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

TANZANIA

A young group of irrigators discuss irrigation techniques in Rudewa-Mbuyuni, Tanzania
Photo: Petra Schmitter, IWMI

Feed the Future Innovation Laboratory for Small Scale Irrigation (ILSSI) Research Results Discussion Brief

Key research findings

- Small scale irrigation (SSI) is profitable when using motor pump water lifting for high value vegetable production, provided that credit is accessible and reasonably priced.
- SSI is not always associated with women's empowerment and so requires careful targeting.
- Homestead pocket gardens use less water and labor than conventional gardens, and so offer a potentially important avenue for improving household nutrition and diversifying livelihood options for women.
- Labor is a major cost in irrigated production. Labor is more costly than technologies over time, but the upfront costs of technologies and fuel constrain investment.
- Reducing recommended crop water requirements for certain vegetables according to location will improve yields, increase farmer revenues and provide significant water savings.
- Irrigated fodder production as a cash crop can be profitable in Tanzania, access to good quality forage and fodder seed as well as to adequate storage and conservation techniques will be key to success.

Recommendations

- Increase access to finance products and information
- Reduce labor requirements through technology and tools
- Apply solutions with youth entrepreneurs as entrepreneurs in service provision
- Adapt technologies and sites to women farmers' preferences
- Expand role of private sector actors in technology supply chain and finance provision
- Match technology packages suitable to context
- Improve governance mechanisms

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Introduction

The Feed the Future Innovation Laboratory for Small Scale Irrigation, initiated in 2013, has been a focal point of the USAID investment strategy to provide improved efficient methods of supplying water to small holder farmers. The project worked to create research-based evidence that would contribute to increased food production, improved nutrition, accelerated economic development and the protection of the environment. The project involved stakeholder-driven field studies to evaluate small scale irrigation (SSI) interventions, and household surveys to assess the impact of SSI on nutrition, economic status and women's empowerment. An integrated suite of analytical models, the Integrated Decision Support System (IDSS) was then used to evaluate and interpret results from field studies. The sustainability of interventions, employed through the project, has been promoted through continuous dialogue with stakeholders and a strong focus on multifaceted capacity development.

The target beneficiaries were smallholder farmers, though a wide range of stakeholders were engaged by the research team. This included practitioners at local levels, national decision makers, private sector investors in technology, and future development donors. Studies conducted in farmer's fields, household surveys, analysis and capacity development (both at individual and institutional levels) formed the key components of the research process. These enabled investigation of the consequences of SSI interventions on production, the environment, economic factors, nutrition and equity. ILSSI also explored opportunities and constraints to scaling up some of the technologies, approaches and practices from farm to national levels. ILSSI conducted research and piloted interventions in three countries; Tanzania, Ethiopia and Ghana.

SSI technologies offer a number of income and nutritional outcomes, while also playing a role in enhancing environmental sustainability. SSI has been shown to improve labor efficiency and can reduce the time spent on this labor across multiple water uses. SSI has also been shown to improve yields and incomes from them, and to help reduce crop losses, while offering multiple value chain opportunities for farmers and others in farming communities. With regard to nutrition, irrigators have in general been found to perform better than non-irrigators in household food security and dietary diversity analysis. Use of SSI can also help support environmental sustainability in that they have been found to improve water and land productivity, offer effective nutrient management opportunities, and provide both on-farm and off-farm water management options.

During the five year research project, the ILSSI team undertook a total of 28 water resources sustainability assessments in 19 basins, including 6 international trans-boundary basins. ILSSI initiated research on 9 new technologies or management practices and in addition, undertook field testing of 8 new technologies, and at least 15 new technologies were made ready for transfer under the project. In general the technologies were found to be feasible, profitable and to have multiple benefits though it was clear that women face more constraints to accessing and using them than men.

To mitigate some of the risks of SSI, and as part of efforts towards ensuring improved sustainability of the interventions, ILSSI tested irrigation scheduling tools and trialled conservation agriculture (CA) with farmers. The results indicate that combining water lifting technologies with tools to enhance on-farm management can greatly increase the benefits of SSI for smallholders. Farmers recognized some of the benefits on farm, while other benefits were seen at the watershed level. A number of unique data sets were also produced including ones on: gender and nutrition at the intra-household level, on-farm water management, and hydrological data (including shallow groundwater).

In Tanzania, ILSSI piloted interventions with over 110 women and men farmers in Rudewa, Mkindo and Kiloso in Morogoro region and Babati in Manyara region. The interventions in Babati involved fodder only.

Water sources: ILSSI assessed the potential of a variety of site relevant water resources to sustainably meet productive water needs, as standalone sources, or in some cases in combination to enhance sustainability, or because groundwater alone would be inadequate. Shallow groundwater was a focus in Ethiopia and Ghana.

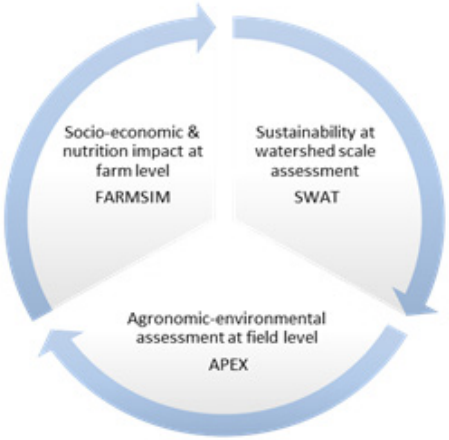
Water lifting technologies: ILSSI research examined the use of motorized pumps in all three countries, solar pumps in Ethiopia and Ghana, and both rope and washer and pulleys in Ethiopia. Water lifting technologies alone provide benefits, but also carry risks, such as under or over application of scarce water and suboptimal yields and quality.

Water application: the benefits, constraints and impacts of both drip systems and furrow irrigation systems were examined in all three countries.

Use of the Integrated Decision Support System (IDSS)

The Integrated Decision Support System (IDSS) enables assessment of the consequences of small scale irrigation interventions on production, environmental and economic outcomes, based on data collected from the field. IDSS is a suite of models including SWAT, FARMSIM and APEX, each of which examines a different set of key aspects. Analysis using IDSS was conducted to help scope existing SSI and to understand its varied impact on agricultural production, environmental sustainability, and both economic and nutritional outcomes.

Using data collected in the field, IDSS was then used to explore the impact of SSI on agricultural production, environmental sustainability and economic and nutrition outcomes. Analysis of gaps and constraints helped to identify factors that limit the adoption of SSI and to suggest mitigation options. The potential for expanding SSI and its impacts in a given location were then studied through up-scaling analysis using IDSS.



IDSS analysis capability
Source: Project team

Capacity Development

In keeping with the strong focus of ILSSI on capacity development, short-terming training was provided to a total of 938 producers, 115 civil servants, 36 private sector actors and 193 members of civil society (907 men and 375 women overall) across the three countries. Training ranged from practices and tools for on-farm water management and fodder production for farmers, to use of data collection and analysis using the IDSS. Furthermore, as part of ILSSI's commitment to enhancing research capacity in each country, a total of 26 graduate and 10 undergraduate students across the three countries received degree-related training and support, including research design, data collection, field research methods, publication preparation mentoring, and assistance to participate in national and global scientific conferences.

Estimated small-scale irrigation adoption potential in Tanzania

Use of IDSS analysis revealed potential for improved vegetable production yields in Tanzania. The most productive areas for vegetable production using SSI during the dry season were found to be located in central and southern Tanzania. There are also some pockets in northern Tanzania however which could also produce optimal yields. The potential for upscaling SSI was only analyzed on agricultural land and did not include grasslands, parks, forested areas or water bodies. IDSS was also used to analyze irrigation water requirements for dry season cropping and analysis showed that soil loss due to erosion is generally low in Tanzania.

Improving irrigation scheduling

Research results show that irrigation scheduling tools may be key to enhancing SSI sustainability. In particular, irrigation scheduling tools were found to increase yields and profitability, improve water use efficiency and productivity, and to improve fertilizer efficiency (in some cases). They were also found to promote water sharing.

Labor is a major SSI production cost, although it differs across crop types and technologies. It is important to note therefore that irrigation scheduling tools were shown to reduce SSI labor requirements. This may also be an important consideration in their adoption by women farmers. The improvements in water use efficiency offered by these tools is particularly important where water is scarce, as it is in regions of all three countries studied. Women face a number of constraints to accessing irrigation scheduling tools. They would benefit from a greater focus on providing them with both information and training.

Benefits of Conservation Agriculture

Conservation agriculture (CA) aims to improve sustainability of agricultural production by offering benefits such as improved water resource efficiency and reduced labor costs. Conservation agricultural techniques such as mulching, biologically diverse crops in rotation and low tillage approaches, sometimes combined with the use of drip irrigation, were trialled by ILSSI. These CA methods can have multiple benefits including some that support climate resilience. There are also some constraints to the use of, benefits derived from, and opportunities to scale up the use of, CA.

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Overall ILSSI found that CA enhances SSI benefits, for instance when used in commercial gardens, even under temperature stress conditions. Vegetable yields, for example cucumber grown in Tanzania, were found to be improved by as much as 85% compared with non-CA farmer practices. However, in Mkindo cabbage yields were found to be 47% lower when grown using CA practices. This may have been due to negative effects of the type of mulch used (banana leaves) which was found to encourage pests and cause nitrogen stress. Use of other types of mulch in Mkindo, such as ones similar to those used successfully in Ghana or Ethiopia, may not result in these yield reductions. Additionally, ILSSI found that irrigation water use was significantly reduced (by as much as 14-46% in all sites), and both soil quality and soil moisture content were improved under CA. In some, but not all, cases CA was also found to reduce labor costs.

ILSSI also identified a number of key constraints to the success of CA in Tanzania. These include potentially limited supplies of mulch or competition for other uses, such as animal fodder, and pest control challenges. The lack of sufficient agronomic and irrigation advisory services was also identified as one of the main challenges to effectively and productively cultivating vegetables in Tanzania. These will all need to be addressed if the use of CA is to be scaled effectively.

Scaling irrigated value chains - fodder for livestock

ILSSI found that small scale irrigated fodder production is profitable as a cash crop, for example growing it for sale in fodder markets. Other benefits include improving both on-farm livestock generally and more specifically the stock's productivity, for example in milk production, though the levels of profitability generated may vary.

Research conducted into the potential for irrigated fodder production in Tanzania took place in Mvomero, Kilosa and Babati districts, involving a total of 26 farmers (12 women and 14 men), 17 farmers (8 women and 9 men, and 27 farmers (8 women and 19 men) in each district respectively. Irrigated fodder production is not a familiar feature of traditional livestock production systems in Tanzania, however it became clear that Tanzanian farmer's interest in improved forages increased during the research process. Napier (Pennisetum purpureum) was the preferred cultivar. Although the Tumbukiza planting process requires more labor to establish, it was shown to result in higher yields than other planting systems. Overall it was clear that farmers in Tanzania are willing to grow irrigated fodder but that there are some limitations relating to availability of land, good quality seeds, water, storage and conservation techniques, transportation and effective approaches to combat diseases and pests.

Linkages between irrigation and nutrition

Significant differences were found between irrigators and non-irrigators in the areas of household food security, household dietary diversity and women's dietary diversity. Irrigators performed better in measures of food security and dietary quality in all three countries, although the differences in female dietary diversity were not statistically significant in Ethiopia.

Econometric results, using data from household surveys in each country, indicate that access to irrigation significantly improves both household income and production diversity. However, although increases in household income were found to lead to higher dietary diversity, increases in household production diversity did not necessarily contribute to increases in dietary diversity. This reveals that irrigation improves nutrition through an income pathway rather than through household consumption of the diversity of food grown.

	Non-irrigators n=224 (Mean)	Irrigators N=227 (Mean)
Household food insecurity access scale: 0-27 (higher = worse)	**3.92**	2.58
Female dietary diversity score: # of categories consumed	**3.71**	4.20
Household dietary diversity: # of food categories consumed	**4.88**	5.63

Figure A: Irrigation-food insecurity-dietary quality
Source: Project research results

Further research will need to investigate why irrigation doesn't appear to have significant effects on agricultural income, production diversity, and female dietary diversity in Tanzania, as detailed in Figure A, whereas it does have positive impacts in the other two countries studied.

Irrigation for greater gender equality

Results from the Women's Empowerment in Agriculture Index (WEAI) show that in general women irrigators are better off than non-irrigators. However, results also revealed that women and men do not have equal access to technologies, information, training, credit or inputs and that women have lower levels of access to technologies, or lose rights over them, to men within the household.

SSI is not always associated with women's empowerment

- TANZANIA -

Irrigators	Non-irrigators	Contributors to disempowerment
WEAI Score	WEAI Score	
0.88	0.86	• Group membership • Credit access • Leisure time • Speaking in public • Autonomy in production

Figure B: WEAI scores for irrigators and non-irrigators in Tanzania
Source: Project research results

As summarized in Figure B, household survey results showed that SSI does not always lead to women's empowerment. As an example, irrigated fodder may have great potential, but women may end up losing out if the crop gets 'too' profitable and is taken over by the men in the household. In households where women's labor is perceived to be plentiful, male decision-makers may be less apt to invest in irrigation technologies, which could otherwise have reduced women's labor burden.

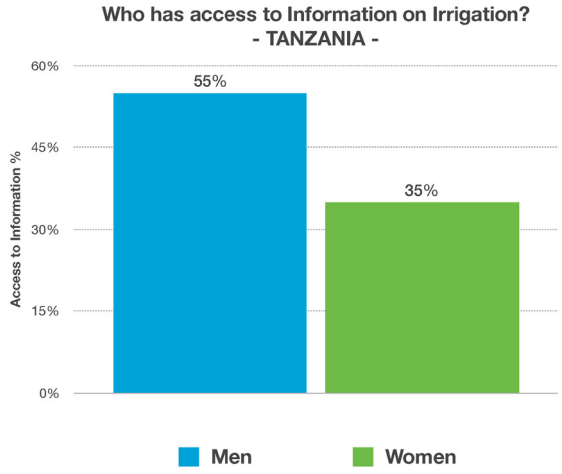

Figure C: Percentage of men and women in Tanzania with access to irrigation information
Source: Project research results

Levels of empowerment, the roles of women and men, and the contributors to women's disempowerment as well as the distribution of benefits and costs vary across the three countries. However, women face a number of common constraints to adoption of irrigation technologies. For example, technologies not matching women's needs and preferences (with regard to affordability, maintenance needs, fuel requirements, transportability, and applicability for multiple uses).

Women also lack access to and control over the assets required for adoption (such as land), and lack of access to sufficient information (for example mobility constraints and/or not belonging to groups where information is disseminated). Ownership of irrigation equipment is also unbalanced between men and women in Tanzania. The difference in access to irrigation information in Tanzania between men and women is shown in Figure C. Women often have limited ability to participate in decision-making over the use of water resources for irrigation, and low control over management of technologies or the benefits of adoption. Limited access to credit is also a common constraint.

Efforts to ensure women's equal access to irrigation will be crucial to achieving the goals of scaling up irrigation for climate resilience, improved productivity and enhanced food and nutritional security.

ILSSI identified a number of opportunities for the promotion of greater gender equality in irrigation, including:

- Capitalizing on the great potential for participatory, user-centered technology design to better address women's needs and preferences
- Supporting women's greater participation in group decision-making
- Developing new outreach models to ensure information effectively reaches both men and women
- Facilitating access to credit on both the supply and demand sides, providing financial literacy training for women and men and helping them to forming groups to manage and share risk
- Identifying ways to enable women to focus on under-explored crops which may be profitable and to capitalise on the high potential of seed production through approaches that don't increase the risk of women losing profitable and preferred crops to men, such as fodder and leafy greens
- Enabling access to and control over assets and inputs and encouraging joint ownership of productive assets

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Markets and returns on SSI investment

ILSSI investigated the potential for scaling up household investment in water lifting technologies, by analyzing investment costs, yields, production costs and selling prices, in combination. Three economic feasibility indicators were assessed; Net Present Value (NPV), Internal Rate of Return (IRR) and payback period. In Tanzania, one household level water lifting technology (diesel/petrol pump) was assessed in two sites (Rudewa and Mikindo) focusing on two principle crop types (tomato and African eggplant). In general, the results show that investments in SSI technologies and complementary inputs can contribute to poverty reduction in Tanzania. More specifically, investments in SSI technologies can have a stronger effect on reducing poverty for women farmers and female-headed households than for male-headed households, notably through increasing consumption expenditure. Enabling access to rural finance increases the likelihood of adoption of SSI.

Project findings to development impact

ILSSI analyzed SSI interventions and the impact of SSI on nutrition, economics and women's empowerment through household surveys, and the use of the IDSS to evaluate and interpret results from the field studies. The results of the multidisciplinary research revealed a number of important findings to be considered for upscaling SSI and its benefits in Tanzania. Labor is a major cost and constraint to sustainable SSI adoption, though motor pumps are financially feasible for high value vegetable production if credit is accessible and credit costs are reasonable.

Homestead food production can be beneficial because pocket gardens use less water and labor than conventional gardens. Income from pocket gardens may be modest but women can control that income. Nonetheless, overall SSI is not always associated with women's empowerment and so must be carefully targeted. Results show that there is a need to build rigorous business cases for SSI, including profitable irrigation business models for men, women and youth, and to identify ways to enhance private investment in the various aspects related to the use of SSI in Tanzania. By taking these insights into account, and acting on them, the goals of increased food production, improved nutrition, accelerated economic development and protection of the environment can be more affectively achieved.

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Further information

This brief has been produced by the ILSSI project: ilssi.tamu.edu

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