Africa Research in Sustainable Intensification for the Next Generation - West Africa

Research in sustainable intensification of cereal-based farming systems in the Guinea-Sudan-Savanna of West Africa

2018-2019 Research Year Work plans - Mali

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

Through action research and development partnerships, Africa RISING will create 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 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 an associated project on monitoring, evaluation and impact assessment.

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Key partners and their roles

Name	Acronym	Role/responsibility
Government Ministries & Entities		
Institute d'Economie Rurale	IER	Research on crops, livestock, natural resources management and nutrition. Capacity building to graduate students and national partners.
Regional Direction of Agriculture in Sikasso	DRA-Sikasso	Scaling out technologies, provision of secondary data on socio-economics
Academic/ National Research Institutions		
Wageningen University	WUR	Farming systems research, Postgraduate training program. Reports on typologies and farm characterization.
Institut Polytechnique Rural-De Formation et de Recherche Appliquee Katibougou	IPR-IFRA	Undergraduate and postgraduate training program
Non-Governmental organizations & research institutions		
Association Malienne d'Eveil et de Développement Durable	AMEDD	Community mobilization, assisting research activities and implementation of field trials in farmers' field. Facilitating multi-stakeholders interest group meetings. Hosting site coordinators. Capacity building to national partners. Leading implementation of scaling programs in phase II.
Centre d'Appui a l'Autopromotion pour le Développement	CAAD	Scaling out groundnut technologies. Assisting implementation of animal health and fattening program by ILRI and IER.
Fédération Nationale pour l'Agriculture Biologique et Équitable	FENABE	Community mobilization to facilitate implementation of field trials in farmers' field. Work in collaboration with AMEDD on multi-stakeholders interest group meetings in Bougouni.
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.
International Crops Research Institute for the Semi-Arid Tropics	ICRISAT	Mali project management. Consolidation of work plans, technical and financial reports. Activity coordination. Research on crops, natural resources management, socio-economics and scaling strategies. Capacity building to graduate students and national partners.
International Food Policy Research Institute	IFPRI	Support provision to monitoring and evaluation. Guidance on preparation of work plans to fit into FtF and other custom indicators.
International Institute of Tropical Agriculture	IITA	Overall project management and scientific guidance. Approval of work plans, evaluation of approved work plans and timely fund release. Organization of regional planning, review and scientific meetings and exchange visits.
International Livestock Research Institute	ILRI	Research on livestock and scaling out strategies. Capacity building to graduate students and national partners.
The World Vegetable Center	World Veg.	Research on vegetables, nutrition and scaling strategies. Capacity building to graduate students and national partners.

Summary

The Africa RISING West Africa (WA) project is being implemented by multi-disciplinary research teams and development partners from the public and private sectors in collaboration with farmers and community-based organizations in northern Ghana and southern Mali.

This document presents the work plan for the 2018-2019 research year for Mali. The work plan is mapped under the three Outcomes in the Phase 2 project logframe (See Table 1 below). A total of fifteen activity protocols are presented – 11 for Outcome 1; 1 for Outcomes 2; and 3 for Outcome 4.

Gender mainstreaming, capacity building and knowledge exchange and dissemination are embedded in all activity protocol. Linkages between activities are presented in each activity protocol. Publication of research results and better communication among research teams within and across countries will be a major focus.

1. Background

Phase 1 (1 October 2012 - 30 September 2016) and the first year of phase II (1 October 2016 – 30 September 2017) 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 9 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'*. Research activities under Phase 1 were organized around 3 research outputs (ROs), namely: 1) Situation analysis and program-wide synthesis (RO1); 2) Integrated Systems Improvement (RO2) and 3) Scaling and Delivery (RO3). Capacity building and gender were cross-cutting.

Phase 2 (1 October 2016 to 30 September 2021) of the WA project was launched in February 2017. The work plan is organized around 21 activities under 11 outputs to achieve four outcomes (Table 1). Implementation will be guided by achievements and lessons from Phase 1. There will, however, be a shift in approach from Research-for-Development(R-4-D) in Phase 1, to Research-in-Development (R-in-D) in Phase 2.

Technological packages and/or practices validated in Phase 1 (see Table 2) will be scaled out targeting agro-ecosystems and socio-economic circumstances defined by the sustainable intensification (SI) domains - productive, economic, social, human and environmental. Linkages will be established with research and development partners to undertake both generic and back-stopping research. The generic research aims at completing the loose ends of research on the SI innovations in Phase 2 plus any other emerging issues; the emphasis of the back-stopping research will be to address researchable issues emerging from the scaling-out of SI innovations with the development partners.

Table 1: Outcomes, outputs and activities of the Africa RISING West Africa project Phase 2	
Outcome 1: Farmers and farming communities in the project area are practising 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. Activity 1.1.2: Test and disseminate a combination of improved breeds, housing, feeding, health and breeding practices to intensify rearing of livestock (sheep, goat, pig, and poultry) for meat, egg and milk production. Activity 1.1.3: Test and disseminate integrated crop-livestock-soil and agroforestry systems to increase and sustain productivity and reduce risk.
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 to 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. 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 rain-fed and irrigated conditions. Activity 1.2.3: Test and promote integrated soil fertility and integrated pest management technologies and practices to increase and sustain productivity and reduce risk.
Output 1.3: Labor-saving and gender-sensitive technologies in target areas to reduce drudgery while increasing labor efficiency in the production cycle delivered.	Activity 1.3.1: Train local partners on appropriate use of drudgery-reducing technology delivery. Activity 1.3.2: Introduce, test and adapt existing pre-harvest and post-harvest small-scale mechanization options to farmers and partners in the intervention communities.
Outcome 2: More farmers and farm families are adopting technologies and practices to improve nutrition, food and feed safety, post-harvest 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 2.1.1: Develop a nutrition strategy to harmonize the nutrition activities with national nutrition approaches and link them to the crop and livestock activities. Activity 2.1.2: Train farm families, especially women to produce and consume diverse and more nutritious food. Activity 2.1.3: Use nutrition-focused activities as an entry point for greater involvement of younger women and the youth in the production and consumption of diverse and more nutritious foods.

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. Activity 2.2.2: Build capacity of farm families to reduce postharvest losses
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: Enabling policies and institutional arrangements to increase participation of farm families, especially women and youth in the output and input markets and decision-making are advocated for implementation by national governments, policy makers and development partners.	Activity 3.1.1: Review existing policies and institutional arrangements affecting equitable access to production assets and markets. Activity 3.1.2: Identify constraints to and opportunities for improving access to the output and input markets by women and youth in the target area. Activity 3.1.3: Advocate enabling policies and institutional arrangements to increase participation of farm families, especially women and youth in the output and input markets.
Output 3.2: Options to expand accessibility of production assets and increase participation in household decision-making by disaggregated groups by gender.	Activity 3.2.1: Identify constraints to, and opportunities for increasing women and youth access to production assets in the target area.
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 the 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 socio-economic analyses to identify and quantify adoption constraints and opportunities for different farmer contexts. Activity 4.1.2: Map and assess relevant stakeholders to establish a dialogue for the exploration of mutual synergies for scaling delivery of validated technologies. Activity 4.1.3: Leverage/link and integrate (engagement and outreach) with existent initiatives including Government extension systems to support and encourage the delivery pathways.
Output 4.2: Gender-sensitive decision support tools to assess technology-associated risks and opportunities are available for use by project partners.	Activity 4.2.1: Identify and communicate gender-sensitive decision support tools in the context of different farm typologies.
Output 4.3: An updated framework for monitoring technology adoption to be used	Activity 4.3.1: Monitor and report technologies and their associated beneficiaries or farmers exposed to the innovations using the tools developed by IFPRI

by the project team and scaling partners available and accessible	Activity 4.3.2 Make these reports available on the Africa RISING repositories
Output 4.4: Knowledge sharing centers (physical structures) and learning alliances are developed within existing local and regional institutions	Activity 4.4.1: Establish knowledge-sharing and learning alliances among scaling actors.

Table 2: List of validated technologies ready for promotion through development partners in Bougouni and Koutiala districts

Broad category	Validated flagship technology
Introduction of new crops and varieties to overcome existing biotic and abiotic stresses and improve productivity per unit land area	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 unit land area, and improve soil nitrogen	Cereal-vegetable intercropping (tomato, pepper) Cereal-legume intercropping (groundnut) Dual-purpose food legumes
Integrated S*triga* and soil fertility management as a cost-effective approach to replenish soil fertility	Fertilizer micro-dosing, composting Cereal-vegetable intercropping (tomato, pepper) Cereal-legume intercropping (groundnut)
Improved livestock feeds and feeding, housing, health and breeding management packages	Stover quality improvement using feed chopper
Introduction of improved land and water management systems	Contour bunding associated with fast-growing tree species
Seed treatment	Apron Star 42WS

2. Planned work

The planned activities are presented in protocols. Activities under each protocol are aimed at achieving the outputs under the outcomes in the project logframe (Table 1).

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.
a. Output 1.2:	Integrated management technologies and practices 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.
b. 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.
c. Sub-activity MA1212-18:	Improving crop livestock productivity and household income through the use of contour bunding and agroforestry options.

d. Research team

Name	Institution	Role
Kalifa Traore	IER	Activity leader
Oumar Samake	IER	Field implementation

e. Student(s)

Name	Institute	Degree	Start	End
Cheick Oumar Dembele	IER	PhD	2017	2020
Fotigui Tamboura Cisse	IER	MSc	2018	2019

f. Location(s)	Bougouni and Koutiala
g. Start	March 2017
h. End	April 2019

1. Justification

Key elements to ensure sustainability of agriculture-livestock systems are adequate production of quality forage for animal supplementation but also the availability of water and soil nutrients (Penning de Vries and Djiteye, 1982). Among these quality forages, fast-growing nitrogen fixing tree species and herbaceous plants occupy a prominent place. According to Breman and Kessler (1995), the power to concentrate and save nutrients, produce and maintain high biomass quantity exceeds far that of cereals and other grass species. All the fast-growing nitrogen fixing trees (FGNFT) are not acceptable to livestock because of nitrogen content and availability.

A study on fodder yield and nutritive value of many trees species in west African humid areas (Larbi et al., 2005), showed that *Gliricidia sepium and Leucaena leucocephala,* were identified to have high potential for the development of integrated crop-livestock agroforestry technologies because of fodder yield, concentrations of CP, NDF, ADF and lignin. Larbi et al. (2005) reported that coppicing regrowth of these species could be harvested between 16 and 20 weeks to maximize yield and quality of the fodder. In Western Kenya, a biomass yield of 21 tons ha^{-1} was observed with *Sesbania sesban* on many nutrient-depleted soils (Sjogren et al., 2010). It is in this context that we propose to study possibilities of introducing fast-growing forage tree species in farmer's fields under Contour Bunding (CB) techniques.

Traore et al (2017b) reported that water storage was always higher in CB plots compared to control plots with a surplus of 0.23 mm day^{-1} in 2012 and 0.43 mm day^{-1} in 2013 in the CB plots over the monitoring period in the Cinzana sahelian area of Mali. Also, millet grain yield in 2012, 2013, and 2014 was statistically higher in CB plots compared to the control with yield difference ranging from 301 kg ha^{-1} in 2012 to 622 kg ha^{-1} in 2013. These values corresponded to an increase of 60 and 56%, respectively. Concerning sorghum grain yield, it increased consistently from 461 kg ha^{-1} in 2012 to 1378 kg ha^{-1} in 2014. Moreover, the qualitative assessment done by farmers on the effects of CB revealed that rain water was kept between contour ridges reducing runoff and consequently increasing infiltration and producing higher crop yields (grain and straw) in contoured plots than in the control plots. Also, with the use of CB, soil moisture was found to be better conserved and allowed field operations for an extended 7 to 10 days (Traore et al., 2017a).

2. Objectives

2.1 Monitor growth and quantify forage production of fast growing trees species *(Gliricidia sepium and Leucaena leucocephala)*

2.2 Increase crop yield through improving rainwater conservation in improved cropping systems
2.3 Study the effects of fast growing trees species on soil physicochemical properties
3. Research questions
3.1 How can the use of Contour Bunding Technology (CBT) increase crop grain and straw biomass yield?
3.2 Does the use of CBT increase trees growth and biomass?
3.3 Does the use of CBT improves soil physical and chemical properties?
4. Procedures (survey methods, gender disaggregation, treatments, experimental design, sample size, etc.)
Twenty collaborative farmers will be chosen in two villages because this number is what is feasible with accurate data according to the experiment type. Prior to implementation, soil sampling will be performed using an auger at 0-20 cm and 20-40 cm depth and samples will be send for physicochemical analysis in the Soil-Water - Plant Laboratory of IER. The field of each farmer will be divided in two parts. The first part is under contour bunding (CB), i.e. ridges follow contour lines, and the second one with farmer's practices labeled as non-contour bunding (NCB) implemented as a control. The contour lines will be planted with fast growing trees species chosen by farmers, such as *Gliricidia sepium* and *Leucaena leucocephala*. Trees species will be planted on the crest of the contour bund which will be 0.8 m width and 100 m length. Distance between trees species will be 3 m. Trees will not be planted in the 10 x 4 m plot but along the contour bund. Therefore, 17 trees will fit into a 40 m^2 area along the contour bund. In each part, 10 trials based on cotton or sorghum intercropped with soybean will be implemented regarding the activities of the PhD thesis. In each trial only the inputs (fertilizer, pesticides) will be supplied by researchers, all the other factors (crop species, varieties, tillage technique, maintenance, etc.) will be those of farmers. In two fields, soil moisture will be monitored using TDR probes in CB and NCB plots.
Data will be analyzed using STATBOX 7. Analyze of variance will be used to assess performance of treatments and means comparison by LSD procedure.

5. Data to be collected and uploaded	Responsibility/Institute
5.1 Biophysical data: height, basal diameter, crown radius and diameter at 1.3 m height when possible) will be performed on fast growing trees species starting at their plantation date.	IER
5.2 Cultural operations: Plowing or ridging date, planting date, emergence date, thinning date, planting density, plant density at harvest, plant height, grain yield, straw yield, thousand grain yield.	IER
5.3 Soil physical and chemical properties	IER
5.4 Soil moisture content	IER
5.5 Trees biophysical parameters	IER
5.6 Crop yield (straw and grain)	IER

6. Milestones

Deliverables	Means of verification	Date
6.1 Report	Interim report submitted to ICRISAT	Dec. 2018
6.2 Data on agronomic and tree growth	Data uploaded on Dataverse	Dec. 2018
6.3 Recommendation of best agro-forestry technology in combination with CBT	Report and brief to be uploaded on Africa RISING West Africa Wiki page	Mar. 2019
6.4 Farmer exchange visit	Field visit , technical report and IER's yearly Committee of Program report to be uploaded on Africa RISING West Africa Wiki page, pictures (photo and film)	May 2019 (Africa RISING technical report), Jun. 2019 (IER's yearly Committee of Program report)

7. Sustainable intensification indicators	
7.1 Productivity	Crop production (yield), input use efficiency, cropping intensity at farm level
7.2 Environmental	Soil quality (nutrients level) at plot level

7.3 Economic	Profitability, returns to land, labor and inputs, diversification of income at household level
7.4 Social	Gender equity, social cohesion at household level
7.5 Human	

8. How will scaling be achieved?
In September, when there is very little field work, a farmer exchange visit will be organized to show the growth and development of the different fast-growing trees species planted on the crest of the contour line. They will be trained on how and when to start the nursery and trees plantation. In each village, at least 40 farmers will be part of the exchange visits. Farmers who have developed interest on the technology will be recorded and new materials (brief notes) will be made available for them.
9. How are the activities in this protocol linked to those of others?
This activity is linked to improve crop livestock interaction to help agricultural activities and also small ruminant fattening.