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

REPORT ON

NUTRITION

and Small-Scale Irrigation

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FEED THE FUTURE INNOVATION LAB FOR SMALL SCALE IRRIGATION

Small-scale irrigation shows high potential for improving nutrition and resilience

As water crises worsen amid climate change and energy constraints, the impact on food security is already being felt—hunger is on the rise. It is increasingly critical to understand the relationships between water security, food security, and nutrition.

The evidence on the potential for agricultural interventions to contribute to improved nutrition has grown considerably over the past decade. Numerous studies have explored both positive and negative effects of agriculture on nutrition and health. The Innovation Lab for Small Scale Irrigation has helped to fill the evidence gap on small-scale irrigation and nutrition linkages. The studies, implemented by the International Food Policy Research Institute and national partners, examine the potential of small-scale irrigation as a nutrition-sensitive investment.

Through this work, more development partners are recognizing the interconnections and beginning to design irrigation investments to intentionally improve nutritional and health outcomes.

Pathways from irrigation to nutrition and health

Irrigation is expected to improve nutritional outcomes through multiple pathways. Domènech (2015) describes several pathways through which irrigation can influence food security, nutrition, and health outcomes, including 1) a production pathway, 2) an income pathway, 3) a water supply pathway, and 4) a women's empowerment pathway. A fifth, negative pathway that links irrigation to water pollution and disease via the application of fertilizers and pesticides and via hosting vector-borne diseases, such as malaria or schistosomiasis, respectively (Passarelli et al., 2018).

Irrigation may be expected to affect nutritional outcomes within agricultural interventions.

The production pathway reflects irrigation's role in increasing crop productivity and broadening the range of crops that farmers can cultivate. This includes the cultivation of crops with higher water requirements, such as fruits and vegetables, that also have higher nutritional value. This pathway also reflects irrigation's provision of stability of food supply, by enabling more cropping seasons and reducing the risks of rainfed production. Irrigation can also improve nutritional outcomes through an income pathway because irrigation investments often support the production of high-value cash crops. Increased income, in turn, enables farm households to purchase nutritious foods such as animal source foods, and to invest in other nutrition-enhancing interventions, such as health services. When irrigation infrastructure is designed as a multiple use system, it can improve households' access to water for hygienic and other domestic uses—positively affecting nutritional outcomes through a water supply pathway. Women's decision-making authority over production and income decisions of irrigation systems can have positive implications for the health and nutritional status of women and their children. In particular, women's preferences for the types of crops planted, how these crops are used, and how the income gained from irrigation is spent (prioritizing food and healthcare) can influence the nutrition-sensitivity of irrigation.

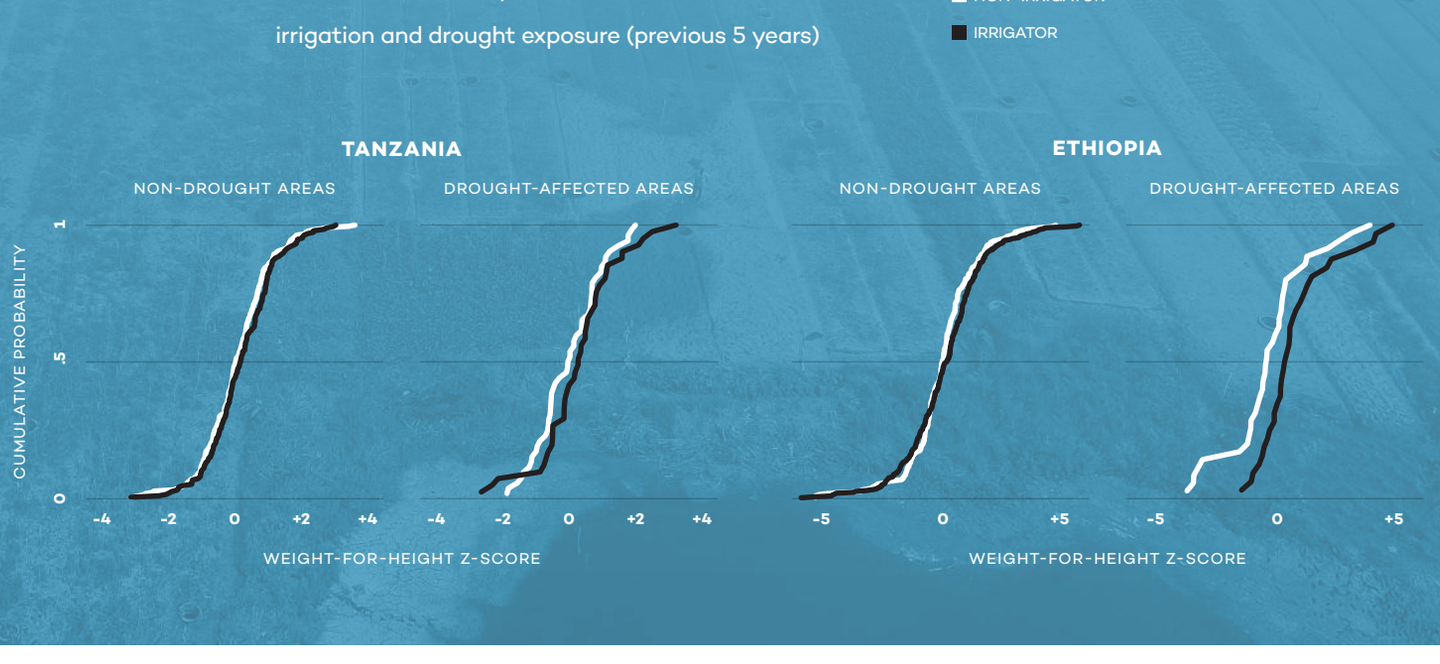
MULTIPLE USES SERVICES:

Household water sharing across uses to cope and adapt

Households continue to manage multiple sources of water for different uses even after irrigation systems are developed. As irrigation investments are increasingly at household level and managed by farmers directly, ILSSI supported research to understand how household multiple use water practices and water sharing affect development goals. Research in Mali showed a pathway to women's empowerment through multiple use services. Research in Ghana indicates that water sharing helped households to adapt and cope, but can also contribute to tensions in intra- and inter-household relations.

Weight-for-height z-scores

of children under 5 by households' access to irrigation and drought exposure (previous 5 years)



Building evidence through case studies

In addition to analyzing pathways, ILSSI studies have also documented the relationships with data collected in Ethiopia, Ghana, Tanzania, and Mali. Baye et al. (2022) have shown that there is a high seasonal variation in women's diet in Ethiopia, but this can be partly offset by irrigation practices which buffer their seasonal dietary gaps for women. The study also showed that compared to non-irrigators, women in irrigating households have higher consumption of Vitamin C and Calcium during the irrigation season, which helps to address important micronutrient deficiencies.

1 CASE STUDY

IN ETHIOPIA, Mekonnen et al. (2022) have shown that children in irrigating households have better weight-for-height (WHZ) scores—0.87 standard deviations higher weight-for-height (WHZ) than children in non-irrigating households. The study also provided evidence of reduced wasting of children in irrigating households in Ethiopia, notably among children who live in households that experienced drought. (See figure above.)

2 CASE STUDY

IN NORTHERN GHANA, Mekonnen et al (2019) found only a modest difference in the Household dietary diversity Score (HDDS) between irrigators and non-irrigators, but more significant differences in the consumption of animal source foods, and significant differences in the consumption of fruits and vegetables as well as sugar and honey between irrigators and non-irrigators. As other studies have highlighted, consuming animal source foods has strong positive impacts on nutrition, particularly for children.

Irrigated fodder and household nutrition

A study co-sponsored with the Innovation Lab for Livestock Systems, projected smallholders that irrigate fodder achieve higher productivity and income. Using the FARMSIM model, results suggested that the introduction of crossbred dairy cows with a high potential for milk production increased the potential profits three times that of native cows. Results show annual average profit for households irrigating fodder is almost twice that of the rainfed producers. In terms of nutrition, the analysis also indicated that deficits in fat intake at the household level would be addressed largely through increased income, while deficits in calcium could be partially alleviated through the increase in own consumption of milk produced.

Nutrition analysis for fodder irrigating households showed diet diversification and available protein increases by 12%, fat by 24%, calcium by 73%, and vitamin A by 17%.

IFPRI survey data from Mali

Irrigating households on average consume 1.36 food groups more than non-irrigating households. Dietary diversity is an important measure of nutritional security and health.

DIETARY QUALITY — % households Reporting	**Irrigators**	**Non-irrigators**	**Difference** (Pv)
Consumed cereals (millet, sorghum, maize, rice, wheat)	97.7 %	97.8 %	0.9278
Consumed root crops (potatoes, cassava)	67.0 %	43.4 %	0.0000***
Consumed vegetables	85.2 %	71.3 %	0.0000***
Consumed fruits	68.4 %	63.1 %	0.0390**
Consumed meat (any beef, pork, goat, wild game, chicken)	71.8 %	59.5 %	0.0000***
Consumed eggs	41.3 %	27.7 %	0.0000***
Consumed fish (any fresh or dried fish)	80.9 %	75.4 %	0.0359**
Consumed legumes (beans, peas, lentils, or nuts)	57.0 %	42.1 %	0.0000***
Consumed milk (milk or other milk product)	67.0 %	50.3 %	0.0000***
Consumed oils (foods made with oil)	80.0 %	74.5 %	0.0410**
Consumed sugar	88.6 %	89.0 %	0.8317
Any other foods (e.g condiments, coffee, tea)	94.3 %	91.5 %	0.0937*
OVERALL HOUSEHOLD DIETARY DIVERSITY SCORE	**8.73**	**7.37**	**0.0000*** **

CASE STUDY 3

IN MALI, Nkonya et al. (2022) showed that irrigators are more likely to grow vegetables, fruits, and roots and tubers, which may help supply more nutrient-dense foods to the market for wider nutritional impact. In addition, at household level, households with irrigation had significantly better dietary quality and diversity and were more food-secure than non-irrigators. Irrigation also changed land use and labor, as irrigated plots were more intensively used with 22% and 17% higher use of improved varieties and inorganic fertilizers; five times more days/ha of family labor and 2.4 more days/ha of hired labor than non-irrigated plots.

Irrigation and resilience to climate change & weather extremes

Water and food insecurity often occur at the same time, worsening hunger where farmers rely on rainfed production and cannot access irrigation. Droughts cause backsliding from development gains, and push people deeper into poverty. However, Mekonnen et al. (2022) have shown irrigation's role for increasing resilience to drought.

Irrigators in areas affected by the drought were able to maintain their net crop income, area cultivated, share of harvest sold, and Household Dietary Diversity.

In Ethiopia, the researchers showed that among households who reported experience with drought, women in irrigating households had higher dietary diversity scores compared to women in non-irrigating households. In Tanzania, women in irrigating households also had higher women's dietary diversity score (WDDS) compared to non-irrigators and the impact of irrigation on WDDS more than doubled among households facing drought. Moreover, among households in Tanzania who reported having faced a drought shock, irrigating households had higher household dietary diversity (HDDS) compared to non-irrigators. This study highlights the ways in which irrigation contributes to climate adaptation and resilience, and smooths out nutrition during weather shocks.

Recent research has further documented the role of irrigation during the 2016 El Niño Southern Oscillation (ENSO) drought in Ethiopia. Among rainfed farmers, the 2016 ENSO decreased net crop income by 37%; area cultivated reduced by 8% and the share of harvest sold declined by 10%. Overall, this worsened HDDS by 3%.

The study provides evidence that irrigation was a key climate smart agricultural intervention that improved the resilience of farming households in the face of a major weather shocks.

CASE STUDY:

Assessment of WASH-irrigation interlinkages

Irrigators are more likely to have sufficient water available for domestic use and better access to improved sanitation facilities, but the source of water is the key determinant for a household's hygiene practices. Groundwater is an overall better-quality source for domestic purposes than surface water. Moreover, intentional design of irrigation to support WASH outcomes, in the form of a multiple use system, is a promising intervention for improved nutrition. Hygiene practices are independent from the water source; they do not change merely by introducing new access points for water. In order to align development of water sources with health and nutrition goals, behavioral change communication needs to be integrated into projects, including irrigation projects that target improved nutrition.

Where irrigation investments are led by farmers rather than public agencies or non-governmental organizations, initiatives will be needed for broader public messaging on hygiene and health.

For small-scale irrigation to effectively support WASH and, thus, to strengthen nutrition and health outcomes, systems need to be codesigned by irrigation and health specialists, and women farmers who are largely responsible for ensuring WASH need to participate in the design and management of dual-purpose systems.

CASE STUDY:

Irrigation and water pollution

ILSSI's research showed that small-scale irrigation (SSI) improves agricultural production, household income and nutrition. However, SSI is often accompanied by increased use of agricultural inputs (e.g. fertilizer, pesticides) for optimal production. There is a growing concern that use of such inputs may cause freshwater pollution, particularly given household reliance on irrigation water sources and shallow groundwater for domestic uses, including drinking.

Analysis based on household surveys in Ethiopia showed that irrigated crop production may indeed raise the use of fertilizers, mainly through increased cropping intensity in annual crop production. IDSS model analysis showed that small-scale irrigation in the dry season may affect phosphorus and nitrogen loading through consumption by crops, but total nitrogen loading may increase if additional fertilizer is used for dry season crops or through fixation of nitrogen in the case of irrigated legume crops.

The results of the modeling analysis overall show that an expansion of SSI in Ethiopia may create hotspots with elevated water nutrient pollution risk. Thus, irrigation development in Ethiopia, or more broadly in Sub-Saharan Africa, has impacts on the environment that go beyond traditional environmental impact assessments. More efforts need to be taken to ensure the environmental sustainability of SSI.

Entry points for improved nutritional outcomes

The current body of evidence on the links between irrigation, water management, and nutrition provides important clues as to what nutrition sensitive enhancements are needed to achieve greater impacts on early child nutrition. The following approaches are recommended to increase the nutritional impact of irrigation and water management investments.

Providing guidance for irrigation investments that target water, food and nutrition

Overall, through these studies, irrigation is shown to have a strong effect on households' economic access to food and on nutritional outcomes of women and children. With such evidence, policy makers and development partners can begin to shift toward an inter-sectoral approach that jointly plans for and invests in water, food and nutritional security. Thus, **irrigation investments are nutrition-sensitive interventions, in addition to growing yields and incomes.**

In a collaboration between IFPRI and the World Bank, Bryan et al. (2019) developed guidance on how to improve the nutrition sensitivity of irrigation and agricultural water management. The guidance provides entry points [see illustration above] and indicators to monitor the nutrition sensitivity of irrigation. Guidance was contextualized for Mali and shared with key decision makers. Videos complement the guidance for decision-makers facilitating understanding of entry points for improving nutrition through irrigation.

KEY POINT:

Irrigation investments should be intentionally designed to improve nutritional and health outcomes.

This new evidence on the irrigation-nutrition pathways is encouraging. However, it is important to note that these pathways rely on complementary infrastructure and services, and that **potential environmental challenges need to be addressed for irrigation to have lasting impacts on nutrition.** For example, access to markets (income and proximity) is crucial for both the production and income pathways. Evidence from Northern Ghana shows that proximity to markets changes the way productivity and production diversity affect dietary diversity. Production diversity has a stronger effect on dietary diversity in settings with limited access to markets. Moreover, higher income is not necessarily spent on more diverse foods.

Research shows that who controls income has implications for spending decisions. Also, if the additional time women spent on irrigation would interfere with breastfeeding, the timely provision of complementary foods, or other childcare responsibilities, this may have negative impacts on infant and young child feeding. At the same time, to the extent that irrigation reduces women's time use on agricultural activities or on collecting water for domestic uses, additional nutrition benefits could be obtained.

Further research into irrigation-nutrition pathways should incorporate aspects of the local context, including market access, gender roles and preferences, water supply and environmental considerations, and appropriateness of technologies. Moreover, more insights are needed on factors that influence household decisions on food expenditures in different contexts to identify entry points for improving food choices of agricultural households.

CONTRIBUTORS

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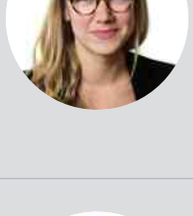
Claudia Ringler is Deputy Division Director of the Environment and Production Technology Division at the International Food Policy Research Institute and the CGIAR Research Program on Water, Land and Ecosystems. A thought leader on water for food, Claudia published more than 100 journal articles in the areas of global water and food security, gender, nutrition, climate change and energy.



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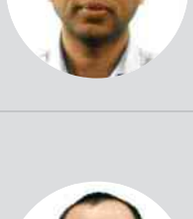
Elizabeth Bryan is a Senior Scientist in the Environment and Production Technology Division where she focuses on climate change adaptation and mitigation and water resourced management. Prior to joining IFPRI, she worked as a consultant for the Poverty Reduction Group of the World Bank where she helped compile a database of impact evaluations. From 2002-2007, she was Program Assistant in the Latin American Program of the Woodrow Wilson International Center for Scholars. Elizabeth received an MA in International Development with a concentration in Development Economics from American University in May 2007.



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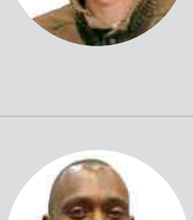

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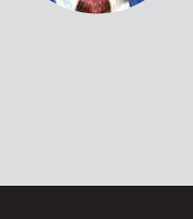

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RESOURCES

Related readings supported by the Innovation Lab for Small Scale Irrigation:

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