FEED THE FUTURE

The U.S. Government's Global Hunger & Food Security Initiative

FINAL PERFORMANCE EVALUATION OF THE FEED THE FUTURE INNOVATION LAB FOR SMALL SCALE IRRIGATION

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USAID

FROM THE AMERICAN PEOPLE

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Cover Photo: Demonstration of a rope and pulley water lifting system, Robit Bata research site, Amhara region, Ethiopia, (credit: Nils Junge)

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ABSTRACT

The Innovation Lab for Small Scale Irrigation (ILSSI) is a research project funded by the United States Agency for International Development (USAID)/Bureau for Food Security (BFS). ILSSI aims to contribute to Feed the Future's overarching goal of sustainably reducing global poverty and hunger through transforming key production systems and enhancing nutrition and food security through small scale irrigation (SSI). This external performance evaluation assessed ILSSI's achievements and provides empirical evidence supporting learning and improvement for BFS' Feed the Future work. The evaluation team (ET) used mixed-methods and multiple sources of evidence, including document review, observations, focus group discussions, key informant interviews, and field visits to Ethiopia and Ghana. The ET found that ILSSI is well managed, despite being a complex project with activities across three countries. The project provided capacity building on high-demand Integrated Decision Support System and associated models to universities, research institutes, and government entities. Farmers indicated that the new technologies and practices ILSSI introduced have potential to increase yields, incomes, and living standards. The research is high quality but several economic and social-behavioral issues, including access to equipment and supply chains, unwillingness to pay for equipment, and sparse ground support, constrain scaling up. Partners recognize these issues but note the importance of understanding and addressing them before scaling up SSI. To facilitate scaling-up, the evaluation recommends a second ILSSI phase that incorporates entrepreneurial and practical solutions for research, covers environmental and economic conditions, and focuses on market solutions and scaling innovations, while continuing to generate knowledge.

ACKNOWLEDGMENTS

This report is the result of a collaborative effort that drew on the support, inputs and advice of many people. Special thanks go to ME&A's PEEL project unit. Led by Florence Nyangara, this team – Sujata Ram, Isadora Vigier-DeLatour, Clarissa Rossi, and Johanna Beduhn, provided feedback and additional research, and were instrumental in getting the report across the finish line. The authors would also like to recognize the high levels of cooperation from the ILSSI project partners in general and the Managing Entity in particular. Led by ILSSI Project Director, Neville Clarke (Borlaug Institute/Texas A&M AgriLife), they arranged a very useful workshop with representatives of almost all key project implementers at the launch of the study. This greatly facilitated the ET's understanding of the project activities. Furthermore, anytime the ET sent questions to the Managing Entity, they were answered quickly and thoroughly. Nicole Lefore, Project Manager on behalf of IWMI, was also of great help in connecting the team with stakeholders in both countries and in responding to our inquiries. At the research sites in Ethiopia, Seifu Tilahun (Dahir Bar University, Dahir Bar) and in Ghana, Sylvester Ayambila (University of Development Studies, Tamale) were invaluable in organizing field visits and connecting the ET with key informants. Finally, the ET would like to express thanks to all the individuals (including those mentioned above) who took the time to be interviewed and share their experience and perspectives on the project. They are listed in ANNEX D, and the collective knowledge they provided forms the basis of the evaluation analysis.

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ACRONYMS

Acronym	Definition
ABM	Agent Based Model
AOR	Agreement Officers' Representative
APEX	Agricultural Policy/Environment eXtender
ARP-R	Office of Agricultural Research and Policy/Research Division
ATA	Agricultural Transformation Agency
BDU	Bahir Dar University
BDZ	Bahir Dar Zuria
BFS	Bureau for Food Security
BI	Borlaug Institute for International Agriculture
CGIAR	Consortium of International Agricultural Research Centers
CRA	Cooperative Research Agreement
CRSP	Collaborative Research Support Program
EC	Ending Cash
EQ	Evaluation Question
ET	Evaluation Team
FARMSIM	Farm Scale Nutrition and Economic Simulation Model
FEAST	Feed Assessment Tool
FGD	Focus Group Discussion
GFSS	Global Food Security Strategy
GIDA	Ghana Irrigation Development Authority
iDE	International Development Enterprises
IDSS	Integrated Decision Support System
IFPRI	International Food Policy Research Institute
IL	Innovation Lab
ILRI	International Livestock Research Institute
ILSSI	Innovation Lab for Small Scale Irrigation
IP	Implementing Partner
IRB	Institutional Review Board
IWMI	International Water Management Institute
KII	Key Informant Interview
KNUST	Kwame Nkrumah University of Science and Technology
M&E	Monitoring and Evaluation
ME	Management Entity
MIS	Management Information System
MTR	Mid-Term Report
NCA&T	North Carolina A&T University
NCFI	Net Cash Farm Income
NGO	Non-Governmental Organization
NPV	Net Present Value
O&M	Operations and Maintenance

Acronym	Definition
PEEL	Program Evaluation for Effectiveness and Learning
SIIL	Sustainable Intensification Innovation Lab
SNNP	Southern Nations, Nationalities, and Peoples
SRI	System of Rice Intensification
SSI	Small-Scale Irrigation
SUA	Sokoine University of Agriculture
SWAT	Soil and Water Assessment Tool
TAMUS	Texas A&M University System
TDR	Time Domain Reflectometry
UDS	University of Development Studies
U.S.	United States
USAID	United States Agency for International Development
USG	United States Government
WFD	Wetting Front Detector
WRI	Water Resource Institute
WUA	Water User Association
ZOI	Zone of Influence

EXECUTIVE SUMMARY

Evaluation Purpose

This is a report on the final performance evaluation of the Innovation Lab for Small-Scale Irrigation (ILSSI) project, funded by the United States Agency for International Development (USAID). The evaluation was commissioned by the USAID Bureau for Food Security (BFS) and was independently conducted by an external evaluation team (ET) assembled by the Program Evaluation for Effectiveness and Learning (PEEL) project, led by Mendez England & Associates (ME&A). The purpose of the evaluation was to evaluate the management and implementation of the research program on: 1) identification of technologies and practices as well as related production, environmental, economic, nutrition, and gender impacts; 2) constraints and opportunities; and 3) capacity development and stakeholder engagement. The primary audience for this evaluation is the USAID/BFS, Office of Agricultural Research and Policy/Research Division (ARP-R), and the ILSSI Implementing Partners (IPs).

Project Background

ILSSI is one of 24 Feed the Future Innovation Labs (ILs), formerly known as Collaborative Research Support Programs (CRSPs). The project started on August 13, 2013, and is expected to conclude on August 11, 2018. It is implemented by a consortium led by the Norman Borlaug Institute for International Agriculture/Texas A&M University (BI/TAMU). The overarching goal of ILSSI is to help farmers use scarce water resources effectively on limited landholdings, while monitoring results and evaluating impacts. ILSSI also seeks to empower women by using small scale irrigation (SSI) to create opportunities for greater engagement, economic control over household resources, and training. On a higher level, the project aims to contribute to Feed the Future's overarching goal of sustainably reducing global poverty and hunger by transforming key production systems and enhancing nutrition and food security through agriculture. Project activities were undertaken in Ethiopia during the first year, and were extended to Ghana and Tanzania during the second year. Implementation in Ghana was delayed due to disruptions related to the Ebola crisis that affected operations in Ghana.

Evaluation Design, Methods, and Limitations

ILSSI's evaluation addressed 10 main questions that related to three overarching project components: 1) Program Management; 2) Research Program; and 3) Program Future. The evaluation questions (EQs) were answered predominantly through qualitative methods of data collection and analysis. The decision to use a qualitative approach was driven by several factors, including: the nature of ILSSI (a research project); the focus of EQs on issues which are well suited to evaluative inquiry (e.g. 'how' and 'why' questions), but which are not well captured by closed-ended questions (e.g. 'what' questions); and the diversity of stakeholders and the modes of intervention. Primary data was collected in Ethiopia and Ghana. The ET conducted two rounds of interviews with a total of 55 key informants. The first round was conducted in-person with a total of 38 key informants, 20 from Ethiopia and 16 from Ghana. The second round was conducted by telephone, primarily with IPs and with USAID (for a total of 17 key informants). In addition, the team held four focus group discussions (FGDs) with 32 farmers (16 men and 16 women) in the research sites. To quantitatively gauge stakeholder perspectives on the project's management effectiveness and satisfaction with the technologies farmers used, two Likert-scale type questionnaires were included and administered during key informant interviews (KIIs) and FGDs. Only 43 out of 55 KIs were given the questionnaire about the project, and all of them responded with a rating. During FGDs, all 32 farmers were given the satisfaction with technologies questionnaire, and all responded with a rating.

The evaluation had several limitations, with the most important being limited time and resources that prevented the team from visiting a third country - Tanzania. The timing was also an issue, as the evaluation took place during the rainy season when the irrigation was not being practiced.

Main Findings and Conclusions

The main evaluation's findings and conclusions are summarized in the table below.

FINDINGS	CONCLUSIONS
EQ.1: In what ways could program management, communication, coordination and implementation be improved to better achieve goals and objectives?	
On a scale of 1 to 5, where 1 means 'very poorly managed' and 5 means 'very well managed,' project management scored 4.2. Thirty-seven out of the 43 respondents (86 percent), gave a rating of 4 or higher. The rating is somewhat higher in Ethiopia than Ghana, which likely reflects the greater government engagement and institutional capacity in Ethiopia. The project was well managed and largely implemented according to plan. Initial challenges included resource constraints, crop disease, flooding/droughts, data collection and the Ebola crisis in Ghana. These issues were worked out over the early 'learning period.' Both coordination and communication functioned well at the time of the evaluation. For some CGIAR (Consortium of International Agricultural Research Centers) partners and their subcontracted local research institutes, the one-year Cooperative Research Agreements were a constraint that made financial management challenging and motivation of researchers difficult.	While there are areas for improvement, ILSSI management has performed well. Key influencing factors include prior collaboration experience, strong expertise, commitment, good communication, and coordination between partners. Clearly, government engagement and responsiveness have an impact. ILSSI is a complex project, with many partners operating at different levels, in three different countries, and conducting a wide variety of activities. Given the project's complexity, the evolving context, and unanticipated problems outside of the project's control – the Ebola crisis in Ghana, flooding and droughts at some sites in Ethiopia, and pests and diseases which ruined crops – ILSSI's management can be commended for its performance. One area that stakeholders would like to see improved is having contracts that are longer than one-year, in order to be able to motivate researchers and keep them employed.
EQ 2: How well has the ILSSI project identified promising SSI interventions, technologies and management practices using criteria that are context specific, evidence-based and robust? To what extent are these criteria relevant and scientifically rigorous?	
ILSSI's interventions are based on existing evidence and adapted to the context. The interventions are generally appropriate for research purposes, and specific to the natural resource and social context. Interventions under different conditions have generated rich data and insights on key issues, such as links between SSI and gender and SSI and nutrition. Key informants reported that the selection of interventions was driven partly by local preferences and partly by research design imperatives (top down and bottom up). Selection of technologies was made in a consultative manner between project implementers, and national and district stakeholders. Finally, farmers themselves had to agree to use the technologies. According to trial farmers, the SSI technologies are useful and have increased their yields. However, the assumption that producers apply the optimal amount of water to their plots was difficult to test.	The project research design was based on real world conditions and incorporated past research findings, such as the links between SSI, gender, and nutrition. Based on farmer satisfaction levels, and the project partners' willingness to switch out technologies and incorporate farmer feedback into the design, the technologies used appear to be relevant and appropriate, in large part because they were identified in collaboration with national partners and governments. The project rates well across a series of indicators related to research rigor, but there is room for improvement. For example, conceptual design, sampling methods, use of meaningful comparators, rate well. However, there were some early issues with data collection and quality control although they were later addressed.

FINDINGS	CONCLUSIONS
While most FGD participants expressed high levels of satisfaction with the technologies, they nonetheless noted various issues they faced, including clogging of drip lines, difficulties for women in lifting water to fill tanks, disease and pests, etc. The project has proven flexible enough to explore research areas which were not part of the original plan, and to make changes to the technologies. The introduction and popularity of irrigated fodder at selected sites was an unanticipated success. Farmers appear to be unaware of the cost of equipment they received as part of the project. Lack of awareness of costs was partially explained by the fact that participating farmers did not have to find and purchase the technology on the market, but received it from the project. Arrangements made for financing technologies provided to project farmers proved challenging and apparently were not clear to farmers. Access to finance for smallholder farmers is an issue in the project regions, where microfinance options are limited.	Research conducted to date indicates that while most forms of SSI are potentially profitable, local conditions and preferences are strong determinants of what type of technology and practices will be used. The emerging finding that most SSI technologies are economically feasible is good news for both sustainable intensification in general, and for the ILSSI project in particular. While not neglecting the issue, the project has paid less attention to access to and affordability of equipment. Lack of awareness on the part of project farmers of the cost of equipment, makes it impossible to assess farmers willingness to pay for these technologies. The biggest challenge to scaling up may be willingness to pay. With the introduction of new SSI technology and practices, crop production can, without adverse environmental impact, be increased in regions with sufficient groundwater resources. However, potential for scaling up does not mean scaling up will occur automatically. In fact, there appear to be significant constraints related to farmers' awareness of costs and willingness to pay. The financial arrangements for technologies provided to project farmers was not fully understood and some local stakeholders were "*concerned about creating unrealistic expectations in the study areas.*"
EQ 3: To what extent have the following concerns been incorporated in the identification, evaluation and testing of selected technologies, including the consideration of potential trade-offs and synergies: productivity, environmental, economic, nutritional, and gender impacts? In what ways have opportunities to exploit SSI in an environmentally sound way been assessed and carried out? What could be done differently to better address these concerns?	
All 32 farmers interviewed during FGDs reported that their crop yields had increased - in some cases significantly (e.g. double) - following use of the new technologies or practices, enabling them to improve their living standards and or/income. The project has conducted cost-benefit analysis on four SSI interventions and four dry season irrigated crop types to assess their economic viability and profitability. The ET found that the project has addressed environmental issues from various angles through its modeling and analytical work on SSI, and through Environmental Monitoring and Mitigation Plans (EMMPs). However, real world conditions ended up having an impact on the experiments. One Ethiopia-based key informant noted that the project did not consider risks of pests and diseases, although they are common in dry season irrigation in the region. In both Ethiopia and Ghana, drought, pests, and disease became a significant problem, both for farmers and for the research. In Ghana, problems became so severe that a research site, Dimbasinia, had to be dropped (which implementers note is not uncommon in field research projects).	ILSSI has devoted significant attention to and has successfully incorporated productivity, gender, nutrition, and environment issues into the research design and analysis. ILSSI is contributing to the research literature through generating new knowledge about the under-researched issues around gender and irrigation. The approach to incorporating economic issues into the analysis is valid but may be too narrow. While the project recognizes economic constraints to scaling up in theory, it has spent less time assessing what it would take for the technologies to be adopted more widely, in the absence of the project. The project could have done more to address issues around access to finance, the credit environment, willingness to pay for SSI equipment, and behavioral changes. While it did work to develop microfinance institution capacity to facilitate credit to farmers for equipment, this is a new area of lending for them. All these issues have major implications for scaling up.

<table>
<tr><th>FINDINGS</th><th>CONCLUSIONS</th></tr>
<tr><td>Intermediate nutrition indicators were incorporated into the panel household survey implemented by IFPRI, and differences were found between baseline and endline for dietary diversity. However, identifying nutritional impacts as reflected by physiological changes (stunting, wasting, and neurological impacts) goes beyond the scope of the research capacity.

All key informants agreed that the project has been sensitive to and has mainstreamed gender issues throughout its four components. Links between irrigation and gender are expected to generate new insights. An isolated case in Ghana pointed to how values occasionally diverge between communities and researchers when it comes to women's empowerment.</td><td>The project is addressing nutrition issues through the IFPRI household level analysis. While the study is assessing how and whether household diets change as a result of practicing SSI — this is an intermediary outcome. If the project produced correlations between household use of SSI and stunting/wasting, this would contribute to evidence of positive irrigation impacts.

Gender issues have been taken into account in every applicable aspect of project design and implementation. Based on FGD reporting, the focus on empowering women is also in line with national policy and farmers' values.</td></tr>
<tr><td colspan="2">EQ 4: What ILSSI technologies are more likely to be adopted by farmers (including women) and scaled sustainably in each of the three countries? And why, why not? (e.g. access to finance, potential availability of replacement equipment, training needed, etc.)</td></tr>
<tr><td>Labor costs and intensity are key determinants of SSI technology preferences. As such, solar pumps and drip-irrigation with mulching show particular promise.

The most commonly cited technology among key informants with potential for upscaling is the solar-powered pump[1], which requires no manual lifting or operating costs. However, willingness to pay for such technology appears to be an issue.

Women farmers prefer technologies that do not require heavy manual labor like lifting and carrying buckets, such as pulley and rope.

There is minimal evidence of spontaneous adoption of project SSI technologies or practices, except for dry-season forage. However, the approach the project partners took was to generate knowledge on what works (best) during an initial phase, before finding ways of promoting uptake nationally.

Farmer behavior change will be critical for adoption but its inclusion in the model is limited. Farmers are naturally conservative, given the risks they bear if an innovation fails, and are unlikely to try something new unless they see that is working for their neighbors.</td><td>Farmers prefer technologies with lower operating costs and labor intensity. Many of the farmers interviewed were unaware of the cost of the SSI technologies they were using. This is explained, in part, by the fact that they did not purchase the technology but received it from the project on terms that they may not have understood or did not recall.

From the interviews, farmers appear to prefer technologies that require lower operating costs and lower labor intensity even though they understand that the use of some SSI technologies will help increase productivity.

The models used by ILSSI are useful for assessing SSI potential in terms of geographic suitability, sustainable recharge, economic returns, and appropriate crops. However, they appear to be somewhat limited in what they say about social and behavior change bottlenecks. If SSI is to offer a path to sustainable intensification, incorporating these and other potential bottlenecks described in the report either through a follow-on phase for ILSSI, or through other projects, will be critical.</td></tr>
</table>

[1] Note that evaluators were unable to visit research sites where solar-powered pumps were being tested.

FINDINGS	CONCLUSIONS
EQ 5: What types of opportunities and constraints have been identified related to the widespread adoption and scaling of small-scale irrigation technologies and practices by smallholder farmers? In what ways, if any, have opportunities been maximized to support scaling? What approaches have been identified to address these constraints? What could the project do to better address the challenges to improved access and use for smallholder farmers?	
The evaluation has identified a range of constraints and opportunities: Constraints include: i) risks faced by farmers, such as crop damage due to drought, pests, disease, and flooding, which make them reluctant to invest in SSI technology; ii) lack of capacity of the extension services in each country, but especially in Ghana, and lack of other sources of support and technical assistance; iii) limited percentage of cultivable land suitable for SSI; iv) lack of understanding by many farmers of water saving technology, or its importance; v) high interest rates and lack of collateral, which limit the ability of farmers to borrow; vi) lack of working capital for buying and maintaining equipment; vii) a weak linkage between research and the watershed management program; and viii) water rights, which may be an issue, especially in Ghana.	The project implementers are aware of the constraints and have incorporated them into their modeling and analysis in various ways. At the same time, many constraints fall outside the area of focus or expertise of project partners. As is clear from the large number of constraints identified, a host of issues remain before SSI can be taken from research level to national scale. Researching these constraints is a key goal of the project. Given the many issues, there is much more work to be done on SSI. At the same time, ILSSI has identified many opportunities for promoting SSI in general, and SSI scaling in particular. While ILSSI has highlighted these opportunities – such as the IDSS dashboard, the project's interdisciplinary approach, and watershed management - and is addressing a select number of them, there are clearly additional critical areas for research, collaboration and engagement, which a second phase of ILSSI can and should take advantage of.
Opportunities include: i) ILSSI's interdisciplinary approach is able to address issues in an integrated way; ii) the Integrated Decision Support System (IDSS) dashboard, which ILSSI modelers are in the process of developing, would allow different stakeholders (including policy makers, extension services and farmers) to use the IDSS to plan and assess investment options; iii) introduction of measurement instruments can help control the leaching of nutrients from the soil; iv) watershed management can be improved by applying engineering and bioengineering technology; v) because institutions in Ghana have not yet been closely engaged in the project, there are opportunities to ramp up government involvement in SSI.	

FINDINGS	CONCLUSIONS
EQ 6: In what ways are relevant partners, including USAID missions, CGIAR Centers, NGOs, host country governmental and academic institutions, and community stakeholders being engaged? What potential is there for other partnerships and collaborations, including other Feed the Future Innovation Labs and other relevant USAID programs in the target countries?	
ILSSI IPs took systematic and concerted actions to engage with national-level country stakeholders. ILSSI IPs have been strongly engaged with key stakeholders outside the project. Collaboration on research with other projects working on irrigation issues has been a key feature of ILSSI. Project partners have clearly given significant attention to how best to engage and communicate with stakeholders and are asking the right questions on how best to approach this, e.g. meetings, through networks, platforms, and the media. The engagement of other stakeholder groups has received less attention and presents an opportunity for future engagement. According to key informants, the reasons the project has not engaged with these actors as fully as it could have related to their capacity, country priorities, as well as the project's focus on generating data on suitability for upscaling, rather than addressing bottlenecks.	The highly participatory nature of the project is its key strength, but successful engagement depends on both the project implementers and on the country. The contrasting experiences of Ethiopia and Ghana demonstrate that stakeholder engagement requires reciprocity to be effective. Ethiopia's more centralized government institutions, the prioritization of SSI, and strong research capacity facilitated project engagement. Stakeholders at an individual level were engaged in Ghana, but at the institutional level engagement was somewhat weak. Specifically, there was less collaboration with relevant government agencies [Ghana Irrigation Development Authority (GIDA) and Water Resource Institute (WRI)].
Interviews with key informants made clear that they are committed to and interested in the ILSSI project. They noted the professional benefits and opportunities, the increase in knowledge and capacity, and the positive interactions between the partner institutions. Agricultural extension services may be the weakest link from the perspective government support to scaling.	Engagement of different stakeholder groups will likely be necessary for promoting scaling up SSI in a follow-on phase. While it is understandable that development partners such as non-government organizations (NGOs) are minimally involved at this stage of the project (iDE being an exception), which is heavily research-focused, they can serve a valuable role in mobilizing farmers, building their capacity, and helping spread the technology. Although reforming or building the capacity of the extension service is not the project's mandate, promoting SSI would naturally fall under the mandate. However, extension services in both countries are under-resourced to perform the responsibilities they already have.

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<tr><th>FINDINGS</th><th>CONCLUSIONS</th></tr>
<tr><td colspan="2">EQ 7: Are the appropriate type and number of people being targeted for the right kind of training? What improvements, if any, are needed in how academic and technical capacity strengthening activities are identified and implemented?</td></tr>
<tr><td>The project has a well-developed, systematic approach to building national stakeholder capacity, with an emphasis on providing training on decision support tools and analysis.

ILSSI has implemented a multi-pronged capacity building program that targets different levels. Stakeholders report that training provided by ILSSI is welcomed, relevant, highly appreciated, and meets demand.

The main challenge with training on IDSS and associated models is that country data is often scarce — this has implications for accuracy. Specific attention has been paid to female participation in training on models and IDSS. The only concern has been the need for more and better data to use in the training and modeling, especially in Ghana.</td><td>The training quality is high and many national stakeholders are benefiting. The training on IDSS to country nationals is well-targeted, and demand is high.

Data quality and availability poses a problem in both countries. The amount of data needed for the modeling, especially SWAT, is often insufficient, with implications for the ability to construct accurate and useful models.

Affirmative action used to select trainees favors women applicants, ensuring most applicants are accepted.

O&M appears to be one of the areas where capacity is lacking the most.</td></tr>
<tr><td>The institutions in greatest need of capacity building are the national extension services, in both countries, where capacity is reportedly weak and resources are scarce.

Although farmers received training in a range of areas, including water and soil management, irrigation scheduling, and conservation agriculture, key areas where capacity is still lacking appears to be operating and maintaining (O&M) the equipment.</td><td>Capacity appears to be weakest at the level of the extension services. Although this is a government responsibility, the extension service in both countries (but especially so in Ghana) lacks the resources to advise and train farmers on SSI.</td></tr>
<tr><td colspan="2">EQ 8: In what ways, if any, have the training programs contributed to strengthening institutional capacity in target countries?</td></tr>
<tr><td>IDSS appears to have influenced informing policymaking and institutionalization within the research community. Bahir Dar University (BDU), Ethiopia, has entered into an agreement with the Blue Nile Water Institute (BNWI) to include IDSS as part of its curriculum with the aim of spreading IDSS use throughout East Africa.</td><td>In Ethiopia, training in IDSS and associated models is likely to continue exerting a positive influence on SSI promotion. Training in the models is likely to continue to exert a positive influence on Ethiopia's promotion of SSI.

In Ghana, insufficient government buy-in and weaker engagement by ILSSI with government agencies suggests that institutionalization of the ILSSI may not take place without additional efforts to demonstrate SSI benefits and to engage with government agencies.</td></tr>
<tr><td>Individuals who took the training already belong to organizations (or are likely to join organizations) where they have the ability to use the acquired knowledge. Two experts who received training at University of Development Studies (UDS) in Ghana and are employed as lecturers reported that they are already using what they learned in their coursework for their students.

In Ghana influence is likely to spread through individuals applying it, rather than through institutionalization.</td><td>The greater the technical capacity of policy makers and researchers to conduct, understand, and use research, the greater the chances SSI will be effective and scaled. This is especially true when spontaneous adoption of new technologies is unlikely, as the ET believes is the case in the target countries due to behavioral change issues, supply chains, access to credit, and affordability.</td></tr>
</table>

FINDINGS	CONCLUSIONS
EQ 9: To what extent does/will ILSSI's research align with the Feed the Future research strategy (and the Global Food Security Strategy)? What adjustments may be necessary to the research to ensure better alignment with the Global Food Security Strategy?	
Both ILSSI's objectives and activities generally align with the Global Food Security Strategy (GFSS) objectives - especially the higher-level objectives of increasing productivity and enhancing nutrition and food safety. ILSSI contributes to Feed the Future's research focus areas in rationale, approach and goals. ILSSI's activities are carried out in Feed the Future Zones of Influence in the three countries. The project clearly aligns with the Feed the Future Research and Capacity Building focus areas. However, compared with field research, modeling and training activities, ILSSI has placed relatively little emphasis on engagement with private sector partners, which both Feed the Future and the Strategy envision as a pathway out of food insecurity and poverty.	With some exceptions, ILSSI is broadly in line with both the Feed the Future and the GFSS. ILSSI is addressing a relatively new area of research and investment. SSI is still not widely known or practiced in the ILSSI countries relative to its potential (although it is still several times larger than large-scale irrigated areas). Compared with large-scale irrigation schemes, up until recently Africa has seen less investment or focus on SSI. SSI thus has significant potential to contribute to productivity (with accompanying social and economic benefits) for many smallholder farmers.
ILSSI's objectives align with the GFSS' objectives. Bearing in mind that the GFSS was developed well after ILSSI was designed, their focus areas and goals also overlap. This is especially the case for higher level objectives of increasing productivity and enhancing nutrition and food safety.	There are opportunities for ILSSI to incorporate more of the GFSS. If, and when, SSI approach succeeds in increasing production at scale in a given region, then the issue of accessing markets to sell their product will become critical for smallholder farmers. If smallholders are to go beyond subsistence farming, i.e. producing primarily for own consumption, and have opportunities for income generation, then challenges related to credit, infrastructure, distribution, wholesale markets, and agro-processing, among other things, will need to be overcome. Most of these challenges will involve the entrepreneurial skills of private sector actors.

RECOMMENDATIONS

The recommendations are presented by theme:

Project management — ***Institutionalize an internal feedback mechanism among project partners to enable them to easily communicate concerns.*** These mechanisms should be worked out among the partners themselves and agreed with management. The feedback would then be part of the agenda at project management meetings where mutually satisfactory changes can be discussed and decided.

In the future, ***partners recommend that USAID and TAMU should consider having contracts that are longer than one-year,*** in order to be able to motivate researchers and keep them employed.

Include and engage one or more organizations active in the entrepreneurial space, which can promote scaling up of SSI technologies. Bringing more partners into the project would enable ILSSI to expand its focus from research and capacity building to translating research findings and promoting adoption and scaling up of the technology. There is considerable activity promoting innovations around the world, much of which is compiled on the Global Innovation Exchange. The remit of this 'social entrepreneur' partner would include research and promotion of innovative practices and their dispersion, technology and practices marketing, incentives, public communication, impact investing, social behavior change (including areas like 'nudge theory' relating to unforced compliance), and producer affordability and willingness to pay issues.

Risk assessment and mitigation — ***Future projects should prepare contingency plans and include them in the project design***. Plans should consider potential issues (crisis, diseases, and droughts) that could affect implementing the work in a timely manner. Planning for how to respond to scenarios ranging from natural disasters, pests, diseases, and droughts, to issues like data collection problems, weak policy responses, or weak engagement could reduce disruption. Future project phases can use lessons learned through commonly and periodically encountered 'shocks.'

When scaling up, assess adverse impact on groundwater. Conduct groundwater table monitoring, especially where irrigation demand appears to exceed groundwater recharge, as may occur in Ethiopia if SSI is widely embraced. Groundwater modeling such as MODFLOW (or other appropriate model) can be useful, and can be integrated with the holistic approach of ILSSI.

Address constraints — In future similar projects as ILSSI, ***the design of equipment financing should be given greater attention from the start.*** That is, the beneficiaries/research participants should know about the cost sharing and cost of technology they need to pay before the field research activities are launched. Leasing or rental arrangements should be explored. The terms of how equipment is provided to farmers should take into account the constraints identified as part of the current project — including microfinance sector capacity, farmer awareness of terms, information about technology costs, and behavior issues like willingness to pay and appetite for risk.

Ensure that models incorporate constraints to upscaling. The models ILSSI uses are useful for policymakers to predict potential for scaling in terms of suitability. In terms of behavioral and social dimensions of SSI adoption and scaling, the models have limitations. A Management Information System (MIS) can be established with the help of models and upgraded by local users (universities or academic institutions). Updated models will be useful for the decision-making authorities. Key questions the models could incorporate as parameters are:

- How can the knowledge produced by the project best be passed on to farmers in areas suitable for SSI (beyond farmers participating in the research or other farmers in their communities)?
- What will it take to convince farmers to adopt it?
- How can the capital investments needed for SSI technology be made affordable?
- How can technical advice be provided to farmers so that they use the new technology in an appropriate manner, given the weak capacity of national extension services?

Explore building on the model of lead farmers (Farm Business Advisors), as used under the project implemented by International Development Enterprises (iDE). This could be facilitated by a project partner, or NGOs with entrepreneurial focus or impact investing, and expanded to regional and national levels. It would be challenging, costly, and time-consuming to build capacity of vast national extension services, so alternate ways of spreading SSI technology knowledge and practices are a more viable solution. Ideally, innovation adoption spreads spontaneously through farmers observing each other and taking calculated risks. However, for now, the lack of supply acts as a natural barrier to adoption.

Expanding and rebalancing the scope of research — If future projects focus on application or scaling, ***a new balance will need to be struck between knowledge generation and real world practical application research***. The broader set of stakeholders would include NGOs with a social impact focus, entrepreneurs, and others with knowledge, capacity, and motivation to build supply chains and access to finance.

There is a need for research to support and facilitate adoption, but the project should expand interventions to encompass research on adoption and scaling. This could include identifying policy support and interventions that would stimulate supply chains, markets for equipment, and manufacturing (see Section 4.4 on scaling). Illustrative research topics could be:

- Markets and value chains/supply chains for equipment – private sector (in Ethiopia);
- Behavior change and communication — under what conditions farmers are willing to invest;

- Innovation adoption and scaling; and
- Farmers' willingness to pay (for technology, advisory services).

More in-depth research on linkages between SSI and nutrition could be conducted, with the caveat that this issue is considered sufficiently important by policy makers and project stakeholders to allocate funding. The research could involve panel surveys comparing stunting/wasting indicators in children over time. However, if there is sufficient evidence, generalizable to the countries in question, in the literature, suggesting nutrition is positively affected by dry season irrigation, more research may not be necessary.

Entrepreneurial and private sector components should be integrated into research work. To align with GFSS' focus on impacts, and to incorporate private sector partnership objectives, engage more closely with private sector actors in regions where SSI can scale. The ET recognizes that stimulating the private sector is a development matter associated with the field of impact investing, but it will likely be critical to scaling up.

Costs and benefits to producers — ***deepen the understanding of costs and benefits from the producer perspective and build greater awareness in farmers on the benefits of appropriate SSI technologies***. Methods may include:

- Distribution of printed information, such as brochures, to districts where SSI is feasible. Given lower rural literacy rates, brochures could be illustration-heavy, depicting technologies, practices, benefits, procedures, risks, etc.
- Establishing a program for model farmers to demonstrate the benefits on their own farms. In tandem, develop a program for model farmers to advise other farmers. Supporting model farmers may require significant planning, resources, and coordination with the national extension services.

Identify innovative approaches to make technologies more affordable. This could involve farmers pooling resources to buy equipment to share, or an increase in the number of entrepreneurs who rent out equipment and offer operation and maintenance (O&M) services.

Capacity building and engagement — Increase partnerships and facilitate networks of stakeholders to leverage resources for ***training and providing national extension services in areas where SSI is suitable.***

Make more proactive efforts to bring in national institutions in Ghana. GIDA and WRI staff suggested a strong interest in a closer partnership. For results of research to leave a lasting impact, national institutions responsible for research and policy need to be integrated as partners.

Increase affiliation of educational and research institutions with SSI initiatives. Other institutions, such as Farm Training Centers, can be included in research work.

Develop deeper national capacity in Ghana by encouraging more researchers and students to pursue studies relevant to SSI. This may require greater outreach efforts or partnering more closely with research institutes or universities with greater capacity for modeling, such as Kwame Nkrumah University of Science and Technology (KNUST). For lasting impact, ILSSI should find champions at government agencies and research institutions willing to promote SSI research and modeling, involve a greater number of government agencies active in agriculture related fields, and organize frequent workshops.

Develop instruction manuals for farmers so that research findings can be systematically translated from the field to farmers and other stakeholders. Manuals for farmers and extension agents would help spread awareness, understanding, and proper implementation of SSI methods and technologies. Given that many farmers are illiterate, the manuals could have a significant pictorial element.

1.0 EVALUATION PURPOSE AND QUESTIONS

1.1 Evaluation Purpose

This is a report on the performance evaluation of the $12.6 million Innovation Lab for Small-Scale Irrigation (ILSSI) project. The project is funded by the United States Agency for International Development (USAID) and implemented by a consortium led by Norman Borlaug Institute for International Agriculture/Texas A&M University System (BI/TAMUS). ILSSI seeks to promote innovative irrigation practices and technologies in sub-Saharan Africa by supporting research on small-scale irrigation (SSI) in Ethiopia, Ghana, and Tanzania.

The purpose of the ILSSI evaluation was to assess the management and implementation of the research program and progress toward outcomes, including: 1) identification of technologies and practices as well as related production, environmental, economic, nutrition, and gender impacts; 2) constraints and opportunities; and 3) capacity development and stakeholder engagement.

The evaluation findings, conclusions, and recommendations are intended to inform USAID's Bureau for Food Security (BFS), Office of Agricultural Research and Policy/Research Division (ARP-R), in its decision-making concerning the continuation and/or expansion of ILSSI and other Innovation Lab (IL) investments. The evaluation results will be shared with implementing partners (IPs), universities, and other stakeholders to improve research, implementation, potential for scaling, and capacity development. The evaluation results may also be relevant to others involved in designing research for development programs.

1.2 Evaluation questions

As per the Expression of Interest (EOI), the evaluation team (ET) structured the evaluation by the evaluation questions (EQs) that are closely aligned with the three components of the project. The questions and accompanying guidance and headings are presented in their original formulation.

Program Management

1. In what ways could program management, communication, coordination and implementation be improved to better achieve goals and objectives?

Research Program

The following questions show an approach to linking the questions more explicitly to the four components of the project (see underlined below):

<u>Identifying promising, context appropriate, SSI interventions, management and practices for poverty reduction and improved nutrition outcomes</u>

2. How well has the ILSSI project identified promising SSI interventions, technologies and management practices using criteria that are context specific, evidence-based and robust? To what extent are these criteria relevant and scientifically rigorous?

<u>Evaluating production, environmental, economic, nutritional and gender impacts, trade-offs and synergies of SSI</u>

3. To what extent have the following concerns been incorporated in the identification, evaluation and testing of selected technologies, including the consideration of potential tradeoffs and synergies: productivity, environmental, economic, nutritional, and gender impacts? In what ways have opportunities to exploit SSI in an environmentally sound way been assessed and carried out? What could be done differently to better address these concerns?

4. What ILSSI technologies (solar irrigation, irrigated fodder, conveyance methods such as drip irrigation, etc.) are more likely to be adopted by farmers (including women) and scaled sustainably in each of the three countries? And why, why not? (e.g. access to finance, potential availability of replacement equipment, training needed, etc.)

<u>Identifying key constraints and opportunities to improve access to SSI technologies and practices</u>

5. What types of opportunities and constraints have been identified related to the widespread adoption and scaling of SSI technologies and practices by smallholder farmers? In what ways, if any, have opportunities been maximized to support scaling? What approaches have been identified to address these constraints? What could the project do to better address the challenges to improved access and use for smallholder farmers?

<u>Capacity Development and Stakeholder Engagement</u>

6. In what ways are relevant partners, including USAID Missions, CGIAR (Consortium of International Agricultural Research) centers, non-governmental organizations (NGOs), host country governmental and academic institutions, and community stakeholders being engaged? What potential is there for other partnerships and collaborations, including with other Feed the Future ILs and other relevant USAID programs in the target countries?
7. Are the appropriate type and number of people being targeted for the right kind of training? What improvements, if any, are needed in how academic and technical capacity strengthening activities are identified and implemented?
8. In what ways, if any, are trainees likely to put into practice the knowledge and skills acquired? In what ways, if any, have the training programs contributed to strengthening institutional capacity in the target countries?

Program Future

9. To what extent does/will ILSSI's research align with the Feed the Future research strategy (and the Global Food Security Strategy)? What adjustments may be necessary to the research to ensure better alignment with the Global Food Security Strategy?
10. If renewed for a second phase, what changes, if any, are needed to improve the ILSSI' management, research (i.e., design, implementation, communications, stakeholder involvement etc.) and/or training (i.e., student recruitment and selection, content, location etc.) programs, and/or institutional capacity collaboration?

2.0 PROJECT BACKGROUND

Overview

Feed the Future Initiative's Food Security Research Strategy goals are to advance the productivity frontier, to transform key production systems, and to enhance nutrition and food safety through agriculture as a way to contribute to Feed the Future's overarching goal of sustainably reducing global poverty and hunger. The Initiative focuses on helping smallholder farmers increase productivity and resilience to drought. This is done through research on innovative technologies, practices and management led by U.S. universities in partnership with research institutions and governments in the target countries.

ILSSI is one of 24 Feed the Future ILs, formerly known as Collaborative Research Support Programs (CRSPs). The project started on August 13, 2013, and is expected to end on August 11, 2018. The ILSSI project was required to "*identify promising small-scale irrigation technologies, practices, and strategies at the farm-level that have the potential to improve agricultural productivity, reduce farmer risk during the dry season, improve dietary diversity and nutrition outcomes, and reduce poverty*."[2]

Project goals

According to the ILSSI's cooperative agreement, the project's goal is to conduct research aimed at increasing food production, improving nutrition, accelerating economic development, and contributing to environmental protection. In addition, ILSSI seeks to empower women by creating opportunities for greater engagement, economic control over household resources, and training. ILSSI's high level goal is to contribute to Feed the Future's overarching goal of sustainably reducing global poverty and hunger. Specifically, ILSSI was designed to help farmers use scarce water more effectively on limited landholdings, while monitoring the results and evaluating the impacts.

ILSSI addresses issues of biophysical, infrastructure, economic, and societal constraints; location-specific natural resources; agricultural needs of women and men; agricultural input requirements; and impacts on food production, land and water resources. Its activities were undertaken in Ethiopia during the first year, and were extended to Ghana and Tanzania during the second year. Implementation in Ghana was delayed due to disruptions related to the Ebola crisis affecting operations in the country.[3]

Context – agriculture in sub-Saharan Africa region

Farmers in sub-Sahara Africa rely either on rain, groundwater, or surface water to grow crops. In areas with seasonal rainfall, irrigation is the only way to grow crops in the dry seasons. To use groundwater, farmers must own or have access to technology and infrastructure to lift the water out of the ground (water lifting). They also need a way to distribute both ground and surface water to their crops (conveyance). Options for water distribution depend on the prevalence of ground or surface water, topography, and existing infrastructure like dams, irrigation canals, or wells. Technology can be as simple and cheap as a bucket or watering can, and as complex and expensive as dams, reservoirs, deep wells, electric or diesel motor pumps, and automated drip irrigation systems.

One fifth of the globe's cultivated land contains irrigated agriculture, but only three percent of that is in sub-Saharan Africa. This is a region where rates of undernourishment are more than double the global average — 25 percent compared with 12 percent worldwide.[4] As Africa's population continues rapid growth, and the demand for water and food supplies grows with it, natural resources utilization is increasingly important. Compounding the problem of food security is suboptimal planting and irrigation practices, reliance on seasonal rains, and seed and livestock varieties with low production mean that farmers in Africa obtain yields well below that of their

[2] USAID. 2012. Request for Applications (RFA) No. RFA-OAA-12-000036. Global Hunger and Food Security Research Strategy: Climate Resilience, Nutrition, and Policy

[3] Ghana did not report cases but travel to the region was affected and the Gov. of Ghana asked to not hold meetings in the country for a certain time period.

[4] FAO. AQUASTAT. Available at http://www.fao.org/nr/water/aquastat/didyouknow/index3.stm

peers in the West. The potential to improve livelihoods, food security, and nutrition across Africa by expanding the use of irrigated agriculture is as large as the need to do so.

ILSSI Target Areas

ILSSI has been working in 10 research sites in three countries in the Feed the Future Zones of Influence (ZOI). Ethiopia has four sites, Ghana and Tanzania each have three (Table 1 and Figure 1). Within these sites, the target population of the research is male and female smallholder farmers and their household members.

Ethiopia

In Ethiopia, three quarters of the labor force works in agriculture, which contributes 44 percent of the Gross Domestic Product (GDP)[5]. An estimated five percent of cultivable land is under dry season irrigation. Smallholder farmers are generally unable to expand their farms for crops or livestock. In rural areas, the population is increasing at an estimated 1.9 percent per year[6]. The only feasible alternative to impoverishment or rural-urban migration (to supplement or replace on-farm income) is sustainable intensification of existing agricultural land. This means increasing food production on the existing land while minimizing environmental pressure.[7] Because yield levels are far below those of more developed countries, there is significant potential for increased productivity. SSI holds promise as a method for sustainable intensification by enabling farmers to grow crops multiple times in a year instead of only once (rain season).

Ghana

As of 2013, 53.6 percent of the labor force in Ghana worked in agriculture—the industry accounted for 23 percent of the GDP.[8] Although extreme poverty fell steeply between 1991 and 2006 (especially in the North), food security remains a significant problem. As a result of food insecurity and poor nutrition, an estimated 27 percent of children suffer from stunting[9], which has lasting negative impact on cognitive development. More than 75 percent of young children and half the women of childbearing age are affected by anemia.[10] While government irrigation schemes have been in place for decades — the Ghana Irrigation Development Authority runs 22 irrigation schemes that serve a tiny number of farmers. Official statistics from 1996 indicate an estimated 11,000 ha (0.26 percent) of the country's cultivated land is under irrigation.[11] Weak land tenure laws discourage landholders from making investments like irrigation technology, and encourage unsustainable land use practices that degrade natural resources. Seasonal migration among rural populations is common, especially during the dry season. Expanding SSI could increase agricultural yields directly — by extending the growing season; and indirectly — by increasing labor force productivity through improved nutrition and health outcomes.

Tanzania

In Tanzania, 75 percent of the working population is employed in agriculture, which contributes to 27 percent of the GDP. Food security is improving but not at the rate of overall economic gains. Smallholder farmers face challenges that include: access to and affordability of good quality seeds and fertilizer; a poor infrastructure that impedes access to markets; and lack of storage facilities. About one third of the population is food insecure and 35 percent of children under five are stunted. The government considers agricultural development, which includes increasing productivity and smallholders moving into commercial production, as a key to reaching middle income country status. Although irrigation has been practiced in Tanzania for hundreds of years, only about one percent of agricultural land is irrigated. Irrigation schemes are at risk from population increase, lack of upkeep, and various environmental issues, such as catchment degradation and waterlogging.[12] Tanzanian National Agricultural Policy seeks to employ the private sector in agricultural development. In practice, though, private

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[5] FAO. 2014. Ethiopia: Country fact sheet on food and agriculture policy trends. October 2014
[6] World Bank Development Indicators.
[7] Oxford Martin Program for the Future of Food. http://www.futureoffood.ox.ac.uk/sustainable-intensification.
[8] FAO. 2015. Ghana: Country fact sheet on food and agriculture policy trends. March 2015
[9] Glover-Amengor, M., et al (2016). Nutritional status of children 0–59 months in selected intervention communities in northern Ghana from the Africa RISING project in 2012. *Archives of Public Health,* 2016 74/12. Available at: https://archpublichealth.biomedcentral.com/articles/10.1186/s13690-016-0124-1
[10]Glover-Amengor, M., et al (2016).
[11] Agyare, A. et al., 2008
[12] ILSSI. Research design – Tanzania.

investment is limited. Weak land tenure laws discourage landholders from making investments that would improve agricultural yields and, instead, encourage competitive, unsustainable land use practices that exacerbate climate change effects on natural resources and food security.

Table 1. Research sites by Country

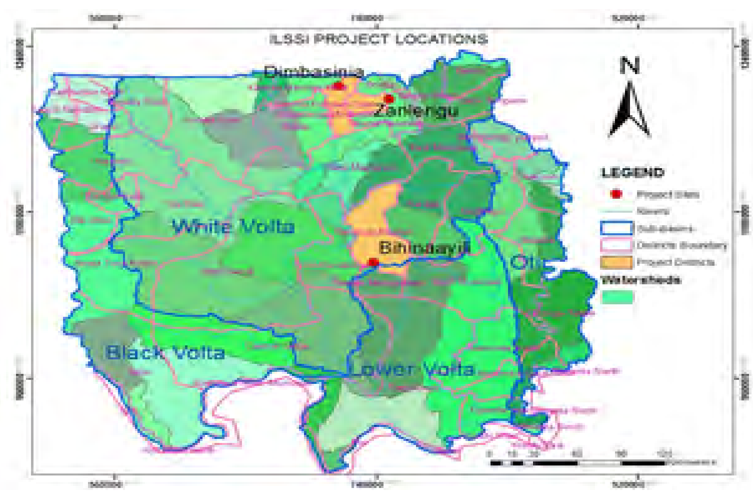
Country	Project Research Sites
Ethiopia	Limu/Lemo (SNNP region), Dangela (Amhara region), Robit Bata (Amhara region), and Adami Tulu (near Ziway) in the Rift Valley (Oromia region)
Ghana	Bihinaayili, Dimbasinia* and Zanlerigu
Tanzania	Rudewa, Mvomero, Babati

**After two failed harvest seasons at Dimbasinia research site in Ghana (the first year was flood related, the second years was due to inadequate water resources and nematodes) research was discontinued there.*

Figure 1: Maps of Research Sites by Country

Ethiopia

Ghana



Tanzania

Project Implementation

ILSSI was launched on August 13, 2013, and is scheduled to close on August 11, 2018. In 2014, the project held stakeholder consultation workshops in Ethiopia (January), Ghana (April), and Tanzania (August). The workshops focused on obtaining stakeholder feedback on lessons learned, and discussing potential SSI technologies, including irrigated fodder technologies tested in the research sites. Field interventions were first implemented in Ethiopia, with the beginning of the dry season at the end of 2014. At the end of 2015, field interventions were expanded to Ghana and Tanzania. However, disruptions in Ghana related to the Ebola crisis delayed stakeholder workshops, the International Food Policy Research Institute's (IFPRI) survey, and qualitative gender research.

ILSSI builds on earlier collaborative work of the AgWater Solutions project, which was funded by the Bill and Melinda Gates Foundation and involved several ILSSI partners. The U.S. and national partners currently engaged under a sub-agreement include:

- BI/TAMU, incorporating:
    - Agricultural and Food Policy Research Center – Department of Agricultural Economics
    - Spatial Sciences Laboratory – Department of Ecosystem Science and Management
    - Blackland Research and Extension Center – Temple, Texas
- Three Consortium of International Agricultural Research Centers (CGIAR) Centers:
    - International Water Management Institute (IWMI)
    - International Livestock Research Institute (ILRI)
    - IFPRI
- North Carolina A&T University (NCA&T)
- National universities in the three countries:
    - Ethiopia: Bahir Dar University (BDU)
    - Ghana: University of Development Studies (UDS)
    - Tanzania: Sokoine University of Agriculture (SUA)

Each partner institution has a specific focus and activities in the project, which align with their area of expertise. However, there is overlap in responsibilities among and between partners, as indicated below.

BI/TAMU is the lead institution and formally designated Management Entity (ME) with responsibility for ILSSI's leadership, management, and cooperative agreement administration, and for conducting research and capacity building. The BI/TAMU team develops and applies models that evaluate SSI interventions, including environmental and economic consequences. Through collaboration with partners, potential opportunities and constraints are assessed at local, regional, and national levels. In its facilities in College Station and Temple, Texas, the BI/TAMU team provides academic and technical training for graduate students, faculty, and agricultural and natural resources specialists.

IWMI is responsible for field interventions (experiments). The results of these interventions form the base of research aimed at identifying solutions to enable farmers to transform their livelihoods through economically and environmentally sustainable SSI adoption. Key interventions involve introduction and assessment of water lifting technologies; irrigation scheduling tools; crops; microfinance options; water and soil analysis; and gender disaggregation.

ILRI provides leadership in field research related to livestock and fodder management, and engages with stakeholders from farm level to national level. Among other things, in its laboratories, it analyzes irrigated fodder quality and conducts fodder market surveys. It partners with national organizations (usually universities) to conduct research in farmer's fields.

IFPRI is responsible for conducting baseline and end line household surveys and focus groups to analyze the project's nutrition, health, and gender outcomes. Its specific research focuses on how adoption of irrigation technologies can strengthen women's empowerment and nutritional outcomes; and the constraints and benefits of such adoption.

NCA&T is responsible for research on conservation agriculture production systems and drip irrigation for commercial kitchen gardens. It collaborates with IWMI on field testing, and is supported by efforts using the Agricultural Policy/Environment eXtender (APEX) model. The research focuses on female farmers whose products enhance household nutrition and contribute to income. It also assists with Integrated Decision Support System (IDSS) training and model parameterization.

UDS (Ghana), ***BDU*** (Ethiopia), and ***SUA*** (Tanzania) collaborate with ILRI and IWMI on research activities in farmers' fields.

Under ILSSI, BI/TAMU and IWMI receive the majority of funding. NCA&T, ILRI and the three CGIAR institutions participate fully but have smaller budget allocations.

Activity/Mechanism Goals and Objectives

ILSSI's approach involves identifying, testing, and demonstrating technological options in SSI of food crops and irrigated fodder. The project has four components that inform relevant research:

1. Identifying promising, context appropriate, SSI interventions, management, and practices for poverty reduction and improved nutrition at farmers' fields at the research sites in each country;
2. Evaluating production, environmental, economic, nutritional, and gender impacts; trade-offs; and synergies of SSI technologies and practices;
3. Identifying constraints and opportunities to improve SSI technologies access and practices; and,
4. Developing capacity and partnerships.

Through these components, the project seeks ways to improve livelihoods by identifying sustainable SSI technologies and practices under varying conditions. Success would lead to scaling up SSI from experimental plots in farmers' fields to condition-appropriate areas nationally.

Project Analytical Approach

ILSSI utilizes four interrelated analytical elements for its research practice:

1. Analyses and assessment;
2. Field studies, using interventions to test different SSI technologies and practices;
3. Household surveys and focus groups; and
4. Modeling (IDSS, incorporating a suite of models).

The analytical work feeds into the ultimate objective of the research — taking solutions to scale. To assist, stakeholder engagement and capacity development are key components of the ILSSI project.

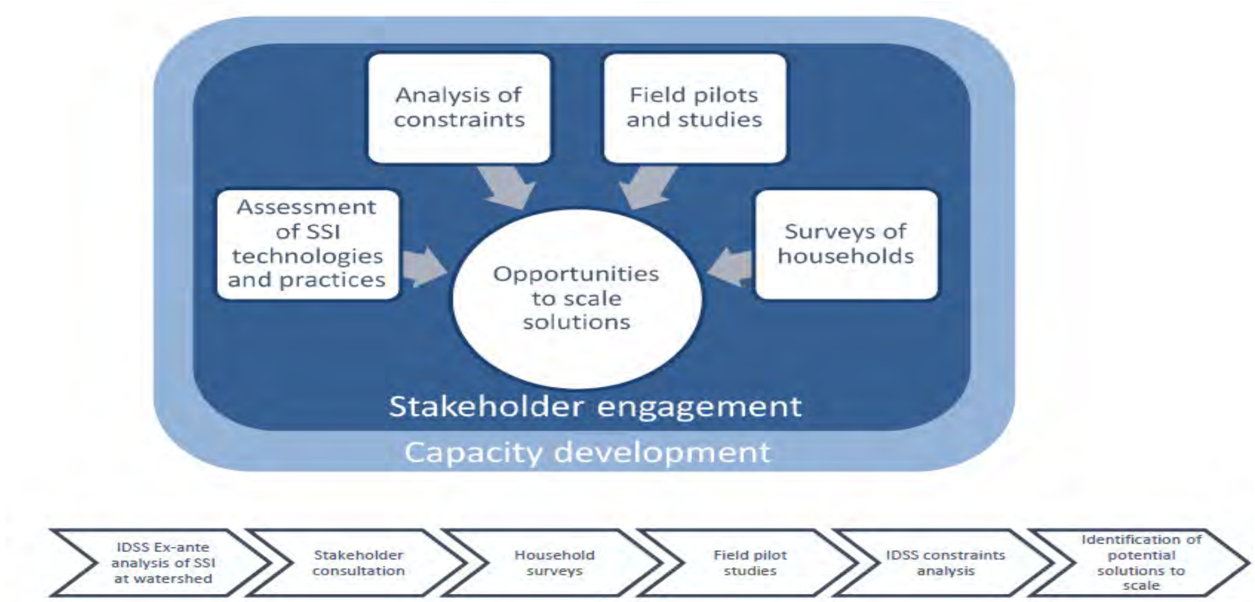
Analytical work results feed into models that allow project partners to analyze constraints and opportunities and make projections. A key component is IDSS, a suite of integrated models that enables scientists to analyze production, environmental, and economic consequences of different options. IDSS is a decision tool developed within TAMU over many decades. It draws on the following models:

- Soil and Water Assessment Tool (SWAT): watershed impacts;
- APEX: crop and forage growth;
- Farm Scale Nutrition and Economic Simulation Model (FARMSIM): Economic and nutritional impacts;
- Nutritional Balance Analyzer (NUTBAL): Animal performance; and
- Phytomass Growth Model (PHYGROW): Pasture conditions.

Project documents describe the various ways IDSS analysis fits within the ILSSI project. It is used to:

1. Evaluate results of field studies;
2. Produce quantitative stochastic integrated estimates of outcomes and impacts of the interventions;
3. Seek optimal combinations of inputs for best use of interventions;
4. Assess upstream, downstream, and community -level implications of the interventions
5. provide input to training and educational materials for use at local and higher administrative levels;
6. Scale up the estimates of production, environmental, and economic consequences of the interventions to geographically equivalent areas of the country; and
7. Provide policy makers and private sector investors with scaled-up inputs that contribute to decisions on future investments.[13]

Figure 2: ILSSI Functions



[13] ILSSI. Small-Scale Irrigation Applications for Smallholder Farmers in Ethiopia Ex Ante Analysis of Options.

3.0 EVALUATION METHODS AND LIMITATIONS

3.1 EVALUATION METHODOLOGY

The ILSSI evaluation used a non-experimental evaluation design to address the EQs presented in the EOI. The performance evaluation predominantly used qualitative data collection methods and analysis, with limited use of quantitative data analysis. The design and methods were determine based on the following factors:

1. EQs focused on issues well-suited to evaluative inquiry (e.g., "how" and "why" questions), but are not well captured by closed-ended questions (e.g., "what" questions). A qualitative approach using open-ended and probing questions allowed the evaluators to go beyond dichotomous (e.g., yes/no) answers and examine underlying issues of concern to the project and the evaluation.
2. Given the diversity of stakeholders, the nature of the research questions, the many different modes of intervention, wider scope, and the fact that this is an evaluation of a research project, qualitative methods were considered the most appropriate to capture different perspectives of those closely involved in the research project, national stakeholders, trainees, and farmers. This helped evaluators obtain a "circumferential" 360-degree perspective. However, this also meant not all topics discussed were relevant to all interviewees; therefore, the sample size for certain topics was relatively small. For example, there were only seven individuals who took IDSS training among the key informants interviewed.
3. Because ILSSI is a research project focused on collecting and analyzing information and, based on that analysis, predictive models are developed, a large amount of quantitative data and outputs are being produced and analyzed by the project itself. Such quantitative analyses include cost-benefit across crops and locations, and upscaling analyses based on geography, climate, environmental sustainability, and socio-economic outcomes. The project also utilized qualitative methods in upscaling analysis. Attempting to reproduce this research to test methods or replicate findings on issues like upscaling probability, identification of optimal technologies, etc., was not the intention or scope of the evaluation. Two valuable contributions to the evaluation of ILSSI are the evaluation of gender inclusivity and protocol for stakeholder engagement in consultation and implementation. Evaluators provide a second opinion on the outcomes of participant recruitment; tools and training for farmers and civil servants; and strategies for promoting buy-in of research institutions, government institutions, and potential donors.
4. The project recruits and trains participant farmers in testing irrigation technologies, and utilizes stakeholder involvement to identify constraints to scaling. Stakeholder consultation continues through data collection and analysis. Using both researcher-and stakeholder-identified constraints and solutions, the project also conducts outreach activities at the global, regional, national, and local levels. Outreach is made to an audience of research institutions, technical experts, government representatives, and potential donors. Beyond testing technologies, project objectives include influencing research, investment, decision-making, and engagement of end users. Media and web-based communications supplement in-person outreach events. Finally, the project will produce presentation materials that can be used for analysis, planning, and implementation beyond the conclusion of the project. Therefore, the product of the intervention is not just the predictive model for scaling technologies, but also the capacity building efforts initiated, and materials produced for use beyond the timeframe of the intervention. The nature of these efforts calls for qualitative performance evaluation methods to synthesize an array of data pertaining to environmental, geographic, social, political, and economic factors, and to review communications materials content.

Data Collection Methods
Specifically, the evaluation used desk and document review, key informant interviews (KIIs), focus group discussions (FGDs), a brief satisfaction survey, and field observation methods to gather data. The data collection methods are discussed below:

- *Desk and data review of project documents*:
  - The reviewed project documents included the Results Framework from Feed the Future Guide – May 2010; the Comprehensive Mid-Term Report and its annex; the most recent semi-annual report; footnoted documents from mid-term evaluation plan; checklists for assessing research and data quality; and journal articles published under the project.
  - Data included project beneficiary information; baseline data (in the mid-term report and other references); field-based monitoring and assessment; IDSS outputs; and any historical weather data, crop yield data, soils data, and economic data provided by the project.
- *Preliminary discussions with implementers*:
  - Complementing the desk review, a two-day workshop at BI/TAMU with presentations by partners and discussions helped the team better understand the project, (July 17-18, 2017).
- *Semi-structured KIIs*:
  - The ET interviewed 55 key informants between September 4 and October 3, 2017. Interviewees included representatives from the ME and partner organizations; government ministry personnel involved in, or aware of, the project; extension agents; farmers; ILSSI Executive Committee; Africa Rising partners (Ethiopia); Ethiopian Agricultural Transformation Agency (ATA); Ghana Irrigation Development Authority; Water Research Institute (Ghana); UDS (Ghana); International Development Enterprises (iDE); and others. Tables 2 and 3 present key informants by gender and location.

Table 2: Composition of Key Informants by Gender

Gender	Number (N)
Men	45
Women	10
Total	**55**

Table 3: Composition of Key Informants by Location

Country	Number (N)
Ethiopia	22
Ghana	16
U.S./International	17
Total	**55**

  - Interviews were conducted in two rounds. The first round, completed between September 4 and 15, 2017, was conducted in person with 38 key informants, 22 from Ethiopia and 16 from Ghana. KIIs were also carried out with USAID Mission staff in the countries, covering issues concerning both the project and country context. The second round was conducted by telephone primarily with IPs and USAID (17). A separate KII guide was prepared for the second round of interviews (see Annex E).
  - Two key informants submitted answers to a short list of questions via email (not included in the interview count) because it was easier for them than scheduling a phone call or meeting.
  - Almost all interviews were recorded. Handwritten notes were taken during all interviews.

- *Focus group discussions*:
  - Four FGDs were held with farmers from the research sites. Eight farmers participated in each FGD. At each FGD, men and women were equally represented, for a total of 16 men and 16 women. The evaluators facilitated FGDs using FGD guidelines. The Team Leader moderated each FGD. A locally-hired interpreter and note taker were also present.
  - FGD participants were all trial farmers participating in the ILSSI project at its research sites.

Evaluators met or communicated with 90 ILSSI project stakeholders or people with project knowledge.

Table 4: Types of Interactions with Project Stakeholders

Types of Interactions with Project Stakeholders/Knowledgeable Persons	Number (N)
Key informants (including follow-up emails)	55
As part of FGDs (33 farmers, including 1 non-project farmer)	33
Communication via email only	2
Total	**90**

Figure 3: Focus Group with Trial Farmers, Robit Bata, Ethiopia

Figure 4: Focus Group with Trial Farmers, Bihanaayili, Ghana

- *Satisfaction survey:*
  - To gauge stakeholder perspectives on the project, two quantitative Likert-scale type questionnaires were included and administered during KIIs and FGDs. Likert-scale type questions about project management effectiveness were asked during KIIs, and questions concerning satisfaction with technologies and practices were asked during FGDs with farmers. A total of 43 KIs (out of the 55) were asked these questions, and all responded with a rating. During the FGDs, the 32 farmers were asked the questions about satisfaction with technologies and all responded with a rating. Although the sample was not statistically representative or rigorous, this approach provided additional insights into these issues, especially as they were followed up with other questions asking respondents to explain the reasoning behind their rating. This data was analyzed and tabulated for the two types of questions (quality of project management and farmer satisfaction levels with project technology) and included in the report.

- *Field observations*:
  - Evaluators observed the research sites, which allowed them to better understand the local context and environment; look at the technologies (although most were not in use since it was the rainy season) and crops in experimental areas (e.g., Napier fodder and maize at Robit Bata research site in Ethiopia); and assess whether observations corresponded with information obtained from KIIs and FGDs.

3.2 Evaluation Limitations

The ET faced a number of limitations in data collection and analysis as well as report writing.

Excluding travel, the time available for data collection in the field was less than five days each in Ethiopia and Ghana. Data analysis and report writing were also completed under significant time pressure. Time constraints limited the number of in-country interviewees, which had implications for both the depth of analysis and triangulation between sources.

The extremely limited time for qualitative analysis and writing also impacted the evaluation. There are methods for analyzing qualitative data in a quantitative way, such as coding responses to questions manually or by using computer assisted qualitative data analysis software (CAQDAS) tools. However, these methods require transcribing all FGDs or KIIs, entering them into a database, and coding and analyzing them. For the approximately 40+ hours of recorded KIIs and FGDs, this would take about 3 to 4 weeks.[14]

Because the evaluation used purposeful sampling and not random selection of key informants or FGD participants, care should be taken when interpreting the results. They are not generalizable in a statistical sense. However, the ET made every effort to interview most key stakeholders from all levels in the two countries, and believes the findings approximate the actual situation.

Given the time issues, the team could only interview stakeholders if meetings had been pre-arranged, which may have introduced some biases as to who was selected. This meant that only occasionally were new interviews added based on stakeholder recommendations. Adding meetings as the data collection progressed would have been the standard and preferred approach for an evaluation of this scope, but it was not feasible due to time and resource constraints.

[14] Industry average is one hour per 15 minutes of recorded interview, so this would involve approximately 160 hours of transcription time, or 20 person days. For this evaluation, USAID provided only 14 person days in total for data analysis and draft preparation between the three team members, and three person days total for draft revisions.

The large number of EQs impacted the interviews and analytical depth. USAID tasked the evaluation with addressing 10 EQs and 21 sub-questions.[15] To address issues in depth, EQs require a larger number of interview questions; however, to keep meetings at one hour, not all key informants could be asked all the questions. Topics were covered strategically, and those deemed not as relevant were skipped during the interview.

Data collection was not carried out in Tanzania. Therefore, as agreed upon with USAID, the ET did not conduct analysis of Tanzania activities. However, when it is integrated with the project as a whole, some information on Tanzania is included in the evaluation.

The timing of the evaluation meant that the team visited the countries during the rainy season, when irrigation was not being practiced. Therefore, field observations were limited to viewing plots growing rain fed crops, and examining irrigation technology that was not in use.

[15] Some of these questions are long, multi-part questions. For example, EQ3: "To what extent have the following concerns been incorporated in the identification, evaluation and testing of selected technologies, including the consideration of potential trade-offs and synergies: productivity, environmental, economic, nutritional, and gender impacts?" asks about identification, evaluation and testing in four different areas - productivity, environmental, economic, nutritional, and gender impacts.

4.0 FINDINGS, CONCLUSIONS AND RECOMMENDATIONS

4.1 PROGRAM MANAGEMENT

4.1.1 EQ 1: In what ways could program management, communication, coordination, and implementation be improved to better achieve goals and objectives?

FINDINGS

Stakeholder perceptions are largely positive regarding how well the ILSSI project is being managed by BI/TAMU and the respective IPs. On a five-point Likert scale, the project management component had an average score of 4.2 out of 5, based on 43 responses by project stakeholders (of whom 37 rated it "5"). Although the sample is small, the high average score indicates that stakeholders[16] view ILSSI's management positively. For the most part, stakeholders felt that the project was well managed; however, they also mentioned that "*there is always room for improvement,*" especially given the scope and complexity of the undertaking (Table 5).

Table 5: Ratings by Location of Key Informants

Location	Average	Respondents (N)
International/U.S.-based	4.3	15
Ethiopia	4.2	18
Ghana	3.9	10
Total	**4.2**	**43**

The ET asked project stakeholders about how well they thought the project was being managed in terms of responsiveness, timeliness, and organizational skills of the ME. The following are direct quotes from four key informants:

> "*Management has been very good, in terms of communication and getting back to us with information, with what is happening*."
>
> "*The whole process is probably as well organized as it could have been, given the many players involved.*"
>
> "*Management has been interested in results*."
>
> "*We are fortunate to have BI/TAMUS leading the group*."

Some key informants had specific comments on the ME's management style. For example, many of the project partner stakeholders noted that they were impressed by the ME's capacity to manage and organize the numerous partners, components, and activities. However, 2 out of the 35 project implementers noted an occasional tendency from the ME to micromanage, specifically, getting involved in detailed project planning issues at the country level. A key informant from an IP stated, *"The people managing the program in Texas are 100 percent employed by the project. - which might have led Texas to micromanage the project."*

At the same time, key informants suggested that more could have been done to facilitate transfer of knowledge into practice. There was widespread praise for the quality and rigor of research among stakeholders; however, a key informant partner pointed out that emphasis was heavily academic and reflected the make-up of the partner

[16] That is, key informants who felt they were familiar enough with the project to comment on its management.

consortium, "*TAMU probably misjudged a little bit…the effort needed for outreach, communications and taking the academic research to impact…the environment.*"

In Ethiopia, stakeholders viewed project management in a strongly positive light. When asked to rate project management based on their awareness and interaction with the project, 14 out of 16 key informants (87.5 percent) gave a rating of 4 or above on a 5-point scale. The positive rating was given for reasons that included the "*ability of the project to identify problems and collaborate with local universities,*" the ME Director's "*complete follow-up…pushing people to deliver,*" and "*the open lines of communication and responsiveness to partners and issues*." Positive ratings were also given for the close level of engagement and collaboration between international and local partners, high levels of commitment and professionalism, and coordination of data collection activities.

In Ghana, stakeholders' perceptions of project management were mixed but positive. On the 5-point scale, 7 out of 10 key informants (70 percent) gave the project a rating of 4. The others rated it at 3 or 3.5. Those who rated it 4 or 5 emphasized the project's relevance in addressing smallholder farmer issues and the commitment of project partners. Those who gave it lower rating (30 percent) highlighted insufficient budget resources for work, data collection issues due to low capacity of collectors than anticipated, early management challenges, and the project's insufficient attention to field-level realities compared with modeling diagnostics. They also noted that they expected national institutions such as the Water Resource Institute (WRI) to be more formally involved in this type of project but their involvement was not institutionalized. When asked why WRI was not engaged more in the project, two international project partners noted that both WRI and Ghana Irrigation Development Authority (GIDA) suffered from weak capacity.

Communication and coordination between project stakeholders — U.S. universities and CGIAR centers, national research partners, and government entities — was functioning well after four years of project implementation. Some communication and coordination issues were worked out during an early "learning period" and, at the time of the evaluation, management functioned smoothly. Issues, when they arise, are addressed in a timely manner through consultations between relevant parties. The ME, in particular, is highly regarded for its efficient and proactive management, thoroughness, quick response to queries, and for addressing challenges as they come up. The ME prepares an annual work plan on an annual basis, which takes into account changes occurring in the preceding year. IPs have adeptly identified opportunities to partner with other projects or organizations, and found resources outside the project. When it was clear that the means of securing SSI technology for farmers at research sites was not part of the Request for Application (RFA), a solution was found — local microfinance institutions were brought in to provide credit. Similarly, when IWMI and others discovered unanticipated problems with field data collection that included, among other things, poor quality and late delivery, additional resources and personnel were allocated and the problem was largely resolved.

In Ethiopia, communication and collaboration among project partners and stakeholders is particularly strong. The project is managed in a highly participatory manner, is demand-driven, and is in line with government policy and commitments. For example, because the Government has a policy to promote rope and pulley irrigation, the project introduced this technology at some of the research sites. National, regional, and local government entities, and farmers were consulted on project design. This included an inception workshop and other workshops that focused on identifying constraints and sharing results with partners. According to key informants, strong government commitment to promoting SSI and robust agricultural research capacity (especially through the work of the Gates Foundation funded-ATA), enabled the project to collaborate closely with government stakeholders.

Although communication and collaboration levels among project partners and stakeholders are generally satisfactory in Ghana, there is room for improvement. Because of the Ebola crisis, activities in Ghana began one year late. The delay prevented consultations and field work from starting on time and impacted cooperation levels. The relationship between partners did not have much time to mature and solidify as in Ethiopia. In the case of iDE, some communication and payment delay issues (with NCA&T) were noted, which led to uncertainty and implementation delays. However, project management addressed the issue through personnel changes. A weaker government emphasis on SSI, and the fact that UDS is not seen as institutionally strong in research, also contributed to collaboration issues in Ghana. However, the project had to make a trade-off between working with UDS, which is located in Tamale (within the Feed the Future ZOI) and where all the research sites are within a 30-minute to two-hour drive, or working with Kwame Nkrumah University of Science and Technology (KNUST), which is said to have more capacity in the field of modeling but is located in Kumasi, a seven-hour drive from Tamale.

Challenges

International project partners may not have communicated clearly that farmers themselves would have to pay for the technology. Instead, they left it up to national project partners to inform the farmers. In both Ethiopia and Ghana many of the interviewed farmers were unclear about the terms of participating in the project, especially in respect to paying for the technologies. The majority of the 32 farmers that participated in the FGDs seemed not to realize they would eventually have to pay for the equipment they received, or gave ambiguous responses in interviews. Ethiopian extension service[17] key informants told the ET that farmers initially thought the project was similar to those run by NGOs working in the region. NGO projects provide aid as an economic support and cash for per diems. However, the extension service key informants noted that one of the selection criteria for farmers was an expressed willingness to pay back the loan for the equipment. Key informants reported that it took repeated efforts to convince farmers that ILSSI was not a typical NGO project but an experimental research project. This could have been due to a misunderstanding of the terms of participation, the fact that some equipment was given as a grant while other equipment was on credit, the extension service agents not adequately explaining the terms, or possibly an unwillingness from the farmers to accept terms of the repayment.

Initially, the project was affected by poor data collection and data management. One of the most common issues raised by stakeholders concerned data collection and data management of farm level data, such as the amount of water withdrawn, labor inputs, soil moisture, etc. Coupled with long delays, the poor quality of data was a significant problem at the beginning. The international IPs were not involved and assumed the capacity for data collection was higher than it was. Key informants reported that problems with data collection related mostly to poor understanding of what data was being collected, lack of data collection experience, and poor connectivity in the regions. Also problematic was the lack of capacity to implement (or contract out) farm-level data collection and produce financial reports, which are required. This led to more delays in disbursing budgets. Eventually, additional budget resources were applied, data collectors trained, additional data collectors were contracted as consultants, and the issue was resolved.

Two international project partners and one subcontractor noted that the limited budget allocation made carrying out their responsibilities and the activities in the project agreement challenging. One project partner noted that the original contract language was very high level, focusing more on research dimensions than translating research into practice. He said, "*we ended up doing a lot of the coordination and facilitation of [transferring] the research to policy and practice…but then the budget was not necessarily adjusted for that additional activity."* Despite this constraint, the partners did the necessary work, often drawing on other projects or their own internal resources. Budgetary inadequacy was raised with project management and USAID, additional allocations were made, and the issue was partially resolved.

Some project partners noted that more transparency would be welcomed. Three out of 35 project partners, or 8 percent, reported that project management could have been more transparent concerning respective roles and responsibilities among IPs (vis à vis fieldwork and modeling) and, in particular, regarding how budgets were determined and allocated. Based on a review of project documentation, the ET found the project could have done a better job documenting these challenges. For example, although Dimbasinia was dropped as a research site after the second (failed) growing season, this was not mentioned in progress reports. However, project implementers note that it is not uncommon for field research sites to be dropped for one reason or another in these types of projects.

[17] Extension services are system of advisory services for farmers and rural residents in many countries. FAO summarizes their work as "Rural extension…is a basic element in programmes and projects formulated to bring about change in rural areas. Extension services are similarly a common feature of the administrative structure of rural areas and these services have the responsibility, in partnership with the farmers, of directing programmes and projects for change." Oakley, P. and C. Garforth. 1985. *Guide to extension training*. FAO, p. 9.

The project budget is not divided evenly among project IPs. Key informants from one of the project partners with smaller budgets (especially the CGIAR centers) said they were sometimes reluctant to express their views or preferences because they felt their relatively small budgets did not give them the right. The key informants said this perception was also shared by other partners.

For some CGIAR partners and their subcontracted local research institutes, the one-year Cooperative Research Agreements (CRAs) were a constraint because research projects typically have timeframes longer than one year. Therefore, having one-year contracts made financial management challenging. Also, given the uncertainty over contract renewal, made motivation of researchers difficult. However, most contracted project partners did not perceive this to be an issue or a constraint. The issue seems dependent on constraints internal to the partners that were contracted this way.

Partners have their own mandates and agendas in the respective countries they are active in, which sometimes differ from those of ILSSI. An Ethiopian key informant familiar with IWMI and the ILSSI project noted "*there is some tension between [their] priorities*" and those of the project. In some cases, a less than desirable level of attention is given to project goals compared with partner goals. However, it should be acknowledged that project IPs do have multiple ongoing projects and need to strike a balance in devoting the necessary time and attention to each set of projects.

CONCLUSIONS

Overall, the project has been managed well. KIIs and document review make clear that the project has been implemented largely according to plan, and has adapted to and addressed issues that arose along the way. Given the project's complexity, the evolving context, and the problems outside of project control, like the Ebola crisis in Ghana, flooding and droughts at some sites in Ethiopia, and pests and diseases which ruined crops, management's performance is commendable.

Based on stakeholder feedback, the key factors for good management are the quality and commitment of the individuals involved, the fact that in many cases partners built on relationships that preceded the program, a shared "research culture," and a general alignment of goals. With a small number of exceptions, stakeholders reported they had sufficient resources to carry out their tasks. Good project management helped generate goodwill and buy-in among stakeholders. The dedication and enthusiasm of key informants regarding the project reflects well on its management. The project has run smoothly, faced relatively minor problems, and dealt with them constructively. This speaks highly of both individual and institutional-level project partners.

Cooperation and coordination between partners was helped by the fact that most had worked together before, so the consortium was formed with a degree of trust already built in. Being able to rely on relationships between international and national partners, which predated the project, clearly creates trust and allows cooperation and good activity implementation. Committed professionals were responsible for project activities but beyond this, project management success can be attributed to the existing relationships among the CGIAR centers, with TAMU, and between the CGIAR country operations and government entities, and their previous collaborations.

There were some internal shortcomings. A relatively small number of key informants from project partners mentioned internal management issues. They noted a tendency by the ME to micromanage project partners and expressed a desire for more transparency on budgets allocation among partners. They also mentioned a reluctance among 'junior' partners (those with relatively small budget allocations from the project) to raise issues. These problems do not seem to be widespread, but addressing them can improve cooperation and smooth implementation.

In a project of this scope — working in three countries, with multiple IPs (five international and three national) engaging at national, regional, and local levels — external issues are inevitable and good project management becomes critical. Project management had to work within a set of pre-existing constraints. The ET argues that the measure of good project management is not whether everything runs smoothly and no problems arise[18], but rather whether problems are recognized and addressed in a timely and appropriate manner. According to this standard, ILSSI's management has performed very well. Management could have done better in anticipating and proactively solving certain broader issues related to government priorities, capacity, and risk of droughts, pests and diseases. Because Ethiopia, where field research was launched earlier than in Ghana, presented a more conducive environment, the project may not have been as prepared for the challenges that arose in the latter country.

RECOMMENDATIONS

In the future, project management should outline contingency plans for dealing with potential issues that could affect its ability to implement the work in a timely manner. These plans should be included in the project design. Advance planning for how to respond to scenarios ranging from the natural disasters, pests and diseases, and droughts, to issues like data collection problems and weak policy responses or engagement could reduce the disruption that they cause. This does not imply the need to predict all possible scenario risks and include them in the model. Many are 'unknown unknowns'. However, future phases of the project can draw on lessons learned in the first phase from the more commonly and periodically encountered 'shocks'. At a minimum, these would include disruptions closely linked to the research outcomes and crop production, such as: climate, pest and disease, changes in market conditions, and data availability.

The ET does not recommend systemic or structural changes to the ILSSI project management. However, recognizing that some shortcomings are matters of management style, institutionalizing an internal feedback mechanism would enable partners to communicate concerns. These issues could be worked out among the partners themselves. The feedback would become part of the agenda at management meetings where mutually satisfactory changes can be discussed and decided.

Prior to signing, identify ways to mitigate the short-term contract period of CRAs with the relevant institutions. Although it is understood that because of USAID's funding rules the terms of CRAs cannot be extended beyond one year, some stakeholders expressed concerns about the impact of the short time frame. These concerns could be addressed when the CRAs are signed. Because this issue appears to be specific to a small number of partners, the ET does not recommend a blanket solution. Instead, it proposes alleviating concerns by discussing mitigation measures with the relevant institution on an individual basis prior to signing.

Note: Stakeholder engagement, identification of appropriate SSI technologies, and project partner profiles are also issues related to project management, and are covered under the relevant sections below.

4.2 RESEARCH PROGRAM

4.2.1 EQ 2: How well has the ILSSI project identified promising SSI interventions, technologies, and management practices using criteria that are context-specific, evidence-based, and robust? To what extent are these criteria relevant and scientifically rigorous?

FINDINGS

The ET found that ILSSI followed valid and appropriate research design principles. It has been collecting biophysical and socio-economic data to run the models used for integrated decision making (SWAT, APEX and FARMSIM). Specifically, design principles take into account:

- Lessons Learned — The project incorporated past research on what leads farmers to change their practices and dis-adopt (i.e. discontinue use) new technologies and practices;

[18] The starting point for projects such as ILSSI is that they operate within challenging environments, i.e. some combination of suboptimal information social, economic, policy, ecological environments. (If the environmental conditions were optimal, intervention would hardly be needed and market forces would address allow supply and demand to find an equilibrium.)

- Context — The project's research approach acknowledges the importance of knowing local conditions and recognized that natural resource conditions and farmer preferences differ from one place to another;
- Affordability — This includes considering potential equipment affordability constraints and possibly suggesting mitigation measures, including access to finance cooperatives;
- Transparency — It is important to keep farmers fully informed on approach and interventions; and
- Risks — The project implementers did not try to minim2ize risks that farmers themselves might face under normal practices, which allows a real-world view on potential issues.

Implementation

Through FGDs with farmer-participants, KIIs with stakeholders, and document review, the evaluators confirmed that, at the sites visited, the principles are largely being followed; the interventions have been introduced — although with some modifications; farmers are using and benefitting from the technologies; and data was being collected (see Table 6).

At the same time, the extent to which farmers are following project guidelines [for the Time Domain Reflectometry (TDR) and wetting front detector (WFD)] to apply the optimal amount of water to their plots is difficult to assess. Because measuring the actual amount that farmers use is virtually impossible, models rely mainly on farmers' recall ability, and the assumption that farmers are following the guidelines given to them. However, both farmers and key informants noted that, prior to interventions, there has been a customary preference for the flooding approach, which may mean that farmers were overwatering and more training may be required.

Table 6: Small Scale Irrigation Interventions at research sites visited

Site	Small Scale Irrigation Interventions
Ethiopia	
Dangishta Kebele, Dangila	Drip, rope and pulley, irrigation scheduling, dry season vegetables, and fodder irrigation
Robit Bata Kebele, Bahir Dar Zuria	Drip, rope and pulley, irrigation scheduling (using WFD and TDR), groundwater recharge, dry season vegetables, and fodder irrigation
Ghana	
Zanlerigu, Nabdam	Rainwater harvesting, motor pump with hose pipe and water tank (3000 litre), dugout, water can, dripper for home garden, irrigation scheduling (WFD and TDR), dry season vegetables, fodder irrigation, and fencing of irrigation plots
Bihinaayili, Savelugu	Motor pump with hose pipe and water tank (250 litre), water can, irrigation scheduling, dry season vegetables, and fodder irrigation

Selection of SSI technologies and practices

Decisions about which interventions to test used both top-down and bottom-up approaches. Key informants reported that intervention selection was driven in part by local preferences and in part by research design imperatives. The IPs drew on past experience with the AgWater Solutions project. Specific technologies for each site were selected through consultation between IPs and national and district stakeholders. Finally, farmers themselves had to agree to use the technologies.

In consultation with the Government of Ethiopia (GOE), project partners selected rope and pulley - a lower-cost alternative - to fill overhead tanks manually with buckets. Promoting the rope and pulley mechanism was prioritized because it is a GOE policy. Other practices include drip irrigation with gravity flow; rope and washer pump (a simple manual device consisting of a rope inside a long pipe, with knots tied into the rope which lift the water up); using WFDs for irrigation scheduling and for monitoring nutrition leaching in some plots; groundwater recharge using techniques for breaking hardpan soil[19] (at Dangishta); surface runoff measurement;

[19] A hard layer of soil below the surface which impedes drainage and plant growth

and irrigated fodder. At the Dangishta research site, rope and washer technology was initiated but proved unpopular with farmers. Instead, they switched to rope and pulley, which was used at the Robit Bata research site.

Project documentation shows that IPs had early awareness of the need to balance innovative practices and technologies against local preferences, which may not necessarily be particularly innovative.[20] In Ethiopia, the rope and pulley mechanism is well known and promoted by the government. In Ghana, at Bihanaayili for example, some farmers had been using motor pumps, which are reportedly already quite common in many regions in sub-Saharan Africa[21].

Terms of participation

Participating farmers were essentially asked to take a risk by setting aside part of their plots for testing new technologies and practices. A key informant in Ethiopia noted that it took time for trial farmers to adapt their practices, or even agree to participate fully. He observed that "*the farmers have their own interests, we have our own interests, so balancing that was challenging*."

SSI technologies were provided to farmer participants at the start of the research, and farmers were trained in using the technology. Additional training involved planting techniques such as seed soaking, and guidance on water scheduling and water amount. Field visits were organized so farmers from different research sites could learn from each other. An Ethiopian key informant reported that "*livestock feed is a major constraint"* and that most research conducted to date has focused on rain-fed agriculture.

Irrigated fodder

The project has proven flexible enough to explore research areas, which were not part of the original plan, and to make changes to the technologies. Introducing fodder irrigation is an innovation that can help farmers increase yield of dairy livestock and increase income when sold. Irrigated fodder was an unanticipated success when it was introduced at selected sites. The experiments with irrigated forage were described by an ILRI key informant as "*almost an afterthought*" but are popular with farmers. ILRI and Africa RISING promoted various forage plants, such as Desho and Napier grass, for farmers to grow for their own livestock or to sell. The number of farmers using irrigated forage increased from 22 to 67 over the course of the project. Key informants reported that returns on irrigated forage have been attractive enough for farmers that they have expanded their land under fodder cultivation.

Irrigation scheduling

To illustrate how irrigation scheduling works, two technologies — the WFD and TDR — are shown below. The WFD is used to monitor nutrient leaching from the soil. In the SWAT model, it compares with the base soil profile (nutrient balance/loss from the soil) and helps maintain nutrients in the soil.

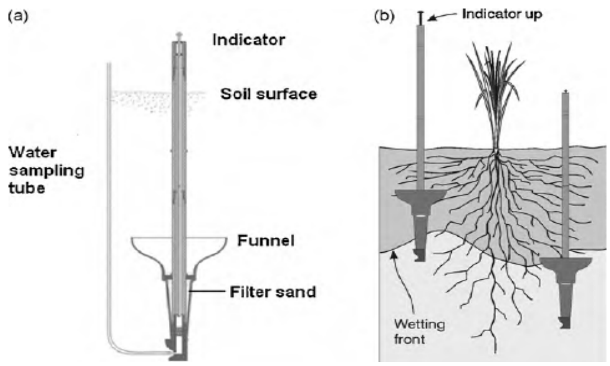
[20] ILSSI 2017. Annex to Mid-Term Report, 2014-2016.

[21] de Fraiture, C. & T. Clayton AgWater Solutions Irrigation Service Providers: A Business Plan. 2012.

Figure 6: Installation of Wetting Front Detector, Dangishta, Ethiopia

Source: IWMI Not so quiet on the wetting front: http://www.iwmi.cgiar.org/2015/09/not-so-quiet-on-the-wetting-front

Figure 7: Schematic of Wetting Front Detector and Example



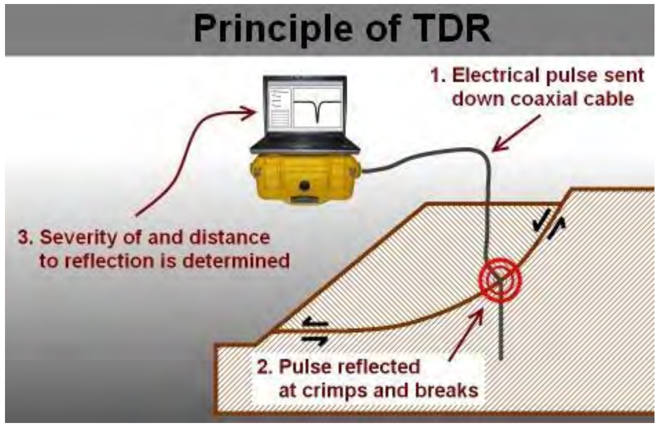
Source: http://www.allsun.com.au/FullStop/FullStopIntro.html)

TDR measures the volumetric moisture content of the soil. Like the WFD, this helps with irrigation scheduling by helping farmers understand when soil moisture levels are appropriate or require irrigation.

Figure 8: Use of Time Domain Reflectometry to Find Volumetric Moisture Content of Soil

Source: https://www.vanwalt.com/tdr-soil-moisture-measurement.html

Figure 9: Principles of TDR



Source : http://www.kanegeotech.com/instrumentation

Recruiting

The ET found that the project is generally recruiting appropriate farmers for research trials. The project developed a four-stage process for selecting farmers, involving consultation with regional stakeholders, engagement of community leaders, community meetings, and meetings with targeted household heads. The process included a list of 10 criteria that farmers and their households must meet.[22]

The ET found that the areas under irrigation among project farmers participating in FGDs ranged from 0.1 ha to 2.50 ha (see Annex E). Farmers must be willing to participate in the research over the life of the project. Most participants continued with the project, but some dropped out and were replaced. Reasons for dropping out were said to be negative or positive and personal in nature and not related to the project. According to the IP informants, the reasons were sometimes related to a death in the family, a job, or an educational opportunity. While the consultation process to select areas and farmers is clearly important, anecdotal evidence suggests that the project has not always selected optimal participants. In one area, for example, the ET came across a relatively wealthy project household. Instances like this suggest that favoritism toward certain people may creep into the process of selecting both sites and farmers.

[22] TAMUS. "ILSSI: Description of the process of consent of farmer participation."

Box 1: Site Selection

The project relied on multiple criteria and methods to select sites. In both countries, sites had to be in Feed the Future ZOI. ILSSI researchers conducted ex-ante analysis of SSI interventions at all potential research sites using SWAT, APEX, and FARMSIM modeling tools. Existing data from international, national, and local sources was used, and assumptions were made where data was missing. The models were then used to simulate a wide range of conditions, including watershed-scale hydrology, flow, sediment, crop yields, fertilizer application, farm-family economics, etc. Several scenarios were developed (with different technologies, crops, irrigated vs. non-irrigated) and the simulated outcomes, related to nutrition, informed the scenarios to implement for research and further simulation work. A tool developed under AgWater Solutions, the Participatory Rapid Opportunities and Constraints Analysis (PROCA), was used to narrow down the optimal sites. Selected sites cannot be representative of the entire country, or even of their respective districts or regions. However, using agent-based modeling, a bottom-up paradigm, ILSSI researchers are able to analyze diffusion of technology at the farm level.

In **Ethiopia**, site selection was based on several factors beyond Feed the Future criteria, including that they were located in areas of government priority, as per its Agricultural Growth Program (AGP); and had relative good accessibility by road and proximity to research universities (Bahir Dar University and Arba Minch University). Selection of individual research sites was aided by the ex-ante modeling exercise, which was used to estimate potential availability of shallow groundwater and other natural resources. Finally, the district administrations advised on selection of individual sites and selection of smallholder farmers — those interested in participating in the experiments and willing to provide plots for research.

In **Ghana**, sites were located in the Feed the Future ZOI above the 8th parallel, in accessible areas determined with input from local stakeholders. The selected ILSSI project sites are near reservoirs with shallow groundwater. Rainfall patterns in the last two decades have trended higher, suggesting potential for rainwater harvesting. The suitability of land and willingness of the farmers to provide plots for research were other factors taken into account for site selection.

To gauge the end-user perspective on SSI technologies, the ET asked the farmers participating in FGDs to rate (on a scale 1-5) their satisfaction levels with the interventions[23] and explain their reasoning (see Table 7). Farmers tended to be more satisfied with the rope and pulley and motor pump technologies. The water can technology was less popular. However, water cans are still considered an improvement over buckets. Farmers preferred technologies that were less labor intensive or strenuous, especially for women. According to a project implementer in Ethiopia, farmers were "*asking for a technology that automatically fills the tank. They like the drip [irrigation]. What they don't like is that every time they get the water from the well [they have to] fill the tank. It is a bit labor intensive.*" While most FGD participants expressed high levels of satisfaction with the technologies, they did note a number of issues they faced, including clogged drip lines, difficulties for women lifting water to fill tanks, and crop disease and pests.

[23] The small sample of farmers means that these ratings are not representative. They were used to generate a sense of how farmers think about the technologies and to spur discussion, with the underlying aim of assessing the project's approach.

Table 7: Farmers' Satisfaction with SSI Technologies

Research Site	Number (N=32)	Main SSI Technology Used by FGD Participants	Satisfaction Rating
Dangishta	8	Rope & pulley	5
Robit Bata	8	Rope & pulley	5
Zanlerigu	8	Motor pump/Water can*	4.6
Subgroup 1	5	Motor pump	5
Subgroup 2	3	Water can	4
Bihanaayili	8	Motor pump/Water can	3.6
Subgroup 1	4	Motor pump	5
Subgroup 2	4	Water can	2.3

*Water cans were given to the control group, to compare them with the new technologies.

Farmers appear unaware of the cost of equipment they received as part of the project. The project recognized that providing free equipment would deviate significantly from real world conditions and arranged to have cooperative credit organizations supply credit. When asked, none of the 32 farmers knew the cost of the technology they were using as part of the research. Technology included the tanks, pumps, and water cans. Lack of awareness of costs was partially explained by the fact that participating farmers did not purchase the technology on the market but received it from the project. Technology costs touch on the interrelated issues around technology availability, affordability, and scaling.

At Robit Bata research site in Ethiopia, the topic of equipment ownership and terms of payback was confusing to participating farmers. Purchasing the technology did not seem feasible to them, and they said they could not afford the upfront costs. Only three out of eight farmers said that they knew they had to pay it back. However, all agreed that the costs were high, and the challenge was producing enough crops and vegetables to meet household needs and still cover these debts. After further deliberation among themselves, they said there are some farmers in the area who are already paying, and that farmers who could afford to pay the debt were linked to area cooperatives. They also noted that women-headed households face more problems paying off debts, because without adult males their households have fewer income-earners or people able to do heavier manual labor.

The ET findings (derived from FGDs) on the issue of cost awareness are at odds with the perceptions of project partners. Partners noted that "*all farmers were informed of the cost of the equipment each year by the national partners. Moreover, in Ethiopia, each participating farmer signed an agreement with a local finance provider for credit to pay for the technology. All farmers underwent at least one training on savings (and credit) to manage repayment, with some farmers undergoing two trainings*." Partners acknowledge that the cost of certain technologies (especially WFDs, tanks, and hoses) were not shared with farmers, but emphasized that "*every effort was made to inform the farmers*" about these costs. Additional research would be needed to explain the discrepancy between farmers' and project partners' statements. Possible explanations might be that FGD participants did not recall the cost of equipment; the FGD participants were reluctant to reveal that they knew the cost; or that, although the national partners told international partners they provided the information, this was not, in fact, the case. Regardless, the apparent lack of clarity is a concern that touches on upscaling potential.

The project did facilitate microfinance institution engagement. Since partners were not authorized to provide financing to project farmers, national stakeholders identified microcredit institutions or cooperatives in the research areas, and IWMI formally transferred technology ownership to those institutions. Farmers formed groups and technology was provided on credit, with the agreement that it would be paid back in installments. However, a project partner key informant noted that most of the microfinance institutions have "*very low capacity so they do not manage records well.*" The informant went on to say that one of the microfinance cooperatives had close to a 50 percent illiteracy rate, which had implications for the effectiveness of provided trainings. The informant noted that "*they still find recording and reporting a challenge*."

The project partners noted that the loan for technology cost was considered during the farm simulation when household-level profitability of SSI technologies was evaluated. However, some farmers claimed to be unaware of the borrowing terms, how much they would owe, or if they would owe anything at all. Others said they could not pay the full loan amount because pests, disease, and droughts led to lower than expected revenues. Farmers were discussing ways to lower their payments.

The problem of pests and disease highlights the challenge of conducting research under real world conditions. The project responded well to the pests and disease problem by incorporating it into the model, but farmers were not given assistance (USAID policies prevent the project from providing/advising on use of pesticides). This would have been an opportunity to bring in the Integrated Pest Management IL. However, this was not feasible because activities and budgets at ILs are planned in advance and could not be adjusted on short notice.

While project partners were aware of the issue and addressed it, arrangements for financing technologies proved challenging and apparently were not clear to farmers. In the project regions, access to finance for smallholder farmers is an issue and microfinance options are limited. Interest rates are over 20 percent. By design and necessity (CGIAR rules), project partners took a hands-off approach to the issue. National stakeholders made arrangements to organize credit for project farmers so the equipment was not free of charge. However, these arrangements were not fully satisfactory. Noting that the project RFA did not consider the terms under which farmers would receive technologies, the issue came up with local stakeholders, "*who were concerned about creating unrealistic expectations in the study areas.*" KIIs indicated that credit repayment for equipment was not a project priority. A project partner KI noted that providing technologies free of charge would have made the research on impacts easier. However, from a broader market and sustainability perspective, this would have been undesirable. Any experiments reliant on free or unavailable inputs could face policy and scaling challenges.

CONCLUSIONS

ILSSI technology and practice interventions were based on evidence, are generally appropriate for research purposes, and are specific to the natural resource and social context. The project made significant efforts to introduce and test a variety of interventions. Based on feedback from government stakeholders, farmers' satisfaction levels, project partners' willingness to switch out technologies, and incorporating farmer feedback into data collection, the technologies and practices introduced appear broadly appropriate to the local context and country priorities.

The variety of interventions under different conditions generated rich data and insights on key issues. The project has tested different methods and technologies, which will provide better understanding of linkages between irrigation and productivity, nutrition, gender, labor, and farmer preferences, among other issues. Through policy notes and discussions, the project is informing relevant government agencies in Ethiopia and is expected to do so in Ghana.

The project rates well across a series of indicators related to research, but there is room for improvement. The ET conducted a brief assessment of research quality, using an Indicator Assessment checklist, and concluded that ILSSI rates well in terms of conceptual design, sampling methods, use of meaningful comparators, and modeling and dissemination of findings. At the beginning, the project faced issues with data collection and quality control but these were addressed appropriately.

Preferences may be highly localized. According to key informants, research conducted to date indicates that while most forms of SSI are potentially profitable, local conditions and preferences are strong determinants of the type of technology and practices used. The emerging finding that most of the SSI technologies are economically feasible (with rainwater-harvesting using poly tank storage and a drip system)[24] is good news for both sustainable intensification and for the ILSSI project in particular.

While not neglecting the issue, the project partners may have paid little attention to access to, and affordability of, equipment. Project farmers who took part in FGDs demonstrated a lack of awareness of the cost of equipment. While the terms of participation were reportedly explained to farmer from the start, apparently many of them did not understand what this meant. It is also possible that the people charged with informing farmers did not provide clear explanations, or believe that the actual cost of equipment was important. This makes it very difficult to assess farmers' willingness to pay for these technologies, a key factor in adoption and scaling up. Assuming that the farmers were being candid with the ET, the fact that farmers participating in the FGDs did not seem to know, or were not interested in the prices, raises at least two issues. The first concerns the terms of microfinance arrangements used to buy the project equipment, and the second concerns why the farmers had so little interest in informing themselves. Factors may include the relatively weak and untested microfinance institutions, poor communication between farmers and researchers on the ground, or differing assumptions about what participation meant. Further investigation would be needed on these questions. Nonetheless, it can be argued that modeling provided information on economically feasible and environmentally suitable interventions that the government can use to develop a policy to address gaps. These issues are further addressed in Section 4.4, which covers questions of adoption and scaling.

The biggest challenge to upscaling may be willingness to pay. As per ILSSI project modeling results, with the introduction of new SSI technology and practices, crop production can, without adverse environmental impact, be increased in regions with sufficient groundwater resources (where recharge rates exceed abstraction rates). However, potential for scaling up does not mean scaling up will occur automatically. In fact, it seems there are significant constraints. At the research sites, farmers did not have to purchase the new technology up front, and arrangements were made with local microfinance institutions who provided credit. Farmers appeared to be unaware of what the costs of equipment are. Certain technologies, like WFD and TDR, are either not available or are relatively expensive for smallholder farmers. Credit is difficult to access. This implies a gap between what works in theory and what works in practice. Equipment supply issues, willingness to pay, and social behavior would need to be better integrated into the scaling analysis. Project partners are aware of these issues, and have taken some steps to explore and address them through facilitating microcredit institutions. ILSSI conducted workshops, both at inception in 2014 and again in 2016, that focused on constraints[25]. However, in the future, a much greater emphasis should be placed on addressing what is an interlinked 'package' of issues that includes social behavior, willingness to pay, and equipment cost. Project partners report that papers will be published in 2018 on willingness to pay, credit and adoption behavior, and intra-household decision-making that affect adoption behavior.

The project partners noted that ILSSI used a wide range of technologies to address a variety of challenges that previously received little attention. Before ILSSI conducted research, knowledge for any of these technologies, including more traditional technologies, did not exist. ILSSI was also attentive in incorporating local and government stakeholder needs for specific technologies.

Equipment financing was added to the research design in response to stakeholder consultation; therefore, efforts to identify and train local micro-finance entities were substantial. Still, some key stakeholders mentioned that a wider range of other options should be considered.

RECOMMENDATIONS

In a follow-up phase, equipment financing should be given greater attention. The ET understands that universities and CGIAR centers do not provide financing. Further, it recognizes the imperative to ensure continued technology use throughout Phase I data collection and analysis. Without it, there was a risk of losing farmers and data that underpinned findings on impact and scaling potential. From a development perspective,

[24] ILSSI. Technical Report. Profitability and Economic Feasibility Analysis of Small Scale Irrigation Technologies in Zanlerigu and Bihinaayili, northern Ghana. 2017.

[25] ILSSI. Stakeholder Consultation Workshop Report: Ethiopia, Ghana and Tanzania – 2016. Identifying and prioritizing constraints and opportunities. 2016

however, significant attention needs to be paid to the terms on which farmers receive and use equipment. Leasing or rental arrangements may be feasible and should be explored. The terms of providing equipment to farmers should take into account the constraints identified as part of the current project. These include microfinance sector capacity, farmer awareness of terms, information about technology costs, and behaviors like willingness to pay, and appetite for risk.

ILSSI should go beyond researching innovations related to SSI equipment and practices. While recognizing the need for research to provide and facilitate adoption, the project should expand interventions to encompass research on adoption and scaling. This could include emphasizing identification of policy support and interventions that would stimulate supply chains, markets for equipment, and manufacturing (see Section 4.4 on scaling). Incorporating a better formulated theory of change would strengthen the project's logical framework. Illustrative research topics could be:

- Markets and value chains/supply chains for equipment – private sector (in Ethiopia). The project notes that modelling results can be used to make the case for the private sector to get involved in the whole value/supply chain of SSI technologies (production, markets, technology tools, etc.);
- Behavior change and communication regarding conditions for farmers to be willing to invest;
- Innovation adoption and scaling; and
- Farmers' willingness to pay (for technology, advisory services).

To manage and study these interventions, one or more organizations with expertise in the areas should be included in the consortium. The partner(s) could be an NGO or consulting firm that focus on the illustrative research topics listed in the previous recommendation.

4.2.2 EQ 3: To what extent have the following concerns been incorporated in the identification, evaluation, and testing of selected technologies, including the consideration of potential tradeoffs and synergies: productivity, environmental, economic, nutritional, and gender impacts? In what ways have opportunities to exploit SSI in an environmentally sound way been assessed and carried out? What could be done differently to better address these concerns?

FINDINGS

ILSSI's research partners have explored linkages with productivity, environmental, economic, nutritional, and gender impacts. To analyze a range of linkages with SSI, IFPRI is conducting household surveys and FGDs to collect data on nutrition, health and gender outcomes. The data will generate insights into socio-economic behavior and assess socio-economic dimensions, including labor, household assets, credit, and other behaviors. Baseline surveys were conducted in each country and end line surveys are either completed or ongoing. The surveys cover both project and non-project households. This section does not address ILSSI's findings on irrigation linkages and impacts (which are beyond the scope of the evaluation), but instead assesses the degree to which the various issues were addressed.

The project partners reported that because of knowledge gaps prior to Phase I in links between gender and SSI, they were unable to assess how access to technology would be determined at household level. Innovative findings from the qualitative research helped address this gap, and future projects focused on scaling will have an evidence basis for targeting female and male farmers in projects promoting SSI.

Productivity

Estimating productivity increases, as defined by crop yields and inputs such as labor and technologies, is one of ILSSI's central research questions. Identifying optimal SSI technologies and practices to help farmers obtain more from the land per unit of labor is critical to increase food security. The project addresses productivity by analyzing crop and water productivity using IDSS. It has modeled tomato, onion, and fodder yields, and assessed the impact of influencing factors, including water lifting technology, fertilizer use, tillage methods, and more.

The evaluation received confirmation (based on the project research findings) from farmers that the new technologies are increasing production. All the farmers the ET interviewed as part of FGDs reported their crop yields increased after using the new technologies or practices. In some cases, the increase was significant — double, which enabled them to improve their living standards and income.

> *I used to harvest two baskets of vegetables twice [a year] but now we have increased to about five to six baskets with the use of watering cans and expansion of land. We can now harvest about four times on the same plot since we have enough water using the machine.* – Bihanaayili FGD participant

> *I sell [the harvest] to take care of my family's health care needs, children's education and food, and also use part of the money during the wet season. After harvest in the wet season the proceeds are used to finance dry season farming.* – Zanlerigu FGD participant

In Ethiopia, there was higher than expected demand for irrigated fodder. After using dry-season irrigation, farmers reported that yields doubled what they were without irrigation. Irrigated fodder is more nutritious so stock has higher milk and meat yield.

Environmental concerns and risks

Farmers face significant risk of unexpected extreme events like drought, heavy rainfall, disease and pests. These can reduce yield and cause soil erosion or salinization from poor drainage and high-water tables.

The ET found the project addressed environmental issues from various angles through its modeling and analytical work on SSI, and through Environmental Monitoring and Mitigation Plans (EMMPs). It has modeled water optimization, groundwater recharge rates, efficient fertilizer use, and rainfall patterns.

As the project implementers anticipated at the research design stage, real world conditions ended up having an impact on the experiments. One Ethiopia-based key informant noted that the project did not consider risks of pests and disease, although they are common in dry season irrigation in the region. In both Ethiopia and Ghana, drought, pests, and disease became a significant problem, both for farmers and for the research. In Ghana, problems became so severe that a research site, Dimbasinia, had to be dropped because of a series of problems relating to pests and disease.

According to the IPs, a number of issues prevented data collection at the site from being completed. During the first season, there were pests, disease, severe storms, and flooding. In the second season, nematode infection occurred. Major damage and loss of crops resulted from these conditions. Without two seasons of data, field-level analyses of productivity and cost-benefits were impossible. From the third year onward, research activities in Ghana have been limited to the Zanlerigu and Bihanaayili sites. This illustrates risks associated with doing action research under non-experimental conditions. It also represents a loss of data inputs. At the same time, these experiences have been useful for the modelers because they required them to adjust their model design and assumptions.

The USAID guidelines on dealing with pests and disease contributed to the problem. Project management noted that in accordance with USAID guidelines, they developed a detailed EMMP for each site. The EMMP had to include a provision to avoid advice and/or instruction on disease and pest treatment. When tomato diseases were observed in Robit Bata site, BDU employed an agronomist to diagnose the diseases and provide recommendation to farmers and students. In Ghana, national extension services were informed of any pests and diseases, and they provided the required support.

Ethiopia's drought in 2016 caused crop and income losses for farmers, but enabled researchers to incorporate effects into models. Now the project takes environmental issues into consideration in terms of water optimization, groundwater recharge rates, fertilizer use efficiency, and rainfall patterns.

SWAT, APEX, and FARMSIM models were used to incorporate environmental and economic sustainability parameters in solutions. Research also looked at optimizing water use efficiency, and comparing flood to drip irrigation at Robit Bata site. Climate data was an input for the APEX model.

The models considered tomato and onions appropriate dry season crops. The SWAT modeling analysis compared environmental impacts of SSI at the watershed level over 20 years and found no major environmental impacts from SSI. Research also looked at surface runoff and shallow groundwater recharge rates for selected sites.

In Ethiopia, government institutions have begun using decision tools introduced by the project. ATA is using IDSS (SWAT and APEX) to determine the extent of environmental damage due to poor water management practices on land used for irrigated agricultural. This will inform the design and implementation of cost-effective drainage systems. In Ghana, which began later, government engagement is not as far along, although the Water Research Institute uses IDSS model, and the ILSSI-team is assisting them on model setup, calibration, and validation of their study in the Volta basin.

Economic concerns

The ET found that the ILSSI researchers have cast a wide net to incorporate economic aspects of SSI by addressing economic issues across various dimensions. At the farm level, this includes household income, labor, and the cost-benefit analysis of adopting different practices and technologies. Data are being collected through a "before and after" household survey, through focus groups conducted by IFPRI, through Africa RISING surveys, and other sources. Farm-level economic impacts are modeled through FARMSIM to produce variables. These variables include annual net income for crops and/or livestock, and annual ending cash reserves. They also include probabilities of economic success, and of increasing real net worth and positive cash flows.[26] The project also assessed farm labor cost, with the understanding that this is a relatively new area of inquiry.

To assess economic viability and profitability, IWMI and UDS conducted cost-benefit analysis on four SSI interventions and four dry season irrigated crop types. In a study on northern Ghana, both Gross Margin Analysis (GMA) and Cost-Benefit Analysis were used to analyze profitability and economic feasibility. The analyses took into account all costs that could be reasonably measured, including cost of irrigation labor, inputs, technology, and opportunity costs. The report summarized three policy implications of the findings.

ILSSI also conducted research on market access and prices to assess potential constraints to scaling. Noting a knowledge gap, it added a research protocol.

SSI may have a significant social and earnings impact for families that currently migrate, for part of the year, to work in the south. As a result of practicing dry-season irrigation, farmers in northern Ghana reported that they no longer needed to travel to urban areas like Accra and Kumasi for seasonal work. FGD participants described dry-season irrigation as an important way to provide for their needs, one which allows them to stay in their community and care for their children, a particularly important benefit for the women farmers.

> *"More women should join the project to prevent them from having to travel to work in southern of Ghana. When women stay home without travelling, they give their children good guidance and training instead of travelling and remaining in the south throughout the dry season."* Female FGD participant, Zanlerigu, Ghana
>
> *"I used to travel to the southern part of Ghana to work but with this project I stay and farm and am now able to satisfy my needs."* Male FGD participant, Zanlerigu, Ghana
>
> Since the project started, *"No farmer travels anymore, all farmers concentrate on irrigation farming. In the dry season, all farmers are involved in irrigation."* Female FGD participant, Bihanaayili, Ghana

Although research conducted cost-benefit analysis that incorporated labor requirements, crop types, and other factors, affordability and farmer willingness to pay for technology or services was given less attention. Technologies generated positive returns, but this does not necessarily mean farmers will be willing or able to purchase the equipment.

Project implementers reported working with microfinance institutions to develop their capacity to lend funds to farmers for equipment. However, this is a new area of lending for microfinance institutions, and based on FGD feedback, these efforts may not have been sufficient.

[26] Blackland Texas A&M AgriLife Research and Extension Center: https://blackland.tamu.edu/models/farmsim/

Nutrition

The ILSSI project placed a strong emphasis on nutrition. It covers nutrition issues both through the FARMSIM model and through household surveys, which assess linkages between irrigation and nutrition. As part of the IFPRI's household survey and analysis, the project is using econometric analysis to assess which of four possible pathways (within a diagrammatic theory of change) connect SSI with outcomes in nutrition in areas of food production, agricultural income, water access, and women's empowerment.

ILSSI collaborated with the IL to incorporate Sustainably Intensified Production Systems (SIPS) and Improved Nutrition (SIPS-IN) into the household survey conducted by IFPRI. Because of time and budget constraints, the "best" (most rigorous and detailed) nutrition module available was not used. Instead, second-best scenario was employed. This trade-off was deemed necessary given the project's multiple competing priority focus areas. In Tanzania, ILSSI included areas under the Helen Keller International (HKI) Enhanced Homestead Food Production project as part of its analysis.

However, while contributing to the literature, ILSSI is not expected to be able to make definitive statements correlating irrigation with nutritional outcomes or broader impacts. This is related to the size of samples and datasets. In Ethiopia and Tanzania, 439 households were surveyed, and in Ghana 902 households were surveyed [the larger sample size enabled by combining resources with the CGIAR Water, Land and Ecosystems (WLE) motor pump random control trial]. Medical staff from a partner organization participated in the household survey, and took women's and infant's weight and height measurements. The limited sample size, and the time lag between putting irrigation interventions in place, means any measured changes are not statistically significant.

Gender issues

The project has mainstreamed gender issues throughout its four components. While determining *SSI interventions* (Component 1), ILSSI took into account differential capacities between men and women. The goal was testing out the benefits and trade-offs of different water lifting technologies for women. It has *evaluated* (Component 2) women's empowerment, the differential use of irrigation equipment, and cropping patterns by including the Women's Empowerment in Agriculture Index module in the household surveys. It has *identified key constraints and opportunities* (Component 3) by considering women's roles in agriculture, irrigation, and as related to income control. Finally, it has made strong efforts to promote women's participation in the training on models offered by the project.

Asked about the project's attention to gender issues, all 43 key informants agreed that it had made good efforts. IFPRI researchers, however, stated that they wished they had greater ability to integrate gender issues into the research design at inception.

Half of all farmers participating at the research sites are women. During the FGDs with men and women farmers conducted by the evaluators[27], the ET asked whether and how women farmers benefited from dry-season irrigation. Responses from both men and women were almost unanimous that women benefited. This is because irrigation created more opportunities for them in farming, and certain technologies reduced labor intensity. The result was greater control over income, which allowed them to better provide for their families. Evaluators confirmed that certain irrigation technologies requiring more strength and effort, such as filling tanks for drip irrigation, are not well suited for women.

The project is contributing to the nexus of gender and SSI — a relatively new area of research. Key informants noted that, to date, academic literature has focused mainly on linkages between gender and agriculture. Research has been on gender and large-scale irrigation schemes and less on gender and SSI, an emerging field. The project used the household and focus group data for research on women and irrigation linkages relating to rights of use, differential adoption rates, women's awareness of and ability to try out new technologies, and the benefits and costs of adoption. The household survey, which had "How can women's empowerment be strengthened through adoption of irrigation technologies?" as a focus area, collected information on women's roles and responsibilities and disaggregated it by sex. The survey included a module on Women's Empowerment

[27] FGD participants were selected so that the gender balance of groups were half men and half women.

in Agriculture Index (WEAI), which assesses inclusion of women in domains considered important to the agriculture sector and has as an output a Gender Parity Index. The standard WEAI module was modified slightly for the household survey to incorporate additional gender aspects, including time allocation on irrigating, working with equipment, and decision-making roles on irrigated food/cash crops. IFPRI analyzed baseline household survey data from Ethiopia and Tanzania in terms of contributors to empowerment and disempowerment. Describing the value of the WEAI results to practitioners in the field, an Ethiopian key informant noted, *"one of the issues is not being able to identify the issues [around gender and small-scale irrigation]*." This is a knowledge gap which the WEAI survey is helping to plug.

FGD findings from the Dangishta research site in Ethiopia illustrate farmer perceptions of how SSI can affect women. According to FGD participants, the new technologies enabled them to increase crop yield, use family labor effectively and efficiently, improve their diet, and use land that, previously, remained idle in the dry season. Women became engaged in many irrigation activities since they created opportunities for them to earn money. Their lives have improved because they can afford to buy processed products like sugar and other consumables. As they sell surplus products from their farmland, they are able to buy products for themselves and their children. The SSI technologies also helped them obtain clean water for drinking and cooking. They allow mothers to get water close to their homes.

To build awareness and sensitize national stakeholders on the linkage, the project conducted training workshops on gender and SSI issues in each country. IFPRI led three workshops on the issue of gender and irrigation. Policy makers, academics, researchers, donors, and others attended. Key informants noted that while there were many specialists in agriculture, irrigation, economics, and gender, there were almost none familiar with both disciplines.

Prioritizing research of women farmer participants sometimes conflicted with local context. For example, for the research iDE carried out on conservation agriculture and drip irrigation, NCA&T gave strict parameters, calling for 15 women in each of the three countries to work on trial plots of 10 square meters. The objective was to obtain the same empirical data across the three countries. However, in northern Ghana, gender roles are such that males decide what women do on the plots, not external actors like U.S. universities. This led the selected women to refuse participation. The parameters were then relaxed and the field trial proceeded with three men and three women.

The goal of promoting gender issues and women's empowerment in irrigation is in line with country priorities of Ethiopia and Ghana. The Ethiopian ATA reported that that "*there is a particular interest around gender,*" noting that the work with ILSSI on gender has been "*a good collaborative effort*."

Nonetheless, the research focus on gender and local customs can intersect in unanticipated ways. In the case of iDE, NCA&T insisted on gender parity at the project site, even though on-the-ground knowledge indicated that local traditions would lead to women not participating. The use of affirmative action to accept all female candidates, while applying more stringent criteria to males, may also seem like discrimination, and results in male trainees being more qualified, on average, than their female counterparts. Both examples suggest that gender considerations may occasionally collide with capacity building and research objectives. This is not to question the goal of promoting women's empowerment, which is shared by the governments of Ethiopia and Ghana and backed by research as a driver of growth and a key factor in increasing agricultural output. Food and Agriculture Organization (FAO) estimates that when women are given equal access to land and productive assets in developing countries, yields could increase by 20 to 30 percent, and agricultural output could rise by 2.5 to 4 percent.[28]

[28] FAO. 2011. The State of Food and Agriculture 2010-11. Women in Agriculture. [The State of Food and Agriculture 2010-11 | FAO | Food and Agriculture Organization of the United Nations]

CONCLUSIONS

The project devoted significant attention to incorporating productivity, gender, nutrition, and environmental issues into the research design and analysis. From a research perspective, with the construction of different plausible scenarios for SSI and crops, the project is producing analysis useful to national stakeholders and farmers (with the caveat that because of lack of national level data, certain assumptions might not hold). ILSSI is contributing to the research literature by generating new knowledge about under-researched issues around gender and irrigation. These insights can add value to making a case for women's empowerment by demonstrating benefits through specific practices and techniques for dry-season irrigation. They can also make a case for the untapped resources of women's labor and skills (with the caveat that women have far more household responsibilities than men).

The project is addressing nutrition issues through the IFPRI's household level analysis. While the study is assessing how and whether household diets change as a result of practicing SSI — whether food intake includes more varieties — this is an intermediary outcome. If the project produced correlations between household use of SSI and stunting/wasting, this would contribute to evidence of positive irrigation impacts. However, the time gap between irrigation intervention and impacts on undernutrition and the limited sample size means that any changes measured are not statistically significant. The limited number of measurements for stunting and wasting should not necessarily be a problem. They may be relevant for other nutrition indicators, such as information on micro and macronutrients.

The approach to incorporating economic issues into the analysis is valid but may be too narrow. While the project addresses economic aspects of SSI, clearly more work is required for incorporating access to finance, the credit environment, willingness to pay for SSI equipment, and behavioral changes. All these issues have major implications for scaling up.

The project put strong emphasis on gender issues. This includes disaggregating findings by sex and ensuring that, to the extent possible, women are included on an equal or representative basis as participants in trial farming. Affirmative action maximized the number of women in IDSS training.

RECOMMENDATIONS

Incorporate a broader set of socio-economic dimensions into the research. From a development impact perspective, behavioral, social, and economic obstacles to scaling should be closely examined. In a follow-on phase, the project should deepen coverage of economic issues beyond the farm level by including analyses of markets, value chains, and the role of the private sector.

When scaling up, adverse impact on groundwater needs to be carefully assessed. Where irrigation demand appears to exceed groundwater recharge, groundwater table monitoring must be conducted. This may occur in Ethiopia if SSI is widely embraced. Groundwater modeling like MODFLOW (or other appropriate model) can be useful and can be integrated with the holistic approach of ILSSI.

When designing research, expand gender research to take into account local socio-economic and behavioral contexts. Specifically, the project should take existing gender imbalances at both the farm and research level into account and review how to address them. This can contribute to a better understanding of how gender issues play out in the regions where research is conducted.

More in-depth research on linkages between SSI and nutrition could be conducted, with the caveat that this issue would need to be seen as sufficiently important by policy makers and project stakeholders to allocate funding to it. The research could involve panel surveys comparing stunting/wasting indicators in children over time. However, if there is sufficient evidence in the literature suggesting nutrition is positively affected by dry season irrigation and it is seen as generalizable to the countries in question, more research may not be necessary.

4.2.3 EQ 4: What ILSSI technologies (solar irrigation, irrigated fodder, conveyance methods such as drip irrigation, etc.) are more likely to be adopted by farmers (including women) and scaled sustainably in each of the three countries? And why or why not? (e.g., access to finance, potential availability of replacement equipment, training needed, etc.)

FINDINGS

As one of the primary components of the Cooperative Agreement, adoption and upscaling of SSI technologies and practices form a core of ILSSI research. If one or more SSI interventions introduced at research sites by ILSSI becomes widely and sustainably adopted by farmers, it would constitute a major project success. The project's approach to assessing adoption of technologies and practices is summarized in the Comprehensive Mid-term Report, 2014-16. The report discusses the complexities around adoption and scaling in terms of opportunities and constraints, labor inputs, gender, access to credit, geographic suitability, and crop prices, among other things.[29]

At the time of writing, aside from some adoption of irrigated forage, the project has not produced significant evidence of spontaneous adoption of SSI technologies or practices introduced by the project, with the exception of fodder. Which technologies will be adopted and scaled sustainably in the future can only be assessed probabilistically, not based on evidence.

Labor costs and labor intensity

From the farmers' perspective, labor costs and labor intensity appear to be key determinants of SSI technology preferences. Both project partner key informants and farmers participating in FGDs reported that the least labor-intensive technologies are the most popular. Farmers consider trade-offs between labor costs, technology costs, and productivity (crop yields). There is a preference for keeping labor and technology costs low, rather than maximizing productivity.

Labor costs go beyond finance. Sometimes, others are paid to do work like filling water tanks. But opportunity costs exist, and can be measured in the time taken away from other tasks. Finally, there are "wear and tear" costs in terms of physical exertion, such as the greater effort required to water with buckets than by spraying with a hose. Based on FGDs, at least some farmers find that SSI technologies allow them to cover a larger cropping area — this is highly attractive even though it requires a higher number of labor hours. For example, in Robit Bata, a farmer noted that with the pulley and rope system his yields are higher and his family members engage far more hours in irrigating and farm work because the returns are so much higher. This indicates the preference among farmers is not necessarily reduction in labor hours but that if returns are good, they will increase the number of labor hours.

Women farmers

Women farmers prefer technologies like the pulley system that do not require heavy manual labor. This contrasts with the traditional irrigation conveyance method of manually lowering buckets into wells. According to FGD participants, women are not averse to putting in more labor hours, but heavy lifting means they either must rely on male family members or hire laborers. In other words, with the introduction of SSI, willingness to engage in light manual labor is high and can increase labor hours. Willingness to engage in heavier manual labor is lower, especially among women farmers. While the data the project collects for research does not distinguish between 'heavy' and 'light' labor, the research does take into account the amount of land irrigated using a given unit of labor.

[29] The present evaluation, relying on two weeks of site visits and review of secondary sources, could not (and was not intended to) replicate the scientific research conducted by a consortium of universities and research institutes over four years (and much longer, when previous research activities by the respective institutions are taken into account.) Thus, the ET did not systematically analyze each technology/practice in terms of its likelihood of adoption and upscaling, a research task well beyond the scope of the evaluation. This evaluation cannot verify and does not attempt to second guess ILSSI analysis and findings. The findings in this section should, instead, be considered high level findings based on stakeholder feedback provided to an independent observer (i.e. the ET). We noted whether there were any discrepancies between project reports and field observations, and highlighted what may be conceptual gaps. ILSSI research has modeled costs and benefits and geographic suitability for sustainable SSI in Ethiopia. The findings suggest significant potential for the practice of widespread, although not universal, irrigation. For now, these are theoretical findings, based on assumptions that farmers are willing to invest, are not risk-averse, will make choices based on full understanding of the costs and benefits of a given SSI technology.

Equipment cost

Reliance on equipment provided by the project is substantial. It is, of course, a prerequisite that farmers participating in the field experiments used the technology on which research was being conducted. The project therefore had to ensure that they all obtained it. However, many FGD participants were either not clear on the terms of paying for the equipment or noted that they were trying to get better terms (in order to lower the payments). Supplying farmers with equipment is not part of the project's mandate, and was not in the RFA. However, in order to test the technologies including motor pumps, WFDs, TDRs, water cans (for the study group farmers), etc. and collect data on their effectiveness, the project worked with local micro-finance institutions to provide farm with credit. [30] Unfortunately, borrowing for equipment appeared to be a relatively new phenomenon, and micro-finance institutions in rural areas were underdeveloped.

Feedback during field visits suggested that the project places a heavy emphasis on research, which is not surprising given that the project partners are universities and CGIAR centers. The project also ensured that the field experiments on productivity proceed. In one example, a woman participant in the commercial vegetable kitchen garden research site at Bihanaayli (Ghana) reported that her rainwater-filled tank ran dry midway through the dry-irrigation season. The project paid her to hire labor to refill it. The objective was to ensure the experiment continued so data could be collected. This, however, raises serious questions about the feasibility of this technology.

Most farmers were unable to state the price of the technologies they were using, including the cost of water cans, which were given to the control group. A non-project farmer who used buckets and jerry cans for water said he would not buy water cans, even though he acknowledged that they would be superior to his buckets. According to key informants, while motor pumps and pipes for drip irrigation are available locally (although more expensive than the average farmer is willing to pay), technologies being tested for irrigation scheduling and optimizing water efficiency like TDR and WFD, are not.

Farmers at the research sites received equipment up front and were told they could pay it off in installments later (which they may or may not have understood). Because they did not have to come up with the investment capital, they may not face the conditions farmers without that support might face. The attraction seemed to be the provision of technology to raise productivity.

Local key informants noted that farmer behavior change will be critical for scaling. Given that they bear risks if an innovation fails, they are unlikely to try something new unless they see it working for their neighbors. In northern Ghana, the large numbers of NGOs operating in Feed the Future areas have led farmers to expect no-cost technical assistance and equipment. A key informant noted that NGOs create expectations that international organizations will provide handouts. Although the project has not collected data, repayment rates for loans are reportedly quite low, which raises further concerns. This may have affected willingness to pay for equipment.

Popular technologies and practices

The pulley system (see cover photo) is low-tech water lifting technology stakeholders reported as likely to be adopted. It is also a popular low-tech method, which the GOE is promoting. Compared with using bucket, the pulley system reduces the labor effort required for water lifting. The equipment is fairly basic and is produced domestically, which is considered an advantage.

In Ethiopia, the most commonly cited technology with potential for scaling up is the solar-powered pump. Tested under the Africa RISING project, the pump requires no manual lifting or operating costs. The cost of solar panels is expected to fall, making this technology feasible in the future. Solar pump technology contrasts with motor pumps, which use diesel fuel that is relatively costly for many farmers and must be purchased. Solar pumps contrast with manual water lifting technologies as well. These require significant physical effort and are thus less attractive for women farmers. According to government key informants, the GOE is planning to promote solar-powered pumps. Motor pumps are efficient and have the highest productivity, but both capital

[30] A project implementation partner noted that that with random control trials farmers are simply given the equipment. This removes any obstacle that financing the equipment or non-willingness to pay might pose. Of course, it also comes at the cost of creating conditions that are not necessarily 'real world' conditions.

and operating costs are high, making them affordable only to farmers with larger land holdings who can generate better revenue. Currently, solar-powered pumps are still costly for individual farmers, but production costs of solar pumps are expected to decrease. Their maintenance costs are lower than motor pumps, which makes them attractive.

In Ghana, NCA&T and iDE, an NGO project partner, are researching conservation agriculture and drip irrigation for commercial vegetable home gardens, an area that shows promise. Conservation agriculture involves using mulch to control weeds and prevent loss of moisture. Because mulching means that tillage is not needed, it is an attractive labor-saving feature. Mulching improves soil fertility and the quality and quantity of crops. It appears to be seeing success through use by early adopters as Farm Business Advisors (consultants who work on commission) rather than extension agents. It is forward financing, which allows farmers a grace period — after which they pay their purchases off in installments. iDE has had poor experience with microfinance institutions and cooperatives, which are described as weak. However, iDE reports that capital requirements have been limiting. Since it must supply the equipment up front, the company has only been able to serve 37 farmers. iDE's Korsung model, a social enterprise, contrasts its approach to supply-driven approaches by focusing on utilizing *"access to high-value vegetable markets and irrigation technical assistance to pull farmers to invest in irrigation technology."*

Fodder irrigation

Currently, only the practice of dry season irrigated forage has shown signs of spontaneous adoption and up scaling. The number of farmers using irrigated forage reportedly increased from 22 to 67 over the course of the project. Key informants reported that returns on irrigated forage have proven to be attractive enough for farmers that they have expanded their land under fodder cultivation.

Modeling

To the extent that good quality data is available, models are useful for assessing SSI potential in terms of geographic suitability, sustainable recharge, economic returns, and appropriate crops. They appear to be somewhat limited in what they say about social and behavior change. The modeling exercises appear to be useful and interesting to policymakers in Ethiopia and to researchers in both Ethiopia and Ghana. For now, their value is circumscribed by insufficient empirical country data, which reduces accuracy. This has implications for predicting where SSI can be sustainable and economically viable. Furthermore, the models and IDSS have less to say about how social and behavioral bottlenecks to farmer adoption and scaling can be overcome, although project partners report that they can address these issues.

CONCLUSIONS

Farmers appear to prefer technologies that require lower operating costs and lower labor intensity, even though they understand that the use of certain SSI technologies would increase productivity. Keeping costs low, rather than maximizing productivity, with concomitant higher investment costs, is a priority for farmers. Given a choice between high operating costs and high returns or labor-intensive water lifting, they prefer low operating costs and low labor intensity, even if potential income and crop yields are lower.

The models used by ILSSI are useful for assessing SSI potential in terms of geographic suitability, sustainable recharge, economic returns, and appropriate crops but appear to be somewhat limited in what they say about social and behavior change bottlenecks. If SSI is to offer a path to sustainable intensification, incorporating these and other potential bottlenecks described here - either through a follow-on phase for ILSSI, or through other projects - will be critical.

RECOMMENDATIONS

Deepen the understanding of costs and benefits from the producer perspective and build awareness and educate farmers on benefits of appropriate SSI technologies. Extension service agents are unlikely to have the capacity to build awareness and educate more than a small share of farmers who could benefit from SSI. Alternative methods need to be found. These can include:

- Distribute printed information, such as brochures, to districts where SSI is feasible. Given lower rural literacy rates, brochures could be illustration-heavy, depicting technologies, practices, benefits, procedures, risks, etc.
- Establish a program under which model farmers demonstrate the benefits on their own farms. In tandem, develop a program for model farmers to act as advisors to other farmers. This approach is being used by iDE, under which model farmers receive a commission on equipment sold, to incentivize them. Supporting model farmers may require significant planning, resources, and coordination with the national extension services.
- Identify innovative approaches to increase affordability of technologies. This could involve farmers pool resources to buy equipment such as pumps or irrigation lines and share them, or it could indicate an increase in the number of private sector entrepreneurs who rent out equipment and offer operation and maintenance (O&M) services. The AgWaters Solutions project reports that there is an emerging pump rental market. This suggests there may be opportunities to rent out or lease other types of SSI equipment (e.g. WFDs, TDRs) and services, as a way of addressing affordability concerns.[31]

Provide training and additional resources to national extension services in areas where SSI is considered suitable. This approach would build on an existing system with staff who already have relationships with farmers. Its feasibility would depend on, among other things, avoiding the risk that additional assistance to extension agencies might reduce technical assistance in other areas.

Ensure that models incorporate constraints to upscaling. The models ILSSI uses are clearly useful for policymakers in predicting the potential for scaling in terms of suitability. The data are available, are of good quality, and have high applicability. Governments can use them to effectively target areas where SSI can be sustainable and profitable. However, in terms of behavioral and social dimensions of SSI adoption and scaling, the models appear to have some limitations. A Management Information System (MIS) can be established with the help of models that can be used to upgrade/update by the local users (by local universities, academic institutions). Such updated models will be useful for the decision-making authorities. Estimating SSI scaling potential in the framework of resource constraints (both natural resource and economic) is not the same as identifying methods and approaches to unlock that potential. For example, key questions the models do not appear to tackle, are:

- How can the knowledge produced by the project best be passed on to farmers in areas suitable for SSI (beyond farmers participating in the research or other farmers in their communities)?
- What will it take to convince farmers to adopt it?
- How can the capital investments needed for SSI technology be made affordable?
- How can technical advice be provided to farmers so that they use the new technology in an appropriate manner, given the weak capacity of national extension services?

[31] de Fraiture, C. & T. Clayton. AgWater Solutions Irrigation Service Providers: A Business Plan. 2012.

4.2.4 EQ 5: What types of opportunities and constraints have been identified related to the widespread adoption and scaling of SSI technologies and practices by smallholder farmers? In what ways, if any, have opportunities been maximized to support scaling? What approaches have been identified to address these constraints? What could the Project do to better address the challenges to improved access and use for smallholder farmers?

FINDINGS

ILSSI is estimating the potential for upscaling SSI technology at the watershed level using four main methodological approaches: spatial analysis (using APEX for environmental and social suitability of land); biophysical modeling (using SWAT); economic modeling (using FARMSIM); and cost-benefit analysis. Different crop types are introduced as factors. Analysis is also conducted to provide a vision of SSI technologies adopted at a national scale. An additional tool, agent-based modeling (ABM), was developed and used alongside other methods, including pre-suitability analysis, SWAT, Spatial Allocation Model and DREAM models in this national-scale analysis. ABM is a computational model used for simulating actions and interactions of individuals and groups. It considers social influences, suitability considerations, economic viability, and water availability. In the upscaling analysis, scaling potentials are predicted using the modelling tools noted above, based on natural resource constraints, economic cost-benefit, and biophysical and environmental impacts of intensification.

A key informant from one of the project implementers, who was not familiar with modeling before the project, offered this perspective on the modeling work done under ILSSI:

> "*I believe that it is quite a powerful tool. A real planning tool for policy makers, large-scale development agents, [who are] planning investments, targeting the areas, hopefully being able to tell you, look, that is as much water as you might exploit without over-exploiting. The more I understand the parameters used, the kind of validation used, the more I became convinced that it is a very powerful tool.*"

Project findings are encouraging. ILSSI's researchers have estimated that the potential area for introducing SSI is significant. In addition, it was found that all of the SSI technologies tested, with the exception of non-motorized water lifting for women, have positive returns, and are potentially profitable for smallholder farmers. In Ethiopia, preliminary suitability analysis found that 6 million ha is suitable, which represents 12 percent of rain-fed land. Economic analysis suggests the potential income SSI adoption could generate is approximately $250 million annually.[32]

Project partners and government stakeholders are aware of the numerous constraints to scaling up *in practice* in the current enabling environment in both countries. A project implementer key informant noted that ILSSI "*was initially a research project, strongly based on modeling, with potential for scaling, and the fieldwork was [designed] to make that modeling better and more accurate.*" He noted a general assumption that research naturally translates into results on the ground, as in adoption and scaling. However, after project launch, it became clear to project partners that significant efforts are required to facilitate translation of knowledge into policy and practice. Referring to ILSSI in terms of exerting an impact, one key informant said, "*the intention is good, the impact is unclear.*" Ending ILSSI without renewing it for a second phase could risk the research not being taken to the next level.

Below, we outline the key constraints and opportunities identified through KIIs — all factors ILSSI will need to grapple with in order to leave a lasting and significant development impact at country level.

[32] Dile et al., 2017. Upscaling methodological report.

Constraints

Risks facing farmers. Farmers face risks such as crop damage due to drought, pests, disease, flooding, and more, some of which may be linked to dry-season irrigation. Although dry-season irrigation can reduce risks to livelihoods, knowing that droughts may ruin a harvest may make farmers reluctant to invest in SSI technology, even if it means potentially improved yields, income, and nutrition. When asked whether non-project farmers would invest in the technology themselves, the focus group participants were skeptical — they highlighted the risks of drought, disease, and the need for capacity building.

Behavior changes slowly. Many farmers still overwater their crops because they do not fully understand water saving technology or its importance. While farmers tend to be savvy when it comes to assessing risks, costs and benefits, especially in the current era of unpredictable climate fluctuations, lack of education may play a role in their willingness to change behavior.

Extension services lack capacity to support farmers. The lack of capacity faced by extension services in each country, and the lack of other sources of support and technical assistance, pose a significant constraint to scaling. This is especially true in Ghana. Only the small number of farmers participating in donor-funded irrigation projects like ILSSI have access to technical advice. Farmers participating in FGDs, and several key informants, cited support as critical. This implies that through the public sector at national level few, if any, farmers are likely to receive advice on SSI practice and technologies.

Only a limited percentage of cultivable land in each country is suitable for SSI. Ground-water resources are too scarce to meet irrigation demand. Analysis of recharge rates shows only some areas are suitable for SSI. While some farmers will be able to successfully use SSI, many will continue to rely on rain-fed agriculture. For them, sustainable intensification to increase productivity will have to come from other methods like higher yielding seeds, higher-producing (hybrid) livestock, mechanization, innovative methods for deeper tillage, and others.

High interest rates and lack of collateral limit the ability of farmers to borrow. In both countries, interest rates are as high as 30 percent. This makes borrowing unattractive and risky. Repayment rates are low and default rates are high.[33]

From the farmer perspective, payment in installments may be too costly, especially considering the risk of not achieving expected returns due to crop damage or something else. Although cost-benefit analysis may indicate positive returns on SSI investing, farmer behavior suggests that either some assumptions do not hold, or that farmers are not aware of mitigation measures. One Ethiopian key informant, referring to customary methods of farming and the challenges of promoting change, spoke about the farm level research, saying "*we have noticed an improvement in income and nutrition, but culture is important*."

Access to technology is a major stumbling block to widespread adoption in Ethiopia. Key informants from IFPRI and iDE reported that in Ghana equipment is available on the market through distributors. However, in Ethiopia, SSI technology and equipment used for ILSSI research is difficult or impossible to find. The fact that SSI is a new approach to farming may mean that there is not yet a market for SSI equipment or O&M services, let alone spare parts.

Related to the lack of technology is the lack of working capital for buying and maintaining equipment**,** including operational motor pumps. Farmers must feel confident that an investment in technology will generate sufficient income.

Wide prevalence of development projects is a particular issue in northern Ghana. Because of the large number of projects operating in rural areas, and the fact that NGOs are perceived as providing free or subsidized equipment, it may be difficult to persuade farmers to pay for SSI technology.

[33] A 2013 study on credit default risk at 6 MFIs in Ethiopia estimated default rates at 27.1 percent, far above the international standard of 3 percent. Setargie, S. Credit Default Risk and its Determinants of Microfinance Industry in Ethiopia, *Ethiopian Journal of Business and Economics* Vol. 3 No. 1/2013

The absence of a regular crop cut survey mechanism to check the output against baseline information limits data quality. At present, crop yields are only being monitored at the research site, and only at harvest time for each season.

Limits to observing groundwater conditions. In each watershed, various locations were selected to observe ground water table fluctuation and its relation to stream flow. At present, there is limited capacity to analyze groundwater conditions in areas considered suitable for irrigation. Project management reports that the IDSS uses groundwater maps, when available, as one of the inputs to SWAT and APEX. They then use the SWAT model to estimate the impact of various interventions on changes in groundwater amount and runoff. This emphasizes the fact that the models are dependent on good data to produce accurate predictions. In scaling up ground water use, it is important to analyze the viability of confined/unconfined aquifers. At the Dimbasinia research site, the research was shut down in part because of inadequate groundwater. This raises the risk that farmers who begin engaging in SSI might see it as unfeasible and become discouraged. Farmer discouragement could have negative ripple effects.

In Ghana, water rights may be an issue. If SSI scales up in Ghana, usufructuary rights related to water resources (i.e. water usage rights) issues could become important, and formal or legal agreements between landowner and tenant may be needed. The project implementers note that water user associations (WUAs) were established to integrate farmers within formal irrigation schemes. This leaves a general governance gap not addressed by WUAs. However, GIDA reported that a previous organization set up for irrigators under the formal irrigation system — Irrigation Farmers Association (IFA) — is being converted into WUA. This will cover all types of water users from a common source such as a reservoir or canal, including farmers using canal water for SSI. This new system is being tested at demonstration sites and there are plans to eventually implement it throughout Ghana.

Opportunities

Adoption and scaling of SSI technologies is an untapped area with possibility for further action research.

The ILSSI project's interdisciplinary approach is able to address issues in an integrated way. ILSSI uses an integrated approach for the agricultural development. Researchers, experts in a wide range of agricultural fields such as irrigation, hydrology, health, nutrition, livestock, economy, and gender, come together to contribute to improved beneficiary agriculture production, food security, and nutrition status.

The IDSS dashboard, which ILSSI modelers are developing, will allow different stakeholders (including policy makers, extension services and farmers) to use the IDSS to plan and assess investment options. By helping those working at the field level to make decisions on crops and irrigation, an effective and user-friendly IDSS dashboard could potentially spread the application of the model beyond researchers.

Irrigation scheduling can be improved with the use of technology. Technologies like TDR and WFD can significantly enhance its use in real-time irrigation programming. WFD also helps in irrigation scheduling, and monitors salts and fertilizer levels in the soil.

Watershed management can be improved by applying engineering and bioengineering technology. Construction of soil bund, check dams, channel or river training/protection with re-forestation and bioengineering/plantation of soil retaining plant control the surface runoff, improve groundwater recharge, and help in stabilizing the slope/landslide control.

CONCLUSIONS

While the identified constraints may not be directly linked to adoption scaling per se, unless they are taken into account and addressed, it is likely they will impede the spread of SSI and, therefore, its benefits. However, many of the issues fall outside the area of focus/expertise of the project partners. These include the weak extension services, the NGO culture of providing beneficiaries with cost-free items, and water rights. This implies that if SSI fails to scale (and thus address food security issues), it is not solely due to the project.

ILSSI is well aware of constraints and has taken them into account by identifying them at stakeholder workshops and incorporating them into models. Based on KIIs with project partners, scaling appears to be understood primarily by using the SWAT to model potential for scaling up SSI at the watershed and national levels.

ILSSI identified opportunities for promoting SSI in general, and SSI scaling in particular. Given the many issues, there is more work to be done on SSI. The number and range of opportunities is considerable. While ILSSI highlighted them, and is addressing a select number, there are clearly many areas for more research, collaboration, and engagement. A second phase of ILSSI could take advantage of these opportunities.

The fact that SSI has not been widely adopted is not ILSSI's responsibility, given that field experiments to date have only been conducted over three growing seasons in Ethiopia, and two in Ghana and Tanzania. ILSSI focused on helping governments understand where SSI is suitable, what technologies are optimal, and what crops generate good returns. However, if ILSSI is to leave a lasting impact, not just "*feed today,*" as one key informant put it, knowledge will need to translate into on the ground impacts. Furthermore, ILSSI project implementers intentionally focused on building up an evidence base to assess which interventions work, before determining which can and should be promoted for adoption during a potential follow-up phase.

RECOMMENDATIONS

Re-orient a second ILSSI phase to encompass practical solutions to scaling up, in addition to knowledge generation. Many constraints and opportunities to scaling SSI require a new orientation that goes beyond academic research to more entrepreneurial and practical solutions. While research and modeling are critical, greater emphasis should be placed on addressing practical barriers to scaling up SSI.

Introduce chameleon soil moisture sensors as an additional tool similar to WFDs. Chameleon soil moisture sensors measure soil tension and estimate amounts of water in soil, allowing farmers to reduce plant stress, over-irrigation, nutrient loss, and water logging — vital for irrigation management.

Implement innovative financing methods to reduce capital and operating costs. Innovative ways to lower both capital costs, such as investing in drip irrigation lines or solar-powered pumps, could address one of the key bottlenecks to adoption.

Increase the affiliation of educational and research institutions with SSI initiatives. While ILSSI is successfully partnering with several institutions in each country, there are many more that can be brought in to help spread learning and awareness of SSI. Other institutions, such as Farm Training Centers, can also be included in research work.

4.2.5 EQ 6: In what ways are relevant partners, including USAID missions, CGIAR Centers, NGOs, host country governmental and academic institutions, and community stakeholders being engaged? What potential is there for other partnerships and collaborations, including with other Feed the Future ILs and other relevant USAID programs in the target countries?

FINDINGS

Project approach

Stakeholder engagement is a strategic component of the project. Led by the ME, project management developed an influence matrix categorizing targets in terms of influence, interest, and specific activities aimed at global, national, and local audiences. They also developed country-level engagement activity matrices that target public sector, development partners, and the private sector. ILSSI calls this 'engagement for impact.' Based on document review and feedback from key informants, it seems ILSSI IPs have taken systematic and concerted actions to engage with national-level country stakeholders. Engaging with stakeholders serves multiple purposes, including getting advice on project design, selection of technologies, and prioritization of constraints. It also enables collaboration on research; learning and capacity building; informing policy makers and farmers of research findings; and promoting project impact sustainability.

ILSSI engages with both country stakeholders and with non-project partners**.** For example, in Ethiopia, ILSSI partners with Africa RISING on another USAID project focused on sustainable agriculture intensification. Together, ILSSI and Africa RISING coordinate research on fodder production. With IFPRI, ILSSI collaborates on data collection, and IFPRI shares findings on experiments using solar-powered pumps. ILSSI also works with the Ethiopian Institute of Agriculture Research, which is conducting a study on wetting front detectors. Internationally, ILSSI has shared findings from the project at numerous global and regional events.

Many partners describe the ME's engagement and responsiveness levels as exceptional. However, sometimes communication and involvement between project partners was reported as uneven — not in terms of goodwill, but in terms of communication frequency and information sharing.

Value of engagement

Stakeholders have been engaged to provide project partners with advice on specific implementation issues. In 2014, national level stakeholders, representing government agencies, NGOs, and research institutes, participated in workshops focused on identifying appropriate SSI technologies and practices for the project to implement. This was instrumental in helping the project to refine its research design. In June and July of 2016, national stakeholders were invited to participate in workshops in each country to develop shortlists of constraints facing promotion of SSI. The key informants the ET spoke to were open to these opportunities. GIDA and WRI in Ghana, noted that they would have liked to engage more deeply with the project, as collaborators (see below).

Collaboration on research with other projects working on irrigation issues has been a key feature of ILSSI. Some of these projects include Africa RISING, LIVES, Sustainable Intensification Innovation Lab (SIIL) and, under the AgWater Solutions project, Water, Land, and Ecosystems (WLE). ILSSI project partners are being simultaneously engaged on these projects outside of ILSSI, which facilitates collaboration. The project is also building on long-standing relationships between the CGIAR centers, and the centers and Ethiopian research institutions. Collaboration adds value to the project in multiple ways:

- Identifying complementarities with ILSSI research, such as sustainable intensification with the SIIL project; and benefiting from additional household data with Africa RISING in Ghana (where a larger household survey was made possible);
- Leveraging additional resources to enhance ILSSI activities and those of other projects; for example, BI/TAMU using the Texas A&M administrative resources for contract management, or IWMI drawing on work done under the WLE project;
- Addressing issues that were identified as part of the research activities, such as fodder irrigation with Africa RISING; and
- Promoting the dissemination and use of modeling activities nationally through research institutions such as BDU.

National level engagement

Government partners are key to institutionalizing findings and recommendations, and the project recognizes this**.** Government institutions will be essential for sustaining and scaling up of project research results. They were closely involved in selecting sites, and will be consumers of the results. In particular, ATA in Ethiopia is a key conduit of information to the Ministry level. Policy notes on findings are shared with ATA, which passes them to the Ministry of Agriculture, who takes them into account when formulating policy.

In Ethiopia, KIIs indicated that engagement between project partners and national stakeholders is very strong. The project has a robust participatory element, which is facilitated by strong government interest in promoting SSI. With a few exceptions, country partners, the Ministry, research institutes, universities, and basin authorities are well integrated into project activities. Through the Inception Workshop, partners were involved in advising on project scope and design, participating in implementation activities, reviewing progress, collecting and analyzing data, and integrating data into the various models and IDSS. ATA plays a key role in bringing actors together. The exceptions — unengaged stakeholders— are some government ministries (the Ministry of

Health), and extension services. A key informant from one agency told us that the project "*could engage us more deeply in data collection, capacity building, and disseminating information*." The extension services also expressed a strong desire to be more involved, receive more training, and integrate more into the project.

Gaps in stakeholder engagement

The ET found that certain stakeholder groups have received less attention, some of which are likely to be key players in capacity building or scaling up. According to key informants, the project has not engaged with these actors as fully as it could have due to capacity limitations (extension services in both countries) and country priorities (national agencies in Ghana). To date, the project has focused on generating data on biophysical suitability and cost-benefit for scaling up technology use, with less emphasis on addressing bottlenecks in the supply chain, farmer behavior (with regard to willingness to pay, willingness to adopt), and other factors necessary for successful implementation. This finding must be qualified by noting that the project's intent from the beginning was to generate data and knowledge of what works, and then, in a follow-on phase, make recommendations on what technologies to promote and operationalize their implementation.

Key informants mentioned several stakeholder types as potentially relevant to ILSSI goals but not included in the project design. These include private sector actors, which are critical in developing a market to ensure SSI can spread. Private sector actors include manufacturers who could potentially produce certain technologies in Ethiopia; entrepreneurs who could identify market opportunities; service providers who could rent out or service equipment; and traders to distribute and sell. Other stakeholders important to SSI uptake include NGOs as development partners and other ILs, such as the Pest Management IL. As development partners, NGOs do not play a role in the project.

Cooperation with other ILs could also be strengthened. In both countries, crop spoilage due to pests and disease was an unanticipated problem that led to crop losses and lower productivity than models predicted. Risks related to pests and disease were not initially included in the models, but were added, which represented an opportunity to refine the model. This was an opportunity to cooperate with the Integrated Pest Management IL. However, given the nature of project planning and budget allocations, which are determined in advance and allow for minimal flexibility, cooperation was unfeasible.

In Ghana, national institutions are not as well integrated into the project, and national level stakeholder engagement has been weaker. Agencies such as GIDA and WRI participated in workshops and consultations, but their involvement is more as sector stakeholders than partners. According to key informants, this partially reflects Ghana's more decentralized administration, and partly reflects capacity issues and government priorities, which are on larger-scale, formal irrigation systems. Recently, Ghana slashed its agriculture sector budget from over four percent of the national budget to less than one percent, with negative consequences.

Agriculture extension services are another exception to the overall finding of strong engagement. Extension services in research areas are part of the project design, but the district and local extension services in Ethiopia had not received capacity building. Instead, they received a minimal 'top-up' in remuneration. The Agricultural Extension System of Ethiopia is vast but lacks resources and capacity. Extension service staff indicated they would welcome greater engagement in the form of transparent project budget and capacity building. Given that this is a relatively new field, the majority of extension workers have never been trained for SSI.

Local level engagement

Project implementers took into account past research indicating that engaging farmers in research improves results and causes higher rates of change in practice. Farmers themselves, as end-users, beneficiaries, and participants in experiments appear to be well integrated into the project. They have frequent interaction with the project implementer stakeholders, primarily through data collectors, extension service agents, and agricultural experts. Farmers also take part in training workshops and field days to visit each other's sites to learn from demonstrations. However, farmer awareness of investment and cost aspects of SSI was weak. That, and the lack of training on O&M, are areas for improvement.

CONCLUSIONS

A key project strength is its highly participatory nature. By engendering goodwill and cooperation, the deep and continuous level of engagement and commitment by stakeholders clearly helps both implementation and achieving objectives. The project design follows a systematic approach to engaging the most critical country actors.

Successful engagement depends on both the project implementers and on the country. The contrasting experiences of Ethiopia and Ghana demonstrate that stakeholder engagement requires reciprocity to be effective. Ethiopia's more centralized government institutions, the prioritization of SSI, and strong research capacity facilitated project engagement. Stakeholders at an individual level were engaged in Ghana, but at the institutional level engagement was somewhat weak. Specifically, there was less collaboration with relevant government agencies (GIDA and WRI). As such, IDSS is less likely to become widely used, and adoption and scaling up may be less likely.

Engaging additional stakeholder groups could have helped address issues related to technology affordability and accessibility. In addition to those already engaged, closer private sector stakeholder engagement in a follow-on phase will be key for promoting scaling up SSI. It is understandable that development partners like NGOs are minimally involved at this stage in such a research-focused project (iDE being an exception). However, they can serve a valuable role mobilizing farmers, building capacity, and helping spread the technology.

RECOMMENDATIONS

Bringing more partners into the project would enable ILSSI to shift focus from research and capacity building to promoting adoption and scaling. If a second phase focuses on impact on the ground, a new balance will need to be struck between knowledge generation and practical application. This would move the project in a somewhat new direction, broadening its focus from mainly research to development impact. The broader set of stakeholders would include NGOs with a social impact focus, entrepreneurs, and others with knowledge, capacity, and motivation to build up supply chains and access to finance. There is considerable activity promoting innovations around the world, much of which is compiled on the Global Innovation Exchange. For example, USAID/India is known for being an innovative Mission from which some lessons could be learned. The Mission, under its Country Development Cooperation Strategy (CDCS), has a Development Objective 4 of "*Innovations proven in India increasingly adopted in other countries*." One of the members of the ET co-authored an evaluation of this development objective, which includes numerous observations relevant to ILSSI.[34] The remit of this 'social entrepreneur' partner would include research and promotion of: innovative practices and their dispersion, marketing of technologies and practices, incentives, public communication, social behavior change (including areas like 'nudge theory' relating to unforced compliance), and producer affordability and willingness to pay issues.

Make more proactive efforts to bring in national institutions in Ghana. GIDA and WRI in Ghana have recognized capacity issues and, at the national level, there may have been less interest in participating. However, discussions with staff from these organizations suggested a strong interest for a closer partnership. If the results of the research are to leave a lasting impact, the national institutions responsible for research and policy will need to be integrated more fully as partners.

Explore building on the model of lead farmers (Farm Business Advisors), as used under the iDE project. Given that it would be challenging, costly, and time-consuming to build the capacity of vast national extension services, alternate ways of spreading SSI technology knowledge and practices would present a more viable solution. Ideally, innovation adoption spreads spontaneously through farmers observing each other and taking calculated risks. However, for now, the lack of supply on the market acts as a natural barrier to adoption.

[34] USAID. 2017. Evaluation: USAID/India Country Development Cooperation Strategy Development Objective 4 Mid-term Performance Evaluation http://pdf.usaid.gov/pdf_docs/pa00mq9w.pdf

The approach used by iDE of hiring early adopters or lead farmers should be studied. This model could be facilitated by NGOs with entrepreneurial focus or impact investing initiatives and expanded to regional and national levels.

4.2.6 EQ 7: Are the appropriate type and number of people being targeted for the right kind of training? What improvements, if any, are needed in how academic and technical capacity strengthening activities are identified and implemented?

FINDINGS

Project approach

A review of documents and KIIs shows that ILSSI has implemented a multi-pronged capacity building program that targets three levels: national level institutions and organizations; research institutions; and, at the field level, farmers, farmer organizations, and extension agents.

A quantitative assessment to determine whether the 'appropriate type of number' were targeted for training at the national level was beyond the scope of this evaluation.[35] To overcome this issue, the ET considered certain quantitative and qualitative indicators as proxies for targeting. These included demands for training, feedback from trainees, and ILSSI advertising and selection procedures.

The project has a well-developed, systematic approach to building capacity of national stakeholders,[36] and clearly defines objectives, key actors to support, phases, and timeframes. ILSSI's capacity building strategy includes workshops, technical training, clinics, graduate student mentoring, and field exchanges.

ILSSI emphasizes providing training on decision support tools and analysis (SWAT, APEX, FARMSIM) to researchers and students. It offers different types of capacity development in IDSS for individuals from the project countries. They include two to three years of graduate professional training at U.S. universities, extended 90-day training for graduate students, 5-day workshops, and advanced clinics. As of July 2017, there were nine IDSS workshops. Project management reported that it conducted formal IDSS training for 50 participants in Ghana, 313 in Ethiopia, and 170 in Tanzania.[37] In Ethiopia, ATA asked ILSSI to arrange three specifically tailored training workshops for IDSS. The project also organized joint workshops on gender and irrigation with different national partners in all three countries. These workshops reached over 150 participants from government, research institutes, NGOs, and donors.

Gender inclusion

Promoting female participation in training on models and IDSS is a specific goal. USAID asked the project partners to aim for gender parity in participation. According to ILSSI project management, approximately 50 percent of male and 95 percent or more of female applicants are accepted.[38] However, in the project countries, women are a small minority in the agricultural science sector. According to a 2010 study, collectively, in the 28 higher education agencies in agricultural sciences in sub-Saharan Africa, females were only 13 percent of those enrolled in MSc and PhD studies.[39] This meant that achieving an even breakdown between men and women was

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[35] Such an assessment would be extremely time-consuming. For example, it would require reviewing the qualifications of not only applicants, and the actual selected trainees, but all *potential* trainees. These groups would need to be compared using criteria such as degree level, degree type, professional or academic affiliation, and analytical capacity. Furthermore, the term 'appropriate is open to interpretation. If this issue is deemed important, a stand-alone evaluation on capacity development would be warranted.

[36] It is noted that capacity building was not a part of the USAID Request for Applications (RFA), which only called for the program to "collaborate with a leading international water management research institution and link with international, national, and local programs and partners to identify opportunities for leverage, partnership, and in-country capacity-building." However, "Capacity development, partnerships and engagement" became one of four project components under the ILSSI project design.

[37] Communication from ILSSI project partners.

[38] The imbalance in acceptance rates between genders relates to informal affirmative action to promote and empower women in the sector.

[39] Beintema, N. M., and F. Di Marcantonio. 2010. Female Participation in African Agricultural Research and Higher Education: New Insights. Synthesis of the ASTI–Award Benchmarking Survey on Gender-Disaggregated Capacity Indicators. IFPRI Discussion

not realistic. When it came to selecting applicants for training, the project generally aimed to ensure female participation was at least representative of their proportion in the relevant sector or faculty. This implied use of an affirmative action approach to accept virtually all female applicants, while using more stringent selection criteria with male applicants. Evaluators reviewed training data that show the percentage of women attending IDSS training was 12 in Ethiopia, 23 in Ghana, and 24.7 in Tanzania between 2013 and 2016.

Demand

Based on KIIs and project data, demand for training on the decision-making models and issues linked to SSI is described as high in both countries. National partners, under the guidance of international IPs, were responsible for identifying and selecting training participants and were asked to give higher priority to women, institutional distribution, private sector, and applicants with MScs, among others.

Training sessions for IDSS are announced via social media, government agencies, and on notice boards at research institutions. Announcements target potential trainees who teach at universities or research institutes, or who work for NGOs or government agencies and are expected to use their knowledge or pass it to others. PhD and MA students have been hired to collect data, and take training on modeling. Some of these students have been to BI/TAMU on fellowships, and some have received support to pursue degrees at U.S. universities.

It is worth noting that all 22 students who receive mentoring or support from the project to work on their thesis are from Ethiopia. Key informants explained the discrepancy by noting that the UDS in Tamale, Ghana, is not as strong in the area of modeling.

Training sessions for IDSS, announced via social media, notice boards at research institutions and government agencies, are usually oversubscribed This is despite the fact that no per diem is provided and participants must pay their own way, including travel costs if they come from out of town.[40]

Content

Key informants reported that the main challenge with the models is that they are data intensive, and data is often scarce in the countries in question. Because the decision support models are as only useful as the data quality, this has been a challenge. National key informants noted the lack of data, particularly in the case of using SWAT, which demands high volumes of data for predictive accuracy. Data quality and availability poses a problem in both countries which has implications for accuracy. In a follow-up email, a trainee from Ghana wrote that there was no dataset from Ghana they could use, and thus the data they used in the training "*did not have all required values so we all saw the need for us to get an all-encompassing dataset in our local setting*."

The following quotes from individuals who took the 5-day training courses on the models are indicative:

> An Ethiopian training participant was impressed that "*trainers gave training beyond the time that was allocated [for the training]"* and noted that after the course was over the instructors were still available and very responsive to email inquiries.
>
> A Ghanaian key informant at a government institution noted that the MS Excel-based modeling "*opened my eyes*" and that the new knowledge would help him pursue his Ph.D.
>
> Another key informant from Ghana noted that "*there was no data set in Ghana which we could use during training sessions… the class used hypothetical data which obviously has its limitations*." Because of the lack of country data "*people get discouraged because they have to build the data*."

Paper 957. Washington, DC: International Food Policy Research Institute and African Women in Agriculture and Rural Development, in Meinzen-Dick, R. et al. 2013. Engendering Agricultural Research, Development and Extension

[40] One individual even traveled from abroad to attend a training workshop in Ghana.

Quality

All seven of the research-level trainees interviewed by the ET spoke highly of both the quality and relevance of training. The instructors, who included the model developers, and the course content were both rated highly by the participants and were seen as useful to their careers and relevant to the sector needs of the countries. Trainees appreciated that course instructors were available by email, even after the course ended, to answer follow-up questions related to the training.

Individuals who took the training already belong to organizations (or are likely to join organizations) where they will put the acquired knowledge to use. Feedback given by key informants from research institutes — both directors and the seven individuals who received training — indicate that training beneficiaries are expected to join research institutes, universities, government agencies, and NGOs. In these workplaces, at least some of them will use what they learned to conduct or direct research that could potentially influence policy. At a minimum, they will be aware of the models and their application.

> An Ethiopian who took advanced SWAT model training described how he would use what he learned, *"I'm going to do climate change and watershed management scenarios…I will then take future climate change scenarios and enter them into the SWAT [model]. SWAT will then tell me what water will be available for the coming century."*
>
> A Ghana FARMSIM model training beneficiary, in a follow-up email, noted that *"I do sensitivity analysis on my own and the model has taught me another way to compute projected values, which work out well."*
>
> A key informant from Ghana wrote in an email that he expects to use what he learned from SWAT training to *"estimate groundwater recharge and subsurface runoff to predict the thresholds for groundwater abstraction. The training has been very useful in terms of evaluating water budget in a catchment."*

ILSSI also provides practical training to local level stakeholders like farmers, extension agents, private sector firms, micro-finance institutions, and civil society. Training is in areas critical to using and getting the most out of SSI such as irrigation scheduling, conservation agriculture, savings and credit, and improved forage development.

Scope

As of July 2017, ILSSI reported that it provided 1,003 training sessions[41] to local trainees, of which 698 training sessions were taken by men and 305 by women. In addition to training, field days were organized for farmers to visit other sites, learn from each other, and exchange ideas.[42]

Between 2014 and 2016, ILSSI reports that 797 individuals received training (Table 8). Coupled with training workshops conducted in 2017, a total of 613 persons received IDSS training. As of this writing, the total number of people trained by the project is much higher than 797.

At the local level, demand and need for capacity building was higher than anticipated. Project management noted that repeated training was required for farmers and local experts, such as extension agents and sub-national agricultural information offices. The training related to building data collection capacity and O&M of water lifting technologies and conveyances.[43]

[41] Individuals took more than one training sessions each, so the number of unique individuals who took training is much less than 1,003.
[42] ILSSI project. Capacity Development within ILSSI. July 2017. Presentation
[43] ILSSI Project data extracted from "Historical Feed the Future Management System (FEED THE FUTUREMS)"

Table 8. Number and Type of Individuals Who Received Short-term Agricultural Sector Productivity or Food Security Training Under ILSSI from 2014 - 2016

Year	2014	2015	2016
Producers (farmers)	14	382	317
Male			238
Female			79
Government (regional/district level)	5	43	96
Male			72
Female			24
Private sector firms	1	9	10
Male			7
Female			3
Civil society	42	160	374
Male			280
Female			94
Total	**82**	**594**	**797**

Source: ILSSI project management "Historical Feed the Future Management System (FTFMS)"

Farmer level

ILSSI project partners noted that training is critical to promoting technology adoption and ensuring economic and environmental sustainability. The hypothesis is formulated as "*the more experience a farmer has, the more likely she or he is to invest further in technologies and inputs for irrigated production.*"[44] The targeted farmers also receive direct benefits such as increased yields, economic, and social benefits from their training — benefits that go beyond the value the project derives for research purposes.

Farmers participating in FGDs reported receiving training both before using the equipment and, later, upon request. A farmer at Dangishta research site, for example, reported that he received training on water usage and management and "*task management related to labor use on the farm*." Other farmers received training on using SSI equipment, farm management, savings, and women's empowerment. At a FGD at the Zanlerigu research site, participants described the following training:

> *"We were taught the stages [in crop growth] that need more watering and the stages that do not. That is if tomatoes are matured no need to water but if leaves are yellow it means too much watering has been done."* Male farmer, FGD, Zanlerigu research site (Ghana)
>
> *"[Before the project] we did not know how to deal with profitability. They gave us training and assistance which has changed our way of farming and this has improved our income...We know how to use water efficiently and effectively."* – Male farmer, FGD, Bihanaayili research site (Ghana)

CONCLUSIONS

Training on IDSS to country nationals is well-targeted; demand is high. The ET bases this conclusion on its observations that participation is not subsidized or remunerated, yet applications exceed available spots in the training courses. This is a good indicator that the right people are receiving the training. Also, training is advertised through appropriate channels at universities and research institutions; through feedback from knowledgeable key informants, including trainees themselves; and there are few indicators suggesting unqualified people are being trained.

While it is difficult to assess whether the optimal number of people are benefiting from capacity building, **the number, diversity, and levels of training provided speak well of the project's efforts.** The fact that over 600 people have received IDSS training alone, and several hundred others have received training in other

[44] ILSSI Presentation. July 19, 2017. Capacity Development within ILSSI.

topics, suggests the training has benefited a large number of specialists and farmers. Expertise in IDSS is highly valued; only about half the applicants[45] are accepted.

Feedback from trainees strongly suggests that the quality of training is good and national stakeholders are benefiting. That training spot demand exceeds supply is a strong indicator that the capacity building is meeting an unmet need, and suggests that the provided training is highly relevant.

An implied affirmative action approach to selecting trainees favors women. The selection process favored women, as most women who applied were accepted. This may be considered a worthwhile trade-off if the potential benefits of building women's capacity in modeling outweighs the lost opportunity for otherwise qualified males. Stakeholders noted that the project's promotion of women's empowerment in the sector was in line with national policy in both countries.

RECOMMENDATIONS

For researchers and technical staff at government agencies, the training program should be expanded to enable more people to be trained. New modules, which go beyond the introductory level, should be added. Training efforts should be furthered by increasing resources for in-country training. Demand is high, so expanding training duration, topics, and number of participants will increase capacity. The project can build on its success by having IDSS experts/instructors spend more time in the project countries and engage in more frequent, longer, training. More intensive engagement by instructors, advanced training modules should be developed and delivered. This might require additional instructor time or larger facilities to accommodate more trainees.

For farmers, instruction manuals that can help systematically transfer research findings from the field to farmers and other stakeholders should be developed. The availability of instruction manuals for farmers and extension agents would help spread awareness, understanding, and proper implementation of SSI methods and technologies. These manuals could serve as a reference for farmers on how to use SSI technologies, do basic maintenance and repairs, and could describe management practices. Manuals could supplement or substitute for training by extension service agents who may lack the time and resources to train in many of the areas where SSI is suitable. Given that many farmers are illiterate, the manuals could have a significant pictorial element.

4.2.7 EQ 8: In what ways, if any, have the training programs contributed to strengthening institutional capacity in the target countries?

FINDINGS[46]

<u>Ethiopia</u>

In Ethiopia, IDSS appears to have influenced informing policymaking and institutionalization within the research community. Beyond training individuals, the project aims to institutionalize IDSS in the ILSSI countries. The goal is for the government to be able to use IDSS for planning and evaluation. According to one key informant, the President of the Development Bank of Ethiopia has expressed interest in using the results from the suitability mapping to prioritize investments in agriculture and to inform decision-making in procedures for lending.

At BDU (Ethiopia), the Blue Nile Water Institute (BNWI) has entered into an agreement with Texas A&M to institutionalize IDSS courses as part of its curriculum. The President of UDS, following discussions, signed a Memorandum of Understanding to include IDSS courses as part of the curriculum within the BNWI. These courses will be taught by BDU lecturers with IDSS training. According to two key informants, the aim of this initiative is to help spread the use of IDSS throughout East Africa.

[45] When aggregating male and female applicants.

[46] The evaluation was unable to comprehensively assess how trainees are likely to use the knowledge and skills acquired, since time and resources did not allow either a survey or more than seven meetings or email exchanges with key informants who had taken courses.

At the policy making level, ATA is a project research consumer. The Director of ATA highlighted the following areas where IDSS will be deployed by his agency[47]:

- Use of IDSS/APEX/FARMSIM to promote environmentally and women friendly innovations and technologies for irrigation water management. Particularly solar pumps for water lifting and drip irrigation;
- In irrigated agricultural land, use IDSS-SWAT/APEX to identify the extent of environmental damage due to poor water management practices, and to design and implement cost effective drainage systems;
- Develop sustainable value chain for high-value and nutrition-dense household irrigation enabled products, particularly horticulture crops (IDSS-FARMSIM model to check nutrition density); and
- Use SWAT/APEX to assess potential for irrigation in shallow groundwater resources.

<u>Ghana</u>

Ghana is somewhat behind Ethiopia in terms of building institutional capacity to use IDSS through the project. Only a small number of students and staff at UDS have taken IDSS training. Furthermore, two students were studying fields not directly related to irrigation (such as agriculture, hydrology, etc.)

Project partners reported that WRI, the government agency, is actively using IDSS, and ILSSI is supporting research activities, but this is not the same as institutionalizing capacity. Neither WRI nor GIDA are engaged with ILSSI through an institutional arrangement. A Ghanaian key informant noted that *"It is good that IWMI is here…but it is no substitute for a national institution on the [irrigation] water side."* Project partners reported that WRI requested assistance to institutionalize IDSS in the future.

Key informants suggested that the lack of institutionalization is partly related to the delayed start of work in the country, the weaker capacity of UDS in the field of modeling, and the country's focus on large-scale irrigation. The project engages only two student researchers at UDS. Key informants reported that opportunities for more intensive study and updating models and IDSS rest with KNUST, which has higher capacity. ILSSI's decision to work with UDS was driven by its proximity to the research sites. UDS is located in the Feed the Future ZOI, which means the project had limited options. KNUST is located in southern Ghana, not in the Feed the Future ZOI, so involvement at the field level would have posed logistical problems.

When policy makers and researchers have increased technical capacity to conduct, understand, and use research, the chances that SSI will be effective and scaled are greater. This is especially true when spontaneous adoption of new technologies is unlikely, which the ET believes is the case in the target countries. Reasons for this relate to behavioral change, supply chains, access to credit and affordability, all of which are discussed under Section 4.4. Empirical data from the country to use for the models is lacking, and this may also dampen perceived utility of the models.

The institutions in greatest need of capacity building are the national extension services in both countries. Capacity is reportedly weak and resources scarce. Extension service agents participate by linking farmers and the project. They work with farmers to encourage them to participate and to follow guidance on technology practices and use. They lack expertise in the relatively new field of SSI, though. In Ghana, the extension service agent responsible for Bihanaayili noted that he and his staff were responsible for advising farmers in 86 districts. As an incentive to work on ILSSI's activities, extension agents are given modest "top-ups" to their salaries. This is a government responsibility, but several key informants reported that the national extension services in both countries (but especially in Ghana) lack the resources to advise and train farmers on SSI. Further, extension agents have not been trained in SSI.

[47] Personal communication, September 28, 2017, Seyoum Getachew.

CONCLUSIONS

Under the project, capacity development serves to promote sustainability and ensure research quality. Training builds analytical and planning capacity of key national stakeholders engaged in research and policy making. Knowledge transfer to stakeholders promotes continued use and sustainability. Capacity development is necessary at the field level – specifically for farmers, extension agents, data collectors, and finance cooperatives. At this level, training ensures that interventions are implemented as intended, and that data meets necessary quality standards.

Capacity building is more likely when there is an enabling environment. The ET's comparison of Ethiopia and Ghana suggests that institutionalizing decision-making tools is more likely when SSI is a core element of country agricultural policy and when stakeholder engagement is strong. It is also more likely when research capacity is high. In all three areas, Ethiopia outperforms Ghana.

Based on KIIs, the ET believes the training in the models is likely to continue to exert a positive influence on Ethiopia's promotion of SSI. This is because IDSS and use of associated models will be anchored in at least two national institutions (BNWI and ATA) and a large number of students and researchers are being trained in the models. BNWI incorporating IDSS coursework underlines the value Ethiopian stakeholders place on this approach, and reflects the high demand among students and researchers. Among Ethiopian researchers, institutionalization of IDSS will ensure long-term use and wider adaptation of predictive models for agriculture research in general, and irrigation in particular. The ET believes this will contribute to continued use and positive long-term impacts on SSI.

In Ghana, the impact of the training is more likely to be felt through individual application than institutionalization. Less active government buy-in and weaker ILSSI engagement with government agencies suggest ILSSI institutionalization may not take place without additional efforts to demonstrate SSI benefits and engage with government agencies. While three years of project activities in Ghana have benefited UDS research staff, only two students are involved. This suggests a weak knowledge base beyond the life of the project.

For some, training in model use would be strengthened by being less hypothetical. Some trainees in Ghana were challenged in the FARMSIM model and training because country datasets were not available for training exercises. The absence of data was not the training organizers' fault, but it meant the class used data from other countries and incomplete data. According to one trainee, data from the other models "*did not have all required values*."

RECOMMENDATIONS

Greater efforts to build capacity at relevant institutions can be made in Ghana. To develop deeper national capacity, more researchers and students should be encouraged to pursue studies relevant to SSI. This may involve greater outreach efforts, or partnering more closely with research institutes or universities that have greater capacity for modeling, such as KNUST. The factors behind relatively weak engagement in Ghana are clear — capacity issues, government prioritization of irrigation schemes over SSI. They also point to the need for the project to be more proactive. For impact to last, ILSSI should find entry points or champions at government agencies and research institutions to promote SSI research and modeling, involve a greater number of government agencies active in agriculture related fields, and organize workshops more frequently.

4.3 PROGRAM FUTURE

4.3.1 EQ 9: To what extent does/will ILSSI's research align with the Feed the Future research strategy (and the Global Food Security Strategy)? What adjustments may be necessary to the research to ensure better alignment with the Global Food Security Strategy?

To provide context, brief summaries of key initiatives the ILSSI project is expected to align with are presented in Annex H.

FINDINGS

Alignment

ILSSI's objectives were generally found to align with the GFSS' objectives**.** The GFSS was finalized in 2016, well after ILSSI was designed, and their focus areas and goals overlap. This is especially the case for intermediate outcomes of increasing productivity and enhancing nutrition and food safety. ILSSI places less emphasis on 'strategic coordination' with private sector actors than GFSS. The GFSS envisions "*building strong private sector-led value chains*" as a pathway out of poverty. Given the challenges farmers face in finding and buying SSI equipment, there is potential for partnering with private sector actors.

Based on KIIs and document review, the ET found that ILSSI project activities also align with the Feed the Future approach**.** ILSSI activities are carried out in Feed the Future ZOIs in the three countries - in Amhara, Oromia and Southern Nations, Nationalities and People's in Ethiopia; and above the 8th parallel in northern Ghana. ILSSI's work incorporates Feed the Future's focus areas into its research work. The project clearly aligns with the Feed the Future research and capacity building focus areas. ILSSI aims to achieve positive impacts for low income groups, and to generate research outputs with broad applicability. Research conducted under the project focuses on smallholder farmers and places strong emphasis on nutrition, gender, and resilience — all core Feed the Future research elements. The evaluation is agnostic on the effectiveness of the Feed the Future's approach or its implementation, issues which lie outside the scope of our analysis.

Private Sector Pathway

Compared with field research, modeling, and training activities, ILSSI has placed relatively little emphasis on engagement with private sector partners. Both Feed the Future and the GFSS envision partnerships as a way out of food insecurity and poverty**.** One of Feed the Future's six focus areas, private sector engagement calls for coordination with the private sector and for the private sector to invest and share risks in pursuit of food security.[48] For example, for technology to become widely used, it needs to be accessible and affordable to farmers. ILSSI recognizes the role of the private sector and incorporates private sector engagement. A private sector specialist, for example, is on the Executive Advisory Committee, and private sector players are considered stakeholders and invited to workshops and training sessions. However, the ET found that relative to the importance of capital investment needs (e.g. through microfinancing), availability of SSI equipment and service provision, the private sector role will require far greater emphasis in order to overcome bottlenecks to adoption and scaling.

Farmers at the Dangishta FGD noted that purchasing technology themselves is cost prohibitive, and they would like to obtain it "*with government support*.". Key informants and farmers reported that technologies like WFDs, TDRs, and solar-powered pumps are either not affordable or not available —especially in Ethiopia. There is a private sector specialist on the ILSSI Executive Advisory Committee, but the private sector has received relatively little emphasis to date.

CONCLUSIONS

With some exceptions, ILSSI is broadly in line with both the Feed the Future and the GFSS. The selection of project partners and management's focus on results contribute to alignment. ILSSI's project design and implementation are both applicable and appropriate. Likewise, SSI has significant potential to address food security issues. Some of the specific focus areas of the GFSS— gender, nutrition, smallholder farmers — are well covered by ILSSI research.

ILSSI is also addressing a relatively new area of research and investment. SSI is not widely known or practiced in the ILSSI countries. Compared with large-scale irrigation schemes, Africa has seen minimal investment in SSI, which has significant potential to increase productivity for many smallholder farmers. A key informant described USAID's investment in SSI research as '*unique and brave*.' Improving agricultural production

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[48] Feed the Future: Private Sector Engagement: https://www.feedthefuture.gov/approach/Private--Sector--Engagement

through SSI technologies is an essential part of government policy to transition from traditional to modern agriculture and promote sustainable intensification practices.

There are opportunities for ILSSI to incorporate more of the GFSS, which includes two additional IRs that ILSSI could align with. Opportunities include strengthened and expanded access to markets and trade (IR 2); and increased employment and entrepreneurship (IR 3). If and when the SSI approach succeeds in increasing production at scale in a given region, then accessing markets to sell their product will become critical for smallholder farmers. Unlike in other developing countries like India, supply chains for produce in ILSSI countries are undeveloped. If smallholders are to go beyond subsistence farming, challenges in issues like credit, infrastructure, distribution, wholesale markets, and agro-processing must be overcome. Most of these involve the skills of private sector actors.

RECOMMENDATIONS

In order to align any future ILSSI activity with Feed the Future and the GFSS, two adjustments are recommended.

Development results — impacts on the ground — need to be emphasized more. Allocate more resources and attention to translating knowledge into practice. The project is generating a large amount of analysis and knowledge, and should ensure that research is used to inform and promote required changes. IDSS is being embraced by researchers in the project countries and institutionalized in Ethiopia. However, for research to impact smallholder farmers and the rural economy, specific planning efforts and budget allocations should be devoted to promoting research findings at both policy and local levels.

Entrepreneurial and private sector components should be integrated into research work. To align with GFSS' focus on impacts, and to incorporate its private sector partnership objectives, engage more closely with private sector actors in regions where SSI can scale. ILSSI should work to promote availability of SSI technologies, service provision, and access to finance. Future ILSSI work should take up the private sector element embedded in Feed the Future by raising awareness of, and building capacity of, businesses and entrepreneurs about SSI's potential. The ET recognizes that stimulating the private sector is a development matter more closely associated with the field of impact investing than a research issue, but it will likely be critical to scaling up. If the technologies are deemed viable and affordable, and a market is stimulated, the private sector could potentially take some of the burden of capacity building from the project, which would be more efficient and sustainable.

Governments should promote markets for technologies using pull and push approaches. Pull in entrepreneurs by strengthening demand for SSI technologies and services among end-users, and push by fostering an enabling environment. Creating policies to facilitate import, manufacturing, and distribution of SSI technologies would create the environment. Well-targeted private sector involvements could take over promoting the spread of new technologies. It is in their interest to market and train farmers to use, service the equipment, and identify ways to generate business.

4.3.2 EQ 10: If renewed for a second phase, what changes, if any, are needed to improve the ILSSI's management, research (i.e., design, implementation, communications, stakeholder involvement etc.) and/or training (i.e., student recruitment and selection, content, location etc.) programs, and/or institutional capacity collaboration?

Responses to this multi-part question are covered under the respective questions above, as follows: 4.1 for management, implementation, and communications; 4.5 for collaboration; 4.6 for stakeholder engagement; and 4.7 for training.

5.0 ANNEXES

ANNEX A: EXPRESSION OF INTEREST

PEEL TASK ORDER
EXPRESSION OF INTEREST – PERFORMANCE EVALUATION

I. BACKGROUND INFORMATION

A) Identifying Information

1. Project/Activity Title:	Feed the Future Innovation Lab for Small Scale Irrigation (ILSSI)
2. Award Number:	AID-OAA-A-00055
3. Award Dates:	8/12/2013 to 8/11/2018 (based on original award of 8/05/2013)
4. Project/Activity Funding:	Total Estimate Amount: $12,590,245 (Total USAID Amount: $12,385,412)
5. Implementing Organization:	Texas A&M University System / Norman Borlaug Institute for International Agriculture
6. Project/Activity COR/AOR:	Biniam Iyob

B) Development Context

1. Problem or Opportunity Addressed by the Project/Activity Being Evaluated

The Feed the Future Food Security Research Strategy goals are to advance the productivity frontier, to transform key production systems and to enhance nutrition and food safety through agriculture as a way to contribute to Feed the Future's overarching goal of sustainably reducing global poverty and hunger.

The Feed the Future Innovation Labs (the "Innovation Labs" or "ILs" formerly called CRSPs) with U.S. universities were created under Title XII of the International Development and Food Assistance Act of 1975, which authorized USAID to engage U.S. land grant and other eligible universities to address the needs of developing nations while also contributing to U.S. food security and agricultural development. In 2000, Title XII was reauthorized, enabling these U.S. university research efforts to continue "to achieve the mutual goals among nations of ensuring food security, human health, agricultural growth, trade expansion, and the wise and sustainable use of natural resources".

The Innovation Labs are an integral part of the Feed the Future Food Security Innovation Center, established to implement the Feed the Future Global Hunger and Food Security Research Strategy and to respond to two key recommendations from a Board for International Food and Agricultural Development (BIFAD) commissioned CRSP review:[49]

- To develop an overarching and coordinated strategy for engaging U.S. universities in agriculture and food security research and human and institutional capacity development that includes the CRSPs as a central component; and
- To leverage the impact of CRSP investments by strengthening links across universities, U.S. government, global programs, foundations, and other donors.

The launch of the Food Security Innovation Center in 2012 enabled USAID to manage its research, policy and capacity-strengthening portfolio through the following seven thematic areas rather than by institutional home:

- *Program for Research on Climate Resilient Cereals*
- *Program for Research on Legume Productivity*
- *Program for Advanced Approaches to Combat Pests and Diseases*
- *Program for Research on Nutritious and Safe Foods*
- *Program for Markets and Policy Research and Support*
- *Program for Sustainable Intensification*

[49] http://transition.usaid.gov/our_work/agriculture/bifad/BIFADREVIEW_CRSP_August2012.pdf

- *Program for Human and Institutional Capacity Development*

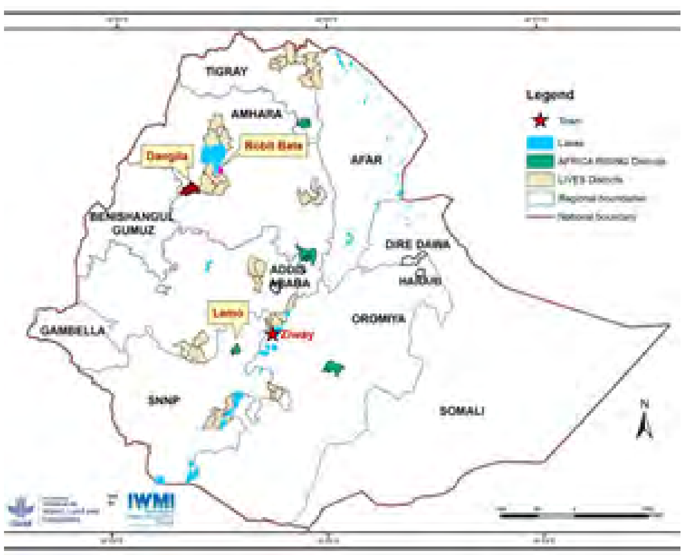
The Innovation Labs funding of these themes is a central component to develop an overarching and coordinated strategy for engaging U.S. universities in agriculture and food security research and human and institutional capacity development and to leverage the impact of those investments by strengthening links across universities, U.S. government, global programs, foundations, and other donors.

The *Program for Sustainable Intensification,* which includes the Feed the Future Innovation Lab for Small Scale Irrigation, works with smallholder farmers and global, regional and national research partners to identify and adapt promising strategies and technologies for local farming systems, in order to intensify and diversify major production systems where the poor and undernourished are concentrated.

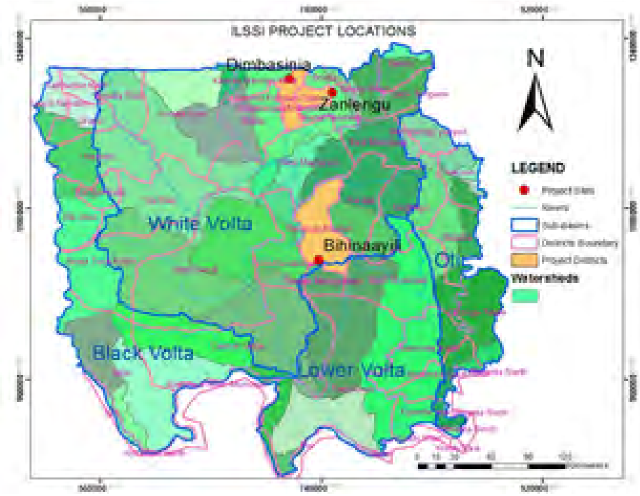
The Feed the Future Innovation Lab for Small-Scale Irrigation (ILSSI) is a cooperative agreement funded by USAID to undertake research aimed to increase food production, improve nutrition, accelerate economic development and contribute to the protection of the environment. The project pursues these objectives through identifying, testing and demonstrating technological options in small-scale irrigation of food crops and irrigated fodder, using the Integrated Decision Support System (IDSS). The IDSS will allow scientists to analyze production, environmental, and economic consequences of these options, using short and long-term training to develop the capacity to use the IDSS, and maintain a continual dialogue with stakeholders to foster sustained use of the IDSS for decision making.

2.Target Areas and Groups

The ILSSI project countries are Ethiopia, Ghana and Tanzania. Below, see the specific sites and maps:



Ethiopia: Woredas selected include Limu/Lemo (SNNP region), Dangela (Amhara region), Robit Bata (Amhara region), and Adami Tulu (near Ziway) in the Rift Valley (Oromia region).



Ghana: Bihinaayili, Dimbasinia and Zanleriguin

Tanzania: Mvomero, and Kilosa, Babati

Key U.S. Partners

The ILSSI projects are led by Texas A&M University System / Norman Borlaug Institute for International Agriculture (Managing Entity). As the lead institution, Borlaug Institute for International Agricultural/Texas A&M University System (BI/TAMUS) is responsible for leadership, management and administration of the overall cooperative agreement. Under a sub-agreement with BI/TAMUS, several partners conduct research and carry out the goals and objectives set forth. Partners in the Feed the Future-ILSSI cooperative agreement include the International Water Management Institute (IWMI), the International Food Policy Research Institute (IFPRI), the International Livestock Research Institute (ILRI), and North Carolina A&T State University (NCA&T).

C) Intended Results of the Project/Activity being Evaluated

Purpose

The Feed the Future Innovation Lab for Small-Scale Irrigation (ILSSI) is a five-year **research for development** project that aims to benefit farmers of Ethiopia, Ghana and Tanzania by improving effective use of scarce water supplies through interventions in small-scale irrigation. ILSSI activities are divided into four components:

- Component 1: Identify promising, context appropriate small-scale irrigation interventions, management, and practices for poverty reduction and improved nutrition outcomes.
- Component 2: Evaluating impacts, trade-offs, and synergies of small-scale irrigation technologies and practices.
- Component 3: Identifying key constraints and opportunities to improve access to small-scale irrigation technologies.

- Component 4: Capacity Development and Stakeholder Engagement and Dialogue

Additional information on ILSSI can be found at: http://ilssi.tamu.edu/

D) Approach and Implementation

The following link contains the ILSSI Results Framework.

II. EVALUATION RATIONALE

A) Evaluation Purpose

The purpose of this final performance evaluation of the ILSSI project is to provide empirical evidence to respond to evaluation questions designed to support learning and continuous improvement for BFS' work. The evaluation will assess progress toward outcomes, the quality of the research program and its outputs, what is and is not working well in implementation, including the effectiveness and contributions of the management entity, and will provide information and recommendations that BFS can use to inform the development of new investments in irrigation research for development (from research directions to management styles) and inform the development of new investments in small scale irrigation research for development.

The evaluation should also consider what changes to the Small-Scale Irrigation Lab's management, research (i.e., design, implementation, communications, stakeholder involvement etc.), training (i.e., student recruitment and selection, content, location etc.), and/or institutional capacity collaboration the evidence suggests will improve implementation and better achieve intended outcomes. The evaluation should also articulate lessons learned to take into consideration for a potential second phase.

B) Audience and Intended Uses

These results are to be used by USAID/BFS/ARP-R to establish a future RFA (including program design) to address outstanding research questions connected to irrigation for smallholders in developing countries and associated value chains. The evaluation results will also be shared with implementing partners, universities and other stakeholders to improve research, implementation and capacity development. The evaluation may also be applicable to others who are involved in designing research for development programs.

C) Evaluation Questions

Part I: Program Management

1. In what ways could program management, communication, coordination and implementation be improved to better achieve goals and objectives?

Part II: Research Program: *The following questions show an approach to linking the questions more explicitly to the four components of the project (see bold blue fonts below):*

Identifying promising, context appropriate, small-scale irrigation interventions, management and practices for poverty reduction and improved nutrition outcomes

1. How well has the ILSSI project identified promising small-scale irrigation interventions, technologies and management practices using criteria that are context specific, evidence-based and robust? To what extent are these criteria relevant and scientifically rigorous?

Evaluating production, environmental, economic, nutritional and gender impacts, trade-offs and synergies of small-scale irrigation

1. To what extent have the following concerns been incorporated in the identification, evaluation and testing of selected technologies, including the consideration of potential tradeoffs and synergies: productivity, environmental, economic, nutritional, and gender impacts? In what ways have opportunities to exploit SSI in an environmentally sound way been assessed and carried out? What could be done differently to better address these concerns?

2. What ILSSI technologies (solar irrigation, irrigated fodder, conveyance methods such as drip irrigation, etc.) are more likely to be adopted by farmers (including women) and scaled sustainably in each of the three countries? And why, why not? (e.g. access to finance, potential availability of replacement equipment, training needed, etc.)

Identifying key constraints and opportunities to improve access to small-scale irrigation technologies and practices

1. What types of opportunities and constraints have been identified related to the widespread adoption and scaling of small-scale irrigation technologies and practices by smallholder farmers? In what ways, if any, have opportunities been maximized to support scaling? What approaches have been identified to address these constraints? What could the project do to better address the challenges to improved access and use for smallholder farmers?

Capacity Development and Stakeholder Engagement

1. In what ways are relevant partners, including USAID missions, CGIAR Centers, NGOs, host country governmental and academic institutions, and community stakeholders being engaged? What potential is there for other partnerships and collaborations, including with other Feed the Future Innovation Labs and other relevant USAID programs in the target countries?

2. Are the appropriate type and number of people being targeted for the right kind of training? What improvements, if any, are needed in how academic and technical capacity strengthening activities are identified and implemented?

3. In what ways, if any, are trainees <u>likely</u> to put into practice the knowledge and skills acquired? In what ways, if any, have the training programs contributed to strengthening institutional capacity in the target countries?

Part III: Program Future

1. To what extent does/will ILSSI's research align with the Feed the Future research strategy (and the Global Food Security Strategy)? What adjustments may be necessary to the research to ensure better alignment with the Global Food Security Strategy?

2. If renewed for a second phase, what changes, if any, are needed to improve the Small-Scale Irrigation Labs' management, research (i.e., design, implementation, communications, stakeholder involvement etc.) and/or training (i.e., student recruitment and selection, content, location etc.) programs, and/or institutional capacity collaboration?

III. TIMEFRAME & TRAVEL

A) Timeframe

It is hoped that a draft report with solid recommendations will be delivered to USAID by June 30, 2017.

B) Travel

Domestic and international travel

Domestic travel is limited to one trip, up to two days excluding transit, to visit the ILSSI Managing Entity (ME) at Texas A&M University. Two one-week site visits to ILSSI in Ethiopia (recommended) and to either Tanzania or Ghana for data collection and observation.

IV. DELIVERABLES & DESIGN

A) Deliverables

- Concept note
- Draft Evaluation Plan
- Final Evaluation Plan
- Preliminary findings presentation
- Draft Evaluation Report
- Final Evaluation Report

B) Evaluation Design

It is expected that all aspects of the mechanism and all countries will be included in the evaluation, not just those where site visits are carried out.

V. TEAM COMPOSITION

The evaluation team will be composed of 3 members: one evaluation team leader and two technical team members. The team members need familiarity with Sub-Saharan Africa's agricultural systems with the following required composition of skill sets and sectoral experience among them: irrigation, modelling/simulation of watershed/irrigation/crops, organizational development, evaluation methodology, quantitative and qualitative evaluation, agronomist/agricultural systems (for both livestock and plants), technology dissemination, social science/economics background, gender, and nutrition.

The candidates will also have: a) the capacity to conduct independent program evaluation; b) a thorough understanding of research and evaluation methodologies; c) the ability to analyze quantitative and qualitative data from a variety of sources/issues and formulate concrete actionable recommendations orally and in writing; d) be available to travel and meet the timelines for completion of the evaluation; e) experience working in Africa (preferably in Ethiopia, Ghana and Tanzania); and f) not have any conflicts of interest.

Evaluation Team Lead (1): a senior-level evaluation specialist with a minimum of 15 years relevant experience in evaluation methodology (including mixed methods evaluation), quantitative and qualitative data collection and analysis, and experience carrying out evaluations of international development projects, involving multiple stakeholders. The preferred candidate should be familiar with USAID (or other donor) funded programs.

Technical team members (2): One of the technical team members must demonstrate strong technical expertise in international agricultural research for development and technology dissemination. She/he must have a strong background in field irrigation (preferably on small scale irrigation), with at least 10 years' experience. A second member should also have a specialization in modelling/simulation of irrigation/basin/water (especially related to the Soil and Water Analyses Tool, SWAT) for agriculture, with at least 7 years' experience.

VI. SUGGESTED LOE

Tasks	Eval. Planning Lead (1)	Technical Team Member (2)
	LOE Days	LOE Days
Conference Call/Desk Review	4	6
Concept note	2	2
Evaluation Plan	5	6
Travel & Travel Debriefs	18	36
Preliminary Findings	2	4
Draft Report	6	8
Final Report	2	2
TOTAL LOE	39	64

ANNEX B: EVALUATION WORK PLAN

Performance Evaluation: Innovation Lab for Small Scale Irrigation (ILSSI) SCHEDULE	
Planning, Design & Approvals Phase	
Kick-off meeting (KOM) with USAID and IP	June 14
Documents for document review available	June 14
Phone call/meeting with IP/ME	
Submit to PEEL 5-page draft concept paper	July 9
Submit to USAID 5-page draft concept paper	July 9
Receive comments from USAID	July 12
Integrate comments and resubmit to USAID	July 14
Visit to BI/TAMUS for 2 days of project review and discussions	July 16-19
USAID approves 5-page concept paper	July 21
Submit to PEEL 20-page draft evaluation protocol (including data collection tools)	July 21
Submit to USAID 20-page draft evaluation protocol (including data collection tools)	July 26
Receive comments from USAID	August 9
Integrate comments from USAID	August 10
PEEL formats 20-page final evaluation protocol (including all data collection tools)	August 10
Submit to USAID final 20-page evaluation protocol (including all data collection tools)	August 11
USAID approves 20-page evaluation protocol (including data collection tools)	August 14
USAID travel approval	Between Aug. 14 – Sept. 3
Obtain visas, plane tickets, other logistics	Between Aug. 14 – Sept. 1
Data Collection Phase	
Data collection in Ethiopia	Between Sept. 3 – 10
Data collection in Ghana	Between Sept. 11 - 15
Key informant interviews (by phone or Skype)	Between Sept. 17 – 20
Analysis & Reporting Phase	
Data organization and analysis	Between Sept.18 – Sept. 29
Draft report drafting	Between Sept.18 – Sept. 29
Submit first draft 50-page report to PEEL	Sept. 29
PEEL reviews first draft 50-page report	Between Oct. 2 – Oct. 6
ET integrates PEEL review of first draft 50-page report	Between Oct. 9 – Oct. 10
Submit first draft 50-page report to USAID	Oct 10
Presentation/preliminary findings	Between Oct. 10 – Oct. 13
Receive comments from all reviewers	Between Oct. 10 – Oct. 24
ET integrates comments from all reviewers	Between Oct. 24 – Oct. 27
Submit second draft 50-page report to PEEL	Oct 27
PEEL reviews second draft 50-page report	Between Oct. 30 – Nov. 3
ET integrates comments to second draft from PEEL	Between Nov. 3 – Nov. 7
Submit second draft 50-page report to USAID	Nov. 7
ET receives comments from all reviewers	Between Nov. 7 – Nov. 14
ET integrates comments from all reviewers	Between Nov. 14 – Nov. 20
ET Submits final 50-page report to PEEL	Nov. 20
PEEL reviews, formats final 50-page report	Nov. 22
PEEL – ET submit final 50-page report to USAID	Nov. 22
USAID approves final report	TBD

ANNEX C: INDICATOR ASSESSMENT CHECKLIST

The research quality and modeling will be reviewed using the following checklist, developed for this evaluation:

	Research Dimension	Quality		
		High	Acceptable	Low
1	Conceptual design			
2	Sampling methods (for household surveys)			
3	Data collection methods			
4	Use of statistical tests of significance			
5	Use of meaningful comparators			
6	Accounting for confidence intervals			
7	Statistical methods used			
8	Modeling: inclusion of key factors, comparison between results and field observation			
9	Use of quality control measures			
10	Accuracy and precision			
11	Safeguards for quality control			
12	Data security			
13	Program logic			
14	Control group credibility			
15	Margin of error calculations and reporting			
16	Plausibility of results			
17	Whether data measures what it is supposed to measure			
18	Application and sharing of findings			
19	Dissemination of findings			

ANNEX D: INDIVIDUALS INTERVIEWED

	Name	Position	Organization
1	Gebrekidan Worku	PhD Candidate	AAU College of Development Studies
2	Melkamu Derseh	Post-Doctoral Fellow	Africa RISING
3	Likawent Yehevis	Director-Livestock	Amhara Regional Agriculture Research Institute (ARARI)
4	Abebe Tesfa	Extension Agent	Bahir Dar *woreda* Office of Agriculture
5	Andarg Yimenu	Extension Agent	Bahir Dar *woreda* Office of Agriculture
6	Fasikaw Atanaw	Lecturer	Dahir Bar University
7	Teshager Sisha	Lecturer	Dahir Bar University
8	Adisu Mulu	Specialist	Dangila *woreda* Office of Agriculture
9	Aschalew Muhamed	Head of Office	Dangila *woreda* Office of Agriculture
10	Gebrie Zerihun	Extension Officer	Dangila *woreda* Office of Agriculture
11	Mulugeta Mohammed	Director	EIAR
12	Ayele Sileshi	Senior Project Officer	Ethiopian Agricultural Transformation Agency (ATA)
13	Seblewongel Deneke	Director Gender & Nutrition	Ethiopian ATA
14	Aberra Adie	Research Assistant	ILRI
15	Michael Blummel	Team Leader Feeds & Feeding Systems	ILRI
16	Seifu Tilahun	ILSSI Focal Point, Associate Professor of Hydrology	Dahir Bar University
17	Getachew Gebru	External Advisory Committee Member	Land and Water Resource Center
18	Tesfaye Hailu	Director	Ministry of Health
19	Gebrie	Farmer – Robit Bata (Ethiopia)	private individual
20	Girma	Farmer – Dangishta (Ethiopia)	private individual
21	Wubaye	Farmer – Robit Bata (Ethiopia)	private individual
22	Mark Tegenfeldt	Feed the Future Coordinator	USAID
23	Emmanuel K. Panyan	Researchers in Pasture Science	Animal Research Institute CSIR-ARI
24	Sakara Richard Abukouri	Extension Agent	Bihanaayili Research Site
25	Edem Odom		GIDA
26	Prosper Glitsa		GIDA
27	Samuel Darko-Koomson	Manager	Instak Agro
28	Brian Kiger	Country Director	Irrigation Development Enterprises (iDE)
29	Bedru Balana	Research Economist	IWMI
30	Richard Appoh	Research Officer	IWMI
31	Timothy Williams	Director, Africa	IWMI
32	Baginpoka	Farmer – Zanlerigu (Ghana)	private individual
33	Bizoola Z Gande	Irrigation Engineer	UDS
34	Saa Dittoh	Lecturer	UDS
35	Sylvester Ayambila	ILSSI Focal Point, Lecturer, Agribusiness Management	UDS
36	Jenna Tajchman-Trofim	Ag Team Leader	USAID Office Economic Growth

	Name	Position	Organization
37	Emmanuel Obuobie	Senior Research Scientist	Water Resource Institute (WRI)
38	Emmanuel Akobta	Agriculture Officer and Engineering Supervisor	Zanlerigu Research Site
39	Biniam Iyob		BFS/USAID
40	Srinivasan Raghavan	Director for Spatial Science Laboratory	BI/TAMUS
41	Jean-Claude Bizimana	Assistant Research Scientist	BI/TAMUS AgriLife
42	Matt Stellbauer	Program Manager, ILSSI	BI/TAMUS AgriLife
43	Neville Clarke	Program Director, ILSSI	BI/TAMUS AgriLife
44	Abeyou Worqlul	Postdoctoral Research Associate	Blackland Research & Extension Center, TAMUS AgriLife
45	Thomas Gerik	Center Director	Blackland Research & Extension Center, TAMUS AgriLife
46	Claudia Ringler	Deputy Division Director	IFPRI
47	Dawit Mekonnen	Research Fellow	IFPRI
48	Elizabeth Bryan		IFPRI
49	Hua Xie	Research Fellow	IFPRI
50	Liangzhi You	Senior Research Fellow	IFPRI
51	Sophie Theis		IFPRI
52	Ben Lukuyu	Animal Nutritionist	ILRI
53	Nicole Lefore	Senior International Manager	IWMI
54	Jennie Baron	Research Theme Leader	IWMI (former)
55	Manoj K. Jha	Project focal point	NC&T University

ANNEX E: DATA COLLECTION INSTRUMENTS

<u>Interviewer Instructions</u>

Before each interview:

- Briefly explain the purpose of the interview for those unfamiliar with the evaluation. "We are independent, third-party evaluators who have been contracted by USAID to review the ILSSI program according to a number of criteria. You have been selected for an interview as a person knowledgeable about the program."

- Note that the interview will last about one hour.

- Provide them with the Consent Form and ask them if they have any questions. Ask them to sign it.

- If they agree to being recorded, turn the voice recorder on.

Key Informant Interview Guide: Institutional Partners - International and Local

General Information

1. What are your main tasks and responsibilities relating to the project?

Project Management (Question Cluster 1)

1. Do you have all the resources (budgetary, human, skills, etc.) you need to accomplish your tasks?
2. What is the biggest challenge you have faced in implementing the project?
3. Were any changes made to how the project was implemented? What were the reasons?
4. On a scale of 1 to 5, where 5 means "very well" and 1 means "very poorly," how well is the project managed?
5. Please explain your rating.
6. In terms of achieving project goals, please describe the quality of ILSSI:
   a. Program management.
   b. Communication with project partners and beneficiaries.
   c. Coordination between project partners.
   d. Implementation of project activities.

Identifying SSI Interventions and Practices (Question Cluster 2)

1. On a scale of 1 to 5, where 5 means "extremely well" and 1 means "extremely poorly" how well has the ILSSI project identified SSI interventions, technologies, and management practices?
2. Please explain your rating.
3. How are SSI interventions, technologies, and management practices identified?
4. When identifying them, how was local context taken into account (i.e., environmental, soil, socio-economic, policy conditions, etc.)
5. Are the Results Framework indicator targets being met? If not, why not?
6. What measures or criteria are used to ensure interventions, technology, and practices are evidence-based and robust?

Research on Productivity, Environment, Economy, Nutrition, and Gender (Question Cluster 3) (for IFPRI and country partners)

1. When identifying, evaluating and testing SSI technologies, how were the following taken into account: productivity, environmental, economic, nutritional, and gender impacts?
2. Did any trade-offs have to be made? What are they?

3. In what ways have opportunities to exploit SSI in an environmentally sound way been assessed and carried out?
4. What environmental considerations were taken into account?

Technology Adoption (Question Cluster 4)

1. What ILSSI technologies and practices are more likely to be adopted by farmers? Are there any that would be likely to be specifically adopted by women? (including women)? Please rate the likelihood of adoption on a scale of 1 to 5, where 1 means "least likely" and 5 means "very likely": solar irrigation, diesel, rope and pulley, irrigated fodder, drip irrigation, other.
2. Please explain your answer.
3. What ILSSI technologies and practices are more likely to be scaled sustainably?
4. Please rate them on a scale of 1 to 5, where 1 means "least likely to scale" and 5 means "very likely to scale."

Constraints and Opportunities (Question Cluster 5)

1. What are the main opportunities the project has identified for widespread adoption or scaling of small-scale irrigation technologies and practices by smallholder farmers?
2. In what ways, if any, have opportunities been taken advantage of to support scaling?
3. What constraints have been faced to adoption and scaling?
4. What approaches have been identified to address these constraints?
5. What could the project do to better address the challenges to improved access and use for smallholder farmers?

Capacity Building and Engagement – How? (Question Cluster 6)

1. How are the partners engaged? What information is shared? How often?
2. What feedback mechanisms are in use to learn from other stakeholders?
3. How could stakeholders from outside ILSSI be involved (if they aren't already)?

Capacity Building and Engagement – Who? (Question Cluster 7)

1. What type of training was provided?
2. Who were the target group for the training?
3. How were trainees selected?
4. How relevant is the training to the needs of the agriculture sector and farmers?
5. In what ways has the training project enhanced the capability of users?
6. Are there paid opportunities for trainees to put into practice what they have learned?
7. Who are involved, from what group, and is there balance between different groups?

Knowledge Into Practice (Question Cluster 8)

1. Do you have any evidence that the training is having an impact?
2. Has the quality of local researchers (at government or academic institutions) improved as a result?
3. What do you think could be improved? (i.e., technology, training, finance availability)
4. Was there any training related to Operation & Maintenance, income generation, account keeping (record keeping), etc.?

ILSSI and Feed the Future Research Alignment (Question Cluster 9)

N/A

Project Modifications (Question Cluster 10)

1. If ILSSI were renewed for a second phase:
    a. What changes, if any, would improve ILSSI management, and research (i.e., design, implementation, communications, stakeholder involvement, etc.)?
    b. What changes would improve the training programs (i.e., student recruitment and selection, content, location, etc.)?
    c. What changes would improve institutional capacity?
    d. What changes would improve collaboration?

Key Informant Interview Guide: Implementing Partners – Modeling Experts/Technical Irrigation Experts

General Information

1. What are your main tasks and responsibilities?

Project Management (Question Cluster 1)

1. Which stakeholder do you collaborate with most closely to do your work?
2. How do you manage databases, such as farmer's inventory?
3. How do you manage environmental issues?

Identifying SSI Interventions and Practices (Question Cluster 2)

1. How were the SSI intervention types selected?
2. To what extent is the project targeting the poor (below the poverty line)?
3. What is the average land holding size?
4. Was the land holding size a selection criterion?
5. How are SSI interventions, technologies, and management practices (ITM) identified/selected?
6. How do the ITM compare with best practice?
7. Are the Results Framework indicators being met? If not, why not?
8. What was the alternative to the ITM (i.e., what practices or technologies were used before the ILSSI project intervention)?
9. What measures or criteria are used to ensure interventions, technology, and practices are evidence-based and robust?

Research on Productivity, Environment, Economy, Nutrition, and Gender (Question Cluster 3)

1. What environmental considerations, if any, were taken into account when determining what technologies or practices to experiment with?
2. Is the research site area susceptible to salinity intrusion and soil erosion caused by irrigation?
3. What are the agricultural impacts such as input use (seeds, fertilizer and pesticides, etc.) and outputs?
4. Have the objectives of enhancement or at least restoration of income level and standard of living been met? In what ways?
5. Is there information (at project level) about:
    a. Food sufficiency, income level, assets ownership pattern, and poverty ranking?
    b. Health and education?
    c. Major livelihood activities that they are currently involved in?
    d. Available human resources?
6. Was the review of the cropping calendar carried out?
7. Was sufficient information/training provided on:
    a. Improved understanding of cropping calendar of each sector of the system and preparation of cropping calendar for each system?
    b. Crop diversification that needs less water which can increase irrigated crop area during winter season?
8. Is the implementation and improvement of the cropping calendar affected by the availability of farmers' need such as production credit, labor, and agricultural input?
9. Do you have an overall increment of income by more than 35 percent and yield by two times for all the crops or this figure is only for commercial crops, such as vegetables and fodder?
10. Do you have the same increment ratio for staple crops as commercial crops?
11. Since groundwater is not sufficient to meet irrigation demand everywhere, how have consumption levels been taken into account?

12. How are nutrition outcomes incorporated into the model?
13. What is the percentage of women involvement in decision making processes at household level?
14. For the modeling and IDSS, have you conducted Algorithm Checking, Model Parameterization, Parameter Testing, and Model Sensitivity Testing?

Evaluation of Technology and its adoption (Question Cluster 4)

1. What is farmers' understanding of modeling results?
2. Are they willing to adapt these results?
3. What are the most common methods of irrigation in the area?
4. In what ways, if any, are water rights issues incorporated into the analysis?
5. How do you prepare a crop calendar and irrigation scheduling?
6. How is the length of growing period changed after the intervention?
7. What kind of training do farmers need for sustainably the new SSI practices and technology in the long term?
8. What ILSSI technologies and practices are more likely to be adopted by farmers (including women)? Please rate the likelihood of adoption on a scale of 1 to 5, where 1 means "least likely" and 5 means "very likely": solar irrigation, diesel, rope and pulley, irrigated fodder, drip irrigation, other.
9. Please explain your answer.
10. What ILSSI technologies and practices are more likely to be adopted by farmers (including women)? Please rate the likelihood of adoption on a scale of 1 to 5, where 1 means "least likely" and 5 means "very likely": solar irrigation, diesel, rope and pulley, irrigated fodder, drip irrigation, other.
11. Please explain your answer.

Constraints and Opportunities (Question Cluster 5)

1. Do farmers and local coordinator have Internet access so they make use of model runs, weather data, communication with scientists at A&M, local mangers, other farmers, etc.?
2. What is the food balance situation before and after intervention?
3. How much, if any, is the incremental crop yield after implementation of SSI?
4. If the crop yield has not increased as expected what are the reasons, and how can it be improved?
5. Was there any problem of land erosion/landslides before implementation? If yes, what is the effect of SSI now?
6. What types of problem, if any, are there with salinity?
7. What is the nutrient situation in soil (i.e., nitrogen, phosphorus, organic matters, etc.) after SSI intervention?
8. What are options of up-scaling SSI to watershed level and to other locations in the country, taking into account ecological zones, water supply, soil, farmer capacity, etc.)?
9. Is there planning or an institutional arrangement for watershed management?
10. Will there be a soil conservation program in upper catchment?
11. Is there any value chain approach to agricultural development linking producers to markets, and addressing constraints at all levels?
12. How far is the market from the project area and what are the means of transport?
13. What is the effect of climate change in availability of water and crop production?
14. What is the cost of farm labor?
15. What is accessibility to farm inputs and labor?
16. Is the annual water balance (as per the cropping pattern) reflected by the IDSS models with accuracy?
17. What is the duty (water requirements in l/s/ha) of the individual crops, application, and overall efficiency of the system?
18. How have the measures been taken to maximize application efficiency?
19. Have you designed optimum size for a furrow plot to maximize application efficiency?
20. As delivering capacity of solar pump has been shown very less than diesel/electric motor pump, has more powerful solar pump system been explored which can replace diesel/electric motor pumps?

21. Have you designed irrigation scheduling based on water stress (optimization of water and yield)?

Project Modifications (Question Cluster 10)

1. If the project is renewed, what would you need to improve your research program?

Key Informant Interview Guide: Policy Makers/Ministry Personnel

Introduction

What is the nature of your engagement with the ILSSI project?

Program Management (Question Cluster 1)

1. Is the ILSSI program in line with your government's poverty reduction and agriculture development strategy?
2. How often are you in contact with ILSSI management?
3. How satisfied are you with the coordination and communication between you and project implementers? Are there any ways in which coordination and communication could be improved?

Identifying SSI Interventions and Practices (Question Cluster 2)

1. How relevant is the ILSSI project to your country's development strategy?
2. On a scale of 1 to 5, where 5 means "extremely well" and 1 means "extremely poorly" how well has the ILSSI project identified SSI interventions, technologies, and management practices?
3. Please explain your rating.
4. Was government involved in research site selection? Are you satisfied with the selection?
5. Does the selection process reflect government policy?

Research on Productivity, Environment, Economy, Nutrition, and Gender (Question Cluster 3)

1. What is the basis for introducing the particular SSI technologies and practices?
2. How do you rate the quality of the research being conducted, on a scale of 1 to 5 where 5 means "very good" and 1 means "very poor"?
3. Please explain your rating.
4. If you are aware of the modeling work, how useful do you think the ILSSI model runs are for estimating impacts on production, environment, production, etc.?

Technology Adoption (Question Cluster 4)

1. What ILSSI technologies and practices are more likely to be adopted by farmers (including women)? Please rate the likelihood of adoption on a scale of 1 to 5, where 1 means "least likely" and 5 means "very likely": solar irrigation, diesel, rope and pulley, irrigated fodder, drip irrigation, other.
2. Please explain your answer.
3. Do you think farmers outside the research sites will use the technology? Why or why not?
4. Is there government policy to support credit facilities for farmers that are interested?
5. Are there subsidies for irrigation technology?
6. Do you believe farmers will continue to use the new SSI technologies/practices after the project ends?

Constraints and Opportunities (Question Cluster 5)

1. Does the participating local university or local consulting firms provide model output or recommendations to farmers or local officials?

Capacity Building and Engagement – How? (Question Cluster 6)

2. In your view, how well do the project partners (USAID Missions, CGIAR Centers, NGOs, host country governmental and academic institutions, and community stakeholders) collaborate?
3. Is there a government policy for the research project implementation?

4. Is the government interested in expanding research in other areas in the agriculture sector?

Capacity Building and Engagement – Who? (Question Cluster 7)

1. What is the basis of selection of targeted group of trainees?
2. Can the trainee selection process and type of training be improved in any way?
3. Is ILSSI providing the appropriate type of training?

Knowledge Into Practice (Question Cluster 8)

N/A

ILSSI and Feed the Future Research Alignment (Question Cluster 9)

1. Does implemented program address the Feed the Future research strategy?
2. Is there any scope of improvement? If yes, what type of improvement?

Project Modifications (Question Cluster 10)

1. What are the lesson learned from this project that should be incorporated in future projects?
2. What are the additional steps needs to be considered to enhance capacity of stakeholders?
3. If the program were being designed today, are there any things you would change?

Key Informant Interview Guide: Extension Agents (working on project)

General Information

1. How are you engaged in the project?

Project Management (Question Cluster 1)

1. How often are you in contact with the project partners?
2. Are they responsive when you have questions?

Identifying SSI Interventions and Practices (Question Cluster 2)

3. How were farmers selected?
4. Do you have a formal Water Users' Association (WUA)?
5. Do you have WUA constitution, by-laws, and rules that define organization set-up and operational arrangement procedure?
6. What are the strengths and weakness of WUA?

Research on Productivity, Environment, Economy, Nutrition, and Gender (Question Cluster 3)

1. How many women members are participating in the project and what is their role in decision making?
2. Does project address local unemployment problem and improving production of specific crop?

Technology Adoption (Question Cluster 4)

1. What is the appropriate technology for the project area? Does the implemented project address that?
2. How does the ILSSI technology being using now compare with previously used technology?
3. Do you think the new technology will be used after project ends?
4. What ILSSI technologies and practices are more likely to be adopted by farmers (including women)? Please rate the likelihood of adoption on a scale of 1 to 5, where 1 means "least likely" and 5 means "very likely": solar irrigation, diesel, rope and pulley, irrigated fodder, drip irrigation, other.
5. Please explain your answer.

Constraints and Opportunities (Question Cluster 5)

1. What are the benefits of SSI intervention?
2. Did the farmers face any challenges during implementation?
3. How did you or the farmers address them?

Capacity Building and Engagement – How? (Question Cluster 6)

1. Did you receive any training? What kind of training was it? How have you used it?

Capacity Building and Engagement – Who? (Question Cluster 7)

1. How relevant is the training to the needs of the agriculture sector and farmers?
2. In what ways has the training program enhanced the capability of users?

Knowledge Into Practice (Question Cluster 8)

1. Are there paid opportunities for trainees to put into practice what they have learned?
2. Do you have any evidence that the training is having an impact?

ILSSI and Feed the Future Research Alignment (Question Cluster 9)

1. How effective will be this project to alleviate poverty and hunger?
2. What other measures should be taken to ensure food sufficiency?

Project Modifications (Question Cluster 10)

1. What recommendations do you have for the project if it is extended?

Key Informant Interview Guide: Farmers Participating at Project Research Sites

General Information

1. Age
2. Gender
3. Land plot size (ha)
4. Size of area under irrigation (m^2)
5. Type of crops grown on all land
6. Type of crops grown under irrigation

Project Management (Question Cluster 1)

1. Please tell us how you joined the Innovation Lab for Small Scale Irrigation program (ILSSI)?
2. Why did you join the project?
3. What do you think of the ILSSI project in general?

Identifying SSI Interventions and Practices (Question Cluster 2)

1. On a scale of 1 to 5, where 5 means "very satisfied" and 1 means "very unsatisfied," how satisfied are you with the new technology and methods you have been using on your farm?
2. Please explain your rating.

Research on Productivity, Environment, Economy, Nutrition, and Gender (Question Cluster 3)

1. What is the most important thing you've learned from participating in the project?
2. [for women farmers] Has participating in the project has changed your life as a woman? If yes, in what way?

Technology Adoption (Question Cluster 4)

1. How does the SSI technology you are using now compare to what you used before? What are the benefits?
2. If and when the project support ends, will you continue using the practice and technology? If not, why not?
3. How often do you talk about the new methods or the project with other farmers?
4. What ILSSI technologies and practices are more likely to be adopted by farmers (including women)? Please rate the likelihood of adoption on a scale of 1 to 5, where 1 means "least likely" and 5 means "very likely": solar irrigation, diesel, rope and pulley, irrigated fodder, drip irrigation, other.
5. Please explain your answer.

Constraints and Opportunities (Question Cluster 5)

1. What is the most difficult part of the project?
2. What is the best part about the project?
3. Are other farmers outside of the project area learning from you?
4. Do you think it will be common for other farmers, outside the project area will start using the SSI technologies and practices you use on your farm? Why or why not?

Capacity Building and Engagement – How? (Question Cluster 6)

1. How often do you receive training or support from the project?
2. Where can you get agricultural training?

Capacity Building and Engagement – Who? (Question Cluster 7)

N/A

Knowledge Into Practice (Question Cluster 8)

1. Did you apply what you learned in the training/workshop? If yes, in what way?

Project Modifications (Question Cluster 10)

1. Do you have any message you would like us to pass on to the project implementers which would make the project better?

Key Informant Interview Guide: U.S. and International Project Partners

Introduction

What is the nature of your engagement with the ILSSI project?

1. **Project Management**: In what ways could project management, communication, coordination, and implementation be improved to better achieve goals and objectives?

   a. What are your main tasks and responsibilities relating to the project?
   b. Do you have all the resources (budgetary, human, skills, etc.) you need to accomplish your tasks?
   c. On a scale of 1 to 5, where 5 means "very well" and 1 means "very poorly," how well is the project managed in your opinion?
   d. Please explain your rating.
   e. What was decision-making behind ending research in Dambasina?

2. **Identifying SSI interventions and practices**: How well has the ILSSI project identified promising small-scale irrigation interventions, technologies, and management practices using criteria that are context specific, evidence-based and robust? To what extent are these criteria relevant and scientifically rigorous?

   a. How did the project determine which interventions to test out at the sites?
   b. Interventions are modest, number of farmers are few, innovations are marginal. Why are ambitions so modest? What is the marginal benefit?
   c. What kind of efforts, if any, are being made to study or promote scaling up the new technologies? Our focus group discussions suggested reluctance to invest among farmers, even in technologies that significantly increase yields?
   d. Ghana research says: "Technologies and inputs are not provided for free to farmers by the project, but rather, the project partners act as brokers to link the farmers to inputs required for the intervention packages and facilitate the use of the technologies through training and mentoring." However, "water tanks will be provided free of charge. Two (2) watering cans will be provided to each of the farmers using water can irrigation, free of charge."
   e. To what extent was affordability of equipment/technology for farmers a concern?
   f. Are the Results Framework indicator targets being met? If not, why not?
   g. IFPRI: How do you measure labor? Different indicators for labor hours vs. intensity?

3. **Research on productivity, environment, economy, nutrition, and gender**: To what extent have the following concerns been incorporated in the identification, evaluation, and testing of selected technologies, including the consideration of potential trade-offs and synergies: productivity, environmental, economic, nutritional, and gender impacts? In what ways have opportunities to exploit SSI in an environmentally sound way been assessed and carried out? What could be done differently to better address these concerns?

   a. Why so few farmers in Ghana (48 but now 32) and what are the implications for research of having a small sample?
   b. Do you think farmers are aware they have to eventually pay for the technology they are using?
   c. Why is the project not trying out wetting front detectors in Dangishta?
   d. Is tillage-plough innovation (in Dangishta) part of the project? Was it added later?
   e. After the stakeholder workshops in each country, how did project decide what issues to research (given that many topics were suggested)?

4. **Research on productivity, environment, economy, nutrition, and gender**: What ILSSI technologies (solar irrigation, irrigated fodder, conveyance methods such as drip irrigation, etc.) are more likely to be adopted by farmers (including women) and scaled sustainably in each of the three countries? And why, why not? (e.g., access to finance, potential availability of replacement equipment, training needed, etc.)

   a. Why are some relatively expensive technologies being tested - solar pump, diesel pump+tank+hose, drip irrigation in these areas? Seem unlikely to be adopted.
   b. Or only with innovative financing schemes.
   c. Do you believe that farmers are following the recommended practice for watering amount?
   d. In Zanlerigu we heard that farmers decided to water with 5 cans twice per day, instead of recommended once per day. What are views on this?
   e. We heard there were issues with size of the tank being too small. What are views on this?

5. **Constraints and opportunities**: What types of opportunities and constraints have been identified related to the widespread adoption and scaling of small-scale irrigation technologies and practices by smallholder farmers? In what ways, if any, have opportunities been maximized to support scaling? What approaches have been identified to address these constraints? What could the project do to better address the challenges to improved access and use for smallholder farmers?

   a. Why is there apparently little emphasis on the private sector role in scaling and adoption?
   b. To what extent are social behavior issues being addressed and how? With respect to farmer willingness to invest?
   c. Margin of error in data collection? Confidence levels?
   d. To what extent are risks (drought, flooding, pests/diseases) incorporated into the model?
   e. How is the project addressing constraints to widespread adoption, scaling?

6. **Capacity building and engagement – how?** In what ways are relevant partners, including USAID Missions, CGIAR Centers, NGOs, host country governmental and academic institutions, and community stakeholders being engaged? What potential is there for other partnerships and collaborations, including with other Feed the Future Innovation Labs and other relevant USAID programs in the target countries?

   a. IWMI: How did you identify capacity gaps?
   b. What is relationship between ILSSI and WLE – [Water, Land, and Ecosystems Research Program of the CGIAR (WLE)] – with loans managed by iDE?
   c. Can you tell us more about ILSSI engagement with other ILs: Sustainable Intensification Innovation Lab (SIIL), Horticulture Innovation Lab (HIL), Livestock Systems Innovation Lab (LSIL), Mechanization Consortium?
   d. Was collaboration with Pest Management IL considered or did it happen?
   e. In Ghana, why are they not working more closely with GIDA, WRI, CRI (Crop Research Institute)?

7. **Capacity building and engagement – who?**: Are the appropriate type and number of people being targeted for the right kind of training? What improvements, if any, are needed in how academic and technical capacity strengthening activities are identified and implemented?

   a. What was the rationale of one-week modeling workshops?
   b. Why was modeling not being done locally in Ghana?

8. **Capacity building and engagement – who?:**: In what ways, if any, are trainees likely to put into practice the knowledge and skills acquired? In what ways, if any, have the training programs contributed to strengthening institutional capacity in the target countries?

   a. The evaluation team heard from farmers in Zanlerigu that they had only received training on plant spacing. Is this correct?

9. **ILSSI and Feed the Future research alignment**: To what extent does/will ILSSI's research align with the Feed the Future research strategy (and the Global Food Security Strategy)? What adjustments may be necessary to the research to ensure better alignment with the Global Food Security Strategy?

    a. From your perspective, what is the Feed the Future program about and how does ILSSI align with it?
    b. Where are "Feed the Future Results" in the theory of change taken from?

10. **Project modifications**: If renewed for a second phase, what changes, if any, are needed to improve the Small Scale Irrigation Labs' management, research (i.e., design, implementation, communications, stakeholder involvement, etc.) and/or training (i.e., student recruitment and selection, content, location, etc.) programs, and/or institutional capacity collaboration?

    a. Are the Results Framework indicator targets being met? If not, why not?

Annex F: Focus Group Discussion Guide

Introduction to Participants

Thank you for participating in this focus group discussion. We are evaluators conducting a study of the Feed the Future Innovation Lab for Small Scale Irrigation (ILSSI) project on behalf of USAID. We have selected you to participate in the study because of your knowledge about and experience with project. We have been asked by USAID to assess how well the project is performing. We want to learn about what works and what (if anything) doesn't. What we learn from you, as farmers who have been participating in this project will help us understand the project better.

We would like to ask you about a number of topics related to your experience with the project – what you have learned, and what effects you have noticed. The discussion will last approximately one and half to two hours. You are under no obligation to answer every question, although we very much value your what you have to tell us!

Everything you tell us will be kept confidential. That means that we will use the information you share with us for our report, but no one will know that it was you who told us. We are going to take notes during our meeting today to use in our study. To protect your confidentiality, we will ask you only for your first names, so that in our final report, no one will be able to identify you personally.

Your participation in this discussion will be taken as a sign of your consent to participate. If you do not wish to participate for any reason, you may leave the discussion now, or at any time, and there will be no penalty.

Composition of Group

Research site	
Region, District Name	
Number of participants	
Gender Composition (e.g., 100% female, 40% male)	

General Information

Go around the room and ask each participant the following information:

	First Name (gender)	Age	Area Under Now Irrigation (m^2)	Irrigation Technology Used	Type of Crops Grown Under Irrigation
1					
2					
3					
4					
5					
6					
7					
8					

Project Management (Question Cluster 1)

1. Please tell us how you learned about the ILSSI project?
2. What is the *main* reason you joined the Project?

Identifying SSI Interventions and Practices (Question Cluster 2)

1. On a scale of 1 to 5, where 5 means "very satisfied" and 1 means "very unsatisfied," how satisfied are you with the new technology and methods you have been using on your farm?
2. Please explain your rating.

Research on Productivity, Environment, Economy, Nutrition, and Gender (Question Cluster 3)

1. What is the most important thing you've learned from participating in the project?
2. [For women farmers] Has participating in the project has changed your life as a woman? If yes, in what way?

Technology Adoption (Question Cluster 4)

1. How does the SSI technology you are using now compare to what you used before? What are the benefits?
2. If and when the project support ends, will you continue using the practice and technology? If not, why not?

Constraints and Opportunities (Question Cluster 5)

1. Are of aware of any other farmers outside of the research area learning from you?

Knowledge Into Practice (Question Cluster 8)

1. Did you receive training?
2. Have you applied what you had learned from the training? If yes, in what way?

Project Modifications (Question Cluster 10)

1. Now please imagine that you are a highly select group of government advisors. What advice would give to the project implementers or USAID about the proeject? Is there anything that can be done better?

Thank the participants for their time and for sharing their responses.

FGD reporting

1. Location:
2. Moderator:
3. Note taker:
4. Date and Time of Discussion:
5. Duration – start and end times:
6. Participant Profile (age, gender):
7. Notes/Comments on the Process:
8. Summary of Responses to Questions 1-10 (note participant first name alongside responses):

<u>Notes for moderator</u>: *If the discussion becomes heated over one particular point, explain that these will be covered in more detail during the discussion to follow, and proceed to the first exercise. If participant feels uncomfortable answering any question in front of the group, move on to the next point (you may try to catch them during breaks or at end of meeting). Note any issues that are brought up and may not be specifically covered in the research. Prompt respondents to discuss/elaborate more in the relevant section of the discussion.*

ANNEX G: KEY INFORMANT INTERVIEW CONSENT FORM

Evaluation of: Feed the Future Innovation Lab for Small Scale Irrigation (ILSSI) project

ET Members: Nils Junge, Mike Schmidt, and Vinay Kumar Koirala

Evaluation Purpose: We are evaluators conducting a study of the Feed the Future Innovation Lab for Small Scale Irrigation (ILSSI) project on behalf of USAID Bureau of Food Security's (BFS). We have selected you to participate in the study because of your knowledge about and experience with the ILSSI project. The goal of this study is to assess the project's performance, provide empirical evidence of what works and what doesn't, and to inform development of new investments in irrigation research for development. The study findings will support learning and continuous improvement of USAID's work.

Voluntary Status: This interview is voluntary, and you can decline to answer any question or withdraw at any time before the interview is completed. Any information you have provided up to that point may be used for analytical purposes.

Recording: If you agree to have this interview recorded, the recording will be used for analysis and aggregation only and will not be distributed beyond the ET. You are free to decline to have the interview recorded.

Interview duration: We expect that the interview will not take more than 60 minutes to complete. Following the interview, we may want to contact you again to confirm or follow up on information.

Confidentiality: Everything you say will only be shared with the ET. Your name will not be identified with or linked to any quotes in any public reports, unless we request your approval and you give your consent. Unless specified otherwise, a list of all interviewees will be included as an annex. If you do not wish to have your name listed in the report annex, please let us know.

Consent: I understand the provided information and have had the opportunity to ask questions. I understand that my participation is voluntary and that I am free to withdraw at any time, without giving a reason and at no cost. I voluntarily agree to take part in this study.

Participant's signature _________________________________ Date ___________

Evaluator's signature _________________________________ Date ___________

ANNEX H: ILSSI AND GLOBAL FOOD SECURITY STRATEGY CONTEXT

The *Feed the Future Research Strategy* aligned with the Results Framework by contributing to its two high level objectives — inclusive agricultural growth and improved nutritional status of target populations. It advances the productivity frontier, transform key production systems, and enhance nutrition and food safety through agriculture. The strategy seeks to add to Feed the Future's overarching goal of sustainably reducing global poverty and hunger. Feed the Future has five focus areas: Inclusive Agriculture Sector Growth, Gender Integration, Improved Nutrition, Private Sector Engagement, Research and Capacity Building, and Resilience.

The USG*'s Global Food Security Strategy* (2017-21) has three themes: Advancing the Productivity Frontier; Transforming Key Production Systems; and Enhancing Nutrition and Food Safety, and describes how the USG and its partners contribute to global food security and the Sustainable Development Goals (SDGs) by reducing global hunger, malnutrition, and poverty. Its main objectives stem from the idea that key food security drivers are in agriculture-led economic growth, strengthened resilience, and a well-nourished population. Nine Intermediate Results (IRs) and six Cross-Cutting IRs support the objectives and allow the USG to "*strengthen the capacity of all participants throughout the food and agriculture system, paying special attention to women, the extreme poor, small-scale producers, youth, marginalized communities, and small and medium enterprises*" (p.3)

Besides promoting consumption of nutritious foods, the GFSS also seeks to promote the conditions for a well-nourished population. "*Nutrition is central to sustainable development and is required to make progress on issues such as health, education, employment, poverty, inequality, and the empowerment of girls and women*" (P.19). Malnutrition not only restricts human potential and productivity, but also imposes a high burden of social and economic consequences on individuals, families, communities, and nations.

The multifactorial nature of poor nutrition requires a multi-sectoral approach. To achieve Objective 3 "a well-nourished population," USG will support global, national and local policies, strategies, and processes; develop partnerships to leverage resources; encourage nutrition advocacy; and promote coordinated actions. (p.20).

Resilience strengthening is the second building block of the GFS Strategy. "*Resilient individuals, households, and communities are able to manage adversity and change without compromising their future well-being. They are able to effectively anticipate, mitigate, and reduce risks and the negative effects of realized risks in the form of shocks and stresses without major, lasting consequences to their food security, nutrition, and economic well-being*" (p.18). Resilience is essential for reducing hunger, malnutrition, poverty and reducing reliance on emergency food assistance.

Increasing gender equality and female empowerment will be a central foundation for the GFSS and is the reason Gender Equality and Female Empowerment is a cross-cutting IR. Women play multiple roles, which places them at a critical nexus in food security and nutrition. On average, women comprise 43 percent of the agricultural labor force in developing countries but have disproportionately less access to resources, markets, technologies, information, influence, and means of risk management[50]. *Source: USAID: https://www.usaid.gov/what-we-do/agriculture-and-food-security/us-government-global-food-security-strategy*

[50] Food and Agriculture Organization of the United Nations. (2011). *The state of food insecurity in the world – women in agriculture: Closing the gender gap for development.* Rome, Italy. http://www.fao.org/docrep/013/i2050e/i2050e.pdf