



# FEED THE FUTURE

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



*Botanga, Tamale. Establishment of demand-supply linkages for scaling of irrigation bundles.*

## Feed the Future Innovation Laboratory for Small Scale Irrigation

ANNUAL REPORT GHANA: October 1<sup>st</sup>, 2021 - September 30, 2022

Submitted by the Norman Borlaug Institute for International Agriculture and Development, The Texas A&M University System & AgriLife Research

Partners in Ghana: International Food Policy Research Institute (IFPRI); International Water Management Institute (IWMI); PEG Africa/Ghana; Kwame Nkrumah University for Science and Technology; University of Ghana

3<sup>rd</sup> January 2023



## 1. Introduction

The Feed the Future Innovation Lab for Small Scale Irrigation (ILSSI) is a cooperative agreement led by the Borlaug Institute for International Agriculture Development (BIAD) at Texas A & M University (TAMU). This report describes progress toward objectives in fiscal year 2022; the project ends August 11, 2023. In Ghana, the project has sub-awards with the International Water Management Institute, International Food Policy Research Institute, Kwame Nkrumah University for Science and Technology, University of Ghana and PEG Africa. In addition, we have two (unfunded) technical partnerships: Horticulture Innovation Lab (UC Davis) and WARC Group's The New African Farmer project.

## 2. Issues, Concerns, and Lessons from the reporting period

### Issues and concerns

Irrigated production continues to increase by farmers with equipment suppliers and associated services, expanding market areas and increasing sales to try to meet demand. Despite weak market integration and relatively limited private sector capacity, companies are growing. Access to equipment and services is increasing and companies are beginning to offer consumer finance and PAYGO options.

Despite slow market growth, prices for pumps (including down payment for finance) especially solar, are too high for the poorest farmers. Approaches are needed to lower pump and equipment costs for the poorest farmers to adapt to climate change and to meet market demands for produce. Farmers will need to invest their own resources in labor-saving water lifting and on field equipment, especially as climate change has increased the need for supplemental and dry season irrigation across crops.

In addition, recent changes in taxes could reduce net margins in the equipment market and disincentivize equipment supply company investment. For example, PEG Africa (BBox) terminated selling solar pumps due in part to changing tax regimes in Ghana. While Ghana attempts to increase tax revenue, the consequences for smallholders and agriculture needs to be explicitly understood.

The exit of PEG Africa prompted ILSSI to work with Pumptech. This will enable lessons on scaling to 'transfer' to the market resilience activity. As ILSSI closes, we need to deepen engagement with the market system resilience (MSR) project and the agriculture finance activity to explore where finance may help irrigation companies.

### Areas requiring further investment

**Poorest smallholders need interventions to be able to invest in irrigation, but it is unclear which approaches to reduce prices are good practice and which might undermine the market.**

Development partners are implementing various approaches to reduce costs for solar and other pumps to farmers in Ghana and in the region, including different finance to different actors.

Notably, development banks may introduce a pump subsidy in Ghana, as has been done in Togo.

Anecdotal evidence suggests public subsidy schemes benefit higher income farmers, i.e. exclude women, and could weaken the market in the medium-term. Analysis is needed across the African region on what is effective under what conditions to reach poor smallholders without disrupting market growth.

**Planning, monitoring and managing water in agriculture at different scales is needed to support sustainability.** The smallholder led irrigation expansion falls outside of public programs and schemes. Given the lack of plans, monitoring and regulation, some areas in Ghana show indication of potential water scarcity and pollution, e.g. Upper East and southern Volta. ILSSI has made a small

contribution at community level through participatory water management, and other USAID projects have also attempted community approaches, but investment is needed to scale, especially in high-risk watersheds. An institution – preferably non-governmental – could host a national coordination mechanism to support scaling (across geographies and actors) and sustainability beyond a single project.

**Skilled, human resource pipeline for private and public sectors will be critical** to the expansion of the market in irrigated agriculture and in particular, sustainability (regulatory and planning). Public sector shows no indication of reforming institutions to address irrigation expansion by smallholders. Private companies will likely be expected to self-regulate in the water sector for business sustainability. Yet, the lack of skilled staff and high staff turnover already constrain private company growth without the added tasks related to self-regulation. At the same time, tertiary education institutions are not developing a human resource pipeline to supply skilled staff. The low capacity is likely to contribute to water risks in the medium-term, especially with impacts of climate change.

**Supportive intersectoral water policies and institutions.** Institutional reform (including policy), scientific and private sector human resource pipeline and community/watershed approaches need to be developed together. Community and private sector approaches are important but cannot fill the regulatory and planning gap into the future. A policy approach will be needed to align national goals (e.g. agriculture, climate, economic, water) within a suitable institutional framework.

### 3. Progress toward research objectives

**Objective 1: Identify and test approaches to sustainably scale SSI through reducing constraints and strengthening opportunities for access**

Upscaling opportunities for resilient SSI systems

ILSSI sub-awardee PEG Africa (now BBox) completed work in Ghana, while unfunded partnerships continued with Pumptech and Tech2. Companies offer consumer/asset finance and/or PAYGO options.

Fuel price spikes and decreased access to fuel increased demand for solar powered irrigation systems. However, unfavorable exchange rates, high inflation and other increased input costs reduced farmer ability to pay and increased risk aversion to credit. Constraints in FY2022 include:

- Unfavorable tax environment:
  - Ghana's revised tax code reduced company profit margins
  - New tax discouraged farmers to use mobile money payments that enables companies to reduce transaction costs
- High costs of inputs: High fertilizer cost reduced ability of farmers to invest in pumps; high fuel prices reduced ability of farmers to operate fossil fuel pumps
- Increased financial risk decreased distributors' willingness to provide farmer credit
- Farmers report output markets are available, but low bargaining power with buyers reduces net profits and in turn, the ability to make down payments and subsequent PAYGO payments

Overcoming constraints to scaling for resilient SSI market systems

Ensuring local, context specific marketing and technology system selection

IFPRI found that locale-specific targeting of small-scale irrigation technologies is essential to scaling, with plot level specific advice and technologies for water and land management ([see: Hierarchical modelling of the constraints to irrigation adoption in Ghana, Ethiopia, and Tanzania](#)).

Interventions by IWMI with ILSSI support on market integration and water sustainability, included:

1. Customized solar irrigation suitability maps (combined socio-economic and financial factors, see: <http://sip.africa.iwmi.org/>) for Pumptech; customized maps enable companies to ensure match between client's land area and crop selection with water availability (to avoid aquifer depletion)
2. Supported companies to complete market segmentation for better targeting (Upper West, Northern, North-eastern, Savannah)
3. Co-organized [demand-supply linkage workshops](#) and field demonstrations; i.e. facilitated market linkages within the supply chain, between solar irrigation pump suppliers and related services and suppliers (borehole, pipe/sprinkler suppliers); and between suppliers and farmers. Reached around 2,682 farmers and other value chain actors through 19 demand-supply linkage workshops (Upper West, Northeast, Northern Savannah Regions) and 13 field demonstrations.
4. Co-developed with Pumptech farmer finance modalities for the market segments:
  - a) Direct payment by installment for resource-rich farmers
  - b) Pre-paid pump services (PAYGO) for mobile farmers who use mainly surface water sources to farm during dry season and can afford a movable SPIS
  - c) Pay-as-you-own and/or blended financing for the resource-limited farmers who usually have permanent access to cultivated lands with water from dugouts and wells as their main sources
  - d) Market development and linkages for the farmer groups who can raise funds from monthly or seasonal use paid by members in village savings and loan schemes and gradually accumulate capital to invest in SPIS
5. Trained institutional partners (government agencies, research and development partners) who promote SPIS on solar irrigation and labor-force development

#### Facilitated dialogue between key stakeholders to strengthen SSI scaling

Multi-stakeholder dialogues convened and facilitated IWMI with ILSSI support to bridge information gaps and strengthen irrigation equipment/input markets in FY2022 included:

- [‘Sustainability of cocoa systems: Exploring segmentation, water management and small scale irrigation suitability’](#) (October 2021; 40 individuals; 25 organizations). Co-convened with International Institute of Tropical Agriculture (IITA). **Highlights:** stakeholders are initiating irrigation in cocoa without integration or joint planning; knowledge sharing will be needed to sustainably develop and monitor water use in the sector.
- [‘Market and value chain approaches to farmer-led irrigation development’](#) (April 2022; 51 individuals; 28 stakeholder organizations). **Highlights:** Participants perceive high potential for private sector investment in FLI and irrigated agricultural value chains, especially with: local manufacture of irrigation equipment; growing awareness; bundling technologies with financing; high market demand for irrigated products; interventions to process horticultural outputs for local and international markets. Constraints: dominance of public/donor technology transfer models that undermine markets; lack of inclusion of women farmers; limited product and service packages; poor synergy among donor approaches, which reduce farmer investments.
- [‘Innovations for improving irrigation water use efficiency in farmers’ fields’](#) (July 2022; 51 individuals; 23 organizations), convened with and funded by Ghana Agricultural Sector Investment Programme (GASIP). **Highlights:** Irrigation sector in Ghana is still in a niche stage; opportunities for both government and private sector investment. Surface water and groundwater irrigation can complement each other but must be developed conjunctively.

### Analyzed market structure and margin along different points of SSI chain of actors

**Structure of market:** Lack of synergy in the industry results in poor bargaining power to influence government policy and interventions as well as minimal development of the supply chains. The market is currently not supported by a range of services, such as research, input supply, communication, transportation, local administration, market information, and importantly, financial services.

Irrigation supply chain net market margins are estimated to be between 5%-30%. Market margin is heavily dependent on import prices, port charges, and the business operating environment; there are challenges in the business operating environment across the irrigation equipment supply chains that influence the margin. Intangible costs include bureaucracy, non-adaptation, politics, and poor collaboration costs. Services and fees are not calculated per unit as part of determining margins. Market margins may change significantly with new tax policies and fluctuations in the Ghana Cedi.

**Policy changes in tax and port charges:** Government of Ghana reduced the benchmark from 50% to 30% discount on port charges irrigation equipment importers pay an additional 20% on port charges. Value Added Tax for small- to medium-scale enterprises (annual revenue above 500,000 GHC) also changed; VAT/levies on irrigation equipment increased from 4% to 19.25% under the Value Added Tax (Amendment) Act, 2021 (Act 1072). This has increased the cost of irrigation equipment to farmers.

### Irrigated value chain studies

#### Maize

ILSSI provided a rapid analysis of the potential for irrigated maize production in targeted Zones of Influence in Ghana for the West Africa Rice Company (project funded by West Africa Trade Hub). ILSSI's water resource assessment of the targeted districts suggested low access to suitable water resources; the project paused introduction of irrigation to maize in the short-term.

#### Cocoa production, income and nutrition in Ghana

Cocoa productivity has been declining in Ghana with climate change, especially related to change in rainfall patterns. Farm rehabilitation is hindered by 40% loss of seedlings largely due to lack of water. Cocoa remains central to Ghana's exports, foreign exchange earnings, and direct and indirect employment. An initial suitability assessment for irrigated cocoa suggest that most current cocoa growing areas already lack sufficient rainfall for production. Climate change scenarios point to necessity of supplemental and dry season irrigation. (Partners: IWMI, KNUST, TAMU)

## Objective 2: Identify approaches to scale SSI sustainably to support resilience

### Irrigation and water pollution analysis

IFPRI research shows that fertilizer and purchased seed use is higher in irrigated plots by about 12% compared to rainfed alone, i.e. clear impact of irrigation on input complementarity. However, irrigated intensification will contribute to water pollution from agro-chemicals without proper management. ILSSI developed training materials for farmers on safe pesticide use (transferred to companies and MSR).

### Estimating the potential of solar pumps in improving irrigation access vis a vis energy intensity

IFPRI work on the impact of climate change on the cost-effectiveness of solar relative to diesel irrigation shows climate change supports adoption of solar compared to diesel. Complex interactions across higher solar irradiation levels, increased crop water demands and higher temperatures, increased need for groundwater lifting, which is more cost-effective using solar relative to diesel. The higher economic viability of solar over diesel pumps is irrespective of the food-security enhancing climate mitigation benefits of these systems.

## Objective 3: Identifying and testing approaches to maximize inclusivity, effective governance, women's empowerment, and involvement of youth for nutrition-sensitive irrigated production

### Design and pilot community scale governance approaches

Smallholder-led irrigation is most often based on farmers' own resources and falls outside of formal governance mechanisms. Ghana lacks an integrated monitoring and planning governance structure for irrigation not in public schemes. Areas in Ghana are already at risk of water pollution and/or depletion. Approaches need to be introduced at community and watershed scale, while systems need to be developed in public agencies that can slowly catch up. Local partners have introduced groundwater governance games in Upper East and Volta Region (Keta area) where groundwater irrigation is rapidly expanding and risks are evident. To develop strategies to scale, ILSSI facilitated a workshop in Ghana and introduced a South-to-South exchange event in Ghana between Ethiopian and Ghanaian experts. (Partners: IFPRI, University for Development Studies, Water Resources Institute, University of Ghana)

### Understanding the linkages between SSI and women's empowerment

IFPRI published "[Understanding Women's Empowerment in Northern Ghana and the Relationship with Small-Scale Irrigation](#)" that shows women face serious constraints to participating in and benefitting from small scale irrigation, including difficulties accessing land and water, as well as gender norms that limit women's ability to control farm assets. Despite constraints, many women do benefit from participating in irrigated farming activities that lead to an increase in their agency and well-being achievements. For some women, benefits are indirect—these women allocate their time to more preferred activities when the household gains access to modern irrigation technology (i.e. reduces their labor time on farm and gathering water).

### Gender sensitive business models and scaling, aligned with private partners

Despite the co-development of a gender-responsive credit/customer assessment scorecard with the private companies, individual sales agents act on bias in client acquisition: agents perceive women as unlikely to qualify for credit, and therefore do not pursue pre-sales assessments. Company reluctance to share client data has hindered deeper analysis.

## Objective 4 - Achieve impact through uptake of research results

### Capacity development

#### Strengthening capacity for analysis, monitoring and planning methods

**Integrated Decision Support System Trainings:** ILSSI provided a training on analytical methods for early career scientists related to improving management and monitoring of natural resources, which was hosted by Department of Environment, Water, and Waste Engineering, University for Development Studies, Ghana (February 28 - March 4, 2022): 71 participants (14 women, 57 men). Trainees included lecturers, students, and researchers in agricultural economics, engineering, agriculture and hydrology.

#### Private sector capacity development

IWMI co-organized **demand-supply linkages workshops and field demonstrations** for solar-based irrigation bundles with companies, supported private companies on applying data and suitability mapping to target markets toward safeguarding water resources, and helped tailor suitable finance products.

### Institutional Capacity Development

- South-South knowledge exchange (Ethiopia, Ghana, India) on community-scale groundwater governance based on demand from national stakeholders in Ghana
- Multi-stakeholder dialogue platforms
- ILSSI & PEG Africa co-produced farmer materials on safe agri-chemical use (French, English); private companies and implementing partners are using (e.g. MSR activity)

### Innovation Scholarships and Internships

ILSSI co-supervised four interns working with PEG and Pumptech.

### Post-graduate research training/mentoring

| M/F    | University          | Degree | Major                           | End Date | Country |
|--------|---------------------|--------|---------------------------------|----------|---------|
| Female | University of Ghana | MSc    | Social science                  | May 2023 | Ghana   |
| Male   | University of Ghana | PhD    | Geological/hydrological science | NA       | Ghana   |

## 4. Future work

ILSSI closes August 2023; the project will not be extended at end of 10 years. Final activities include:

### Research and scaling

- Close out scaling partnerships with private sector partners
- Complete the scaling toolkit in online interactive form (to be utilized by MSR activity)
- Complete community-level water governance approaches, scaling strategy development, South-South engagement
- Complete research on multiple-use of water sources and systems in Upper East

### Outreach and engagement

- Demand-supply linkage and demonstration workshops (January/February 2023)
- Multi-stakeholder dialogue close-out (date TBD)
- Africa Region conference on small scale irrigation (target date April)
- Continue to engage and transfer relevant knowledge and networks to MSR
- Outreach to Horticulture Innovation Lab activities as relevant

### Capacity development

- Mentor/support graduate students and field assistants; Complete Innovation Grants, Internships
- Analytical methods and model trainings in Ghana (University of Ghana; May 2023)

## Annex. Relevant data and publications (Ghana)

### Peer-reviewed publications

- Bryan, E., Garner, E. (2022). [Understanding the pathways to women's empowerment in Northern Ghana and the relationship with small-scale irrigation](#). *Agriculture and Human Values*.
- Dekongmen, B.W.; Anornu, G.K.; Kabo-Bah, A.T.; Larbi, I.; Sunkari, E.D.; Dile, Y.T.; Agyare, A.; Gyamfi, G. (2022) [Groundwater recharge estimation and potential recharge mapping in the Afram Plains of Ghana using SWAT and remote sensing techniques](#). *Groundwater for Sustainable Development*, 17, 100741
- Haile, B.; Mekonnen, D.; Choufani, J.; Ringler, C.; Bryan, E. (2022) [Hierarchical Modelling of Small-Scale Irrigation: Constraints and Opportunities for Adoption in Sub-Saharan Africa](#). *Water Economics and Policy*. 08(01), 2250005.
- Ringler, C.; Agbonlahor, M.; Barron, J.; Baye, K.; Meenakshi, J.V.; Mekonnen, D.; Uhlenbrook, S. (2022) [The role of water in transforming food systems](#). *Global Food Security*, 33, 100639.
- Young, S.; Frongillo, E.A.; Jamaluddine, Z.; Melgar-Quiñonez, H.; Perez-Escamilla, R.; Ringler, C.; Rosinger, A.Y. (2021) [Perspective: The Importance of Water Security for Ensuring Food Security, Good Nutrition, and Well-being](#). *Advances in Nutrition*, 12 (4), 1058–1073.

### Briefs/presentations

- Choufani, J.; Bryan, E.; Mekonnen, D.; Ringler, C. (2021) [Exploring small scale irrigation-nutrition linkages](#). International Food Policy Research Institute (IFPRI) Project Notes.
- International Water Management Institute (IWMI). 2022. [Evidence-based strategies to accelerate innovation scaling in agricultural value chains](#). Colombo, Sri Lanka: International Water Management Institute (IWMI). 8p.
- Obuobie, E. [“In-field Experience with Groundwater Governance in Northeast Ghana”](#). August 2022. Stockholm World Water Week.
- Ringler, C. “Solar or Diesel: A Comparison of Costs for Groundwater-Fed Irrigation in Sub-Saharan Africa Under Two Energy Solutions”. November 2021. Africa Water and Sanitation Week. African Ministers' Council on Water (AMCOW).

### Capacity development material

- Innovation Lab for Small Scale Irrigation (2022). Guide to Safe and Effective Use of Chemicals for Crop Production. French and English versions.
- International Food Policy Research Institute (2021). [Pathways to more nutrition-sensitive irrigation](#). IFPRI Video. French and English Versions.
- Demand and supply linkage workshops: How to organize workshops to establish sale and service networks for the farmers, companies, and other value chain actors to reach a larger scale. Videos: <https://www.youtube.com/watch?v=uLE-G-c63Zo&t=14s>