps can be to encourage and support the private sector investors in taking up 'contract farming' as a means to integrated adoption of CA technology interventions, and this is likely to lead to consolidation of small but fragmented scattered plots of varying topography and soil conditions into viable economic operational holdings. There are significant recommendations about further stimulation of private sector contributions described in this report under Objective 3 particularly, and also in Objectives 1 and 2.

iii Communications

The review team believes that the project to date has achieved a lot. It is true that already many documents, case studies and a series of communications materials have been developed. But probably more need to be done to reach to the policy makers and the farmers who are left out. Farmer field days are a perfectly planned strategy to reach to more people and share the success stories. But 2017/18 has seen a sharp decline (442 participants in this half year compared to 4,401 participants last year). Also it may be useful to understand the differences (adoption, productivity, soil nutrients, etc.) between nodes and communicate a suitable strategy to the farmers, as well as exposing them to success stories from elsewhere in the project area. The project should also think about the use of media to disseminate the technology to a larger mass of people.

Prompt communication with donors seemed to be a key factor for the success of the project. Research support from Curtin University was critically important. Communication of research results in the form of workshops, dialogues, reports, leaflets, policy briefs were informative and of good quality. Involvement of media partners in CA focused seminars and field visits would be useful for scaling up its adoption.

7 FOLLOW UP

Given the high positive impact of SRFSI project in scaling up the CASI technology for increasing yield and productivity, reducing tillage costs, saving irrigation water and increasing farmers income, ACIAR may consider a new project to utilize the immense knowledge and capacity building opportunities created by the current project. The future initiative should ideally focus on three dimensions - consolidation and scaling out of proven CASI technology; strengthening synergies in conservation agriculture R &D by partnering institutions with possible inclusion of universities; and deepening engagement in CA policy dialogues and conversations with higher political levels (i.e. agriculture, water, environment ministries). Special budgetary allocation could be considered for mainstreaming CA curricula and policy research at universities. For further awareness building and promotion of CASI technology packages, media partners in each location including local print media would be very useful (e.g. CA success stories can be broadcast through daily Mati O Manush program of Channel i TV in Bangladesh).

8 PROJECT EVALUATION

<table>
<tr><th colspan="3">A – Specific outcomes of the project</th></tr>
<tr><td rowspan="2">A1 – Achievement of outcomes</td><td colspan="2">Guidance: Evaluate the extent to which the project activities and outputs have resulted in the desired outcomes, including engaging project partners and relevant stakeholders outside of the project. What are the most substantial outcomes that have occurred as a result of the project's activities?</td></tr>
<tr><td>Results Statement: The project has substantially delivered on intended outcomes to date. Farmer uptake over 30,000 cf 7000 target. Crop yields have increased with CASI. Incomes markedly increased on significant number of farms. Valuable training successfully delivered to national scientists and farmers. Knowledge sharing mechanisms successfully used. Engagement of women at a high level of achievement. Research synthesis completed. Scaling-out commenced.

.</td><td>Score:

4.5</td></tr>
<tr><td rowspan="2">A2 – Availability of new or enhanced technologies</td><td colspan="2">Guidance: Evaluate the extent to which the project has increased the availability of new or enhanced technologies. Is there any evidence that these technologies have been adopted by next or end users?</td></tr>
<tr><td>Results Statement: The availability of new CASI technologies has been established at most locations, but adoption varies from outstanding to low, according to location. Overall this is a good result to date. Where uptake has been lower, it appears other social and environmental factors are limiting rather than the technologies per se. Clear evidence of adoption by farmers and stimulation of associated service providers. The potential is excellent.

.</td><td>Score:

5</td></tr>
<tr><td rowspan="2">A3 – Skills and knowledge change</td><td colspan="2">Guidance: Evaluate the extent to which the project has increased knowledge and skills of in country researchers and stakeholders, through their participation in the project and the training elements. Has the project contributed to Australian skills and knowledge change?</td></tr>
<tr><td>Results Statement:

The project has hugely contributed in enhancing the knowledge and skills of the researchers and stakeholders including the</td><td>Score:

5</td></tr>
</table>

	farmers. This was quite evident during several interactions during the field visits as well as in the workshop. The farmers are very much confident about the usefulness of the new technologies and want to scale up. The service providers also seemed to be very much determined to provide quality services to the farmers. The review team also believes that the project has substantially contributed in enhancing Australian skills and knowledge as evident from the presentations from many Australian researchers. The whole idea of understanding the variability between regions and farmers, the knowledge about the conditions and structural barriers for women farmers and working towards building a collaborative platform as a cohesive unit, to bring all the stakeholders under one umbrella, were some of the aspects which generated great learning. One of the Australians commented that organizing exposure visits for both women & men together would not work in all places and new approaches are required.	
A4 – Institutional and group practice change	*Guidance: Have the collaborating communities, R&D institutions, local government agencies and collaborating industry partners changed their approach to user directed research and interacting with researchers to facilitate improved collaboration and adoption?*	
	Results Statement: The IPs generally have facilitated exchange of experience and interests of the collaborating partners, which have begun to gradually change attitudes and vocabulary regarding CA versus conventional technology. However, the proceedings of the dialogues and deliberations need to be documented well so as to allow presentation of project impacts to different stakeholders in and out of the IPs.	Score: 4
A5 – Engagement of the private sector	*Guidance: Evaluate the extent to which the project has engaged the private sector in project activities. What benefits have occurred as a result of this engagement? What could have been done better?*	
	Results Statement: Private sector engagement has remained limited. Active involvement of local manufacturers and suppliers of CA machines, rural mechanics, irrigation water sellers, credit suppliers, grain traders and product processors is yet to take place. One of the most important steps can be to encourage and support the private sector investors in taking up 'contract farming' as a means to integrated adoption of CA technology interventions, and this is likely to lead to consolidation of small but fragmented scattered plots of varying topography and soil conditions into viable economic	Score: 3.5

	operational holdings.	
A6 – Empowerment of women and girls	*Guidance: Evaluate the extent to which the project has been able to empower women and/or girls as a result of involvement in project activities or adoption of project outputs. How have women contributed to project implementation? What could have been done better?*	
	Results Statement: The project has seen huge participation of women. In the year 2015-16, 33% women have participated, in the next year it was 53% and in this year it has reached 62%. There were well articulated strategies towards empowerment of women and the appointment of a designated gender focal person is a great idea. During the field visit when the review team asked the participants 'who are the farmers?' it was overwhelmed to see 100% of the women raise their hands. The team also observed that all of the women have participated with a lot of energy. The review team feels that a lot of advancement has happened as far as gender empowerment is concerned.	Score: 4.5

A7 – Communication / extension / dissemination processes and strategies	*Guidance: Were the communication and dissemination activities and strategies appropriate for the content of the project? Were they successful in facilitating practice change and in establishing enduring information sources? What could have been done better?*	
	Results Statement: The review team believes the project to date, has achieved a lot. It was evident that there are many useful documents; case studies; and a series of communications materials has also been developed. But probably more needs to be done to reach to the policy makers and the farmers who are left out. Farmer field days are a very good strategy to reach to more people and share the success stories. But 2017/18 has seen a sharp decline (442 participants in this half year compared to 4,401 participants last year). Also it may be useful to understand the differences (adoption, productivity, soil nutrients, etc.) between nodes and communicate a suitable strategy to the farmers	Score: 3.5
A8 – Publications, scientific outputs	*Guidance: Assess the scientific outputs in terms of their number, quality, distribution and potential contribution to other scientific projects or activities.*	
	Results Statement: Progress to date has been at a high level with excellent documentation of research synthesis report and other technical reports. Production of peer-reviewed papers/books requires further effort now, as does the production of concise technical guides for policy makers.	Score: 4

Additional comments and any recommendations: The matrix of scores for various criteria should be noted in relation to overall project evaluation.

B – Best practice and longer term impact		
B1 - Governance	*Guidance: Comment on the management (practices, policies and procedures) of the project by ACIAR and by the commissioned agency and overseas institutions involved, including the adequacy of reporting and financial administration. Were all the project partners adequately and appropriately engaged in the management of the project? What could have been improved?*	
	Results Statement: The team believes that this is an extremely well run project by ACIAR, CIMMYT and the national partners. The PSC is also strong and provides excellent support to SRFSI. Reporting appears to be timely and comprehensive. Continuing attention needs to be given to minimising overhead costs so as to keep maximum funds available for the essential operational activities at the local level.	Score: 5
B2 - Appropriateness	*Guidance: Were the activities and methods appropriate and implemented with scientific rigour? Were the project partners appropriate and did they collaborate effectively? Was the project well targeted to the needs of the intended beneficiaries?*	
	Results Statement: Choices of activities and methods were quite appropriate. Most partners participated and interacted actively and complied coherently with project mandates, although delineation of tasks was not equally clear in all nodes. Project targets were fully consistent with the needs of the beneficiaries.	Score: 5
B3 - Efficiency	*Guidance: Were the inputs (money, time, personnel, equipment) appropriate in terms of the outputs and outcomes delivered by the project?*	
	Results Statement: The review team is convinced from the information provided that this project is excellent 'value for money'. In many ways, it could be argued that this project has to date, over-delivered on the investments made.	Score: 5

B4 - Effectiveness	*Guidance: To what extent did the project deliver on its aim and objectives in the partner country? Were the planned activities effectively implemented and did they deliver the outputs expected? What could have been improved?*	
	Results Statement: Project delivered outputs i.e. reduced tillage cost, increased soil health, yields and farmers' incomes effectively. Effectiveness could however be improved by intensifying communications and contacts with government departments and high policy levels.	Score: 4.5
B5 - Impact	*Guidance: Indicate how the outputs have been or may be taken up by users, and how these may generate community, capacity building and scientific impacts. To what extent were the proposed impacts achieved? What do you consider the most significant impact(s) achieved?*	
	Results Statement: Great impact on participation of women in such large numbers. Also the CA practices have been adequately demonstrated leading to enhanced confidence of farmers, both women and men, to scale up. The concept of the Innovation Platforms is a great idea. Since lack of credit was cited as one of the constraints in this area, involvement of financial institutes like banks could have intensified the impact to a great way. Also the involvement of Insurance companies and other Govt. departments (apart from department of Agriculture) could have been looked into. Also separate FGDs with only women can throw significant and different light on the impact on their lives.	Score: 4.5
B6 – Legacy - sustainability	*Guidance: Will the partners and stakeholders be able to utilise the outputs after the project ceases? Will there continue to be impacts over time? Why or why not?*	
	Results Statement: There will certainly be substantial legacy benefits from this project in terms of technologies developed and already successfully adopted by thousands of farmers. In addition, the project has also stimulated beneficial impacts in relation to diversification, mechanisation and water-use. As well as important impacts in relation to gender; service provision; and community development. These impacts would be magnified hugely with further investment and activities.	Score: 5.5

Additional comments and any recommendations:

C – ACIAR Learning	
C1 – Lessons learnt relevant to project design	*Guidance: How effective was this project's design? How did the issues raised by external reviewers contribute to this effectiveness? Are there specific lessons related to projects of this nature that could be applied to future projects?*
	Results Statement: Project design was reportedly appropriate as it was based on extensive scoping mission, review of literature, understanding of Ganges basin characteristics, agricultural research institutions, team formation with relevant expertise, appropriate partners, team training and pilot field work, and devising proper analytical methods. Research objectives were clear and activities well targeted. CIMMYT's presence and synergistic experience in other projects in the region i.e. CSISA were particularly useful for the project design. The project's design has mostly taken care of the issues raised by the external reviewers. For example, the project design talks about doing an in-depth assessment of risks & uncertainties. The external reviewers proposed the engagement of Australian experts in technical activities. During the current project review, the team found this to be happening to a great extent and with lots of passion. The project external reviewers proposed involvement of more institutions. During this review, the review team witnessed the involvement of a wide range of organizations like IWMI, IFPRI, Jeevika in Bihar, and many others. Lastly one of the external reviewers commented `*There is plenty of scope for commercialisation of the innovations to be delivered by this project. This requires strong linkages and partnership with other stakeholders and collaborating agencies'.* The current review team visited the work of one of the Service providers – the Satmile Satish Club of Coochbehar - which is already doing a great business and the project could collaborate with a number of corporate & financial entities (eg tractor companies; companies dealing with agricultural machinery; banks to get loans, etc) and has taken a giant step towards commercializing agriculture. Specific lessons relevant to project design which can be replicated: • *A focussed Pre-project planning and funding to identify and understand the area and the variability – people, land, climate, culture, constraints and many other aspects.* • *Creating a strong and cohesive multi-nation and multi-organizational network based on the values of trust and mutual respect. Unleashing the spirit of togetherness to co-create and learn.* • *Giving priority to the diverse needs of the farmers especially the women and appropriating technology to address them.* • *Excellent Project Management Leadership with an unique blend of*

	empathy and rigour provided by ACIAR & CIMMYT. • *Great focus to capacitate the stakeholders at all levels.*
C2 – Lessons learnt relevant to project implementation	*Guidance: What do you consider to be the most important factors that have contributed to the success or otherwise of the project's implementation? Are there specific lessons related to projects of this nature that could be applied to future projects?*
	Results Statement: CIMMYT's able leadership and excellent management reinforced by strong commitment of scientists to CASI. This coordinated management fashion should be applicable to future project design. Other factors are as described in C1 above. The specific lessons related to project implementation which can be replicated are: • Gender awareness and gender sensitisation along with conducting gender analysis is critical for gender empowerment. • Gender focal point helps the implementation of gender mainstreaming. • Greater awareness of modelling processes is very much required to assist stakeholders better understand production scenarios. • Long-term uptake of modelling requires recognition and support (including time commitment) from the stakeholders. • ZT technologies are sustainable, profitable and adaptable. • Building micro-entrepreneurs (farmer clubs, producers groups and service providers) for commercialization of agriculture would help to enhance productivity and income.

C3 – Lessons relevant to collaboration	*Guidance: Are there specific lessons related to specific partners or collaboration between partners that could be applied to future projects of this nature?*
	Results Statement: This shows reasonably good alignment with broader national agricultural policies and priorities for food security, poverty reduction and livelihoods development. CIMMYT's regular reviews and monitoring of field work by partners has helped achieve project goals The specific lessons related to project implementation which can be replicated are: • Creating a strong and cohesive multi-nation and multi-organizational network based on the values of trust and mutual respect. Unleashing the spirit of togetherness to co-create and learn and building a strong team are more important than just technology dissemination • From the very onset, treating farmers – both women and men - as a dignified partner and an important constituent in the collaborative process • Effectively orchestrating a web of partners and including a wide range on organizations from diverse themes including the market players and private sector, creates an economic vibrancy in the area and enhances profitability of production for the poor farmers
C4 – Follow-up and future research	*Guidance: Advise ACIAR on what, if any, follow-up activities and support are desirable to ensure long-term benefits from the project (including spill over to other countries/regions). Where appropriate, provide advice on specific research priorities for future projects*
	Results Statement: Much of this advice is included in the body of this report including specific statements of opportunities and needs for future research. There is little doubt that the current project has been outstandingly successful at many of the locations and it is the strong view of the review team that follow-up activities and support should be given high priority. Careful note should be taken of the 'lessons learned' matrix when considering follow up activities and support.

C5 – Project Document	*Guidance: The format for the Project Document is being tested within ACIAR. Did the document provide adequate guidance for reviewers (and by inference, for the team in the implementation of the project)? What are its pros and cons compared with the usual ACIAR project template?*
	Results Statement: The review team found the Project Document to be adequate and appropriate for its role and activities.

9 OPPORTUNITIES FOR FUTURE ACTIVITIES

The TOR for this review requested 'comments and recommendations' on four specific questions. The review team's responses are as follows:

- **Diversification** This should move beyond crop diversification to agricultural diversification so that farmers' resources and efforts on intensive innovations can then be targeted to non- crop enterprises using a farming systems approach. Trees and shrubs; livestock and forages should all be considered to a greater extent than they have to date. Addressing backward - forward linkages between farm and non-farm activities is another way to support diversification. Intercropping of vegetables with the new crop, maize (both winter and summer varieties) is unlikely to face risk of oversupply because consumption demand for pesticide-free fresh year round vegetables is increasing. Even if oversupply of some vegetable occurs in some seasons, these may not be wasted because they could be fed to livestock as a result of farming system diversification and/or could possibly be used for composting and mulching.

  It should be noted however, that intercropping of vegetables or fruits i.e. melon with maize on a commercial scale, would change gender roles e.g. women engage more in intercultural operations including harvesting vegetables, while men devote their time to seeding/planting, irrigation and marketing of produce. This implies gender differentiated needs for skill and capacity building as diversification is increased.

- **Knowledge gaps** One important research knowledge gap is related to sensitivity of farmers' returns from CASI technology with respect to fluctuations in market prices of crops (eg rising prices of rice often leads to slow downs in the shift from rice production to vegetables and orchard production in Bangladesh). Secondly, empirical knowledge about the impact of diesel prices, subsidies, power failures for irrigation pumps or import restrictions on farm machinery, is missing. In addition, there are technological knowledge gaps relating to seed and fertilizer placement at sowing; soil health; cover crops/mulches/manures; IPM/IWM; nutrient management especially for maize and other 'new' crops.

  In any future project and investment, a provision for establishing a national CASI oversight and policy advice unit with adequate database management capacity should be considered. A somewhat parallel example is the establishment of a Policy Support

unit with the Ministry of Agriculture in Bangladesh by IFPRI. Such a unit can act as an entry point of contact and CASI interactions with the high-level policy makers.

Other important considerations for future planning include: the main strength of partnerships is to benefit from collective thinking and informed actions for project implementation; this also creates opportunities for risk sharing. The common weakness of partnerships constitutes a lack of coordination and sometimes communications, but these weaknesses can be minimized with the selection of credible partners and good project planning. In addition, research - policy linkages are generally weak in small-holder farming situations, due to the huge number and diversity of farms on the one hand and multiplicity of institutions and stakeholders on the other hand. So, in the current partner countries where the government bureaucracy usually plays the top-down role, more direct interaction and dialogues between investors/ CIMMYT about research results could be more effective. Wherever appropriate, reference to the government's commitment to increasing commercialization in national agricultural policies can attract policy attention for scaling up of CASI technologies.

Lastly, in order for the IPs/ farmers' clubs/production organizations, to carry forward CASI as a sustainable business, cooperation from local government bodies (eg Panchayet in WB; Union Parishad in Bangladesh) is strategically important. Since it entails multi interest groups, legal and contractual obligations should be taken into consideration for sustainable operations, as well as minimizing sources of 'elite capture'.

- **Herbicides** Additional research required to develop CA systems with less dependence on herbicides is described in the body of this report and includes; seeding openers with less soil disturbance and consequent stimulation of weed germination and emergence; cover crops and mulches; more diverse rotations that contribute to IWM practices, including cut forages; relay and intercropping. It is very important that practices are not developed which require more and more herbicide usage as they will only lead to problems with resistance, residues and safety concerns.

- **Data management** The project has made very good progress to date in recording, analyzing, modeling and publishing the comprehensive datasets generated by all of the research activities. The reporting requirements of ACIAR; the regular review and planning meetings and the diligence of the research leadership have all contributed to this desirable result and each of these attributes should be reinforced in any future work. One important aspect of data management that is of particular importance, is that this research – and all research in ACIAR's portfolio - is 'research for development' and this differentiates it from most domestic research activities, where frequently, publication of results in a peer-reviewed journal is the desired endpoint. It is essential that ACIAR research data is used in ways that inform and underpin human development, particularly for the resource-poor. Therefore a strong emphasis should be placed on modeling to generate 'what if' scenarios that can advise on the future benefits of different technologies, systems and sector changes. Ready and real time access to data through web-based portals is a very important aspect for ACIAR's research data management and if not already in place should be developed and implemented. The urgency of achieving the SDGs only reinforces this need.

APPENDIX 1 – Terms of Reference

TERMS OF REFERENCE FOR THE EXTERNAL SUPPLEMENTARY REVIEW OF PROJECT "SUSTAINABLE AND RESILIENT FARMING SYSTEM INTENSIFICATION" (SRFSI)

1. Project outputs

Determine and comment on how well the project has achieved the outputs and milestones against each of the Research Objectives 1, 2 and 3, using the table in Attachment 2 (Table 5.2 in the project proposal). Comment on the links of these outputs with the ongoing Objective 4.

2. Project impacts

A number of questions will assist in determining progress towards impacts:

- Has this project had any impacts in the actual period of the project?
- What has been the uptake of the outputs of the project by the 'next users' of the research (e.g. farmers including women, policy makers, other researchers), and including spill over benefits to third parties and/or countries?
- Is the project likely to have any impacts in the five-year period after the project has been completed?

Impacts should be classified as: (i) community; (ii) capacity building; and (iii) scientific.

(i) *Community impacts (social, economic and environmental)*

Indicate how the outputs have been or may be taken up by users, and how these may be translated into economic, social or environmental benefits. Community impact should be interpreted as impact beyond the scientific sphere. It includes impact on farmers, policy-makers and consumers. These may not always be obvious or measured especially in Category 2 and 3 projects. Suggest what could be done to facilitate community impact(s) in the future.

(ii) *Capacity-building impacts*

Evaluate the extent to which the project has increased knowledge and skills of researchers particularly those of the developing country, through their participation in the project and the training elements.

Evaluate the impact on the capacity of collaborating research institutes to continue related research, and on the associated R&D institutions particularly in the collaborating developing country.

(iii) *Scientific impacts*

Assess the scientific outputs in terms of their potential contribution to other scientific projects or activities.

3. Project execution

(i) Assess the scientific methodology and rigour shown in the implementation of the project.

(ii) Consider the formal documentation including reports and publications resulting from the project and its accessibility to potential users, including development/extension agencies.

(iii) Comment on the management of the project, by ACIAR and by the Australian and overseas institutions involved, including the adequacy of reporting and financial administration.

(iv) Assess the degree of collaboration and cooperation developed during the project between countries, institutions and individuals.

4. Follow-up

Advise ACIAR on what, if any, follow-up activities and support are desirable to ensure long-term benefits from the project (including scaling out especially for Objectives 3 and 4, and spill over to other countries/regions).

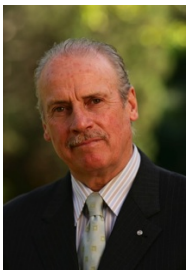
Advise ACIAR how the results of this technical phase of SRFSI as reviewed could be used to inform policy, or define policy research needs.

5. Opportunities for future activities

Provide comments and recommendations on the following specific questions:

i. How can **diversification** activities and innovations researched by the Project be scaled out beyond research; is there a risk of oversupply for the vegetables intercropped with maize if widely adopted.
ii. What are the research and knowledge gaps, limiting the dissemination and adoption of CASI in the Project target areas.
iii. What additional research would be required to develop CA system less dependent on herbicides.
iv. What actions should be taken, in the final period of the project and in any future investment, to preserve and exploit all the data collected, and identify and apply all relevant learnings, including from the Socio-Economic analysis.

APPENDIX 2 - Biodata for Review Team



Professor Timothy G. Reeves FTSE, Review Chair.

Chair, Agriculture Forum – Australian Academy of Technology and Engineering

Professorial Fellow, Faculty of Veterinary and Agricultural Sciences, University of Melbourne, Australia

Former Director General of CIMMYT, Mexico.

Tim Reeves is a graduate of the University of Nottingham (UK) and the University of Melbourne and has worked for over 50 years in agricultural research, development and extension, focussed on sustainable agriculture in Australia and overseas. He was a pioneer of no-till/conservation agriculture research when based at the Rutherglen Research Institute in NE Victoria. His professional career includes: Foundation Professor of Sustainable Agricultural Production, Adelaide University (1992-95) and Director General of the International Maize and Wheat Improvement Center (CIMMYT) based in Mexico (1995-2002). His other international roles have included: Member, United Nations Millennium Project Task Force on Hunger; and Member, European Commission Expert Group for Evaluation of Framework and H2020 Projects. He has also been a Senior Expert with the Food and Agriculture Organization of the United Nations (FAO) working on Save and Grow - sustainable intensification of smallholder agriculture - and recently (October 2016) lead a FAO consultation in Cuba, on the development and adoption of Conservation Agriculture.

He has chaired or participated in many scientific reviews, including the following: FAO/Government of India review on climate change and Indian wheat production; a review at the Global Crop Diversity Trust on behalf of the Bill and Melinda Gates Foundation; a review of the Australian International Food Security Research Centre for ACIAR; a review of the Livestock Production Innovation program for Meat and Livestock, Australia; and in 2014/5 was a member of the Bioscience Advisory Panel for Dairy Australia. Professor Reeves has been a Board Director of GRDC; the Future Farm Industries Cooperative Research Centre (CRC); the Molecular Plant Breeding CRC; and of FAR New Zealand. He is currently Board Chair of: FAR (Foundation for Arable Research) Australia; and past Chair of the Primary Industries Climate Challenges Centre (University of Melbourne/Agriculture Victoria) and the AGFACE Steering Committee (University of Melbourne/Agriculture Victoria).

Tim is an honorary Professorial Fellow at Melbourne University, where he has also been recognised as a Centenary of Agriculture Medallist. In December 2016 the University awarded him a Doctor of Agricultural Science *honoris causa.* Tim is also a former President of the Australian Society of Agronomy and in 2017 the Society awarded him the prestigious Professor C M Donald Medal for lifetime achievement. He is currently a Fellow of the Academy of Technological Sciences and Engineering, where he is also Chair of the Academy's Agriculture Forum. He is an Honorary Professor in the Chinese Academy of Agricultural Sciences. In 2003 he received the Centenary of Federation Medal. He is currently Director and Principal of Timothy G. Reeves and Associates. Pty. Ltd., specializing in national and international consulting in agricultural research. His main areas of current focus are on global food security and the sustainable intensification of agriculture and farming systems.

Mr Arnab Chakraborty has degrees from G B Pant University, and is an agricultural economist with over 20 years' experience working in PRADAN (www.pradan.net) a national NGO in India. He is a member of the PRADAN management committee and takes responsibility for spearheading the organization's mission. Arnab works in the areas of gender, behavioural change communication, knowledge management, and stakeholder management. In addition, he also specializes in integrated natural resource management to generate sustainable livelihood options for the poor.

In PRADAN he has the prime responsibility for spearheading the organizational mission to enable extremely

poor communities to take charge of their lives and livelihoods and lead a dignified life. Administratively, he provides support and mentorship to seventy extremely motivated staff in seven teams in the West Bengal state of India, working with approximately 25,000 very poor women and their institutions in pursuit of this mission. He also closely works with the state government, mapping opportunities for organizational growth in the state. He collaborates with international donor agencies like Australian Centre for International Agricultural Research and has provided leadership in successful implementation of two Integrated Natural Resource Management Projects.

Arnab has received a number of prestigious awards for his substantial achievements. These include:

- 2016 Invitation to join ICNC (International Centre for Non-violent conflict) -Fletcher Summer Institute (IFSI) for the Advanced Study of Nonviolent Conflict. He started learning about Civil resistance and Non-violent movements by implementing ICNC's LIN (Learning Initiatives Network) project
- 2016 Selected as a Global Peace Index Ambassador
- 2014 Appointed as a trusted Mentor for Australian Awards by the Honourable Australian High Commissioner, India
- 2014 Selected to receive a 2014 Rotary Peace Fellowship by The Rotary Foundation for International Studies in peace and conflict resolution program at Chulalongkorn University, Bangkok
- 2011 Invited by Rockfeller Foundation, New York for a collaborative practitioner residency at their Bellagio Center on Self Help Groups & their institutions
- 2011 & 2010 Attended the two phased International Class on Group and Short Term Psychotherapy, East Side Institute, New York
- 2009 Endeavour Executive Award given by the Australian Government to provide professional development opportunities for high achievers in business, industry, education or government from participating countries. Arnab opted to work on `Gender' & `Water' - two very important issues in India – with help from the Australian National University
- 2008 Awarded a John Dillon Fellowship, established by the Australian Centre for International Agricultural Research (ACIAR).

Emeritus Professor Dr. M. A. Sattar Mandal, former Vice-Chancellor of Bangladesh Agricultural University, Mymensingh.

Prof. Mandal, an agricultural economist, has been involved in teaching, research and policy planning in agriculture and rural development for over four decades. On his formal retirement, Bangladesh Agricultural University (BAU), Mymensingh has appointed him the first Emeritus Professor of the university in 2017.

Professor Mandal obtained first class bachelor and master degrees in agricultural economics from Bangladesh Agricultural University and did his PhD from the University of London in 1979 and post-doc research in the University of Oxford in 1986-87. Major areas of Professor Mandal's academic interests include agriculture and rural development, food and agricultural policy planning, irrigation and water resource economics, agricultural technology and rural mechanization, and agribusiness development.

Professor Mandal currently advises the Ministry of Agriculture, Government of the People's Republic of Bangladesh as a member of the Expert Pool, the board of management of the Krishi Gobeshona Foundation (KGF) of the Bangladesh Agricultural Research Council (BARC), a trustee of the Bangladesh Krishi Gobeshona Endowment Trust (BKGET), and the Technical Advisory Committee (TAC) of the KGF.

Professor Mandal was the Vice-Chancellor of Bangladesh Agricultural University (BAU), Mymensingh in 2008-2011. He is currently advises the Bangladesh Agricultural University and Sylhet Agricultural University as a member of the university syndicate.

As a member for Agriculture, Water Resources & Rural Institutions Division during 2011-2013 and as a

member for General Economics Division during 2000-2001 in the Planning Commission, the apex central planning organization of the Government of Bangladesh, Prof. Mandal contributed significantly to the improvement of the rapid approval and evaluation process of the development projects proposals.

Professor Mandal worked as a Senior Advisor to Food and Agriculture Organization of the United Nations (FAO) in Bangladesh, and is currently a member of the Independent Steering Committee (ISC) for the new CGIAR research program on Fish AgriFood Systems (FISH) of the WorldFish, Penang, Malaysia.

As a lead agricultural economist, Professor Mandal contributed to the preparation of important national policy documents including Reorganization Agricultural Marketing Department (2011), Economics of Jute Production (2010), Bangladesh Country Position Paper on Food Security for the SAARC Region (2007), Synthesis of Agricultural Policies (2006), Bangladesh Fishery Research Vision- 2015 (2006), Poverty Reduction Strategy Paper (2005), National Agriculture Policy (1999), Flood Action Plan-12 & 13 (1991), and Agricultural Sector Review (1988). He is currently chairing the expert committee for preparing the Agricultural Mechanization Policy for Bangladesh. He led many collaborative research projects with international funding and published his works widely as journal articles, reports, books and monographs.

He works in different high-level committees of the Government of Bangladesh and advises international development agencies like FAO, CIMMYT, WorldFish, Winrock, IFC, World Bank. He has worked as a visiting professor in many universities abroad including School of Development Studies of the University of East Anglia, UK in 1997 and 2000, and Faculty of Life Sciences of the Rhine-Waal University of Applied Sciences, Kleve, Germany since 2013 through 2017. Prof. Mandal was the President of Bangladesh Agricultural Economists Association and a Vice- President of Bangladesh Economists Association for several terms.

APPENDIX 3 – List of Participants

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