Stakeholder consultation Report

Feed the Future Innovation Lab for Small-Scale Irrigation: Ghana

Stakeholder Consultation Workshop Report
Accra - 23th June 2016





"The Feed the Future Innovation Lab for Small-Scale Irrigation works to enhance food security and reduce poverty by developing and introducing gender-sensitive, small-scale irrigation systems into food and agriculture production on small farms."

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1 Introduction and background

The ***Feed the Future Innovation Lab for Small-Scale Irrigation*** (ILSSI) project aims to enhance food security, improve nutrition and reduce poverty. The project team will do this by developing and introducing promising, context appropriate, small-scale irrigation systems into food and agriculture production on small farms in Ghana, Ethiopia and Tanzania. The project is piloting and modelling high potential interventions in small-scale irrigation and irrigated fodder production through development and use of an *Integrated Decision Support System* (IDSS).

The project, funded by USAID, is led by Texas A&M University (TAMU) in collaboration with the International Water Management Institute (IWMI), International Livestock Research Institute (ILRI), International Food Policy Research Institute (IFPRI) and North Carolina A&T State University.

In Ghana the project is also partnering with the University of Development Studies (UDS), iDE-Ghana, and the Animal Research Institute (ARI) and Water Research Institute (WRI) of the Council for Scientific and Industrial Research (CSIR). Strong engagement with research institutions and non-governmental organizations such as these, as well as with the government of Ghana and other stakeholders active in the country, including farmers, is a key component of the project. The project, which runs from October 2013 – September 2018, is comprised of five major interrelated components:

- Assessment of promising small scale irrigation technologies
- Small-scale irrigation interventions in the field
- Stakeholder consultation at multiple levels of scale
- Engagement with national partners and farmers in order to conduct field studies
- Surveys of farming families in the area surrounding the field test sites
- Analysis of the production, environmental and economic consequences of small scale irrigation options, including but not limited to interventions in farmers' fields, using the Integrated Decision Support System (IDSS)

Capacity building and training at multiple levels of scale are also substantive elements of the project.

Background to this workshop

Consultation with national stakeholders, to assist in planning, implementation and validation of results, forms a key part of the activities of the ILSSI project. This approach to partnerships is an ongoing process conducted throughout the 5 year duration of the project in all three countries. In the first phase of the project, initial engagements at local, regional and national levels helped to identify and define the most promising small-scale irrigation (SSI) scenarios that, with the support of further research, could potentially lead to sustainable adoption and significant development impact.

Over the past two and a half years researchers, through a combination of field surveys, analysis and modelling, have generated a set of initial results that focus on high potential interventions in small-scale irrigation and irrigated fodder production. These results, and corresponding experiences in the field, have been used to identify a number of constraints that affect the adoption of these small-scale irrigation interventions (both those studied in the field and a broader set evaluated using models).

This one day participatory stakeholder workshop provided an invitation to national experts in Ghana (please see **Annex 1** for participant list) to share their knowledge and experience, and draw on the institutional interests and priorities they represent, in order to evaluate and prioritize the constraints that have been identified so far by the ILSSI research team. The workshop took place at the International Water Management Institute, West Africa office in Accra.

Through this stakeholder consultation and evaluation process the research team aimed to collaboratively prioritized a short-list of these constraints specific to Ghana, as a guide for further analysis. It is anticipated that this in turn will result in concrete, context specific proposals emanating from the project to mitigate these constraints and so make the most of opportunities to scale out solutions. The Integrated Decision Support System (IDSS) will be used in this analysis for each of the three countries of the study. A representative of the ILSSI External Advisory Committee, Professor Saa Dittoh of the University for Development Studies, Ghana, was invited to provide perspectives, during the workshop, on the evolution of the project.

2 Objectives of the workshop

The workshop had three key objectives, namely:

- To share research and experiences on small-scale irrigation and irrigated fodder interventions in Ghana.
- To collaboratively prioritize the key constraints to successful and productive small-scale irrigation and irrigated fodder interventions in Ghana that the Integrated Decision Support System can help to address.
- To continue and expand participatory consultation with stakeholders to foster dialogue, networking and enhance partnerships.

The principal planned workshop output was to generate a consensus based, prioritized list of constraints to successful and productive small-scale irrigation and irrigated fodder interventions in Ghana, that the next phase of work with IDSS can focus on with a view to out-scaling small scale irrigation for transformative livelihood benefits in rural communities.

3 Participants

20 stakeholders, representing a wide variety of government ministries and agencies, regulatory organisations, research institutions, NGOs, donors, academia and others active in Ghana with expertise and interest in irrigation and agriculture participated in the ILSSI workshop in Accra, along with five members of the ILSSI project team and the facilitator. Please see the full participant list in **Annex 1** for further details.

Workshop participants, Accra
Photo: IWMI

4 Workshop proceedings

In advance of the workshop, participants were provided with a brief set of background documents to review in order to further familiarise themselves with the project, its aims and approaches, the IDSS and most importantly the set of constraints, identified through the project, that would be discussed and prioritized during the workshop. These documents included:

- An ILSSI project and IDSS background summary
- An example of the IDSS gap and constraints analysis for small scale irrigation systems developed by, and used in, the ILSSI project
- The rationale and agenda for this workshop

The workshop was split into two main sections (please see the workshop agenda in **Annex 2** for further details) providing opportunities to:

- Share the latest developments, findings and approaches of the ILSSI research project team.
- Discuss high potential interventions in small-scale irrigation and irrigated fodder production in Ghana, and collaboratively work to prioritize a set of constraints to the adoption and success of these interventions that the ILSSI project has identified through field work, household surveys and the use of an Integrated Decision Support System (IDSS).

Following a morning of presentations from representatives of TAMU, IWMI, ILRI and IFPRI the second half of the workshop involved a group exercise to collaboratively prioritise the constraints to adoption of small scale irrigation interventions studied in Ghana. The objective was to develop a consensus based, prioritized list of constraints to successful and productive small-scale irrigation and irrigated fodder interventions. These will then provide the focus for the next phase of work with IDSS with a view to out-scaling small scale irrigation for transformative livelihood benefits in rural communities in Ghana, as well as in Ethiopia and Tanzania.

4.1 Opening

Ms Marloes Mul, standing in as acting head of IWMI West Africa office, welcomed participants to the workshop and gave a brief summary of how the ILSSI project fits within the portfolio of projects that IWMI is conducting, and a partner of, in West Africa. Marloes also introduced Professor Saa Dittoh, of the University for Development Studies (UDS) Ghana, and ILSSI project External Advisory Committee member, who said a few words to introduce the ILSSI project and the role of the project's External Advisory Committee.

The facilitator, Thor Windham-Wright, then led workshop participants in a round of introductions followed by a brief review of the workshop agenda and short icebreaker exercise.

4.2 Presentations

Below is a brief summary of each of the presentations given by project partners. Please see **Annex 3** for copies of the full presentation slide decks.

1) Introduction to Feed the Future Innovation Lab for Small Scale Irrigation - Ghana

Dr Srinivasan, Professor, Departments of Ecosystem Science and Management and Biological and Agricultural Engineering, Texas A&M University, led the first presentation introducing the ILSSI project. Dr Srinivasan provided a summary of the project's background, funding organisation, objectives, partners and introduced the key research questions that the project aims to address. This was followed by an overview of research conducted by the project partners in each of the three countries to date and details of the research components and methods. Dr Srinivasan then introduced the stakeholder workshop objectives and intended outcomes.

2) Field level pilot interventions in small-scale irrigation and agricultural water management

Dr Davie Kadyampakeni, Researcher - Agricultural Water Management, IWMI, gave a presentation on research conducted by IWMI into field level pilot interventions in small-scale irrigation and agricultural water management, as part of the project. Davie introduced the project sites, local partners, IWMI research team, and the main research activities of this component including: water lifting devices and watershed characterization, gender aspects of irrigation, irrigation management, crops, and credit constraints and opportunities. Davie presented baseline hydrological data for Ghana, details of annual rainfall and potential evapotranspiration (ET), technical interventions, water use in home gardens, and preliminary results of studies into water use and irrigation scheduling. Davie's presentation concluded with details of some of the constraints to the adoption of small-scale irrigation identified through IWMI research under the ILSSI project in Ghana.

3) Field Level Pilot Interventions in Small Scale: Fodder Cultivation - irrigated fodder production in northern Ghana

Dr Tunde Amole, Postdoctoral Scientist, Livestock Feeds West Africa, ILRI, gave a presentation on research by ILRI into irrigated fodder production in northern Ghana. His presentation introduced this component's main activities including; demonstration and production of irrigated fodder, rainfed fodder production and a feeding trial. He then discussed the agronomic performance of experimental forage species, and gave an overview of the research sites. Tunde then detailed some of the preliminary findings and lessons, including:

- General willingness of the farmers towards irrigated fodder production.
- Small scale irrigated fodder established better at Bihinayili than Zanlerigu.
- Brachiaria and Sorghum regenerates well after several cutting regime and during the dry season where there enough moistures.
- Large area of land is required to produce enough biomass.
- Conflict of interest *(either to use the harvested fodder as feed or sell it).*
- More profitable if fodder production could be targeted at animal fattening.
- To target market, irrigated fodder should start earlier than vegetable production.
- Smaller size hoses should be used for irrigation.

In conclusion Tunde provided an overview of some of the constraints to the adoption of small-scale irrigation identified through ILRI research under the ILSSI project in Ghana.

4) Small-scale irrigation technologies and agricultural water management practices - analyzing nutrition, health and gender outcomes

Dr Joseph Amikuzuno, Senior Lecturer, University for Development Studies, Ghana, gave a presentation, on behalf of IFPRI, detailing analysis of the impacts, tradeoffs, and synergies of small-scale irrigation technologies on health, nutrition, rural livelihoods, and women’s empowerment. He presented the research sites and detailed research activities under this component including:

- Baseline data collection from the 3 ILSSI intervention villages and 9 control villages
- Topics of the survey included:
  - Crop & livestock inputs, production and practices
  - Household and women’s dietary diversity
  - Child health, diet, feeding and anthropometry
  - Household shocks, assets, credit
  - Women’s Empowerment in Agriculture Index (WEAI)

IFPRI preliminary findings include:

- Groundwater is the main source of irrigation water in the project area.
- Irrigation water is largely extracted using buckets. Pumps remain uncommon.
- Buckets, hose, and water cans are the main water application methods.
- Most farmers irrigate twice a day and spend an average of 2 and a half hours per irrigation.
- Irrigators purchase more local seed, but not necessarily improved seed.
- Irrigation is mainly for the production of onions, and to a lesser extent tomato, okra, red pepper, water-melon and leafy vegetables.

In conclusion Joseph provided an overview of some of the constraints to the adoption of small-scale irrigation identified through ILRI research under the ILSSI project in Ghana, including: plant disease, insect damage, and insufficient water.

5) Overview of Integrated Decision Support System (IDSS)

Dr Srinivasan presented an overview of the IDSS model approach, using data from the Dimbasinia watershed, Ghana, (one of the project field sites) demonstrating that it is an integration of APEX, SWAT and FARMSIM models. He then went on to present an example of using the IDSS to analyse the Robit Watershed in Ethiopia, and the associated scenarios, results, impacts, crop yields and net present value of using various water lifting technologies for small-scale irrigation.

6) Candidate constraints from research experience and a preview of the constraints analysis method

Dr Srinivasan then gave a presentation on the candidate constraints identified through the ILSSI project to date, and also on the methods used for constraints analysis. Dr Srinivasan used the example of research conducted on the Robit watershed of Ethiopia to show how the IDSS is used at the watershed scale to analyse resource and environmental constraints. He included a map of Ethiopia that's been produced showing land suitability for irrigation, details of available water in the Robit watershed, and the impacts of SSI at the watershed scale. He also showed how IDSS can be used to; analyse nutritional and economic constraints at the household level, examine field scale irrigation water management and investigate the impacts of fertilizer use on agricultural productivity.

4.3 Plenary discussion and stakeholder comments and questions

A number of questions and comments were raised by participants both immediately after each presentation and at the end of the workshop's presentation session. These included:

Comments:

- The research team should consider that differences across the various communities surveyed by the IFPRI team, especially in light of their geographical spread, may also reflect cultural differences.
- The IFPRI research presentation could benefit from further details about what aspects of nutrition were studied.
- Differences in seasonal requirements need to be considered when examining or proposing irrigation scheduling and duration plans.
- Water deficits at watershed scale: It was felt by one participant that the suggestion in IWMI's presentation that there is a need for between 1100-1300mm required to meet irrigation water needs throughout the dry season was on over estimation, and that a more appropriate figure would be between 500-600mm.
- Local varieties of crops and seeds have largely been discarded even though they often demonstrate more resilience to local diseases and pests than introduced varieties. More research could and should be done into what these local varieties may have to offer.

- Earlier planting scheduling, to capture and more effectively utilize existing soil moisture, (and it's impacts) may be something to consider as part of the research going forward.
- For effectiveness and best impact the ILSSI project should be working with farmers who are already using irrigation in one form or another, rather than trying to convert farmers who are not irrigators to becoming irrigators.
- The timing of micro-finance is key in Ghana. Often it doesn't arrive in time to be used for what it was applied to be used for, or for what it is really needed for. This is considered a constraint to the adoption of small-scale irrigation.
- Conflict over different uses of water is also a constraint that should be considered and examined.

Questions:

- Were the gender aspects of value addition activities/impacts examined?
- Its seems that the research team's approach may be trying to encourage women into agricultural production activities when their existing skills and comfort zone lies in agricultural product marketing. Why is this the case, and is it the most sensible approach? *In response the comment was made that many of the women studied in the 9 communities are already working in agricultural production.*
- What is meant exactly by women having limited access to credit? Does this mean women don't know where to go for credit or are being prevented from obtaining it by male members of their household or community? *In response the comment was made that credit for dry season agricultural practices is seen as high risk, that some of the crops being grown don't qualify for credit, and also that it is often costly and difficult for credit providers to follow up and recover credit provided in rural areas.*
- Has any been training offered to farmers on pest and disease containment and management as part of the ILSSI research project to date? *In response the comment was made that there are no pest management experts on the research team.*
- What part of the IDSS deals with soil types and related impacts (with specific relevance to small scale irrigation)? How does the model handle this aspect?
- Does the IDSS include consideration or suggestions of how to use run-off more efficiently (such as using crop residues to reduce run-off losses and retain soil moisture)? And does the IDSS include consideration of chemical buildup/salinization resulting from irrigation?
- How can the IDSS or its outputs be practically used 'on the ground' at the farm level? There is a strong need for something like this to be practically applicable.
- In the Ethiopia Robit watershed analysis example presented did the research team conduct a baseline soil fertility assessment?
- If, as mentioned in the constraints analysis example presentation, in some areas of the Robit watershed only 40% of rainfall is contributing to groundwater recharge so what is the sustainability of this with respect to the water needs for irrigation? *In response the comment was made that for these reasons only certain areas of the whole watershed can be considered suitable for irrigation, in terms of sustainability, and that this focus on sustainability of small-scale irrigation is a key approach of the ILSSI project.*

4.4 Group work

4.4.1 Group work assignment: prioritization of constraints

Workshop participants were divided at random into 4 groups of around 5-6 individuals. A member of the ILSSI project research team was assigned to each group. Each group was provided with a flipchart and paper, colored cards, pens and guidance on the group work process.

All four groups were then given one and a half hours in which they were asked to:

- Consider from their knowledge and experience what they believe to be the key constraints to small-scale irrigation in Ghana.
- Review the list of provisional constraints identified by the ILSSI project and see where the synergies/differences/gaps are (referring to the list of identified constraints on page 4 of project overview document if required)
- Discuss as a group and prioritize these constraints (based primarily on national considerations). Suggested criteria for prioritization include (but are not limited to) those with the:
    - biggest positive development impact
    - least negative environmental impact
    - biggest potential for scaling up
    - greatest opportunities to result in improved productivity and incomes
- Aim for group consensus on the top ten constraints (representing the most appropriate synergy of constraints from a) participant's experience and knowledge, and b) those already identified by the ILSSI project.
- Write the group's top 10 constraints on colour cards (individually) and stick them to the flip chart paper in two groups of five:
    a) top priority
    b) very important but secondary priority
- Choose a representative to present these findings back to all workshop participants in plenary.

The group work sparked vigorous debate about what the key constraints to adoption of small-scale irrigation in Ghana are, as group members made the case for constraints they felt should be in the top ten and subsequently in the top priority five, based on their expertise, experience and knowledge.

4.4.2 Results of group work

Group 1

Top Priority

- Water availability storage etc. for individual farm
- Cost related to water access
- Lack of access to land, land availability, and land tenure policies - government land banks
- Water lifting technology access
- Energy costs related to pumping

Secondary Priority

- Access to input and output markets
- Microfinance access for investment in irrigation technology
- Climate and rainfall variability
- Access to market for products
- Access to organic manure (water retention, improves soil fertility, reduces production costs)

Group 2

Additions to what ILSSI project put forward:

- Pests and diseases
- Low level of extension services
- Post harvest management

- Gender: access to land and finance
- Access to inputs (availability and costs) for seeds, and fertilizer and agro-chemicals

Top Priority

- Microfinance access for investments in irrigation technologies and other inputs
- Access to markets for products
- Climate and rainfall variability
- Land tenure policies and practices - access and availability
- Water availability, storage, delivery and accessibility for individuals and at larger scales

Secondary Priority

- Water lifting technology access (market prices, exports, etc.)
- Low level of extension services in irrigated agriculture
- Energy costs (related to pumping)
- Labor requirements / costs
- Skills throughout the irrigation value chain (capacity building)

Group 3

Top Priority

- Capacity development (seed production, irrigation management, pest and disease management)
- High labor cost for women
- Pests and diseases
- High cost of water lifting technologies
- Land tenure issues

Secondary Priority

- Inadequate access to markets - transportation
- Post harvest losses and storage
- Limited access to credit or other financing
- Inadequate access to improved seeds / affordability of these seeds
- Bad timing of subsidized fertilizer distribution

Group 4

Top Priority

- Land availability
- Inadequate access to inputs and labor
- Limited access to markets
- Water availability (at the national scale)
- Climate change

Secondary Priority

- High post-harvest losses
- High incidence of diseases and pests
- Low mechanization in relation to land preparation
- High energy costs

- Lack of knowledge / low capacity in small-scale irrigation

<u>Consensus-based consolidated list of top priority constraints</u>

After a representative from each of the four groups presented the group's findings (detailed above) back to all workshop participants, the facilitator asked them to put the cards detailing the 5 top priority constraints from each group onto a whiteboard. The facilitator then led the group in consolidating these 20 constraints. This was done by recognising duplication, or constraints that were very similar, and thereby reducing the total number of top priority constraints to nine. These are detailed below in no particular order (ie. the numbering not representing any order of priority). The facilitator then led participants through an exercise to tease out specific elements of some of these nine constraints that should be considered in the next round of IDSS modelling, where possible and appropriate. These are likewise detailed below. These nine constraints reflect a consensus among the workshop participants on the top priority constraints to the adoption of small-scale irrigation in Ghana.

1) Access to markets

- Transportation infrastructure
- Guaranteed pricing
- Timing of production
- Organized market

2) Water lifting technology access

- Cost of technology
- Operation and maintenance

3) Climate change

- Rainfall variability
- Extreme weather events

4) Water Access

- Availability
- Cost of access (including storage)

5) Land tenure issues

- Land availability
- Land policies - land banks - aimed at promoting ability to use land longer term

6) Diseases and Pests

7) High labour cost for women

8) Capacity development

- Seed production
- Irrigation management
- Pests and disease management

9) Inadequate access to inputs and labor

5 Evaluation of workshop

At the end of the workshop participants were asked to fill in a brief, 1-page, 18 question workshop evaluation questionnaire focusing on both the workshop content and the workshop process. Overall the responses were positive with a few respondents saying they would have liked a bit more time for discussion and Q&A especially immediately following each presentation.

Results:

Workshop content	**Disagree**	**Agree**	**Strongly Agree**
I clearly understand the aims and work of the ILSSI project		45%	55%
I clearly understand the component contributions of each of the project partners	10%	65%	25%
I clearly understand how the IDSS is supporting the overall objectives of the project	10%	70%	20%
The constraints identified for prioritization were the right ones for the Ghanaian context		35	65%
The workshop provided a good opportunity to share research and experiences on small-scale irrigation and irrigated fodder interventions in Ghana		50%	50%
I would like to be kept informed of further ILSSI project work and developments		5%	95%
I am happy to be involved in future ILSSI project stakeholder engagement activities		15%	85%

Workshop process	**Strongly disagree**	**Disagree**	**Agree**	**Strongly Agree**
There was a good balance between presentations and group work			60%	40%
I would have liked more time for the group work	10%	55%	20%	15%
I would have liked more time for the presentations	15%	50%	30%	5%
I clearly understood what was being asked of the participants			40%	60%
There was enough time for discussion		30%	45%	25%
There was enough time for Q&A		40%	45%	15%
The workshop was the right length for the content			35%	65%
I found the workshop a useful learning and information sharing experience		10%	45%	45%
The information materials provided before and during the workshop were relevant and useful			55%	45%
Communication about the workshop was clear and well timed			50%	50%

In response to the question '*What would you like more information about in any follow up from the ILSSI project team?*' respondents replied:

- The IDSS results for Ghana
- The results of the SWAT, APEX and FARMSIM models after the Ghana data has been incorporated
- Details of the development and operation of IDSS
- The application of the IDSS framework
- Research outputs and future development
- Research findings on the various components
- Details of interventions to improve/mitigate the constraints identified
- Website, presentations and project publications

Other participant comments made in the evaluation questionnaire included:

- *"There is a need to build the capacity of stakeholders in the IDSS."*
- *"The IDSS training should be organised on a regular basis."*
- *"Selected experiences outside the project should be invited for presentation. SSI technologies limited on the project."*
- *"Workshop moderation was good."*
- *"It was a great work done from organisation and information sharing was great. Thumbs up!"*
- *"Limited time for discussion after each presentation, however, enough Q&A time after plenary."*
- *"Workshop well planned and early findings well disseminated."*

- *"Facilitation of the workshop was very good."*
- *"There is a need to find innovative ways to connect the research assessment to field level practices."*
- *"Since the project sites are in northern Ghana and most of these stakeholder and results sharing engagements should be held in northern Ghana and should involve farmers."*
- *"There was not enough time for discussion and Q&A. Next time consider 5-10 minutes of discussion and Q&A per presentation."*
- *"I would have liked to have seen more results of the Ghana studies than were shown."*
- *"Good workshop and interaction with the project."*

A blank copy of the evaluation questionnaire can be found in **Annex 4**.

6 Significance of the workshop

The stakeholder workshop in Accra succeeded in bringing key national stakeholders together to; a) share research and experiences on small-scale irrigation and irrigated fodder interventions in Ghana, b) foster dialogue, networking and enhance partnerships, and c) to collaboratively prioritize the key constraints to successful and productive small-scale irrigation and irrigated fodder interventions in Ghana that the Integrated Decision Support System can help to address. The shortlist of 9 constraints identified, discussed and prioritized represents participant consensus (based on local and national knowledge, experience and expertise) on those felt to be most appropriate for the next phase of work with the IDSS, with a view to out-scaling small scale irrigation for transformative livelihood benefits in rural communities in Ghana.

7 Annex 1: Workshop participant list

No	Title	Name	Job title	Organisation	Contact details
1	Mr	Jeremy Agyemang	Assistant Director	MoFA	kwespo@hotmail.com
2	Mr	Maxwell Boateng-Gyimah	*Who has two roles:* Project Manager *and* Project Coordinator	Ghana Water Partnership GWP/WACDEP Water Resources Commission (WRC)	boatgyimax2@gmail.com 0266730876
3	Dr	Emmanuel Obuobie	Research scientist	Water Research Institute (WRI) within the Council for Scientific & Industrial Research (CSIR)	obuobie@yahoo.com
4	Dr	Frederick Yaw Logah	Senior Scientist	Water Research Institute (WRI) within the Council for Scientific & Industrial Research (CSIR)	Hand delivered
5	Dr	Emmanuel Obeng Bekoe	Senior research scientist	Water Research Institute (WRI) within the Council for Scientific & Industrial Research (CSIR)	eobekoe@yahoo.com eobeng.bekoe@csir-water.com 0242729297
6	Dr	Felix Jerry Akpabey	Researcher	Water Research Institute (WRI) within the Council for Scientific & Industrial Research (CSIR) (Tamale)	ffelix39@yahoo.co.uk 0277184630
7	Mr	Baba Inusah	Irrigation Agronomist	Savanna Agricultural Research Institute (SARI) within the Council for Scientific & Industrial Research (CSIR)	iiybaba@yahoo.com 0201629780/024483857 4
8	Mr	Kodimah Mahama	Agricultural Program Director	iDE Ghana	kmahama@ideglobal.org 0203158333
9	Mr	Faisal Seidu	Assistant Program Officer	Environmental Protection Agency (EPA)	faiselseidu@yahoo.com 0244142583
10	Mr	Theophilus Otchere Larbi	Country Programme Officer	International Fund for Agricultural Development (Ghana office)	t.larbi@ifad.org 0302610945
11	Dr	Sampson Kwaku Agodzo	Professor (Research interests include: modelling agricultural water management systems)	Department of Agricultural Engineering, KNUST	skagodzo.coe@knust.ed u.gh +233 20 8165505
12	Dr	Wilson Agyare	Senior Lecturer	Department of Agricultural Engineering, KNUST	wagyare@yahoo.co.uk
13	Dr	Sylvester Ayambila	Lecturer and Project leader (ILSSI) at UDS	University for Development Studies	slynsor@yahoo.com 0244547795
14	Dr	Philemon Yankson	Irrigation Engineer	Northern Rural Growth Programme (NRGP) in Tamale	philyankson@yahoo.com
15	Ms	Jenna Tajchman-Trofim	Agriculture Development Officer	USAID/Ghana Mission	jtajchman@usaid.gov Office: +233-302-741-121 Cell: +233 (0)54-431-2056
16	Ms	Priscilla Addison	Ghana Development Outreach & Communication Specialist	USAID	paddison@usaid.gov
17	Mr	Ellis Ekekpi	Economic Growth Monitoring and Evaluation Specialist	USAID/Ghana	eekekpi@usaid.gov
18	Mr	Prosper Glitse	Agricultural Economist	Ghana Irrigation Development Authority	glitsep@gmail.com Tel: 0203783444

19	Mr	Daniel Nana Sei Mensah	Bilingual Communication Specialist	IFDC	dmensah@ifdc.org
20	Mr	Daniel O. Owiredu		Global Water Partnership (GWP)	Danielowiredu5@gmail.com Tel: 0279781683

No	Title	Name	Job title	Organisation	Contact details
1	Dr	David Kadyampakeni	Researcher - Agricultural Water Management	IWMI	d.kadyampakeni@cgiar.org
2	Professor	Saa Dittoh	Lecturer/Researcher	University for Development Studies (UDS)	
3	Mr	Thor Windham-Wright	Workshop facilitator	Independent	thorww@gmail.com
4	Dr	Tunde Amole	Postdoctoral Scientist, Livestock Feeds West Africa	ILRI	T.Amole@cgiar.org
5	Dr	R. Srinivasan	Professor	Departments of Ecosystem Science and Management and Biological and Agricultural Engineering, Texas A&M University (TAMU)	r-srinivasan@tamu.edu
6	Dr	Joseph Amikuzuno	Senior Lecturer	University for Development Studies (on behalf of IFPRI)	Amikj26@yahoo.com

8 Annex 2: Workshop agenda

Feed the Future Innovation Laboratory for Small-Scale Irrigation (ILSSI)

Ghana Stakeholder Meeting Agenda

23rd June, 2016

Time	Duration	Activity	Lead person
8.30 - 9.00		Registration	
9.00 - 9.10	10 mins	Welcome – recognize External Advisory Committee member for Ghana (Prof Dittoh)	IWMI Head of Office (Ghana)
9.10 - 9.20	10 mins	Participant introductions and icebreaker exercise	Thor Windham-Wright, Facilitator
9.20 - 9.30	10 mins	*Presentation:* Overview of the ILSSI project: objectives, partners and activities	Srini, TAMU
9.30 - 9.45	15 mins	*Presentation:* Field level pilot interventions in small-scale irrigation and agricultural water management (SSI/AWM)	Davie Kadyampakeni, Researcher – AWM, IWMI
9.45 - 10.00	15 mins	*Presentation:* Field level pilot irrigated fodder and integrating livestock	Michael Blümmel, Operating Project Leader, ILRI
10.00 - 10.15	15 mins	*Presentation:* Household level surveys on impacts from SSI/AWM (including gender and nutrition)	Joseph Amikuzuno, representing IFPRI
10:15 – 10:30	15 mins	*Presentation:* Overview of Integrated Decision Support System (IDSS)	Srini, TAMU
10:30 – 11:00	30 mins	Group photo followed by tea/coffee break	
11:00 – 11:30	30 mins	*Presentation:* Candidate constraints from research experience and a preview of the constraints analysis methods	Srini, TAMU
11:30 – 11:45	15 mins	Q&A on the constraints and the constraints analysis through modelling	Srini, TAMU and Facilitator
Participants divided into 2-4 groups (depending on total number of participants), supplied with flipcharts, pens and cards in various colours			
11.45 – 12:45	60 mins	*Group Work* Prioritization of constraints to adoption (nationally) of small scale irrigation interventions studied in Northern Ghana, for further analysis.	Facilitator
1:00 – 2:00	1 hour	Lunch (time for travel expenses admin.)	
2.00 - 2.15	15 mins	Welcome back, review, icebreaker	Facilitator
2:15 – 2:45	30 mins	Group work continues and finalized	Facilitator
2:45 – 3:15	30 mins	Group representatives present back to plenary	Group reps / facilitator
3:15 - 3.45	30 mins	Consolidate list of prioritized constraints, summarize group work outputs and describe how these will be used for the next steps of the project	Facilitator / Srini, TAMU
3:45 – 4.00	15 mins	Conclusion and thanks, External Advisory Committee – summary/ concluding remarks	Facilitator and EAC member
	20 mins	tea/coffee break	

9 Annex 3: Workshop presentations

Presentation 1: Introduction to Feed the Future Innovation Lab for Small Scale Irrigation - Ghana

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Feed the Future Innovation Lab for Small Scale Irrigation

Ghana Stakeholders Meeting
June 23, 2016

Neville P. Clarke, Director FtF Innovation Laboratory for Small Scale Irrigation
http://ilssi.tamu.edu

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OBJECTIVES OF STAKEHOLDER WORKSHOP

- **Continue the stakeholder dialogue from inception to results and application**
- **Review current status of ILSSI in Ghana**
- **Seek advice on constraints and gaps limiting adoption**

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Texas A&M AgriLife Research
ILRI International Livestock Research Institute
IFPRI International Food Policy Research Institute
North Carolina A&T State University
IWMI International Water Management Institute
CGIAR Research Program on Water, Land and Ecosystems
The Texas A&M University System

Partners

Feed the Future Innovation Lab for Small-Scale Irrigation

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PROJECT COUNTRIES

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OVERALL PROJECT SCHEDULE

- **Life of Project - August 2013 – 2018**
- **Initial stakeholder consultation - January 2014 (ongoing)**
- **Planning and site selection - 2014-2015**
- **Initial field studies and baseline household surveys - 2015-2016**
- **Stakeholder consultation – constraints and gaps - June-July 2016**
- **Complete field studies and second household survey - 2017-18**
- **Complete study, stakeholder report and international symposium - 2018**

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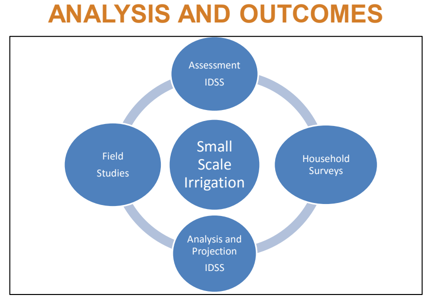
ANALYSIS AND OUTCOMES



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Key Questions

- How much water (and land) available for irrigation?
- How many farmers/households can it support?
- How sustainable is it (now and in the future)?
- What are the bottlenecks and opportunities (technologies, social/cultural; economics)? Labor, population growth, water quality (salinity, fecal, enrichment)
- What are the optimum mixtures of interventions (source, storage, conveyance, use)?
- What difference will it make in income, nutrition and for women?
- What changes in policy, practice and investments are necessary (local, regional, national)?

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COMPONENTS OF PROJECT

- Ongoing Stakeholder Engagement
- Assessment of natural resources
- Field Studies
- Household Surveys
- Integrated Modeling
- Synthesis and recommendations

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Methods

- Assess recent innovations in SSI
- Stakeholder engagement (iterative)
- National partners for field research
- Detailed experimental design
- Ex ante assessment of consequences
- Environmental assessment
- Field studies
- Ex post assessment and scaling out
- Constraints analysis and mitigation
- Training

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Presentation 2: Field level pilot interventions - IWMI

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INNOVATION LAB ON SMALL SCALE IRRIGATION

Field level pilot interventions in small-scale irrigation and agricultural water management

Davie Kadyampakeni
Stakeholder workshop 23rd June 2016

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IWMI - ILSSI GHANA

Jennie Barron: Project Leader

Nicole Lefore: Project Manager

Davie Kadyampakeni: Researcher, AWM

Richard Appoh: Research Officer-AWM

Elsie Odonkor: Research Officer - Gender

Benjamin Ghansah: Research Officer-GIS and Remote Sensing

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NATIONAL PARTNERS

- **Research – University:**
  - University of Development Studies
  - ✓ Dr. Sylvester Ayambila,
  - ✓ Bizoola Gandaa,
  - ✓ Prof. Saa Dittoh,
  - ✓ Afishata Abujaja
  - ✓ 1 MPhil. student 2015 – 2016 (MPhil Soil and Conservation and Management) (Raymond Tetteh)
- **Research Institutes:**
  - Animal Research Insitute - Dr. Emmanuel Panyan
  - Water Research Institute - Dr. Emmanuel Oboubie

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MAIN ACTIVITIES

- GW/SW use: **motorized water lifting devices** (petrol pump), **Watershed characterization**
- **Gender:** female & male irrigators
- **Irrigation management** (Soil moisture based, **CWR (ET), WFD**, Drip & conservation agriculture - NCAT)
- **Crops** (vegetables, & fodder)
- **Credit constraints and opportunities** (survey & interviews, revolving fund)

WFD installation and soil sampling

Drip and tank-hose installation in Zanlerigu

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BASELINE HYDROLOGICAL DATA FOR GHANA INTERVENTION SITES

Watershed	Rainfall (mm)	Rain days	Potential ET (mm)	Mean Temp. (°C)	Minimum Temp. (°C)	Maximum Temp. (°C)	Aridity Index
Bihinaayili	1013 (523-1358)	89	1866 (1799-1966)	28.2	22.6	33.8	0.54
Zanlerigu	1001 (720-1464)	74	2001 (1930-2066)	29.2	23.0	35.4	0.50
Dimbasinia	989 (688-1365)	74	1977 (1911-2060)	29.1	23.0	35.2	0.50

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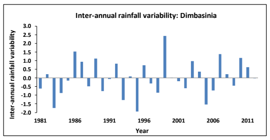
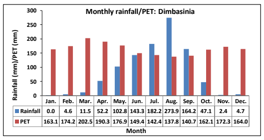
ANNUAL RAINFALL AND POTENTIAL ET





Rainfall (mm)	ER (mm)	ET (mm)	Total water deficit (mm)	Reliable water deficit (mm)	Dry season water deficit (mm)
989	712	1977	-988	-1265	-1105

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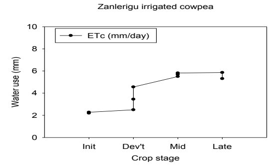
Site	Nat. Partners	Sites	Interventions			Farmers
			Technical interventions	Crops	Finance	
Bihinaayili	UDS	1	• Tank and hose • Water can • WFD	• Corchrus	• Credit/ Revolving fund (protocol under development)	• 16
Zanlerigu	UDS	1	• Tank and hose • Water can • Roof top WH and drip irrigation • WFD	• Onion • Leafy vegetables	• Credit/ Revolving fund (protocol under development)	• 21
Dimbasinia	UDS	1	• Drip (IDE kits) • Drip (UDS kits) • Water can • WFD	• Tomato	• Credit/ Revolving fund (protocol under development)	• 24

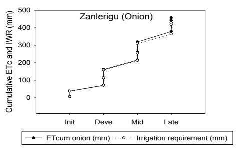
WATER USE IN HOMEGARDENS-ZANLERIGU



Crop stage	K_c value	Days
Initial	0-20	0.5
Development	20-58	0.53-0.89
Mid-season	58-78	1.03-1.04
Late season	79-91	0.92

Net irrigation (mm)	315
Gross irrigation (mm)	450
Cumulative ET_c (mm)	391.5
Effective rainfall (mm)	19.1
Irrigation requirement (mm)	372.4
Under-irrigation (mm)	57.4

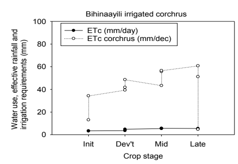
WATER USE AND IRRIGATION SCHEDULING STUDIES-ZANLERIGU

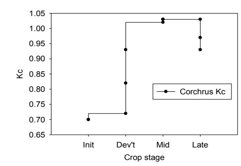


Net irrigation (mm)	358.9
Gross irrigation (mm)	512.8
Cumulative ETc (mm)	449.8
Season duration (days)	95
Effective rainfall (mm)	27
Under-irrigation (mm)	41.9

Crop stage	Initial	Development	Mid-season	Late season
Days	0-20	21-50	51-80	81-95
K_c value	0.70	0.70-0.91	1.02-1.04	0.94-1.04

WATER USE AND IRRIGATION SCHEDULING STUDIES-BIHINAAYILI





Net irrigation (mm)	388.7
Gross irrigation (mm)	556
Effective rainfall(mm)	78.8
Cumulative ET_c (mm)	449.8
Season duration (days)	95
Irrigation requirement (mm)	373.2
Over-irrigation (mm)	94.3

CONSTRAINTS TO DRY SEASON IRRIGATION

i. Too much time spent on watering with the storage tank + water hose as compared to the watering can/ bucket.

ii. The nozzles of the watering can easily get clogged and this impedes the speed of water discharged during watering making it time consuming and tedious.

iii. Disease and pest attack on onion and cowpea worsened by flood water on the onion farms.

iv. Difficulty for women to dig shallow wells.

v. Use of the water hose sometimes destroys some of seedlings. Dragging the hose when watering destroys young plants as a farmer moves through the farm with the hose. Pressure from hose is also too low.

CONSTRAINTS TO DRY SEASON IRRIGATION (2)

vi. The quality of hose provided might not be good in some cases. The farmers usually drag the hose on their fields and so they are easily perforated.

vii. Insufficient water from the water source. At the peak of the dry season, the water in some of the shallow wells were inadequate.

viii. Storage tanks (~250 to 1000 L) are too small and require pumping water several times before you are able to get all beds irrigated.

PROJECT CHALLENGES

- ❑ Drying up of wells in Dimbasinia leading to abandonment of crop fields in during the growing season
- ❑ Land and water access disputes
- ❑ Flooding in the middle of the dry season that led to loss of onion in Zanlerigu

LESSONS LEARNED

- **Opportunity for rainwater harvesting and water storage in northern Ghana: for households with rooftops with corrugated iron.**
- **Shallow wells provide reliable water source for SSI-start planting in September/October each year to meet periods of peak crop water requirement**
- **There are serious water deficits at watershed scale: need for 1100 to 1300 mm to meet irrigation water needs throughout the dry season**
- **Challenges with use of WFD - farmers and AEAs require additional training**

(T. Assefa, 2015)

THANK YOU SO MUCH FOR YOUR ATTENTION!

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Presentation 3: Irrigated fodder production - Ghana (ILRI)

INNOVATION LAB ON SMALL SCALE IRRIGATION

IRRIGATED FODDER PRODUCTION IN NORTHERN GHANA

T. Amole[1], E. Payan[2], A. Ayantunde[1] and M. Blummel[1]
[1]International Livestock Research Institute
[2]Animal Research Institute, Ghana
23rd of June, 2016

INTRODUCTION

- Livestock play important roles in the livelihood strategies of the people.
- Livestock depend mainly on crop residues and natural pasture as feed resources.
- A number of opportunities have been identified related to development of irrigated fodder *(Fodder market, peri-urban livestock production etc.).*
- Given the various opportunities, evaluating the potentials of irrigated fodder as livestock feed and its socio-economic contributions to farmers' livelihood in general remain relevant

MAIN ACTIVITIES

Demonstration and production of irrigated fodder.

- *Feed assessment (FEAST)*
- *Selection and training of farmers*
- *Land preparation*
- *Planting*

Data Collection:

- *Agronomic data*
- *Nutritional value of the irrigated fodder species*
- *Growth performance of animals fed irrigated fodder*

A. 2015 Rainfed fodder production

Bihinayili (12 farmers) and Zanlerigu (18 Farmers)

- ***Chloris gayana + Lablab purpureus***
- ***Brachiaria ruziziensis + Lablab purpureus***
- ***Sorghum almum + Lablab purpureus***

(*Cajanus cajan* was planted as hedges in all the plots)

B. Feeding trial (Bihinayili)

10 young rams from the farmers flocks

- **T_1: Free range and non-confinement**
- **T_2: Fed with sown forages and confinement**

Agronomic performance of experimental forage species

Forage Species	Post emergence (4 WAP) Plant height (cm)	Post emergence (4 WAP) Leaf area (cm²)	Dry Matter yield (12 WAP) (t/ha)
Brachiaria	44.9	40.4	2.1
	42.8	38.2	4.3
	36.6	37.9	1.7
	30.1	25.7	3.4
Sorghum	44.8	72.8	1.3
	63.9	93.2	1.2
	36.6	37.9	2.1
	56.0	90.5	1.4
Lablab	43.4	72.0	-
	88.9	83.7	2.3
	54.9	91.8	1.0
	24.0	67.7	0.9
	34.0	48.0	1.0
	18.5	41.5	1.3
	54.8	91.8	1.0
	55	68.4	2.7
Cajanus	33.0	19.9	1.4
	47.0	27.4	2.0
	34.2	16.9	1.5
	31.7	19.9	1.9
	30.1	13.9	1.3
	32.2	17.4	1.5
	30.0	15.7	1.3
	37.7	19.4	2.8

2016 Irrigated fodder Production

- ***Brachiaria ruziziensis + Lablab purpureus* (7 farmers)**
- ***Sorghum almum + Lablab purpureus***
- **(*Cajanus cajan* was planted as hedges in all the plots)**

Irrigation method

Pump and hose

On-going

- *Agronomic data collection*
- *Nutrient content of the irrigated fodder*

Next?

- *Feeding trial*
- *Survey on market potential for irrigated fodder in Northern Ghana*

SITES OF ACTIVITIES

Northern Region

Savelugu District (Bihinayili)

https://maps.google.com?q=9.6066304,-0.8670067

Upper East Region

Nabdam District (Zanlerigu)

https://maps.google.com?q=10.7919703,-0.7263850

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PARTNERS

- CSIR - Animal Research Institute

  Two (2) Agricultural extension officers selected from each District were also trained for data collection

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EARLY FINDINGS AND LESSONS

Findings

- General willingness of the farmers towards irrigated fodder production.
- Small scale irrigated fodder established better at Bihinayili than Zanlerigu.
- *Brachiaria* and *Sorghum* regenerates well after several cutting regime and during the dry season where there enough moistures.
- Large area of land is required to produce enough biomass.

Lessons

- Conflict of interest *(either to feed the harvested fodder or sell it)*
- More profitable if fodder production could be targeted at animal fattening
- To target market, irrigated fodder should start early than vegetable production
- Smaller size hose should be used for irrigation
- Plan a field day for livestock farmers and sellers to the trial sites.

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CONSTRAINTS IDENTIFIED

Rainfed

1. Post emergence insect attack on Lablab *(Neem seed solution was used as local pesticides)*
2. Fluctuation in onset of rain
3. Maintenance of fodder fields after general food crop harvests
4. Post harvest plot management

Irrigated

1. Land tenure problems
2. Biophysical problem in Zanlerigu (topography, soil quality)
3. Animal invasion *(local fence constructed)*
4. Post harvest plot management
5. Marketing strategies and timing

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CONCLUSIONS

- Irrigated fodder is a new concept in Northern Ghana and may take a bit of time to be widely adopted. The increasing demand for livestock feed in peri-urban will drive the adoption of irrigated fodder.
- More demonstration of potential of irrigated fodder is necessary to stimulate adoption.

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ILRI INTERNATIONAL LIVESTOCK RESEARCH INSTITUTE

Presentation 4: Small-scale irrigation technologies and AWM practices - IFPRI

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INNOVATION LAB ON SMALL SCALE IRRIGATION

SMALL-SCALE IRRIGATION TECHNOLOGIES AND AGRICULTURAL WATER MANAGEMENT PRACTICES

Analyzing nutrition, health and gender outcomes
(International Food Policy Research Institute)
Presented by Joseph Amikuzuno
University of Development Studies

ILSSI consultation workshop
June 23, 2016, Accra, Ghana

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IFPRI'S ACTIVITIES

Analyzing the impacts, tradeoffs, and synergies of small-scale irrigation technologies on health, nutrition, rural livelihoods, and women's empowerment

- Baseline data collection from the 3 ILSSI intervention villages and 9 control villages
- Topics of the survey include:
  - Crop & livestock inputs, production and practices
  - Household and women's dietary diversity
  - Child health, diet, feeding and anthropometry
  - Household shocks, assets, credit
  - Women's Empowerment in Agriculture Index (WEAI)

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SITES OF ACTIVITIES

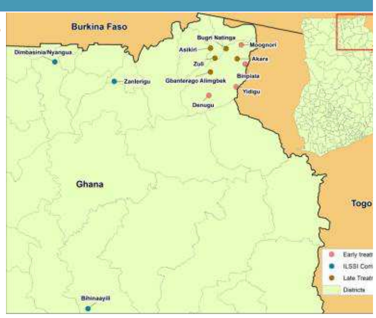
12 communities

Northern Region:
Savelugu Nanton District

Upper East Region:
Kassena Nankana East, Garu Tempane, and Nabdam Districts

Period: November 2015 to February 2016

902 households



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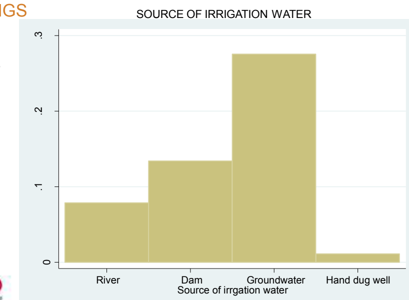
EARLY FINDINGS

Groundwater is the main source of irrigation water in the project area.



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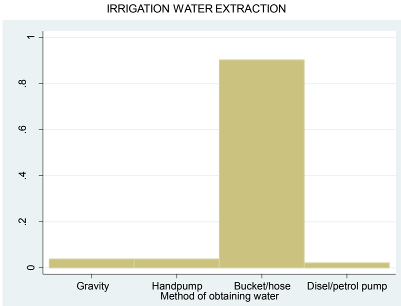
EARLY FINDINGS

Irrigation water is largely extracted using buckets. Pumps remain uncommon.



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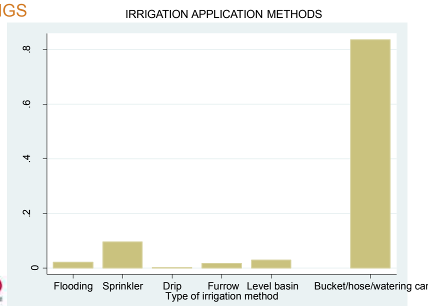
EARLY FINDINGS

Buckets, hose, and water cans are the main water application methods



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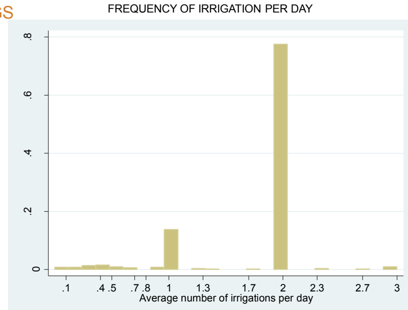
EARLY FINDINGS

FREQUENCY OF IRRIGATION PER DAY

Most farmers irrigate twice per day …



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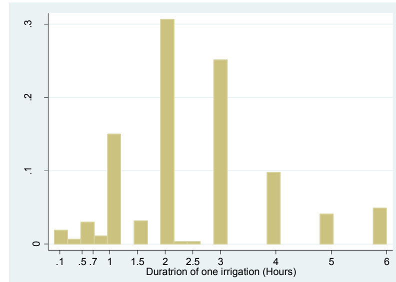
EARLY FINDINGS

LENGTH OF ONE IRRIGATION

… and spend an average of 2.5 hours per one irrigation.



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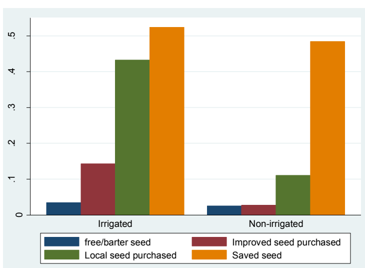
EARLY FINDINGS

SOURCE OF SEED BETWEEN IRRIGATORS AND NON-IRRIGATORS

Irrigators purchase more local seed, but not necessarily improved seed.



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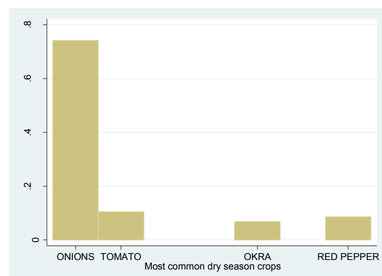
EARLY FINDINGS

IRRIGATED CROPS

Irrigation mainly for the production of onions, and to a lesser extent tomato, okra, red pepper, water-melon and leafy vegetables



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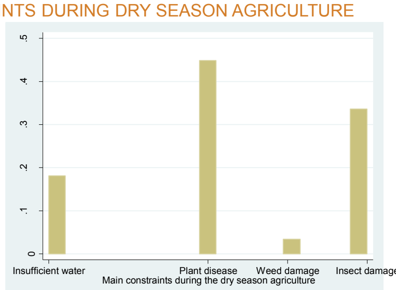
MAJOR CONSTRAINTS DURING DRY SEASON AGRICULTURE

- Plant disease
- Insect damage
- Insufficient water



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NEXT STEPS

- However, these results are at best, suggestive, and further in-depth analysis is currently being undertaken.
- With the second round of the survey, we will be able to make stronger causal statements on the linkages between irrigation, nutrition, health, and gender outcomes; as well as the major constraints hindering access to irrigation.

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GENDER-IRRIGATION TECHNICAL WORKSHOP SERIES

- Given country efforts to scale up irrigation for climate resilience, productivity, food and nutritional security, important to make sure women have equal access to irrigation
- **Three technical workshops** were organized with IWMI and national partners in:
  - Ethiopia (March 9-10) with Ministry of Agriculture and Natural Resources
  - Ghana (April 13-14) with Ghana Irrigation Development Authority (GIDA)
  - Tanzania (April 20-21) with Sokoine University of Agriculture and Platform for Agricultural Policy Analysis and Coordination (PAPAC)
- **Training and knowledge exchange:** gender training from IFPRI/IWMI; presentations and case studies from government, NGOs, researchers, and donors sharing lessons learned on promoting gender equality in irrigation

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Resources from the workshop available here

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CONSTRAINTS TO WOMEN'S IRRIGATION ADOPTION

Key Constraints Identified:

- Technologies don't meet women's preferences (e.g. affordability, maintenance needs, fuel requirements, transportability, multiple uses)
- Less access to information (due to mobility constraints, not belonging to groups where info is disseminated, etc)
- Lack of access to and control over assets required for adoption (e.g. land)
- Exclusion from access to and decision making over collective water resources (e.g. irrigation canals)
- Limited access to credit

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OPPORTUNITIES TO PROMOTE GENDER EQUALITY IN IRRIGATION

Key Opportunities Identified:

- Great potential for participatory, user-centered technology design to better address women's needs and preferences
- Develop new outreach models to ensure information effectively reaches both men and women
- Facilitate access to credit on supply and demand side, providing financial literacy training for women and men, forming groups to manage and share risk
- Support women's participation in decision-making in groups (targets?)
- Targeting women with productive assets (e.g. HKI BF) or encouraging joint ownership/sharing of productive assets
- Sensitization of women's work and contributions (e.g. Send a Cow, Ethiopia)

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Presentation 5: Overview of the Integrated Decision Support System (IDSS) - TAMU

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Feed the Future Innovation Lab for Small Scale Irrigation

Overview of Integrated Decision Support System (IDSS)

Stakeholder meeting (Accra, Ghana), June, 2016
Texas A&M Team, Texas A&M University

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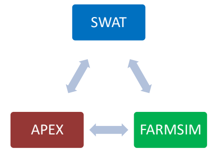
Integration of IDSS



Schematic of the IDSS Integration

- SWAT model analyzes the biophysical impacts of intensification of the interventions at the watershed scale.
- APEX model analyzes cropping systems and to quantify benefits on crop yields.
- FARMSIM used to assess economic & nutrition impacts.

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IDSS ANALYSIS FOR DIMBASINIA WATERSHED, GHANA

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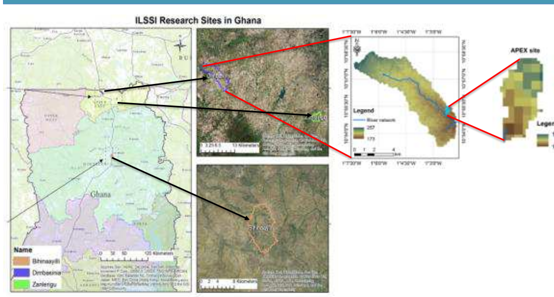

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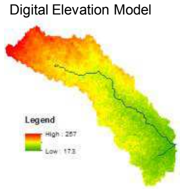
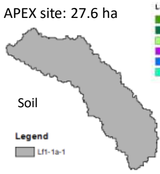
IDSS ANALYSIS FOR DIMBASINIA : SWAT INPUTS

Digital Elevation Model

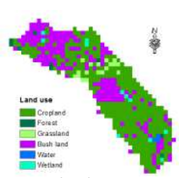


73% sand, Sandy Loam

SWAT site: 34.8km^2
APEX site: 27.6 ha



Soil



Land use

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Baseline scenario : traditional rain-fed crops (e.g. maize and sorghum)

Maize Practice	Dates	Amount	Sorghum Practice	Dates	Amount
Tillage	15-May		Tillage	15-May	
Tillage	1-Jun		Tillage	1-Jun	
Tillage	15-Jun		Tillage	15-Jun	
DAP fertilizer application	15-Jun	50kg/ha	DAP fertilizer application	15-Jun	50 kg/ha
Planting	15-Jun		Planting	15-Jun	
1st stage urea fertilizer application	15-Jul	25 kg/ha	1st stage urea fertilizer application	15-Jul	25 kg/ha
2nd stage urea fertilizer application	15-Aug	25 kg/ha	2nd stage urea fertilizer application	15-Aug	25 kg/ha
Harvest	15-Oct		Harvest	23-Oct	

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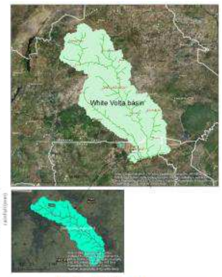
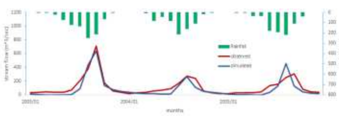
SWAT CALIBRATION FOR DIMBASINIA

- Stream flow data for flow calibration of SWAT.
- Model calibration was done at the Pwalugu river gauging station of the White Volta basin.





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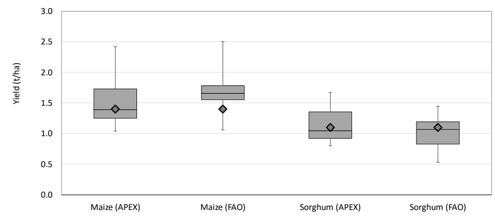
CALIBRATION APEX – CROP YIELD



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STUDIED SCENARIOS

- Double cropping of pepper and fodder production using irrigation water from shallow groundwater aquifer and rainfed crops
- Different Fertilizer scenarios and tillage
- Water lifting technologies:
  - Pulley/bucket
  - Rope pump operated by hand
  - Rope pump operated by animal power
  - Motor pump
  - Solar pump

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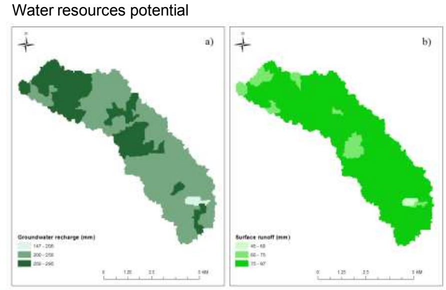
IDSS INTEGRATED RESULTS: DIMBASINIA

Water resources potential



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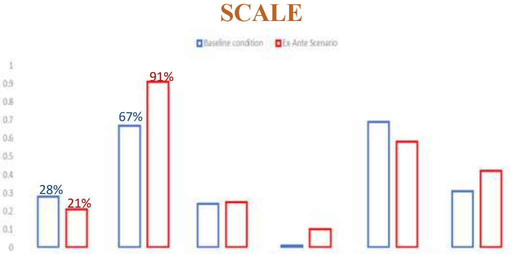
IMPACTS OF SSI AT THE WATERSHED SCALE



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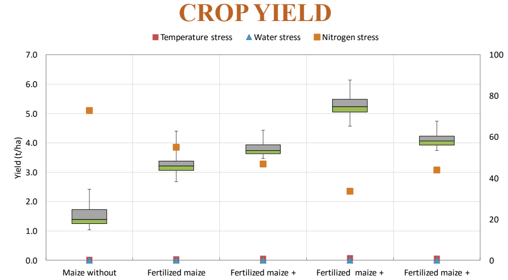
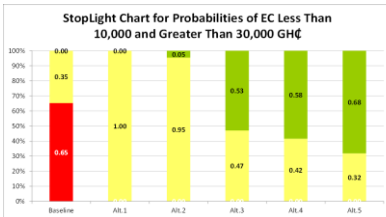
CROP YIELD



Annual Ending Cash Reserves (EC)



Legend

Baseline :	**No irrigation**	Alt.2 :	**Diesel_PR-MV**	Alt.4 :	**Diesel_PO-SV**
Alt.1 :	**Pulley-SV**	Alt.3 :	**Diesel_PR-SV**	Alt.5 :	**Solar_P-SV**

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Conclusions

- There is large water resources potential in the Dimbasinia watershed. However, the average annual irrigation water requirement for cultivating pepper/tomato and fodder was more than the average annual shallow groundwater recharge.
- Addition of 50 kg/ha of urea and 50 kg/ha of DAP doubled simulated maize and sorghum yields.
- Additional fertilizer, multiple cropping and irrigation performed better than baseline scenario. Solar pump was the preferred water lifting technology – less maintenance cost and environmental friendly.

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CAPACITY BUILDING

Year	Ethiopia			Tanzania			Ghana		
	Males	**Females**	**Total**	Males	Females	Total	Males	Females	Total
2014	**52**	**5**	**57**						
2015	**68**	**8**	**76**	66	8	74			
2016	**95**	**9**	**104**	27	11	38	65	6	71

382+


IDSS workshop participants in Ethiopia, Feb 8-12, 2016


IDSS workshop participants in Ghana, Feb 1-5, 2016

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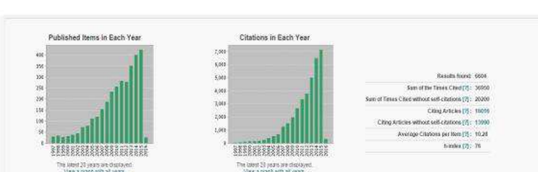
HIGH REPUTATION OF THE IDSS TOOLS

Historical trends of published SWAT-related peer-reviewed articles



Source: SWAT Literature Database as of Jan 23rd 2016 (Web of Knowledge Citations)

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IDSS TOOLS WIDELY APPLIED IN OTHER PROJECTS

- IDSS model development
  - Models developed over 30 years and widely used in USA for agricultural and environmental policy development
  - Worldwide application over past decade
- Past engagements in Ethiopia
  - IWMI and ICARDA hydrologic modeling of **Blue Nile** and **Lake Tana** basins
  - Simulation of farming systems with support from **Gates Foundation**
  - Growing use in **Ethiopian universities**

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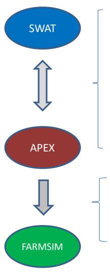
INTEGRATION OF IDSS



- SWAT and APEX share input data
  - Land use types, Soil types, Elevations, Weather, Crop management
- SWAT results (calibrated) are transferred to APEX
  - Hydrologic properties: Runoff/baseflow ratio and ET
  - Water quality: Edge of field sediment and nutrient loads
- APEX results (calibrated) are transferred to SWAT
  - Crop parameters
- APEX output is transferred to FARMSIM
  - Calibrated crop yields for 32 years were used in FARMSIM to set the reference condition for socio-economic analyses.
- Large scale SWAT results will also passed to FARMSIM
  - Area suitable for irrigation,
  - Availability of water for irrigation

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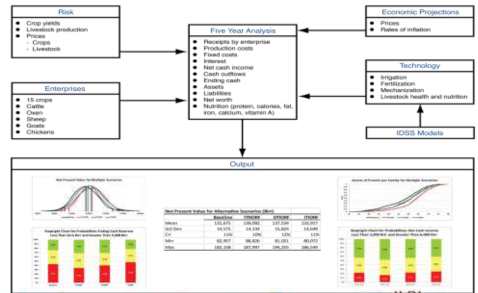
Farm Level Nutrition, Economic & Technology Simulation: FARMSIM



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Presentation 6: Candidate constraints and constraints analysis - TAMU

Feed the Future Innovation Lab for Small Scale Irrigation

Candidate constraints from research experience and a preview of the constraints analysis method

Stakeholder meeting, Ghana June 23, 2016
Texas A&M Team, Texas A&M University

Objectives of constraints and gap analysis

- To define and identify the **highest priority constraints** and their **mitigation** for further evaluation and for development of recommendations to stakeholders at multiple levels of scale.
- To engage with stakeholders to assure that the most important constraints facing decision makers, especially at the national level, are identified for further study, and
- To demonstrate that the modeling capacity and relevant databases of suite of IDSS models will allow stakeholders to address specific scenarios or questions.

Gap and constraint analysis

- The following presentation is an **example** of how the IDSS will be used for constraint and gap analysis
- The example involves only a watershed scale assessment – the full analysis is at larger scales
- The highest priority constraints identified by stakeholders will be analyzed using this method
- Initial results will be developed by October 2016.

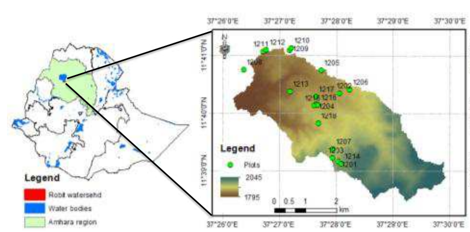
Candidate Constraints and Gaps from Research

- Constraints and gaps are factors that limit the use of small scale irrigation.
- Candidate list of identified constraints and gaps:
  - Low land area/land availability per capita
  - Land ownership vs. rental
  - Costs related to water access
  - Access to seeds for agricultural intensification
  - Access to fertilizer for agricultural intensification
  - Water lifting technology access (market, prices, export, tax, interest/discount rates)
  - Labor requirements/costs
  - Micro-finance access for irrigation technologies and inputs (fertilizer, seeds)
  - Access to market for products (vegetables, fodder, livestock)
  - Energy cost
  - High numbers of low producing livestock
  - Low levels of mechanization
  - Gender sensitive evaluation of all the constraints mentioned above

Gap and constraint analysis

- IDSS was used to assess the gaps and constraints on the **production**, **economic**, and **environmental** consequences of the interventions at multiple scales
  - SWAT model was used to study the ***environmental gaps and constraints*** of the use of SSI at the **watershed scale**.
  - APEX model was used to assess the ***resource constraints and knowledge gaps*** preventing optimum agricultural production at the **field scale**.
  - FarmSIM model was used to assess the ***economic and nutritional gaps and constraints*** at the **household level**.
- Alternative mitigations for the identified gaps and constraints were also discussed.

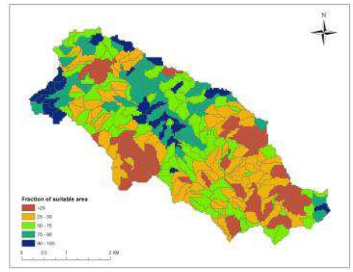
Robit watershed case study



Watershed-scale analysis of resource and environmental constraints

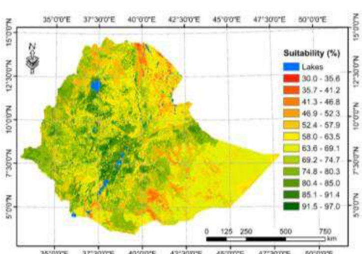
- **Suitability of an area for irrigation and availability of water** were studied using the SWAT model based on:
  - Land use type
  - soil characteristics
  - land slopes within the watershed
- SWAT simulates the Small-Scale Irrigation (SSI) interventions and evaluates their **environmental impacts** and **availability of water** resources at different sources (surface *vs* groundwater) at the watershed scale.

Land suitability for irrigation – Robit watershed



- ~50% of the watershed (1,506 ha) is suitable for irrigation.
- Major rainfed crops were maize, teff and finger millet.
- Dry season irrigated crops were tomato and onion (others can be considered also)

Land suitability for irrigation – Ethiopia

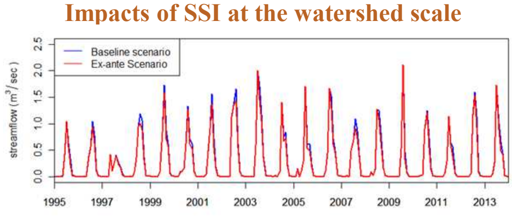


- Factors considered in the analysis were:
  - Land use
  - Soil
  - Slope map
  - Evaporation
  - Rainfall
  - Population density
  - Road network
- The suitable areas account 5% of the land mass (60,000 km^2)

Available water resources in Robit Watershed

- Average annual rainfall = 1,400 mm
  - Average annual groundwater recharge = 280 mm (~4,000,000 m^3 over the watershed or 20% of the rainfall)
  - Average annual surface runoff = 520 mm (~7,000,000 m^3 over the watershed or 37% of the rainfall)
- Amount of water required for dry season irrigation for tomato = 1,500,000 m^3
  - ~40% of the **groundwater recharge**
- At the watershed scale, groundwater recharge can support irrigation for vegetables (in suitable areas) in a sustainable manner.

Impacts of SSI at the watershed scale



- The average monthly stream flow at the outlet of the Robit watershed reduced by ~6%, minor reductions in high flows.
- No major environmental impact such as erosion due to SSI was observed.

Field-scale analysis of resource constraints

- The APEX model was used to identify major resource constraints using tomato as a case study crop.
- The analysis was centered on **water and nutrient availability/limitation** for tomato production.
- Where available the analysis used the field studies and survey data

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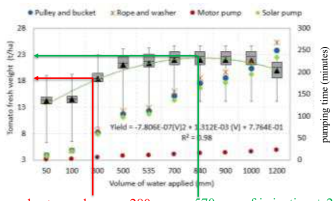
Field-scale irrigation water management

Water production function



Avg. annual groundwater recharge = 280 mm
570 mm of irrigation + 270 mm rainfall

Thus, groundwater recharge alone will not provide maximum crop yield at the field-scale.

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Fertilizer use

- Current fertilizer application rates are lower than rates recommended by the Ethiopian Agricultural Research Institute (EARI).
- Only 30-40% of smallholders use fertilizer.
- Lower applications of fertilizer inputs kept agricultural production and productivity low.
- However, there is an increasing trend in fertilizer use.

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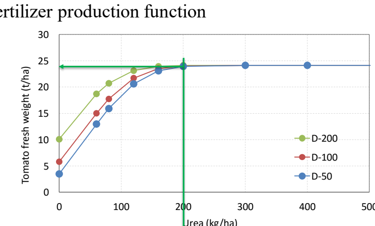
Fertilizer use

Fertilizer production function



200 kg/ha urea and 50 kg/ha DAP (D)

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Household-scale analysis of economic and nutritional constraints

- FarmSIM model used information on **costs of agricultural inputs** and **irrigation equipment**, and **capacities of water lifting technologies** (WLTs) and corresponding **labor** to evaluate the economic and nutrition benefits of adopting SSI technologies.
- The WLTs evaluated include:
  - pulley and bucket
  - rope-and-washer pump
  - motor pump, and
  - solar pump
- Based on field data and simulation results from the APEX each WLT was evaluated as to its capacity to pump enough irrigation water to cover the total potential irrigable land.

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Economic gaps and constraints

Table: Water lifting technologies (WLT)

Types of WLT	Operated by	Flow rate (l/min)	Cost WLT (Birr)	Issues/Constraints
Pulley/bucket	Hand	15	1310	require more labor
Rope and washer pump	Hand	14	3700	frequent breakdowns
Motor pump	Fuel	170	8500	high maintenance costs
Solar pump	Solar	16	16000	high capital costs

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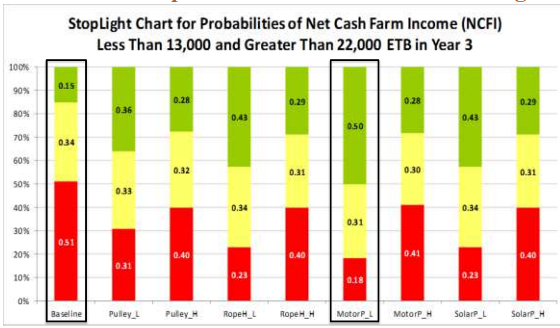
Economic gaps and constraints

- FarmSIM analysis was divided into two case studies:
  - low irrigation labor cost, and
  - high irrigation labor cost (3X low cost category).
- The labor was split between hired and family labor to reduce the costs (forgoing the opportunity cost)

Economic comparison of the different technologies



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Studied constraints and gaps of the candidate list

- Land ownership vs. rental (*value for land leased/rented accounted*)
- Costs related to water access (e.g. digging for wells, etc)
- Water lifting technology access *(access limited for solar pumps)*
- Labor requirements/costs
- Micro-finance access for irrigation technologies and inputs *(40% households received loan access, IFPRI survey 2015)*
- Energy cost
- Access to fertilizer for agricultural intensification in the irrigation season

Partially studied constraints and gaps of the partial list

- Less land area/land availability per capita

Constraints and gaps of the candidate list not yet studied

- Access to seeds for agricultural intensification
- Access to market for products (vegetables, fodder, livestock)
- High numbers of low producing livestock
- Low levels of mechanization
- Gender sensitive evaluation of all the constraints mentioned above

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Example of mitigation of constraints and identification of gaps

- Groundwater recharge can support irrigation water requirement at the watershed-scale, but not at field scale.

  - Locally available **surface runoff could be harvested** and used to support the irrigation water from shallow ground water.
  - It will also **reduce any potential environmental effects** since the surface runoff is harvested during high rainfall season.

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Example of mitigation of constraints and identification of gaps

- Low soil fertility, coupled with ineffective management practices (e.g. water and nutrient), is significant constraint to SSI.

  - application of rates of irrigation and fertilizers that provides the best combination of production, environmental and economic outcomes.

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Example of mitigation of constraints and identification of gaps

- high irrigation labor costs are a significant constraint on the profitability of irrigated tomato production and sale in Robit.

  - use of family labor and less labor-intensive irrigation methods (e.g. drip irrigation) may reduce labor costs.
  - proper training on the operation and maintenance of new WLTs can save resources.
  - policy changes to encourage smooth transition into environmentally friendly technologies (e.g. solar pumps).

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Conclusion

- The ability to concurrently assess the production, economic, and environmental consequences of the interventions provides a new, integrated capacity to analyze and inform strategies and specific applications.
- Constraints and gaps were studied based on field experience (and ex-ante analysis) and corresponding mitigation strategies were proposed.
- This example shows how the IDSS will be used in subsequent constraint and gaps analysis identified by this committee.

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Way forward

- We seek your help on identifying and prioritizing opportunities and constraints that apply to SSI interventions for further IDSS analysis.
- A range of scenarios will be studied to show how the constraints can be mitigated and by how much?
- Optimum solutions that consider production, environmental and economic consequences will be looked for.

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Field-scale irrigation management

- Droughts and rainfall variability keep the agricultural production very low in Ethiopia and sub-Saharan Africa.
- The duration of the rainy season was about **three months** that farmers cultivate only once in a year.
- APEX model was used to assess **water and nutrients requirement** for tomato production during dry season using various **irrigation pumping technology tested at the field studies** and amount of **labor and time** required for irrigation.

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Constraints and gaps of the partial list (greens are studied, yellow partially studied, and grays not studied)

- ***Low* land area/land availability per capita**
- **Land ownership vs. rental** (*value for land leased/rented accounted*)
- **Costs related to water access** (e.g. digging for wells, etc)
- Access to seeds for agricultural intensification
- **Access to fertilizer for agricultural intensification in the irrigation season**
- **Water lifting technology access** *(access limited for solar pumps)*
- **Labor requirements/costs**
- **Micro-finance access for irrigation technologies and inputs** *(40% households received loan access, IFPRI survey 2015)*
- Access to market for products (vegetables, fodder, livestock)
- **Energy cost**
- High numbers of low producing livestock
- Low levels of mechanization
- Gender sensitive evaluation of all the constraints mentioned above

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Economic gaps and constraints

- Constraints related to WLTs include labor, maintenance, and capital costs, as well as equipment breakdowns.

Table: Water lifting technologies (WLT)

Types of WLT	Operated by	Flow rate (l/min)	Cost WLT (Birr)	Issues/Constraints
Pulley/bucket	Hand	15	1310	require more labor
Rope and washer pump	Hand	14	3700	frequent breakdowns
Motor pump	Fuel	170	8500	high maintenance costs
Solar pump	Solar	16	16000	high capital costs

10 Annex 4: Workshop evaluation questionnaire

Feed the Future Innovation Laboratory for Small-Scale Irrigation (ILSSI)

Ghana Stakeholder Meeting Evaluation Questionnaire
23rd June, 2016

Please tick the box that most closely matches your experience of this workshop

Workshop content	**Strongly Disagree**	**Disagree**	**Agree**	**Strongly Agree**
I clearly understand the aims and work of the ILSSI project				
I clearly understand the component contributions of each of the project partners				
I clearly understand how the IDSS is supporting the overall objectives of the project				
The constraints identified for prioritization were the right ones for the Ethiopian context				
The workshop provided a good opportunity to share research and experiences on small-scale irrigation and irrigated fodder interventions in Ethiopia				
I would like to be kept informed of further ILSSI project work and developments				
I am happy to be involved in future ILSSI project stakeholder engagement activities				

What would you like more information about in any follow up from the ILSSI project team?

Additional Comments

Workshop process	**Strongly Disagree**	**Disagree**	**Agree**	**Strongly Agree**
There was a good balance between presentations and group work				
I would have liked more time for the group work				
I would have liked more time for the presentations				
I clearly understood what was being asked of the participants				
There was enough time for discussion				
There was enough time for Q&A				
The workshop was the right length for the content				
I found the workshop a useful learning and information sharing experience				
The information materials provided before and during the workshop were relevant and useful				
Communication about the workshop was clear and well timed				

Additional comments
