Africa Research in Sustainable Intensification for the Next Generation

Sustainable Intensification of Key Farming Systems in the Sudan and Guinea Savannas of West Africa

Technical Report,
01 April 2022 – 31 September 2022

Submitted to
United States Agency for International Development (USAID)

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The Africa Research In Sustainable Intensification for the Next Generation (Africa RISING) program comprises three research-in-development projects supported by the United States Agency for International Development (USAID) as part of the U.S. Government's Feed the Future initiative.

Through action research and development partnerships, Africa RISING is creating opportunities for smallholder farm households to move out of hunger and poverty through sustainably intensified farming systems that improve food, nutrition, and income security, particularly for women and children, and conserve or enhance the natural resource base.

The three regional projects are led by the International Institute of Tropical Agriculture (in West Africa and East and Southern Africa) and the International Livestock Research Institute (in the Ethiopian Highlands). The International Food Policy Research Institute leads the program's monitoring, evaluation and impact assessment.

Africa RISING appreciates support from the American people delivered through the USAID Feed the Future initiative. We also thank farmers and local partners at all sites for their contributions to the program.

Contents

Partners and their roles

Name	Abbreviation	Ghana	Mali	Role/responsibility
Government Ministries & Entities				
Ministry of Food and Agriculture	MoFA	+		Scaling-out SI technologies and establishment of R4D platforms
Ministry of Health (Ghana Health Services)	MoH (GHS)	+		Household nutrition R4D with UDS and IITA; Assist with training of women's groups on nutrition education, data collection, and compilation of reports on activities
Ghana Irrigation Development Authority	GIDA	+		Potential scaling partner for irrigation technologies with IWMI
Veterinary Services Division	VSD	+		Animal health, capacity building community health workers with Animal Research
Institut d'Economie Rurale	IER		+	Socioeconomic and on-farm studies with ICRISAT
Regional Direction of Agriculture in Sikasso	DRA-Sikasso		+	Scale-out provision of secondary data on socioeconomics
Academic/National Research Institutions				
University for Development Studies	UDS	+		Research on livestock nutrition and human nutrition, graduate training and R4D
Science and Technology Policy Research Institute	STEPRI	+		Policy review and analysis
Institut Polytechnique Rural de Formation et de Recherche Appliquée Katibougou	IPR-IFRA		+	Polytechnic for rural education and applied research
Kwame Nkrumah University of Science and Technology	KNUST	+		Graduate student training, research on soil water dynamics
Animal Research Institute	ARI	+		R4D on livestock production (sheep and goats) with ILRI
International Research Institutions				
International Crops Research Institute for the Semi-arid Tropics	ICRISAT	+	+	Sorghum/millet–groundnut R4D with IITA and SARI
International Food Policy Research Institute	IFPRI	+	+	Surveys, and monitoring and evaluation
The World Vegetable Center	WorldVeg	+	+	Lead R4D on vegetable production systems
International Institute of Tropical Agriculture	IITA	+	+	Project coordination and R4D research on cereal–legumes.
International Livestock Research Institute	ILRI	+	+	Lead R4D on livestock, especially ruminants

Name	Abbreviation	Ghana	Mali	Role/responsibility
International Water Management Institute	IWMI	+		Lead R4D on water management
Wageningen University, The Netherlands	WUR	+	+	R4D on farming systems and graduate training
International Center for Tropical Agriculture	CIAT	+		Research on land and soil management
Non-governmental Organizations				
Centre d'Appui a l'Autopromotion pour le Développement	CAAD		+	Scaling out groundnut technologies. Assisting the implementation of animal health and fattening program by ILRI and IER.
Fédération Nationale pour l'Agriculture Biologique et Équitable	FENABE		+	Scaling-out, capacity building, community mobilization, on-farm research
Association Malienne d'Eveil et de Développement Durable	AMEDD		+	On-farm field trials and household nutrition studies with ICRISAT
Le Groupe de Recherches d'Actions et d'Assistance pour le Développement Communautaire	GRAADCOM		+	Scaling out groundnut technologies. Assisting implementation of animal health and fattening program by ILRI and IER.
CARE International	CARE-MALI		+	Disseminate Africa RISING validated technologies in 12 watersheds that constitute 82 villages in Mopti region
Private Organizations and Development Projects				
Community-based Organizations	CBOs	+	+	On-farm implementation of R4D activities
Peace Corps	Peace Corps	+		Introduce Africa RISING technologies to communities they work in
Seed Producers Association of Ghana	SEEDPAG	+		Seed production and training of farmers for quality declared seed
WorldCover	WorldCover	+		Indexed based agricultural insurance, co-sharing of farmers in some communities for synergies
Feed the Future Innovation Labs				
Sustainable Intensification Innovation Lab	SIIL	+		Co-share materials, concepts, and approaches to conducting research, e.g., use of the Sustainable Intensification Assessment Framework
Soybean Innovation Lab	SIL	+		Sharing knowledge and approaches towards postharvest mechanization in communities

Name	Abbreviation	Ghana	Mali	Role/responsibility
Innovation Lab for Legume Systems Research	ILLSR	+		Acting as liaison between the Mission Office and the Innovation lab and conducting joint research activities
Innovation Lab for Small Scale Irrigation	ILSSI	+		Co-location of sites with Africa RISING work and sharing knowledge, approaches, sites, and personnel, e.g., with IWMI

List of validated technologies ready for promotion through development partners in Ghana and Mali

Broad category	**Validated flagship technology**	
	Ghana	**Mali**
Introduction of new crops and varieties to overcome existing biotic and abiotic stresses and improve productivity per unit land area.	• New varieties – drought-tolerant maize, rice, aflatoxin resistant groundnut, sorghum hybrids, early-maturing cowpea, dual-purpose cowpea, short-duration soybean, medium soybean, high yielding, and disease-resistant varieties of improved vegetables (okra, roselle, tomato, eggplant and pepper)	• High performing and dry season-adapted and farmer preferred vegetable varieties of okra (Konni), African eggplant (L10), Tomato variety (Rio Grande) • Aflatoxin resistant groundnut, early maturing groundnut • Sorghum hybrids (Pablo, Fadda and Sewa), dual-purpose sorghum (Soubatimi, Tiandougou Coura, Jiguikala and Peke)
Agronomic practices to improve grain and fodder yield per land area unit and improve soil nitrogen.	• Cereal-legume intercropping • Cereal-legume rotations • Dual-purpose food legumes • Cereal-vegetable intercropping • Cowpea living mulch (Maize cowpea intercrop for NRM and fodder support at household level • Optimal groundnut spacing • Maize leaf stripping for grain and fodder provision.	• Cereal-vegetable intercropping (tomato, pepper) • Cereal-legume intercropping (groundnut) • Dual-purpose food legumes
Integrated soil fertility management as a cost-effective approach to replenish soil fertility.	• Optimized N and P fertilizer rates • Fertilizer micro-dozing • Livestock corralling for manure/urine. • Cereal-legume rotations • Cereal-legume intercropping	• Fertilizer micro-dosing, composting • Cereal-vegetable intercropping (tomato, pepper) • Cereal-legume intercropping (groundnut)

Broad category	Validated flagship technology	
	Ghana	**Mali**
Improved livestock feeds and feeding, housing, health, and breeding management packages.	• Sheep/goat flock feeding package. • Sheep/goat health package • Housing and feeding for poultry. • Guinea fowl hatching and brooding management. • Stover quality improvement • Improved livestock feed troughs for small ruminants.	• Stover quality improvement using feed chopper.
Introduction of pre- and post-harvest technologies to reduce food waste and improve food safety.	• Storage-PICS bags, plastic drums • Aflasafe application • Maize shellers for postharvest support	
The use of natural resources management to preserve soil and water.	• Soil and water conservation measures (e.g., contour bunding, ridge planting, cowpea living mulch)	
Introduction of improved land and water management systems	• Tied ridging and ridge contour cropping	• Contour bunding associated with fast-growing tree species
Seed treatment		• Apron Star 42WS

Summary

This Report provides feedback on implemented work and achievements of Partner activities mapped out against outputs and outcomes in the Phase 2 project log-frame for the 01 April 2022 – 31 September 2022 for the Africa Research in Sustainable Intensification for the Next Generation (Africa RISING) project in West Africa (Ghana and Mali).

Ghana and Mali cross-country summary:

1. **West Africa Handbook:** A "Handbook of agricultural sustainable intensification approaches for farmers in West Africa" was drafted and consensus was achieved in terms of the various team members for each of the Hand Book Chapters. The Handbook can be accessed here: https://docs.google.com/document/d/1HaMpUNUxNxiu8yLDvP2jCZ-gXiHwkGRynMd2J3Q67Jw/edit#
2. For both Countries, the main focus was towards publication of research findings.

Introduction

The United States Agency for International Development (USAID) is supporting multi-stakeholder agricultural research projects to sustainably intensify key African farming systems as part of the US government's "Feed the Future" initiative to address global hunger and food security issues in sub-Saharan Africa (SSA). IITA is the lead institute for developing and implementing the Sudan-Guinea savanna zone project of Africa RISING. The project primarily focuses on the maize/rice-legume-vegetable-livestock and sorghum/millet-legume-vegetable-livestock farming systems in the Guinea and Sudan savanna ecological zones of the West African region using northern Ghana and southern Mali, respectively, as representative implementation sites. Thus, technologies and practices developed from Africa RISING research at the project sites in Ghana and Mali to reduce poverty, food insecurity, and environmental degradation are applicable in other countries with similar biophysical and socioeconomic conditions within and outside the West African region—providing international public goods.

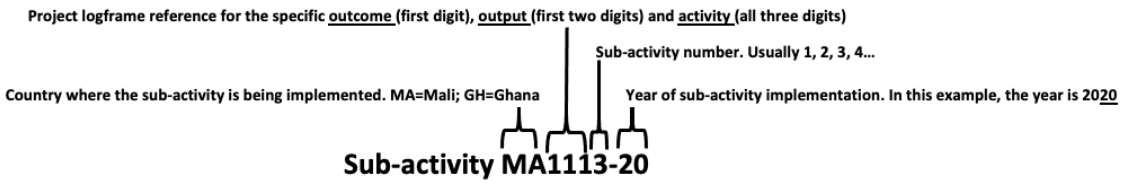
Phase 1 (1 October 2012–30 September 2016) of the USAID-funded Africa Research in Sustainable Intensification for the Next Generation (Africa RISING) project in West Africa (WA) was implemented in 25 intervention communities in northern Ghana and nine villages in the Bougouni and Koutiala districts of the Sikasso Region in southern Mali under the title "Sustainable intensification of key farming systems in the Guinea-Sudano-Sahelian Zone of West Africa".

Phase 2 (1 October 2016–30 September 2021) of the WA project was launched in February 2017. The implementation is guided by achievements and lessons from Phase 1. The activities and sub-activities are mapped under four Outcomes in the Africa RISING West Africa Project Phase 2 logframe. Thirty-four (34) sub-activities are being implemented in the Ghana workplan, while sixteen (18) are being implemented in the Mali workplan. The distribution of the 52 sub-activities per outcome is as presented in Table A below although not all sub-activities are explicitly reported on due to differences in sub-agreement timelines.

Table A: Distribution of sub-activities per West Africa project logframe outcome.

Country	Outcome 1	Outcome 2	Outcome 3	Outcome 4	Totals
Ghana	14	5	6	9	**34**
Mali	10	1	2	5	**18**
Total	**24**	**6**	**8**	**14**	**52**

Each sub-activity in the report is preceded by a label code that is meant to help the reader to gain context about the country of implementation; alignment with specific outcomes, outputs and activities within the project logframe and the relevant year of implementation. This label code is interpreted as shown below.



Linkages among activities, gender mainstreaming, capacity building, and knowledge exchange and dissemination are embedded within all sub-activity plans. Publication of research results and better communication among research teams within and across countries continued to be a major focus.

This report presents progress on implementing sub-activities for the period 01 April 2022 – 31 September 2022 and builds on the technical report for the period 01 October 2021 through 31 March 2022. The Report is presented as sub-activities following similar numbering in the work plans for both Ghana and Mali with a logical sequence to the West Africa log-frame of outcomes, outputs and their associated activities as elucidated earlier.

Implemented work and achievements

Outcome 1: Farmers and farming communities in the project area are practicing more productive, resilient, and profitable and sustainably intensified crop–livestock systems linked to markets

Output 1.1: *Research products for more productive, intensive, diverse, profitable, and resilient crop (cereals, legumes, and vegetables); livestock (sheep, goats, cattle, poultry, and pigs), and integrated crop–livestock farming systems are identified and disseminated to farmers through development partners*

Activity 1.1.1: *Test and disseminate a combination of climate-smart crop varieties and agronomic practices to increase and sustain food and feed production*

Sub-activity MA1111-21: Evaluating crop simulation models using different fertility sources and climate model outputs to improve the productivity of sorghum (Lead institution: ICRISAT)

This sub-activity was concluded with three key outputs:

1. **Steps to Boost Sorghum Productivity in Savanah and Sahelian Region, Mali** produced in French and English languages distributed https://www.slideshare.net/africa-rising/2305-249618456.
2. Publication was finalized ***"Impacts of fertilization management strategies on improved sorghums varieties in smallholder farming systems in Mali: productivity and profitability differences"*** submitted to Heliyon Journal.
3. Work was finalized and a Poster Presentation at an International Conference entitled: "***Modeling approach to evaluate micro-dosing fertilization Strategy on sorghum productivity under the projected mid-century climate scenario in Mali Savanna agro-ecologies"***

Sub-activity MA1112-21: Understanding soil fertility management in cereal cropping systems in southern Mali (Lead institution: ICRISAT)

This sub-activity was concluded with a two key outputs:

1. Biomass and Nutrient Flow Dynamics from Households to Farm Fields: An Experimental Study in Southern Mali resubmitted to Nutrient Cycling in Agroecosystems (FRES-S-22-00016) after revision. This work is based on the Report on Farm Nutrient Dynamics in Southern Mali within this quarter. A manuscript was submitted for Journal publication.
2. Scientific article published in the Journal of Agronomy on Micro-dosing of Compost for Sustainable Production of Improved Sorghum in Southern Mali (https://www.mdpi.com/2073-4395/12/6/1480/htm) This work is based on research from nutrient dynamics from the farm to field have been monitored, composting and its application in a micro-dosing technology was practiced at the technology parks and farmers' fields, and cattle-corralling has been studied to evaluate the productivity of dual-purpose sorghum. The team produced a Report on entitled "Understanding soil fertility management under cereal cropping systems in southern Mali."

Sub-activity GH1113-21: Assessing the potential for a combination of local Napier grass fodder species and pigeon peas for improved soil health and ruminant productivity in the Guinea savannah zone (Lead Institution: UDS-Faculty of Agriculture)

This study was concluded and published as a Journal article and is accessible HERE: Pigeon pea (Cajanus cajan) fodder cutting management in the Guinea Savanna Agro-Ecological Zone of Ghana | SpringerLink.

Further work on this activity entailed engagement of communities on how Napier grass can be produced, chopped, and ensiled for feeding to sheep during times of feed scarcity as demonstrated by the steps shown in Plate 1.

Plate 1: Napier grass from production to ensiling.

Sub-activity MA1113-21: Testing adaptation of dual-purpose sorghum hybrids in Mali to diversify options for crop-livestock integration (Lead institution: ICRISAT)

In Mali, farmers use sorghum and millet as staple food, especially in the rural areas. With the continual increase of livestock coupled with the diminishing natural pastures, crop residues are playing an important role in animal feeding, especially during the dry season. This sub-activity was finalized, data cleaned, analysis concluded, and project team is drafting a manuscript.

MA1113-21: Testing adaptation of dual purposes sorghum hybrids in Mali to diversify options for crop-livestock integration (ICRISAT)

Experiments were conducted under rainfed conditions at the ICRISAT-Mali research station at Samanko (12°34'N, 8°04'W, 330 m), over two consecutive years (2019 and 2020). These trials were laid out in a split-split-plot design where fertilizer treatment (3 levels in 2019 and 4 levels in 2020) was assigned to the main plot, sowing dates to the subplots (3 sowing dates with 2 weeks interval) and varieties to the sub-sub-plot (Soubatimi and Peke). These experiments were described in detail in previous reports. The Project team has published a Journal article: Growing cotton to produce food: Unravelling interactions between value chains in southern Mali. An additional publication is underway.

MA1114-21 Evaluate and disseminate technologies to control vegetable pests and diseases, reduce post-harvest losses and improve human nutrition (Lead: WorldVeg). This sub-activity introduces, evaluates, adapts, and disseminates existing variety disease and pest management, post-harvest technologies and practices. Similar work was conducted in Ghana under sub-activity GH1115-21

Onion is one of the most economically and nutritionally important vegetable crops in West Africa. Onions are very important for consumers due to the antioxidants and compounds they contain that may reduce inflammation, lower triglycerides, and reduce cholesterol levels, resulting in lower risks of heart disease and blood clots. However, high-yielding varieties that are accessible to farmers remain scarce. The objective of the present study was to identify adapted onion genotypes for sustainable production in Northern Ghana and Southern Mali. From the genotype main effects and genotype-by-environment interaction biplots, the best performing lines were AVON1310 (33.32 t.h−1), AVON1308 (28.81 t.h−1) and AVON1325 (31.68 t.h−1). The stability of these lines makes them potential candidates for commercial release in West Africa to contribute to sustainably intensifying onion production in the region. This work can be accessed at: https://www.mdpi.com/2073-4395/12/12/3037

Activity 1.1.2: *Test and disseminate a combination of improved breeds, housing, feeding, health, and breeding practices to intensify rearing of livestock (sheep, goats, pigs, and poultry) for meat, eggs, and milk production*

Sub-activity GH1121-20: Efficient feed utilization through improved feed troughs (Lead Institution: ILRI

The partner finished this sub-activity and published a Journal paper on use of the improved troughs. The work was published in the Tropical Animal Health and Production Journal and can be accessed here: https://link.springer.com/article/10.1007/s11250-021-02847-4. The Publication was building on previous efforts that were summarized in a Technology Brief on Feed and Health package for improved small ruminant production: https://hdl.handle.net/10568/112912

Sub-activity GH1123-21: Assess the effect of feeding maize leaf stripping on digestibility and growth performance of small ruminants and interactions of the technology with child labor (more specifically herding of small ruminants) and school attendance of boys and girls

Three separate experiments were conducted at Duko, Tibali, Cheyohi no. 2 and Tingoli in the northern region to determine the effect of maize leaf strippings on 1) fodder yield, 2) growth performance and digestibility of sheep and 3) carcass and meat/eating quality of sheep supplemented with leaf strippings in the dry season. The treatments consisted of a Control and

Leaf stripping. An area of 4×4 m within each farmer's maize farm was randomly selected and used to determine fodder yield by stripping the leaves below the cob.

An additional paper will be published from this work. This sub-activity entailed some capacity building efforts:

1. A total of 16 farmers (10 males and 6 females) participated in a training program on maize leaf stripping, formulation, and data collection in all 4 AR communities.
2. Two Postgraduate students being trained on forage conservation and utilization in their MPHIL studies.
3. 20 teachers/head teachers were introduced to the concept of the study and made their school registers available for inspection.
4. 20 school enumerators trained on auditing school attendance registers.

Activity 1.1.3: *Test and disseminate integrated crop-livestock-soil and agroforestry systems to increase and sustain productivity and reduce risk*

Sub-activity: MA1131-21: Risk management and informed decision making towards sustainable intensification of crop-livestock systems (Lead Institution: WUR).

Objective: To explore the risk mitigation potential of different diversification strategies in the mixed farming systems of southern Mali

For sustainable agriculture, both yield stability and high productivity are important. In southern Mali, farmers are exposed to many risks. Especially the risk related to climatic conditions is a major problem, resulting in high inter-annual yield variability. Diversification is a common and traditional risk-coping strategy in the region. Nevertheless, the effect of diversification on production variability has not been quantified before. This master thesis, therefore, aimed to explore the meaningful diversification patterns in southern Mali and can downloaded from here: Exploring effective diversification strategies for agricultural risk reduction in southern Mali through modern portfolio analysis. Summarily, the research underlines that only a combination of multiple potential pathways can truly enable SI.

Output 1.2: *Integrated management practices and innovations to improve and sustain productivity and ecosystems services of the soil, land, water, and vegetation resources are developed and disseminated with farmers and development partners in the intervention communities*

Activity 1.2.1: *Test and disseminate land, soil, and integrated land–soil technologies and practices to improve and sustain productivity and ecosystems services at the farm and landscape/watershed levels*

Sub-activity GH1211-21: Assessing buffer and adaptive capacity to harness the resilience of different farm types (Lead Institution: WUR).

In this sub-activity, a draft journal article entitled '*Preparing for, coping with, and bouncing back after shocks. A nuanced resilience assessment for smallholder farms and farmers in Northern Ghana*' has been submitted to a Journal in Feb 2022 and was rejected. The Paper has been resubmitted after review to International Journal of Agricultural Sustainability.

Sub-activity MA1211-21: Determination of cropping management factors using empirical relations, GIS, and Remote Sensing tools in two agro-ecologies of Mali (Lead Institution: AMEDD)

The objectives of this sub-activity include (i) Determination of cropping management factors using empirical relations, GIS, and Remote Sensing tools in two agro-ecologies of Mali; (ii) assess the impact of soil erosion on landscape soils productivity; (iii) Evaluate variations of plant available nutrients, such as carbon, nitrogen, phosphorous, and potassium in different agro-ecologies under different land use systems; (iv) Identify areas affected by soil erosion problems.

Data analysis revealed that, soil water erosion is a common phenomenon, causing problems in the local farming system by reducing agricultural productivity and land degradation. Causes of soil water erosion were discussed in the Focus Group Discussion (FGD), and participants highlighted that deforestation is one of the major contributors to the high rate of erosion. Majority of participants (80%) considered soil erosion as severe, and it is among the factors that decrease productivity and the income of the rural household. Farmers mentioned as recommendation afforestation in a vulnerable area, increase area cover by contour bunding, used plants and stones bound. References to work in support of these achievements can be accessed from:

1. Sanogo, K., Zemadim, B., and Kizito, F. 2021.Vulnerability of landscape patterns from a multidisciplinary approach based on remote sensing and GIS in two agro-ecologies of Mali. Ibadan, Nigeria: IITA. https://hdl.handle.net/10568/113775
2. The team published this work in a manuscript entitled: Landscape pattern analysis using GIS and remote sensing to diagnose soil erosion and nutrient availability in two agro-ecological zones of Southern Mali https://agricultureandfoodsecurity.biomedcentral.com/articles/10.1186/s40066-023-00408-6

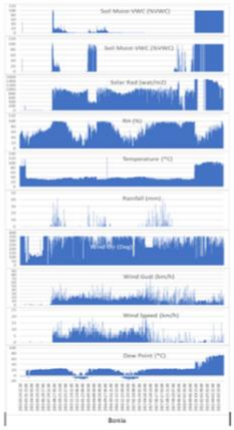
Sub-activity GH1212-21: Assess the impact of soil and water conservation interventions in a maize - cowpea living mulch system (Lead Institution: KNUST)

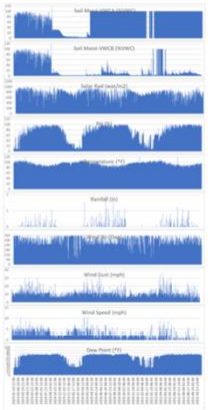
This sub-activity was completed and a guidance manual for extension agents was developed on Soil and Water Conservation Guide Book. The manual is in its final design phase before wider dissemination.

Additionally, a database on land and water management strategies for cereal legume-based farming systems has been compiled. Associated data has been graphed although the trends were not described since there are missing data portions that could introduce potential errors (Figure 1).

Parameters

Parameter	unit	Abbreviation
Soil Moisture-VWC	%VWC	VWCA
Soil Moisture-VWC	%VWC	VWCC
Solar Radiation	wat/m2	SRD
Relative humidity	%	HMD
Temperature	°C	TMP
Rainfall	mm	RNF
Wind Direction	Deg	WND
Wind Gust	km/h	WNG
Wind Speed	km/h	WNS
Dew Point	°C	DEW





Sites and records

Region	District	site	Period		Time step	Records	Condition (remarks)
Upper East	Kasena-Nankana	Bonia	2015.03.24	2015.04.01	15 mins	22,047	
			2015.04.01	2018.10.02	1hour		
			2022.01.01	2022.06.01	1 hour	3,635	
	Kasena-Nankana	Nyangua	2015.10.11	2018.10.03	1 hour	17,590	
			2019.02.01	2022.06.01	1 hour	17,591	
Northern	Tolon	Tingoli	2019.02.10	2021.11.04	1 hour	23,086	
	Kumbungu	Chehoyi No.2	2015.05.16	2018-08.31	1hour	17,592	
	Bongo	Samboligo	2019.02.23	2022.06.02	1 hour	17,593	
	Tolon	Gbanjong	2019.03.18	2020.03.18	1 hour	8,802	
	Savelugu	Tibali	2019.03.18	2021.10.15	1 hour	19,028	
Upper West	Nadowli	Goli	2019.05.26	2022.05.30	1hour	17,590	
	Wa west	Zanko	2016.12.18	2022.05.31	1 hour	17,592	

Figure 1. Screenshot of the parameters, sites and records monitored as well as graphs for the database on land and water management strategies within cereal legume-based farming systems.

The database has been uploaded on Dataverse and an accompanying Report has been compiled. The Report with metadata and summaries can be accessed here.

Sub-activity MA1212-21: Improving crop livestock productivity and household income through the use of contour bunding and agroforestry options (Lead institution: IER-Mali)

This sub-activity was conducted in Mali with the overall objective of improving crop and livestock productivity and household income with contour bunding technology (CBT) and agroforestry options. The major objectives were to assess a) the role of CBT towards increasing households' resilience against droughts, b) evaluate crops and fodder plants growth and yields under CBT, evaluate the effect of micro dosing and intercropping on yields, d) develop a business model on nurseries that engage the youth and women farmers.

References to documents in support of achievements:

1. Traore, S., Zemadim, B., and Kizito, F. 2021.Irrigation technologies for efficient and sustainable agricultural water management in rural Mali focusing on land and soil characterization of potential agricultural investment zones in Bougouni and Koutiala. Ibadan, Nigeria: IITA. https://hdl.handle.net/10568/113774

2. Sanogo, K. and Zemadim, B. 2021. Improved irrigation technologies for efficient and sustainable agricultural water management in rural Mali: Results Based on the Sustainable Intensification Assessment Framework. Ibadan, Nigeria: IITA. https://hdl.handle.net/10568/113759

The project team published this work through a collaborative effort in a manuscript entitled: Contour Ridge Tillage for Improved Crops and Fodder Trees Production in the Villages of Kani and Noumpinesso, Southern- Mali.

Activity 1.2.2: *Test and promote water management technologies and practices to increase water productivity in the small-scale crop–livestock farming systems under rainfed and irrigated conditions*

Sub-activity GH1221-21: Evaluate the technical and agronomic performance of Bhungroo and solar-energy drip irrigation system in the Upper East Region of Ghana (Lead Institution: IWMI)

The sub-activity (GH1221-21) was implemented during 2021/2022 dry season with the main objective of evaluating the technical and agronomic performance of solar-powered drip irrigation system in two communities of Sepaat and Gorogo. The activities conducted included: (a) the assessment of the technical parameters of the Bhungroo; (b) assessment of the water quality and isotope of the Bhungroos (c) determination of the operational performance of the drip irrigation system; (d) evaluation of the agronomic response of the demonstration trials concerning different water application regimes; (e) capacity building for farmers to know and operate the drip irrigation system; (f) Knowledge sharing of the outcomes of the study with stakeholders to advance the research development and use of the irrigation technologies in northern Ghana. The technical and agronomic evaluation activities carried out in the 2021/2022 season were a furtherance of the activities carried out for the same facilities in the 2020/2021 season. Further details on this work are in the Partner Report: Evaluation of the Technical and Agronomic Performance of solar powered Bhungroo with Gravity-Based Drip Irrigation System in Northern Ghana.

- The Technical Guide for Bhungroo can be accessed here

Sub-activity MA1221-21: Evaluate improved irrigation technologies for efficient and sustainable agricultural water management in rural Mali (Lead Institution: ICRISAT)

The main objective was to evaluate existing initiatives and constraints in using efficient and sustainable water management practices using solar energy power pumps and improved irrigation technologies. It combines GIS and remote sensing technologies together with climate information (e.g., solar radiation, hours of sunshine, etc.) to characterize and define suitable zones to implement solar based energy pumps for irrigation in Koutiala and Bougouni. A report titled 'Irrigation technologies for efficient and sustainable agricultural water management in rural Mali focusing on land and soil characterization of potential agricultural investment zones in Bougouni and Koutiala' was published on CG Space.

Sub-activity GH1411-21: Produce regionally relevant extrapolation domain maps for validated integrated technology packages

Mapping the dates and the trends of the onset and cessation of rainfall over space ensure timely delivery of agro-advisories on the cropping calendar activities such as plowing, sowing, fertilizer application, and harvesting. The results revealed that the region's rainfall indices have substantial latitudinal variability with the rainfall onsets recorded at the north of 10^{o} N latitude between 15th April – 25th May, while at the south of 10^{o} N latitude occurred 21st March – 15th April. We observed that daily satellite rainfall (CHIRPS-v2) is biased towards capturing early onsets and late cessations. Therefore, the study recommends bias correction of daily CHIRPS-v2 data for reliable agro-advisories related to targeting climate smart-agricultural technologies. The study considered farmers' perceptions of rain season timing changes, considering that traditional knowledge is an essential trigger of climate adaptation. Farmer perceptions on changing rainfall patterns are a vital determinant of annual cropping decisions. If farmers' perceptions agree with the trends recorded by the observation network, it means more awareness of prevalent trends and a higher likelihood of applying adaptive measures. Farmer's perceptions of trends of onset and cessation of rains showed considerable variation from the gauge data over time and space. This study was published and can be accessed here: Trends of Rainfall Onset, Cessation, and Length of Growing Season in Northern Ghana: Comparing the Rain Gauge, Satellite, and Farmer's Perceptions

Outcome 2: More farmers and farm families are adopting technologies and practices to improve nutrition, food and feed safety, postharvest handling, and value addition

Output 2.1: *Improved technologies, innovations, practices, and habits to increase production and consumption of safe diverse and more nutritious food for farm families, especially by women and children, developed and disseminated in partnership with research and development partners*

Activity 2.1.2: *Increase the capacity of farm families, especially women, to produce and consume diverse and more nutritious food*

Sub-activity GH2121-21: Container gardening training combined with nutrition education for improved vegetable consumption (Lead institution: UDS-SH)

This study built on sub-activity GH2121-20 that investigated the impact of nutrition education through radio broadcastings explaining the preparation and nutritional value of vegetables. The research finding was that the availability and/or own production of vitamin-rich fruits and vegetables is crucial for increasing consumption. Home gardening would be a good alternative, but some households lack access to land. This study evaluated whether training in container gardening combined with nutrition education has an impact on caretakers' nutrition knowledge and attitudes and whether it positively impacts the intake of vitamin-rich fruits and vegetables of children aged between 6-36 months. 422 households were selected in 5 districts in Northern Ghana of which 110 were trained in container gardening combined with nutrition education, 122 were trained in container/ home gardening. This work was published and can be accessed here: Fathers' level of involvement in childcare activities and its association with the diet quality of children in Northern Ghana | Public Health Nutrition | Cambridge Core

Sub-activity GH2122-21: Engaging men to increase support for optimal child feeing practices using the care-group approach/model (Lead institution: UDS-SH)

This sub-activity is closely linked to GH2121-21. Most community programs addressing to improve the well-being of women and children target mothers and their children with little attention to the fathers. This created a situation where the mothers understand nutritional issues better than fathers. In practice, men play a significant role in making household decisions. Study findings suggest that men can act as agents of positive change in support to the women to adequately feed their families. This sub-activity was finalized with a publication entitled: Fathers' level of involvement in childcare activities and its association with the diet quality of children in Northern Ghana.

Output 2.2: *Postharvest technologies and practices to provide options for the food, and feed sectors are tested and disseminated to farmers, through researchers, extension staff, and development partners*

Activity 2.2.1: *Introduce, evaluate, adapt, and disseminate existing postharvest technologies and practices*

Sub-activity GH2211-21: Evaluate the threshing efficiency of different maize shellers with regards to grain quality characteristics as influenced by different varieties and harvest timing (Lead institution: SARI)

This sub-activity is complementary to on-going work being conducted by IITA in Sub-activity 2212-21 entitled "*Monitoring group dynamics among users of small-scale maize shelling machines in Northern Ghana*". This sub-activity examines the emerging role of maize threshing machines in northern Ghana and identifies options to address their accessibility, adoption, and operational efficiency. The study was conducted in four districts in the Northern Region of Ghana. The effect of threshing techniques on efficiency characteristics (damaged grain, whole grain and overall physical purity) was assessed. This study suggests the necessity to upgrade postharvest operations to accommodate emerging developments and dynamics of agricultural intensification where the use of human labor has become costly and less efficient. This study examined (1) the emerging role of mechanized harvesting and threshing operations in northern Ghana and options to address their availability, cost, adoption, and operational efficiencies and, (2) threshing performance characteristics of different maize threshers and socio-economic benefits to farmers. The shelling study has been extended to soybeans and groundnuts. Further details on the training are available in the training of trainees report here

Sub-activity MA2211-21: Reduce vegetable postharvest losses through dissemination of Zero Energy Cool Chamber (ZECC) and processing of vegetables and capacity building in dry season in Bougouni and Koutiala

The objective of this activity was to evaluate the performance of different storage methods on the shelf-life and quality of tomato varieties and to train producers on the use of these technologies. It is comparable with sub-activity GH1116-21.

Two Zero Energy Cooling Chambers (ZECC) were installed in each technology park (Bougouni and Koutiala) and used to set-up the tomato storage experiments. The ZECC installation activities witnessed the active participation of the project beneficiaries who were eager to learn how to install the technology and how it works. Two rounds of storage experiments were conducted in each technology and work for this sub-activity was concluded. The project team is writing up this work for submission of as a peer reviewed manuscript.

Sub-activity GH2212-21: Monitoring group dynamics among users of small-scale maize shelling machines in Northern Ghana

Most smallholder farmers in Northern Ghana do not have access to commercial maize shelling service providers. Consequently, they use the manual method (mainly by using hand or stick) to shell their maize. The manual method consumes a lot of labor time while it is tiresome. Informal interviews we made with farmers show that it takes several days to shell a bag of maize manually. To solve this problem, the Africa RISING West Africa Project donated diesel-powered small-scale maize shelling machines to 18 groups of farmers found in three regions of Ghana (namely, Northern, Upper West and Upper East regions). A two-year study was initiated around the maize sheller user group, work was finalized, data analysis is on-going and will be finalized as a publication.

Outcome 3: Farmers and other value chain actors have greater and equitable access to production assets and markets (input and output) through enabling institutions and policies

Output 3.1: *Improved policies and institutional arrangements to increase participation of farm families, especially women and youth in the output and input markets and decision-making are developed*

Activity 3.1.1: *Review existing policies and institutional arrangements affecting equitable access to production assets and markets.*

Sub-activity GH 3111-21: Strengthen the technical, managerial, and organizational capacities of the major actors in small ruminant value chain through existent institutional structures such as Farmer-based Organizations (FBO), District Assemblies (DA), Community-based Organizations (CBO), Traders Associations, Transport, and Input Dealers Association (Lead institution: CSIR- ARI)

The project aimed to strengthen the technical, managerial, and organizational capacities of major actors in the small ruminant value chain through the use of institutional structures such as Producers' Associations, Value Chain Development Units, District Assemblies, NGOs, and the Department of Agriculture. The implementation team had a meeting with top officers of relevant Departments of Agriculture, a representative of the Minister for Food and Agriculture, and development partners to draw the attention of policymakers to the need to produce a livestock value chain development policy. Resource materials and other policy documents were used in the development of a framework to facilitate the use of the Value Chain Approach for the small ruminant sector in Ghana. Meetings were organized with Cowtribe, CIKOD and the Animal Production Directorate to integrate this project's activities with those of other livestock associations, CIKOD and Cowtribe. Innovation Platform (IPs) meetings were organized for both Navrongo and Wa platforms and the IPs were in the process of being linked to bigger groups to ensure their sustainability. An impact study of the project interventions on the Sustainable Intensification in Agriculture Framework indicators was also done. The project achieved the agenda-setting stage of the policy-making process. A draft manuscript on a comparative study of the performance of the small ruminant value chain in Ghana with that in Burkina Faso has been submitted for publication. In the future, this agenda identified would be developed into a policy document that will guide the development of the livestock value chain in Ghana. If this is done, Ghanaian livestock farmers may become competitive with their counterparts in Burkina Faso.

Sub-activity GH3112-21: Analyze the enabling environment including policies and institutional arrangements and intervention to identify factors that enable the inclusion of women and youth along the irrigated vegetable value chain (Lead institution: IWMI)

In this study, ***a value chain-based scaling pathway*** is defined as a process of designing and implementing a set of strategies and corresponding activities to enable farmers to invest in irrigated farming and commercialize their investment through value chain engagement (Figure 2). Each pathway has one or more strategies to address constraints that limit actor engagement and benefits from their engagement and the chain's performance, create and strengthen linkages between and among chain actors and functions and improve flows of knowledge, resources, products, and distribution of added value. These include improving business linkages and partnerships, strengthening service provision, strengthening the chain's governance structure, and improving policies and the business environment.

The value chain analysis includes mapping the chain structure. ***A value chain structure*** maps the chain's functions, potential actor roles and relevant knowledge and experience, value addition and distribution and governance to determine how to organize the chain. The production analysis emphasizes primary resources required for production, environmental consequences of resource exploitation, primary productivity, potential incomes generated for primary producers and factors facilitating and inhibiting production. Specifically, it needs to investigate what and how irrigated products are produced, and farm size, inputs, services, and resources are required for cultivation. It also needs to examine current irrigation practices, investments, benefits and profits, interest, and willingness to invest, preferences for irrigation equipment and potential financial capital for investment. Finally, it analyses how irrigated products are marketed by investigating market access, marketing, price, and volume of the marketed products.

The irrigation and input supply analysis investigates activities, information and resources involved in moving irrigation equipment, products and services from input and irrigation suppliers to farmers. It also investigates the main actors such as key players in manufacturing, import, wholesale, distribution and retail and the end-user farmers and their interactions. Farmers largely rely on the private sector to access technological innovations and irrigation services. Therefore, insights into inputs and irrigation equipment supply chains can facilitate farmers' access.

The market analysis provides an understanding of market-related factors and determines conditions for products to be successfully produced and capitalized in the chain. It focuses on investigating market structure, demand and supply, specifications and prices and future end-user needs, barriers to entry, market options and market demands and requirements for products to be successfully produced and marketed in the chain. It also studies collection, trading and processing activities and investments needed to leverage the existing local market systems for output market linkages.

The enabling environment analysis provides a foundation and identifies the inputs for the identification of scaling factors. This requires information on incentive structures (value added and benefits for each actor), linkages and power relations in the chain (business practices and relationships among actors, interconnections between chain activities, functions and actors), facilitating services (public sector support to irrigation and agriculture, logistics, transportation, storage, import, export and banking), and the embeddedness environment (informal rules, norms, traditions and cultures, gender and youth roles and involvement).

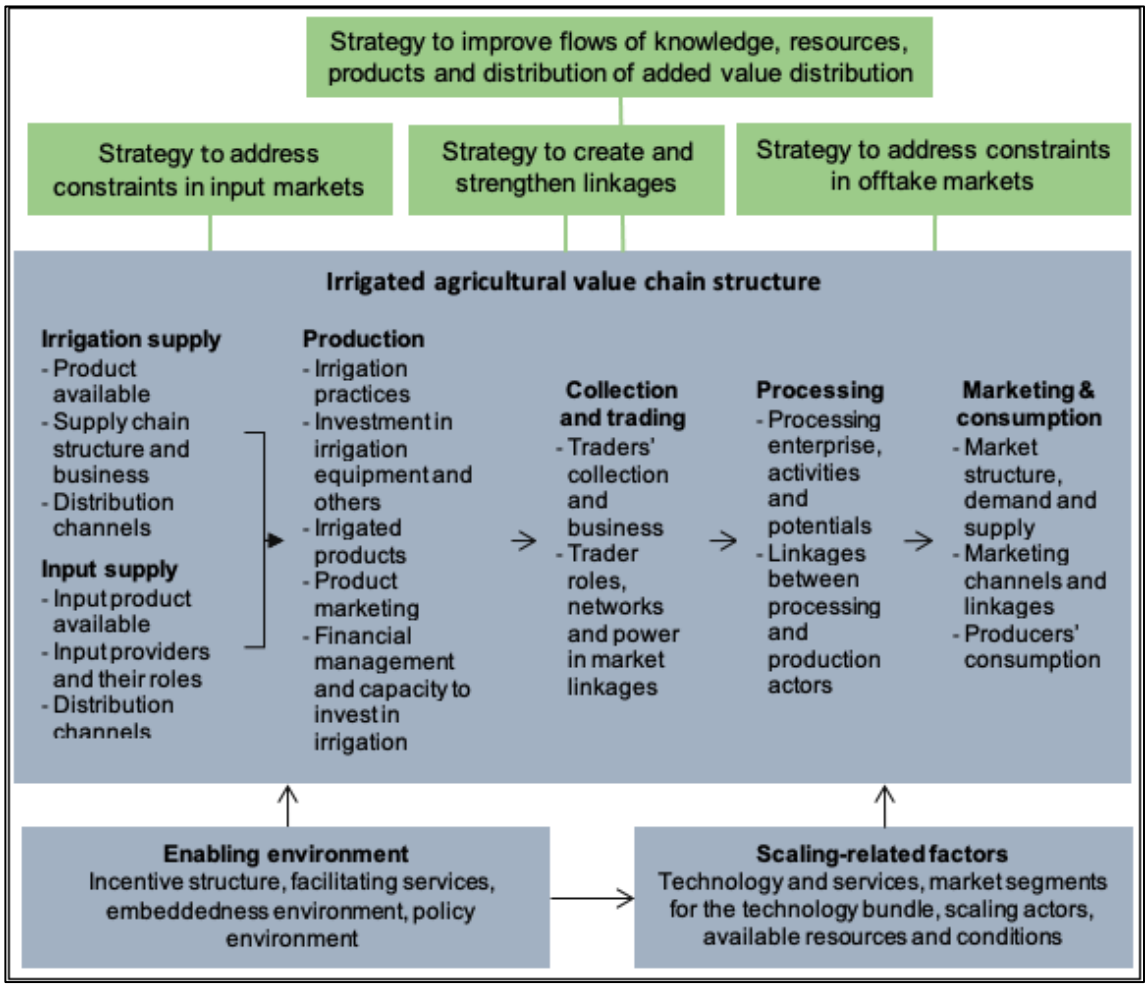


Figure 2. Framework to analyze irrigated agricultural value chain for co-identification of a scaling pathway. **Source:** Author's elaboration.

Scaling factor analysis provides insights to better understand i) how public and private sector engagement could be leveraged in favor of smallholder farmers, ii) how equity and inclusion can be achieved in a way farmers have access to resources and services required for technology access and adoption, especially poor, women and marginalized groups who potentially can be involved in the scaling pathway and what roles they undertake, and iii) what resources are available that can be mobilized for scaling. Hence, it identifies technologies and services and the bundles available and suitable to scale for specific demands and client segments. It also identifies the actors involved and their roles in scaling bundles and how to connect actors and involvement in scaling actions and initiatives.

Methodology: Action research approach
Research process

The research was carried out in the Upper East Region, Ghana in October 2020 by the International Water Management Institute (IWMI) research team. It is an action research approach that has been contextualized to scale irrigation technologies and services in various projects. The research involved four steps as illustrated in figure 2: analyze, co-design, actualize and reflect.

The analyze step aimed at understanding the potential pathways to scaling the best-fit irrigation technologies and services along the irrigated agricultural value chains through carrying out interrelated activities and involving a wide range of actors and stakeholders. In this step, 10 group discussion meetings with farmer communities and 28 semi-structured interviews were conducted involving 150 farmers and 33 individuals representing agricultural value chain actors and stakeholders such as agro-input dealers, borehole drillers and pump repairers, solar partners, traders, and market queens, agricultural extension agents and researchers.

The research team started with investigating irrigated agriculture and agricultural value chains in the Upper East Region, Ghana to map the IVVC structure. Continuously, the in-depth analysis of irrigated vegetable production and the irrigation equipment supply was carried out to scan the best-fit irrigation technologies and services for the region. The scanning involved analyzing the collected data to understand the current irrigation equipment, practices, and investment that farmers are applying and the irrigation equipment and services that private sector companies are supplying. The scanning also looked at the emergent irrigation investment and pointed out the high demand of investing in groundwater and motor pumps for water lifting. Furthermore, the scanning investigated alternative water-lifting technologies that are available in the market and that can reduce irrigation costs for farmers. Finally, the scanning verified the PS2 solar-powered irrigation pumps bundled with pay-as-you-own (PAY-OWN PS2 solar-powered pumps) are the best-fit bundle for the region.

The in-depth analysis also looked at farmers' needs for water for irrigation, their water, and land available, their preference for irrigation equipment, and their financial capacity to pay for the PAY-OWN PS2 solar-powered pumps. This was to categorize market segments for the PAY-OWN PS2 solar-powered pumps by segmenting farmers as potential investors into smaller groups to enable the irrigation equipment suppliers to target them with the right marketing approaches.

The co-design step aimed at co-identifying value chain pathways to scaling irrigation technologies and services and their bundles and link irrigators with input and output markets in the irrigated vegetable value chains in the Upper East Region (Figure 3). This involved conceptualizing the demand-supply linkage pathway and connecting actors and stakeholders to establish and facilitate the scaling partnership. Conceptualizing the scaling pathway involved interactions with the actors identified from the analysis step. Specifically, follow-up meetings were held with members of the managerial board of the Regional Agricultural Extension Department, Ministry of Food and Agriculture (MOFA), identified as the public partner, and with Pumptech Ltd. Ghana, identified as the private sector partner. The purpose of the meetings was to gather demand-supply linkage ideas and co-design a plan to actualize the demand-supply linkage pathway for scaling the PAY-OWN PS2 solar-powered irrigation pumps distributed by Pumptech.

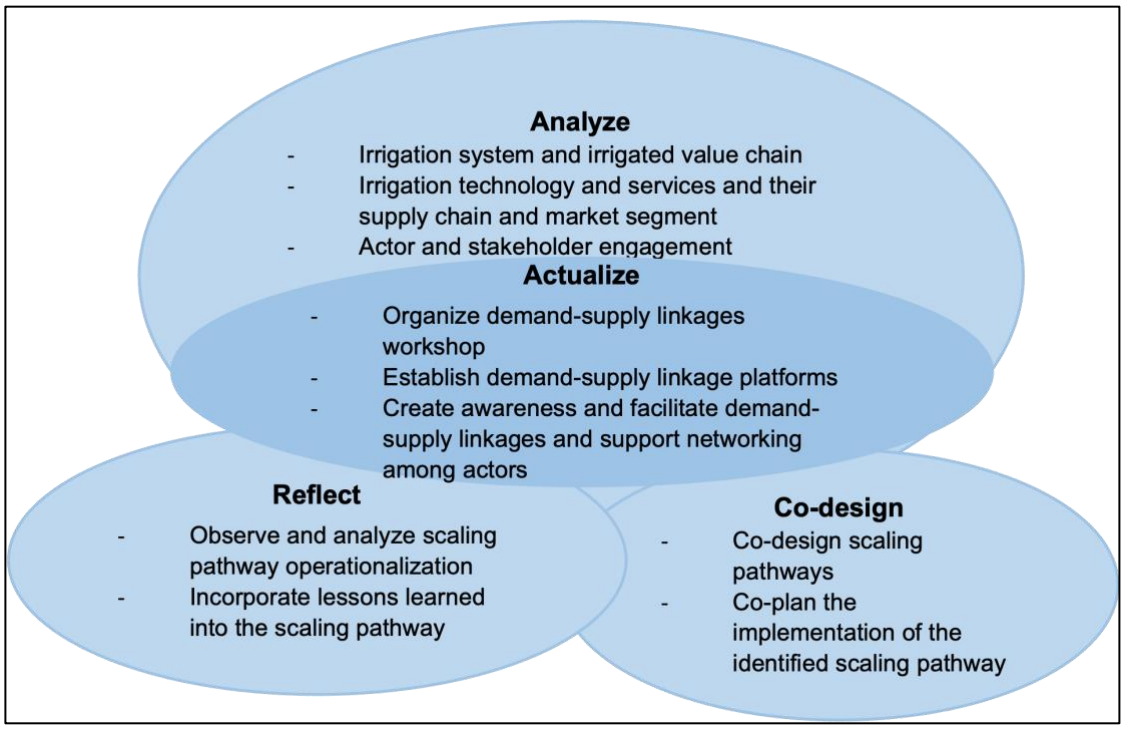


Figure 3. Action research process to co-identify value chain scaling pathway: Steps and activities.

The actualize step aimed at jointly implementing the demand-supply linkages pathway in the Upper East Region and beyond. The implementation began with a series of demand-supply linkage workshops to actualize the scaling of solar-powered irrigation supply chain establishment. Based on the results from the first workshop series, Pumptech continues organizing demonstration workshops with farmers and communities showing interest and did a field survey to further discuss contract terms with potential clients. Pumptech has formed and operated three WhatsApp platforms as a communication channel with their sales and service networks established after three workshops.

The reflect step was undertaken by the IWMI research team and scaling partners throughout the scaling process to assess the PS2 solar-powered irrigation pumps and associated financing and scaling pathway, how to continue the scaling pathway, what the local partners and participants think of the pumps and the scaling approach and how they react. IWMI and Pumptech have also been monitoring water use and environmental sustainability by contextualizing the solar suitability map for the Upper East Region and analyzing water use data collected using the PumpScanner App. The IWMI research team has been analyzing and reacting to critical conditions to optimize scaling to reach the identified market scale and exploring the potential to contextualize the pathway for other regions with the same irrigation conditions. The IWMI research team has been gathering and analyzing feedback from farmers and partners participating in scaling pathways and using it to adapt the pathways and incorporate lessons learned into new scaling pathways to be tested in the future and prepare for further stakeholder engagement events. Further details on this study can be accessed here:

- Demand and Supply Pathways to Solar-based Irrigation Innovations
- Policy linkages for Sustainable Intensification
- The exposure-based pathway to scaling best-fit bundles of irrigation technologies, services, and practices in Koutiala, Mali

Sub-activity GH3121-21: Assess the inclusiveness of women and youth within the vegetable production value chain to enhance vegetable production among smallholder farmers (Lead institution: WorldVeg)

The ultimate goal is to expand women's and youth's incomes and achieve a more balanced value-added appropriation. The involvement of youth and women in the value chain of high-value crops such as irrigated vegetables can sustain production and reduce poverty for poor households. Therefore, there is a need to include both groups within the Upper East and Northern Regions of Ghana as vegetable value chain key players to establish long-term relationships and transform small-scale vegetable production into sustainable businesses. Surveys were conducted in 15 communities (400 respondents in the Northern, Upper East, Upper West- 42% women and 58% men) to understand the constraints vegetable farmers face in assessing seeds and other inputs within the vegetable value chain and Vegetable seed system. Data was collected and analyzed using SPSS V 25. Men, women, and youth definitely occupy different positions in the value chain. Men are more engaged in agro-dealing, women were mostly involved in processing and trading, and the youth in production and transport. This work is being finalized as a manuscript.

Sub-activity GH3122-21: Assess women and youth participation in maize and small ruminant value chains in project communities and the markets the communities are linked to (Lead institution: IITA)

This sub-activity links with many other sub-activities GH 1123-21, GH1113-21, GH2212-21, and GH1112-21 which concerns maize leaf stripping, fodder cultivation, the introduction of feed troughs, N-optimization in maize-based cropping systems. It investigates the gender and intergenerational relations in the maize livestock value chains in communities in which Africa RISING is active and in the markets these communities are linked to. Finalization of this work through a manuscript was halted after the departure of the gender specialist.

Output 3.2. *Options to increase access to production assets and increase participation in decision-making by women, youth, and other vulnerable groups.*

Activity 3.2.1: *Identify constraints to, and opportunities for increasing women and youth access to production assets in the target area.*

Sub-activity GH3211-21: Evaluate risk and vulnerability as well as resilience within maize-cowpea living mulch systems in relation to smallholder farmers' livelihoods. (Lead institution: KNUST)

This sub-activity links with sub-activity GH1212-21 which assesses the impact of soil and water conservation interventions. This sub-activity complements the former in that it evaluates the risk and vulnerability as well as resilience within the maize-cowpea living mulch systems in relation to smallholder farmers' livelihoods. This allows us to explore risk and resilience issues within maize-cowpea living mulch systems and how to reduce vulnerability of smallholder farmers while increasing livelihood opportunities. The work that was conducted for this sub-activity went broader beyond cowpea-living mulch and encompassed other interventions through a region-wide survey that had 545 respondents. Work from this study has developed a synthesis on resilience in smallholder farming systems. The Online version of the Synthesis can be accessed here. In addition, a Journal article that has gone through internal review was submitted to the Agricultural Systems Journal Draft article can be accessed HERE.

Sub-activity GH3212-21: Co-identify value chain-based scaling pathways for irrigation technologies and water solutions with farmers and other actors of vegetable value chains in

the Africa RISING sites in Mali and Ghana and link these sites and activities to ILSSI's multi-stakeholder Dialogue Space on small scale irrigation in Ghana (Lead institution: IWMI)

The irrigated agricultural value chain (IVVC) is crucial in this regard. It currently employs significant numbers of women and youth in both on-farm and off-farm activities and offers opportunities for further development, especially in providing storage, distribution, and marketing services to the subsector. Vegetables also form an integral part of the diet of farming families. Using irrigation to grow vegetables in the dry season not only ensures the nutritional well-being of farming families but also creates an income opportunity for women and youth for between 4 and 5 months of the year. As such, the valuable role of women and youth in agriculture and, specifically, in the IVCC requires policies and interventions that include them. In this activity, we did policy and intervention analysis to understand how women and youth are and are not included in the IVVC in Ghana. Specifically, the analysis aimed to:

- identify strategies used for and gaps in including women and youth in the IVVC,
- understand barriers and opportunities for inclusion, and
- draw recommendations for including women and youth in the IVVC.

In Mali, the enabling environment assessment is being conducted to understand what influences farmers' adoption of irrigation technologies. To ensure youth and gender inclusion in the irrigated vegetable value chain (IVVC) it is necessary to understand the enabling factors but also where in the IVVC these factors contribute to what level of participation. This requires a contextualization of the enabling environment analysis to recognize the enabling factors and link these factors to functions with specific participation levels of youth and women. This activity, therefore, aimed to identify factors that enable the inclusion of women and youth along the IVVC, especially in the output and input markets for irrigated vegetable production. The analysis aimed at:

- characterizing the enabling environment that facilitates the participation of farm families, enables the inclusion of women and youth within the IVVC, and
- identifying factors that enable youth and women's participation in different IVVC functions.

This study assessed the enabling environment for youth and gender inclusion in the irrigated vegetable value chain (IVVC). A total of 40 policy and 48 intervention documents were analyzed. The assessment included policy and intervention analysis using an inventory database template. Cluster and cross-cluster analyses were conducted with a focus on the strategies that enable or hinder women and youth inclusion in the IVVC. Following these steps, the results from the policy analysis were compared with the intervention analysis to complete a synthesis analysis. The latter focuses on the actor and stakeholder landscape, highlighting opportunities and barriers created by the policies and interventions toward an inclusive IVVC.

The findings indicated that Agricultural Value Chains (VC) offer several opportunities for the IVVC. The current policy framework pays little attention to IVVC and is characterized by inconsistency in framing gender guiding principles, including insufficient policies that favor youth and gender inclusion. The current IVVC focus is on a crop diversification strategy where cotton, cereals, and rice receive significant budgetary resources under subsidy programs. IVVC actors are not as well-organized as groups supporting other crops such as mangoes, cashews, and gum Arabic. The challenges to better IVVC coordination include insufficient financial resources, participation related-problems, weak monitoring and evaluation, and the need for improved communication and information among actors. The effects of weak coordination

exacerbated by security problems in some locations have limited the development of irrigation-related infrastructure.

To ensure an inclusive IVVC, it is necessary to:

- Enable a supportive policy and institutional environment and governance mechanisms for youth and gender IVVC inclusion and public and private investment,
- Enable private sector investments in irrigation supply chains, irrigated vegetable value chains, and horticultural subsectors,
- Enhance inclusive interventions to support youth and gender IVVC inclusion and economic empowerment, and
- Transform youth and gender inclusion and economic empowerment at the system level.

Further details on this study can be accessed here:

- Gender and Social Inclusion on Irrigated Vegetable Value Chains (FRENCH VERSION)
- Gender and Social Inclusion on Irrigated Vegetable Value Chains (ENGLISH VERSION)

Outcome 4: Effective partnerships are built with farmers, local communities, and research and development partners in the private and public sectors to ensure delivery and uptake at scale of SI, technologies, innovations, and practices.

Output 4.1: *Alliances and effective partnerships developed between farmers, local communities, and research and development agents in the public and private sectors to enable the release, dissemination, and adoption of proven technologies and practices to scale.*

Activity 4.1.1: *Conduct cost-benefit and gender analysis coupled with other socioeconomic analyses to identify and quantify adoption constraints and opportunities for different farmer contexts.*

Sub-activity GH4111-21: Conduct simulation and other socio-economic analyses of selected SI technologies/practices for different farmer contexts, to have a better understanding of the adoption potential of these proven technologies and opportunities for scaling up (Lead institution: STEPRI).

This study focused this period on two activities a) the dissemination exercise and b) additional analysis of representative technological pathways and gender disaggregated analysis on farmer adoption decisions concerning the Africa RISING Si practices/ technologies. The technologies considered were: 1) row planting of maize and intercropping with cowpea or beans, b) burying of fertilizer along the crop root, 3) use of cover crops and living mulch, 4) use of improved varieties that are early maturing. Further details of this work can be accessed from a these Partner Reports:

- Policy Linkages to Sustainable Intensification 1
- Policy Linkages to Sustainable Intensification 2

Sub-activity MA4111-21: Determine farmers' preferences of technology attributes in cereal-legume systems of southern Mali (Lead institution: ICRISAT)

The objectives of the study are firstly to identify important traits associated with sorghum technologies as perceived by farmers in southern Mali, and secondly to assess the differences in the technology preferences among farmers with respect to gender and other farmer technologies. The study uses two types of data including household survey data and focus group discussion data. The key results from this work were published on CG Space: https://hdl.handle.net/10568/113759

Sub-activity GH4112-21: Evaluate the impact of SI practices on household welfare, poverty, perceived shock, the environment, and food and nutrition security in northern Ghana (Lead Institution: ZEF)

This study concerns the work of a PhD student. Many impact studies on technology adoption focus on yield and gross income. However, relying on gross income alone for policy decision making geared towards scaling out agricultural innovation may lead to spurious and inaccurate decisions since farmers can easily increase income by reallocating resources from other economic activities given the type of technologies they adopt. Also, differences in variable costs and outputs associated with crop production suggest that gross income and yield alone cannot be relied upon for policy decision making. Therefore, to ascertain the benefits of a technology on household income would require estimating farmers' return on investment in addition to gross income. Literature on adoption in sub-Saharan Africa (SSA) has documented several factors (e.g., poor road network, inadequate use of fertilizer, lack of access to new agricultural inputs) that cause low adoption of new agricultural technologies and practices. The literature on adoption focuses less on the type of farm households that need to be targeted during scaling-up. Identifying the farm household type that need to be targeted during scaling-up of agricultural technologies and practices is important since the farming system in SSA is very heterogeneous.

Activity 4.1.2: *Map and assess relevant stakeholders to establish dialogue for the exploration of mutual synergies for scaling delivery of validated technologies.*

Sub-activity GH4121-21: Utilize ICT and GIS tools as a means to share information (agronomic, climatic and market services) and scale-out Africa RISING technologies in collaboration with strategic partnerships in the region

This sub-activity is an integrating activity across the interventions that are promoted in Africa RISING Ghana. It entails working closely with other partners for packaging the right messages, and timing of message delivery to the end users. It also involved awareness raising on the role and benefits of ICT messaging for both farmers and extension officers.

i. Infrastructure for the efficient functioning of the MWANGA Platform is in place. During the reporting period, the **MWANGA Platform** has undergone a process of upgrading the dashboard into a more user-friendly interface. Analytics for completion of platform dashboard designed and in process of completion for Dec. 2022. The platform will also provide farmers with information about when project activities would take place – such as meetings, training opportunities - and will provide a channel for agricultural extension agents, already on the ground, to offer subsequent advice to farmers on agronomic, climate services and market information (https://app.esoko.com/).
ii. Developed guidebook for educating and training farmers on cropping calendars for improved crop productivity. Based on historical cropping calendar, the planting dates and calendar for subsequent cropping activities (including weeding, fertilizer application, pest control and harvesting) and preceding activities (such as land

preparation) have been prepared for 6 major crops (maize, cowpea, soybean, ground nuts, Yam and beans) for 3 regions of Ghana (Upper West, Upper East and Northern). The manual can be accessed here.

Output 4.3. *A framework for monitoring and evaluating technology adoption, and technology-associated risk accessible to the project team and scaling partners*

Activity 4.3.1: Monitor and modify the progress of technology adoption process towards scaling.

Sub-activity GH4311-21: Matching agricultural technologies to farms and their context (Lead Institution: WUR)

This sub-activity provides a brief update on FarmMATCH work. A software engineer has been working with researchers of IITA and IFPRI to prepare data from ARBES and GIS maps and analyzed these data for their use in FarmMATCH. For the testing of the FarmMATCH algorithm, WUR has converted the ARBES data files for Ghana into a relational database (RDB). A draft manuscript has been written, revised, and submitted for publication.

Sub-activity MA4311-21: Sustainable intensification in mixed crop and livestock systems and natural resource governance in southern Mali – Synthesis of interventions (Lead: ILRI)

The objective of this sub-activity is to prepare an overview of various natural resource governance interventions since 2013 in the Africa RISING intervention communities in Bougouni and Koutiala including pertinent recommendations. Some general conclusions about the usefulness of the formalized local conventions, based on group discussions, were finalized and have been submitted for publication in the West Africa Handbook.

Sub-activity MA4313-21: GIS mapping of implemented technologies across different agro-ecologies and gender influence in technology adaptation and use in Bougouni and Koutiala districts of Mali (Lead institution: AMEDD)

The partner had not planned much work for this reporting period. A manuscript on gender dis-aggregated technology adoption for two agro-ecologies in Koutiala and Bougouni districts is under preparation. This sub-activity was carried forward since it was decided to include the analysis of trends of rainfall onsets, cessation, and length of the rainy season from the long-term data obtained from Sikasso, Segou and Mopti regions. This would improve the content of the manuscript under development. GIS maps showing the spatial extent of technology adoption were developed and a journal publication is under preparation.

Sub-activity MA4411: Manage the operations of four technology parks as hubs for innovation, research, extension, advisory, coordination and demonstration in Bougouni.

All technologies tested and validated in the four technology parks of Southern Mali were successful and data was collected to the required standard based on the stated protocols. A total of 332 farmers (30% women; 70% men) participated in the technology validation experiment in the four technology parks. In addition, a farmers' field day (FFD) was conducted in the four technology parks of both districts (Bougouni and Koutiala). In each site had a maximum of 30 participants that was allowed to take part for FFD to minimize the impact of covid-19 pandemic. Hence a total of 120 participants was present for the FFD in the four technology parks. The visited technologies in the parks include contour bunds with fast growing tree species, dual purpose sorghum varieties, sorghum hybrids (Fadda, Tieble and Soumba), and different technologies of ISFM, fodder species that include Brachiaria, Mucuna, and cowpea Sankarannan. Technologies including vegetable sack gardens and postharvest technologies were also visited by participants. This work can be accessed from a photo report.

Communication and knowledge sharing

The main communication channels supported during the reporting period were:

- Wiki internal workspace: http://africa-rising-wiki.net/Program
- Project updates on the program website: https://africa-rising.net/
- Photos: https://www.flickr.com/photos/africa-rising/
- Repository: https://cgspace.cgiar.org/handle/10568/16501

The stories listed below were published and disseminated to stakeholders concerning project activities and outputs.

- How conditional incentives like farmer inputs affect adoption of sustainable intensification (25 October 2022)
- How does access to agricultural markets relate to yield, food security, and poverty in northern Ghana? (23 August 2022)
- Smallholder farmers are interested in sustainable intensification (27 April 2022)

The following meetings and events were held during the reporting period. The communications team supported some of these meetings and events through materials preparation, facilitation etc.

- 1 - 3 November 2022: Africa RISING West Africa Project Close-out Meeting - Bamako, Mali
- 30 August 2022: Africa RISING PCT meeting
- 23 May 2022: Africa RISING PCT meeting

Selected reports and publications

The following peer reviewed journal articles and reports were published by the project team during this period.

Peer reviewed journal articles

- Badolo, F., Kotu, B., Oyinbo, O., Sanogo, K., & Birhanu, B. (2022). Farmers' preferences for sustainable intensification attributes in sorghum-based cropping systems: Evidence from Mali. Renewable Agriculture and Food Systems, 1-12
- Dembele, C.O., Traore, K., Karembe, M., Zemadim, B., Traore, B., Cisse. F. and Samake, O. 2022. Intercropping sorghum and soybean efficiency using contour ridges technology in southern Mali. Journal of Agricultural Science 14(4):126-135.
- Kotu, B.H., Nurudeen, A.R., Muthoni, F., Hoeschle-Zeledon, I. and Kizito, F. 2022. Potential impact of groundnut production technology on welfare of smallholder farmers in Ghana. PLoS ONE 17(1):e0260877.
- Kotu, B.H., Oyinbo, O., Hoeschle-Zeledon, I., Nurudeen, A.R., Kizito, F. and Boyubie, B. 2022. Smallholder farmers' preferences for sustainable intensification attributes in maize production: Evidence from Ghana. World Development 152:105789

Reports, training materials, and briefs

- Grabowski, P., Fischer, G., Djenontin, I. N. S., Zulu, L. Kamoto, J., Kampanje-Phiri, J., Egyir, I. and, Darkwah, A. 2022. A decision makers' guide to equitable sustainable agricultural intensification. IITA, Ibadan, Nigeria