AFRICA RESEARCH IN SUSTAINABLE INTENSIFICATION FOR THE NEXT GENERATION (AFRICA RISING)

USAID-Feed the Future SUSTAINABLE INTENSIFICATION IN AFRICA

MONITORING AND EVALUATION REPORT

(October 2014 – September 2015)

February 3, 2016

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 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. http://africa-rising.net/

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Acknowledgments

This report was prepared by the Africa RISING M&E team at IFPRI (in the Environment and Production Technology Division). The report was coordinated and prepared by Cleo Roberts under the guidance of Carlo Azzarri and Beliyou Haile. Apurba Shee and Sara Signorelli contributed to various chapters. Ivy Romero provided excellent assistance in various aspects of the planning, management and administration of the M&E project.

Executive Summary

Africa Research in Sustainable Intensification for the Next Generation (Africa RISING) is a research-for-development program designed to pilot potential interventions for sustainable intensification of mixed crop-tree-livestock systems and provide data and information that will lead to the better design of development projects. The program comprises three linked projects covering West Africa (Ghana and Mali), East and Southern Africa (Malawi, Tanzania and Zambia) and Ethiopian Highlands).[1] The primary hypothesis of the Africa RISING Program is that sustainable intensification of mixed crop-tree-livestock systems leads to increased whole farm productivity, which in turn leads to development outcomes (improved welfare) such as improved livelihoods (income, assets, capacity etc.) and better food and nutrition security for those who depend on these systems. Africa RISING researchers are testing these hypotheses by implementing baskets of interventions in selected communities.[2] The Spatial Data and Analytics team at the International Food Policy Research Institute (IFPRI) leads an associated project on monitoring and evaluation (M&E).

This report, by summarizing M&E activities in Fiscal Year 2015 (FY 2015) and projecting M&E activities planned for Fiscal Year 2016 (FY 2016), provides clarity about the M&E team's mandate. Based on the experience over the period 2011-15, the IFPRI M&E team has recommended refreshing its mandate to reflect the role the Institute is best suited to play, avoid possible misalignments of expectations and deliver high-quality products that could effectively serve the program.

M&E Activities in Fiscal Year 2015

The AR M&E team conducted a broad range of activities in FY 2015. These activities involved data management for the entire Africa RISING (AR) program through the publication of data in the public repository CKAN, the submission of Feed the Future (FtF) indicators to the FtF Monitoring System (FtFMS), and the visualization of AR data on the Project Mapping and Monitoring Tool (PMMT). Additionally, the M&E team has cleaned, documented, analyzed, and widely shared data from the five Africa RISING Baseline Evaluation Survey (ARBES) datasets. These datasets, collected from mid-2013 to the end of 2014, provide a wealth of information about AR beneficiaries, their communities, and comparable communities to which AR could potential scale up and out. In addition to sharing these data with colleagues at universities and research institutes, the M&E team has provided feedback to some communities in Malawi who participated in data collection. In the same vein, the M&E team has provided

[1] The three projects are: the cereal-based farming systems in the guinea savannah zone of West Africa covering northern Ghana and southern Mali; the cereal-based farming systems in East and Southern Africa covering Tanzania, Malawi, and Zambia – both led by the International Institute of Tropical Agriculture (IITA); and the crop-livestock systems to improve food security and farm income diversification in the Ethiopian highlands – led by the International Livestock Research Institute (ILRI).

[2] Please note that the definition of a community varies among countries, depending on the local administrative and geographical arrangements.

policy briefs for the stakeholders and the public. The team will continue many research papers started in FY 2015 during FY 2016.

Brief Summary of FY 2015 Activities:

- **Cataloguing of AR data**: To comply with the program's approved Data Management Plan, the M&E team has initiated a process to adapt all AR data gathering needs to ILRI's datasets portal CKAN. CKAN is a data repository accessible by all Africa RISING researchers. Here, AR researchers and the general public can access the datasets generated by the program. Users will be able to access the meta-data (i.e., information about the data) even before the datasets are published.
- **ARBES data cleaning and documentation**: The M&E team spent considerable effort in 2015 validating and cleaning the Africa RISING Baseline Evaluation Survey (ARBES) data and putting together accompanying documentation.
- **ARBES data sharing**: The M&E team shared cleaned and partially cleaned ARBES data with numerous researchers within and outside Africa RISING. In addition, the M&E team has constructed agricultural and socioeconomic variables, which it has shared with multiple researchers and with the communities in East and southern Africa where data was collected.
- **ARBES presentation to farmers in Malawi**: The M&E team presented summaries of AR baseline household and community survey data in Dedza and Ntcheu districts in Malawi. The presentations were done in local dialect in six EPAs.
- **Production of sustainable intensification templates at the household and community levels**: The M&E team developed a set of sustainable intensification (SI) indicators capturing information on five core domains: productivity, economic, environmental, social and human capital. The team also developed a practical tool for the collection of supporting data at the household and community levels.
- **Updates to Africa RISING Project Mapping and Monitoring Tool (PMMT)**: The project mapping and monitoring tool (PMMT) is developed to aid project monitoring efforts within and outside AR and is intended to help users (project managers, donors, researchers, data analysts, and stakeholders in general) to understand where and how AR activities are taking place. Based on feedback received from Africa RISING researchers, the M&E team oversaw another round of updates in 2015. Updates include: the separation of the mapping and data report applications to improve speed; embedding of consistency checks; and offline functionality. All updates are designed to be especially useful to researchers with limited internet access.

- **PMMT trainings to AR researchers**: The M&E team organized two-day, in-country trainings for AR researchers in all of the Africa RISING project countries.
- **Reporting and processing of 2014 FtF indicators through the PMMT**: The M&E team aggregated Feed the Future (FtF) data submitted by individual researchers, then uploaded it onto USAID's FTF Monitoring System portal and the PMMT.
- **Africa RISING Policy Briefs**: Based on findings from ongoing research activities, the M&E team produced policy briefs, which inform stakeholders and the public about AR M&E and support the preparation of Africa RISING Phase II.
- **Ongoing Research Papers, Proposals, and Concept Notes**: The M&E team worked on a number of research papers during Fiscal Year 2015, many of which are under review or revision at a peer reviewed journal. These research activities will continue during Fiscal Year 2016.

M&E Activities Planned for Fiscal Year 2016

During FY 2016 the M&E team will maintain its role in cataloguing AR-wide data through CKAN and reporting indicators to USAID. To ensure the accurate sharing of information about program beneficiaries among AR researchers, the M&E team is working to develop a system that all partners can agree upon and implement. Furthermore, the M&E team intends to continue research and communication activities begun in FY 2015. The team will focus on finishing the research papers started in FY 2015 and begin new papers throughout the year. To facilitate planning and information sharing, the team will continue to attend AR program and project meetings. Beyond these meetings, the M&E team will pursue partnerships and collaborations on research topics of interest with AR colleagues and with other universities and research institutes.

Brief Summary of Planned FY 2016 Activities:

- **Cataloguing of AR data through ILRI's CKAN**: In collaboration with ILRI, the M&E team will continue facilitating the uploading of all AR data collected onto ILRI's CKAN since the program's onset.
- **Reporting of 2015 FtF indicator data**: The M&E team expects to continue working with the research teams to compile 2015 FtF indicators data through the PMMT for reporting to donor.
- **Development of beneficiary tracking system**: Over the course of Fiscal Year 2016, the M&E team will work with the research teams in all mega sites to develop an offline beneficiary tracking system. This system will allow the M&E and research teams to track AR beneficiaries using the same identifiers.

- **Research and communication**: The M&E expects to spend significant time in 2016 pursuing and expanding various research studies initiated in 2014 and 2015. Results from these research studies will be communicated with researchers (both within and outside of Africa RISING) and the general public using various outlets.
- **Attend program- and project-level meeting and field trips**: The M&E team will continue to actively participate in various Program- and Project-level meeting and field visits to project sites to better understand the research activities. The team's continued presence and participation in these meetings will facilitate communication between the research teams and the M&E team about research activities on the ground. It will also help the M&E team tailor M&E activities to the needs of the research teams.
- **Partnerships and collaborations**: The M&E team will continue pursuing and exploring collaborations with organizations working in areas of common interest. Many research collaborations with AR researchers on various research topics of common interest are already in progress, with FAO, MSU, World Bank, Wageningen University, Georgetown University, Conservation International, and the Earth Institute at Columbia University (Vital Signs project).

FY 2015 was a productive year for the M&E team, with considerable effort and investment made to analyze baseline data from three program countries (Ghana, Malawi, and Mali). Also, the M&E team's documentation of project locations and activities through the PMMT is enabling users to understand where and how Africa RISING activities are taking place, and improve project strategies and partnerships for greater impact. Yet the M&E team is aware that there remains a need to integrate M&E actions into the program's activities on the ground. Challenges in doing so stem from the systems-based nature of AR SI innovations, which involve complex sets of tangible and intangible elements combined with scientific guidance. While some elements of these innovations may be discrete and easy to identify (for example, a specific crop variety or inorganic fertilizer), the way individual elements interact in a system to create synergistic effects is requires greater efforts and collaboration. IFPRI's M&E team is confident that its continuous efforts will have high payoff and be greatly informative of the targeting criteria and the expected impact across program countries, the characteristics of adopters of sustainable intensification innovations (relative to the underlying population of smallholders), the agronomic and economic effects of these innovations, as well as the implications of targeting for scaling up. Past and current M&E actions have the potential to establish proof of concept, according to which, similar methods and approaches can be applied not only within AR but also in other similar systems-based SI programs.

1. Introduction

Africa Research in Sustainable Intensification for the Next Generation (Africa RISING) is a research-for-development program designed to pilot potential interventions for sustainable intensification of mixed crop-tree-livestock systems and provide data and information that will lead to the better design of development projects. The program comprises three linked projects covering West Africa (Ghana and Mali), East and Southern Africa (Malawi, Tanzania and Zambia) and Ethiopian Highlands).[3] The Spatial Data and Analytics team at the International Food Policy Research Institute (IFPRI) leads an associated project on monitoring and evaluation (M&E), while Wageningen University leads farming systems modeling efforts. The Spatial Data and Analytics team has acquired work experience over the past five years in developing data and analysis systems to support investment decision targeted to enhancing agricultural productivity and increased value-chain participation by smallholder farmers in sub-Saharan Africa.

The primary hypothesis of the Africa RISING Program is that sustainable intensification of mixed crop-tree-livestock systems leads to increased whole farm productivity, which in turn leads to development outcomes (improved welfare) such as improved livelihoods (income, assets, capacity etc.) and better food and nutrition security for those who depend on these systems. It is further hypothesized that a combination of relevant interventions is more likely to increase whole farm productivity than single interventions.

Africa RISING researchers are testing these hypotheses by implementing baskets of interventions in selected communities.[4] Within a community, interventions will be 'offered' to volunteers, with the type of interventions and delivery methods expected to vary across time, space, and local context. Interventions will also vary based on the farm/household typology that will classify farm households 'sufficiently similar' in relation to expected effects of the Program. Farming systems analysis and modelling will be used to help identify and target appropriate interventions across different farm types and to perform ex-ante impact analysis. Crop modeling analysis can also be applied.

This report summarizes M&E-related activities undertaken in Fiscal Year 2015 and discusses M&E activities planned for the Fiscal Year 2016. The rest of the report is organized as follows. Section 2 provides a brief overview of Africa RISING M&E goals and objectives. Section 3 summarizes M&E activities undertaken in Fiscal Year 2015. Section 4 outlines M&E activities planned for Fiscal Year 2016. Section 5 concludes the report.

[3] The three projects are: the cereal-based farming systems in the guinea savannah zone of West Africa covering northern Ghana and southern Mali; the cereal-based farming systems in East and Southern Africa covering Tanzania, Malawi, and Zambia – both led by the International Institute of Tropical Agriculture (IITA); and the crop-livestock systems to improve food security and farm income diversification in the Ethiopian highlands – led by the International Livestock Research Institute (ILRI).

[4] Please note that the definition of a community varies among countries, depending on the local administrative and geographical arrangements.

2. M&E Activities in Fiscal Year 2015

2.1 ARBES Data Cleaning and Documentation

The M&E team spent considerable effort in 2015 validating and cleaning the Africa RISING Baseline Evaluation Survey (ARBES) data and putting together accompanying documentation. Given that the ARBES surveys were conducted electronically, the team reviewed and updated paper versions of the questionnaires to make them consistent with programed and fielded electronic versions. The main tasks involved in the data cleaning process include: (1) organization of raw data from the different modules of the household and community questions into separate Stata files (in "long format"), based on the level at which data were collected, (2) ensuring that each data file has unique identifying variables (e.g., for households, individual household members, parcels, plots) to enable merging of data files from different sections, (3) construction of metric conversion factors for production and consumption based on conversion data collected through the ARBES community survey and secondary sources when necessary, (4) re-organization of data files to fit requests by a number of data users both within and outside Africa RISING.

2.1.1 Cleaning of Ghana and Mali ARBES Datasets and Production of Survey Reports

The M&E team cleaned and documented all the household and community modules of the Ghana and Mali ARBES (GARBES and MARBES, respectively). In addition, the team produced a survey report for each country containing information on the survey design and data collection as well as presenting the main trends emerging from the data. Table 1 and Table 2 show examples of the statistics produced for GARBES and MARBES, respectively.

Table 1: Main crops and cultivation practices of households in GARBES

	Control	ARNB	AR2013	AR2014	Total
Average cultivated area by crop (ha)					
maize	1.39	0.92	0.95	0.8	1.1
groundnut	0.44	0.43	0.48	0.38	0.44
rice	0.47	0.35	0.39	0.34	0.41
Soya bean	0.25	0.11	0.17	0.09	0.18
bean	0.14	0.13	0.17	0.17	0.15
Pearl millet	0.19	0.08	0.11	0.06	0.13
yam	0.1	0.12	0.11	0.09	0.11
Intercropping					
Average number of intercropped plots	0.44	0.39	0.37	0.33	0.4
Average area of intercropped plots (ha)	0.63	0.39	0.38	0.29	0.47
Percentage of households practicing intercropping	32	30	29	28	30
Percentage of households' plots that are intercropped	20	19	16	15	18
Total number of households	500	182	454	148	1,284

ARNB = Non-beneficiary living in Africa RISING site; AR2013 = Africa RISING 2013 beneficiary; AR2014 = potential Africa RISING 2014 beneficiary

Source: ARBES 2014

Table 2: Main crops and cultivation practices of households in MARBES

	Treat	Control	Total
Average cultivated area by crop (ha)			
maize	2.02	2.05	2.03
groundnut	1.06	0.78	0.92
sorghum	2.3	2.55	2.42
cotton	2.41	1.94	2.17
millet	1.83	1.16	1.49
rice	0.44	0.47	0.45
beans	1.05	0.5	0.77
okra	0.18	0.12	0.15
Intercropping			
Size of operated land (ha)	9.21	8.04	8.63
Average area of intercropped plots (ha)	0.02	0.05	0.04
Average area of legume-intercropped plots (ha)	0.01	0.01	0.01
Number of crops	6.23	4.68	5.45
Total number of households	351	354	705

Treat = Africa RISING beneficiary

Source: ARBES 2014

2.1.2 Cleaning of Tanzania ARBES Dataset and Production of Survey Report

In Fiscal Year 2015 the M&E team undertook the cleaning of the Tanzania ARBES (TARBES) dataset. The data collection firm was very careful in the delivery of the data set from the field, which helped with cleaning. Over the course of Fiscal Year 2015 the M&E team delivered a survey report for TARBES. Table 3 presents selected descriptive statistics from TARBES.

Table 3: Main crops and cultivation practices of households in TARBES

	AR/Babati IE Beneficiary	Non-beneficiary	Control	Total
Average cultivated area by crop (ha)				
Total cultivated area	1.67	2.44	2.57	2.07
maize	0.79	1.13	1.15	0.96
bean	0.32	0.12	0.10	0.22
pigeonpea	0.20	0.16	0.13	0.17
groundnut	0.01	0.07	0.10	0.05
Average yield by crop (kg/ha)				
maize	2950.49	1596.47	1672.50	2365.15
bean	696.55	635.76	665.79	686.88
pigeonpea	892.17	872.43	749.42	862.70
groundnut	675.08	834.78	816.09	804.87
Intercropping and other cultivation practices				
Percentage of households using irrigation	3%	1%	2%	2%
Percentage of household practicing rotation	24%	16%	15%	20%
Percentage of households intercropping	94%	79%	62%	81%
Average number of intercropped plots	1.80	1.31	0.93	1.45
Average intercropped area (ha)	1.48	1.64	1.12	1.38
Total households	435	105	270	810

AR/Babati IE Beneficiary = Africa RISING and/or Babati impact evaluation beneficiary; Non-beneficiary = non-beneficiary living in Africa RISING site

Source: ARBES 2014

2.1.3 Cleaning of Ethiopia ARBES Datasets

In Fiscal Year 2015 the M&E team began the cleaning of the Ethiopia ARBES (EARBES) dataset. The cleaning process for EARBES data is still underway. In Table 4 we present selected descriptive statistics from EARBES.

Table 4: Main crops cultivated and intercropping practices of households in EARBES

	On-farm trial farmer	SLATE farmer	Total
Average cultivated area by crop (ha)			
Total cultivated area (ha)	2.69	2.43	2.46
white teff	0.01	0.02	0.02
black teff	0.11	0.10	0.11
maize	0.03	0.05	0.04
wheat	0.98	0.70	0.73
barley	0.17	0.26	0.25
horse beans	0.12	0.12	0.12
potato	0.04	0.01	0.02
Average yield by crop (kg/ha)			
white teff	550.00	1582.14	1478.93
black teff	751.07	1049.60	1015.48
maize	2723.64	2335.11	2381.92
wheat	2718.03	2354.88	2411.21
barley	2230.13	2136.51	2149.00
horse beans	1216.40	1589.78	1545.56
potato	9138.46	8350.00	8600.00
Percentage of households using fertilizer	100%	88%	89%
Percentage of households using irrigation	20%	12%	13%
Percentage of household practicing rotation	93%	89%	90%
Percentage of households intercropping	2%	4%	4%
Total households	61	427	488

On-farm trial farmer = Current Africa RISING beneficiary; SLATE farmer = Expected future Africa RISING beneficiary

Source: ARBES 2014

2.1.4 Production of Malawi ARBES Survey Report

Data from Malawi ARBES (MWARBES) was previously cleaned in Fiscal Year 2014. The M&E team produced the MWARBES data summary report containing a description of the survey design, tools, and main findings from the household and community data in the form of cross tabulations, tables and graphs. The summaries of the household data include demographic and agricultural land characteristics, production and inputs, storage facilities, livestock ownership, dwelling characteristics, agriculture-related shocks, and children and women's anthropometry. The community data summaries cover community demography, access to basic services, labor in agriculture, agriculture-related problems and solutions, land use and major crops, migration, availability of water resources, and prevalence of shocks. Table 5 is an example of the statistics presented in the report.

Table 5: Average cultivated area (ha) and intercropping in MWARBES by study group

	AR Beneficiary	Non-beneficiary	Control	Total
Average cultivated area (ha)				
Total cultivated area	1.18	0.89	0.8	0.95
Maize	0.53	0.43	0.42	0.46
Groundnut	0.13	0.11	0.12	0.12
Beans	0.06	0.09	0.1	0.08
Soyabean	0.1	0.08	0.06	0.07
Cowpeas	0.05	0.03	0.01	0.03
Millet	0.04	0.03	0.02	0.03
Pigeonpea	0.03	0.01	0	0.01
Sweetpotato	0.01	0.01	0.01	0.01
Sorghum	0.01	0.01	0	0
Bambara	0	0	0	0
Rice	0	0	0	0
Chickpea	0	0	0	0
Intercropping				
Average number of plots	4.89	3.35	2.61	3.55
Average number of crop per plot	1.89	2.03	1.78	1.87
Average number of intercropped plots	1.88	1.66	1.15	1.5
Average intercropped area (ha)	0.63	0.57	0.46	0.54
Average legume-intercropped area (ha)	0.27	0.25	0.19	0.23
Percentage of households practicing intercropping	84.65	88.44	70.26	78.53

AR beneficiary = Africa RISING beneficiary; Non-beneficiary = non-beneficiary living in Africa RISING site

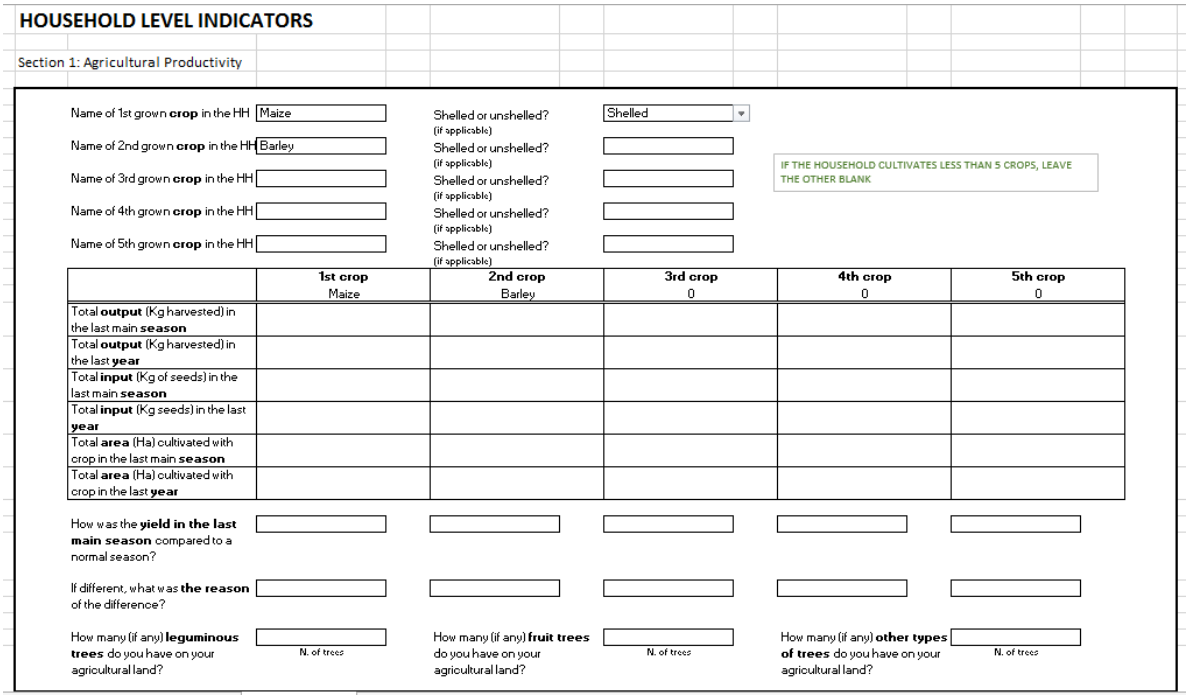
Source: ARBES 2013

2.2 Production of Sustainable Intensification Templates at the Household and Community Levels

The M&E team took notes from the 2015 American Association for the Advancement of Science (AAAS) Annual Meeting, where a roundtable on Sustainable Intensification (SI) indicators was organized by Africa RISING scientists, and developed a set of SI indicators capturing information on the five core domains: productivity, economic, environmental, social and human aspects. In addition to the definition of such indicators, the team developed a practical tool for the collection of the data at the household and community levels using semi-blocked Excel templates with embedded consistency checks. The tool was further presented to researchers in every project country during the PMMT trainings, as well as to the project leaders at the PCT meeting that took place in Wageningen at the beginning of September 2015. The feedback received was incorporated into the final version of the templates, which will serve as

guidance for the SI indicator efforts led by Michigan State University. Figure 1 shows the productivity tab of the household template as an example.

Figure 1: Productivity Tab from the Household Template



HOUSEHOLD LEVEL INDICATORS

Section 1: Agricultural Productivity

Name of 1st grown **crop** in the HH: Maize — Shelled or unshelled? (if applicable): Shelled

Name of 2nd grown **crop** in the HH: Barley — Shelled or unshelled? (if applicable):

Name of 3rd grown **crop** in the HH: — Shelled or unshelled? (if applicable):

Name of 4th grown **crop** in the HH: — Shelled or unshelled? (if applicable):

Name of 5th grown **crop** in the HH: — Shelled or unshelled? (if applicable):

IF THE HOUSEHOLD CULTIVATES LESS THAN 5 CROPS, LEAVE THE OTHER BLANK

	1st crop Maize	2nd crop Barley	3rd crop 0	4th crop 0	5th crop 0
Total **output** (Kg harvested) in the last main **season**					
Total **output** (Kg harvested) in the last **year**					
Total **input** (Kg of seeds) in the last main **season**					
Total **input** (Kg seeds) in the last **year**					
Total **area** (Ha) cultivated with crop in the last main **season**					
Total **area** (Ha) cultivated with crop in the last **year**					
How was the **yield in the last main season** compared to a normal season?					
If different, what was **the reason** of the difference?					

How many (if any) **leguminous trees** do you have on your agricultural land? — N. of trees

How many (if any) **fruit trees** do you have on your agricultural land? — N. of trees

How many (if any) **other types of trees** do you have on your agricultural land? — N. of trees

2.3 ARBES Data Sharing

Cleaned and partially cleaned ARBES data have been shared with numerous researchers within and outside Africa RISING. For all countries, unit conversions for crop production as well as other agricultural-related variables have also been constructed based on ARBES community survey and data from secondary sources. These constructed variables have also been shared with multiple researchers. In addition, the M&E team shared data with the communities in East and southern Africa where data was collected. A list of individual researchers and institutions with whom the M&E team has shared data can be found in Appendix A.

2.4 Sharing of Africa RISING Baseline Data Summary with Farmers in Malawi

The main objectives were to share the main findings of the Africa RISING baseline survey data with farmers- the ultimate owners of the data and to receive their feedback. The summaries of AR baseline household and community survey data were presented using two separate posters for Dedza and Ntcheu districts. The data sharing meetings were conducted in all six EPAs (see Table 6 for number of participants) where the baseline data were collected. The presentations were done in local dialect and

covered the following information at the EPA level: highest education in the household, agricultural land size, yield of key crops, use of chemical fertilizer, manure, improved seed and irrigation, livestock ownership, and allocation of community land. The data presentations were greeted with overwhelming enthusiasm by the farmers. Overall, the farmers actively participated in the discussion and expressed that the data findings truly reflected their areas.

Table 6: Farmers participating in MWARBES data sharing

District	EPA	Male	Female	Total participants
Dedza	Linthipe	5	12	17
Dedza	Lobi	8	7	15
Dedza	Golomoti	15	6	21
Dedza	Mtakataka	3	5	8
Ntcheu	Kandeu	6	16	22
Ntcheu	Nsipe	10	21	31

EPA = Extension planning area

Source: Authors' observations

Figure 2: M&E team presenting MWARBES summary in Kandeu, Malawi

Figure 3: M&E team presenting MWARBES data summary in Nsipe, Malawi

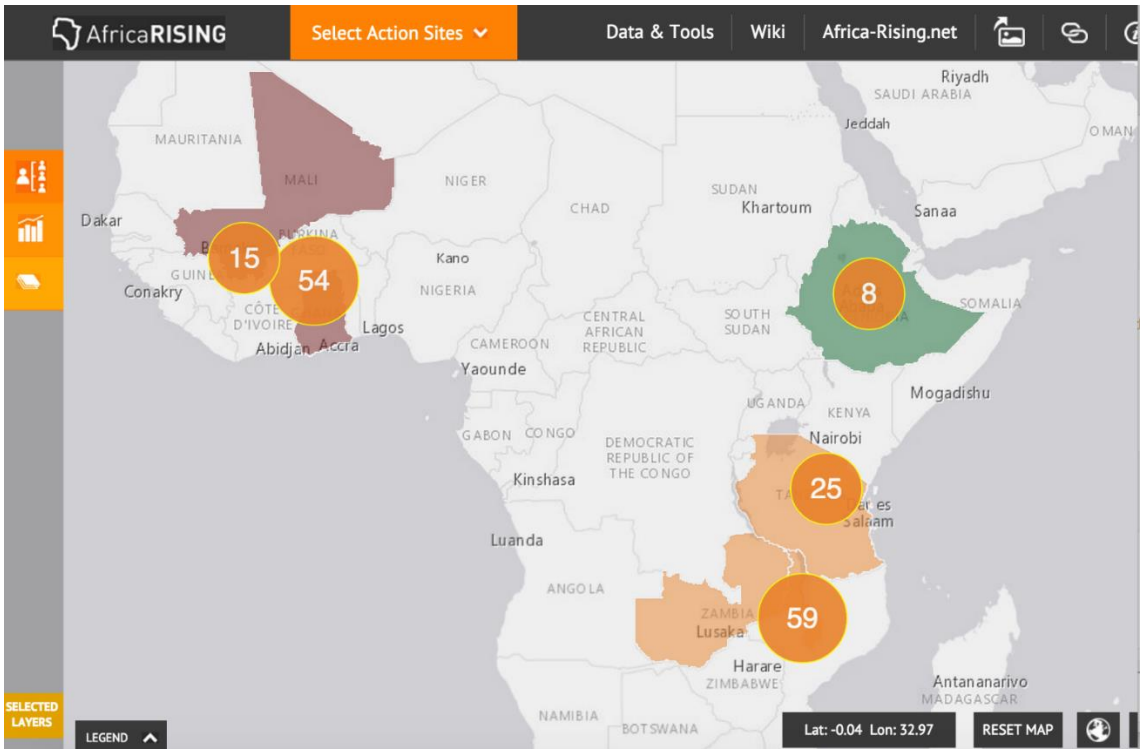
2.5 Updates to Africa RISING Project Mapping and Monitoring Tool (PMMT)

The project mapping and monitoring tool (PMMT) is developed to aid project monitoring efforts within and outside AR and is intended to help users (project managers, donors, researchers, data analysts, and stakeholders in general) to understand where and how AR activities are taking place (see the screenshot below), as well as improve project strategies and partnerships for greater impact of their work. Its features and functions have been designed to inform strategic and project management decisions, communicate programmatic projects to key stakeholders, and understand how programmatic efforts relate to other projects as well as to relevant agricultural and socio-economic information.

The PMMT has three main functionalities:

- A **data management component** that allow users to upload their research outputs (e.g., data, tools, documents) to a secure on-line catalog in any format;
- A **data entry application** component that allows users with the appropriate credentials to add project-related data (e.g., FtF indicators as well as customs indicators) to the PMMT through an intuitive, step-by-step web interface;
- A **mapping application** that allows users to contextualize where Africa RISING research activities are taking place and provide them the opportunity to view and overlay various socio-economic, biophysical, and agriculture-related data.

Figure 4: PMMT Mapping Application



Based on feedback received from Africa RISING researchers, Africa RISING Project Mapping and Monitoring Tool (PMMT) has gone through another round of updates during 2015. Updates include: the separation of the mapping and data report applications to improve speed and allow uploading of monitoring data without the need for high-speed internet connectivity and embedding of consistency checks to make sure that the total reported for each FtF indicator is equal to the sum of the disaggregated values reported. In addition, the M&E team developed a consistency-embedded spreadsheet for offline compilation of FtF indicators data for uploading onto the PMMT when researchers have access to internet.

2.6 PMMT trainings to AR researchers

In order to demonstrate and highlight the different features of the PMMT and how the tool can aid project monitoring efforts of both the research teams and the M&E team, the M&E team organized in-country trainings for AR researchers. The M&E team delivered PMMT trainings in all of the Africa RISING project countries. Each training took place over two days and taught the research teams how to input monitoring data into the Project Mapping and Monitoring Tool (PMMT), including the 8 Feed the Future indicators required by USAID and ad-hoc indicators defined directly by the researchers. The training included some time for each researcher to practice with the tool under the guidance of the trainer and also

for collecting feedbacks on the sustainable intensification indicators, in order to make them representative of the needs of each country. The feedback forms suggest that participants greatly appreciated the training.

Incorporating the feedback received in last year, the PMMT application was improved this year by separating the data entry application from the map application and the system worked much faster during the workshops. The topics covered in the workshop were the main features and capabilities and PMMT tool, data entry and mapping applications, the consistency-embedded Excel template for offline compilation for Feed the Future (FtF) and Sustainable Intensification (SI) indicators. Each of the two days' workshop included enough practice sessions for the participants to be comfortable with the data entry processes for various indicators and the consistency checks embedded in both online and excel template. Although the SI indicator templates for household and community level data collection are still under development, they were highly appreciated by the participants. One highlight of the workshop was the discussion and group work on proposed ad-hoc indicators and entering them into PMMT application.

Figure 5: Training participants in Malawi

Figure 6: Training participants in Tanzania

Figure 7: Training participants in Addis Ababa

Figure 8: Training participants in Tamale

Figure 9: Training participants in Bamako

2.7 Reporting and processing of 2014 FtF indicators through the PMMT

The M&E team also enabled AR researchers to compile and report their FtF indicators data using the updated data entry application of the PMMT. IITA and IFPRI's coordinated the data entry process through the PMMT and the M&E team was responsible for aggregating FtF data submitted by individual researchers by mega-site and then uploading aggregated data onto USAID's FTF Monitoring System portal. Following the updates to the PMMT and in country PMMT trainings, AR researchers uploaded FtF data onto the PMMT. After verifying data submitted through the PMMT, the M&E team aggregated data to mega site level and uploaded data onto the FtFMS portal. See examples of aggregated data in Appendices B and C.

2.8 Cataloguing of AR Data

In the interest of collecting all data generated from AR in one place, and to comply with the approved program's Data Management Plan, the M&E team has initiated a process to adapt all AR data gathering needs to ILRI's Datasets Portal CKAN. We use CKAN as a data repository accessible by all Africa RISING researchers. Here, AR researchers and the general public will be able to access the datasets generated by the program once they have been uploaded. Users will be able to access the meta-data (i.e., information about the data) before the datasets are published. An example of the metadata for the Malawi ARBES dataset can be found here.

The M&E team collected data submitted by the research teams within project countries and catalogued them into the ILRI CKAN database. Each dataset is uploaded together with public metadata describing the details of the data collection. In order to access the data itself, each visitor must contact the research teams directly, thus protecting the rights specific to each file. Currently 46 datasets related to the Africa

RISING program are available through the platform. Table 7 illustrates the distribution of datasets by team.

Table 7: Datasets available through CKAN (*as of January 26, 2016*)

	Datasets Available
Ethiopia	4
Ghana	7
Mali	15
Tanzania	21
Malawi	10
Total	53

Note: Some datasets apply to more than one country.

Source: Authors' observations as of 3 February 2016

2.9 Africa RISING Policy Briefs

Based on findings from ongoing research activities, the M&E team produced the following policy briefs. These briefs serve both to inform stakeholders and the public about AR M&E, but also to aid with the preparation of Africa RISING Phase II. Thanks to consolidated and targeted information about the program's outputs provided by the M&E team, all AR partners can plan informed and specific activities for Phase II.

2.9.1 Targeting and Bias in Participatory Research: Evidence from Malawi

This research examines targeting and bias within the Africa RISING Malawi project. The two study districts (Dedza and Ntcheu) were stratified using temperature-adjusted rainfall and elevation. Subsequently, several "development domains" were identified with varying levels of historical average rainfall and elevation. After project target sites were identified by researchers, control sites were randomly selected such that they represent similar development domains as target sites, while being distant enough from Africa RISING sites to avoid contamination. Next, three groups of households were recruited into this research study– all farmers who were testing innovations as of June 2013 ("beneficiary" group), randomly sampled farmers in project target villages who did not participate in the project ("non-beneficiary" group), and randomly sampled farmers from non-project target villages that represent similar development domains as Africa RISING villages ("control" group). Finally, a detailed socioeconomic survey was conducted in the summer of 2013. Table 8 below shows a summary of selected variables by research group.

Table 8: Mean differences in selected variables

	Group				
	B	NB	C	1 vs 2	1 vs 3
	(1)	(2)	(3)	(4)	(5)
Household size	4.97	4.55	4.59	**	***
Avg. adult yrs of education	5.20	4.51	4.72	***	***
Age of household head(years)	45.8	46.1	45.3		
% with married head	0.75	0.60	0.65	***	***
% with female head	0.27	0.36	0.34	**	**
% in the lowest two quintiles of agr wealth index	0.27	0.46	0.47	***	***
Tropical livestock units	0.45	0.28	0.21	***	***
Per capita land operated(ha)	0.29	0.23	0.23	***	***
Distance to basic services index	0.0015	0.027	-0.013		
% with the closest parcel within 15 minutes travel	0.74	0.57	0.54	***	***
Travel time to seed supplier(min)	42.9	41.7	38.9		
Elevation of residence(meters)	864.6	980.4	945.6	***	***
Observations	397	199	538		

Note: B = Africa RISING (AR) beneficiary, NB = Non-beneficiary in AR villages, C=Non-beneficiary in non-AR villages. ** significant at 5%; *** significant at 1%.

Source: Authors' calculations from ARBES 2013

After controlling for observable differences, beneficiaries had higher maize yield and harvest value, on average and across quartiles, relative to non-beneficiaries during the cropping season October 2012 – May 2013 (

Figure 10 and Figure 11).

Figure 10: Maize yield

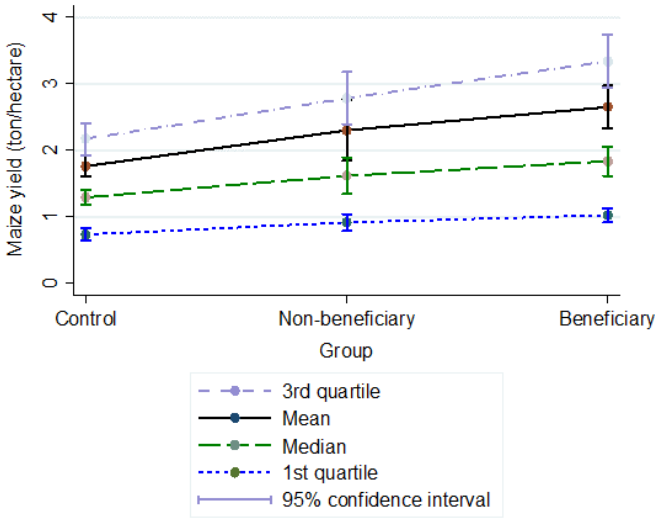
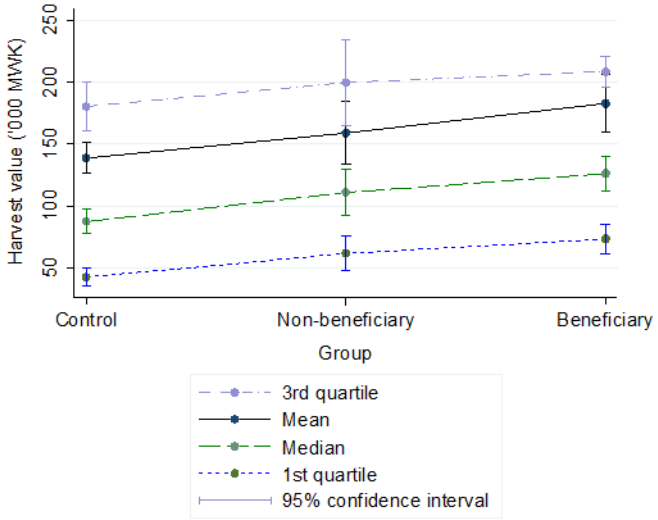


Figure 11: Harvest value



We find that farmers testing agricultural innovations as part of Africa RISING Malawi project (beneficiary farmers) are systematically different from the broader population of smallholders, suggesting possible targeting of better-off households. Beneficiary farmers have a higher value of harvest and maize yield, relative to randomly drawn non-beneficiary farmers. While these early results are encouraging, it should be noted that what worked with better-off farmers may not work (as much) for the broader population of less endowed smallholders to which innovations deemed successful are scaled up.

2.9.2 Plant different, eat different? Insights from participatory agricultural research

Improving household nutrition is one of the goals that Africa RISING aims to achieve. One vector through which nutrition can be improved is dietary diversity, which may be supported by production diversity in

subsistence households. As Africa RISING beneficiaries have increased access to a range of technologies through the program, we hypothesize that the program will affect nutrition through production diversity. This study attempts to establish a causal association between production diversity and dietary diversity within the Africa RISING Malawi project. Establishing a causal association based on observational data is a challenge due to potential simultaneity between production and consumption decisions and confounding factors that could affect both outcomes. The study examines the production and dietary outcomes of Africa RISING beneficiary households with similar outcomes of non-beneficiary (control) households randomly drawn from the target population. After controlling for observable characteristics, we find program beneficiaries to have more diverse agricultural production relative to control households, but there is no statistically significant difference in terms of dietary diversity, a proxy for dietary quality, between beneficiary and control households. Production diversity is measured by the count of unique crops and animal-source food items produced while dietary diversity is measured by the count of unique food items consumed within the household over a period of one week.

Figure 12: Household production diversity

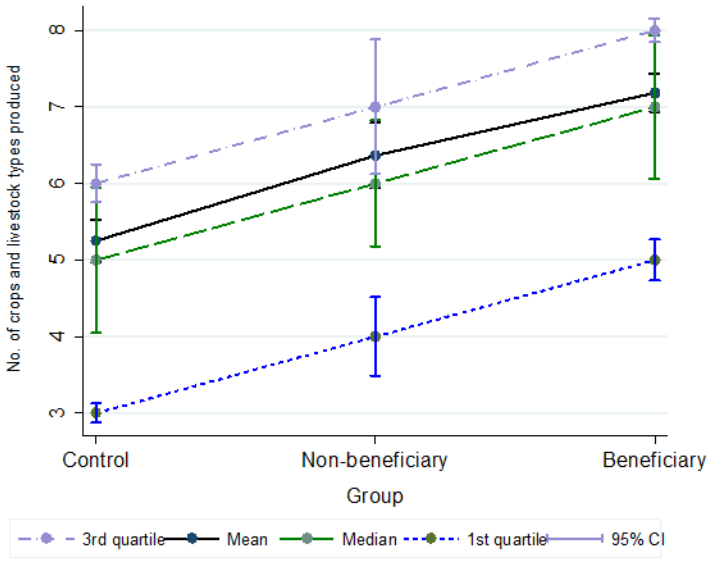
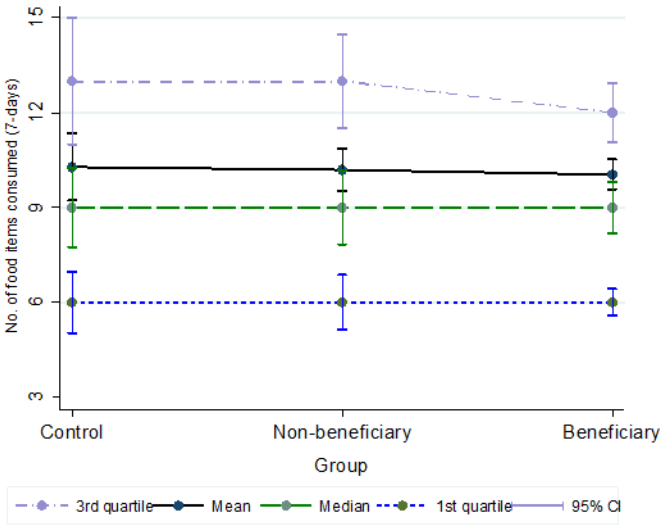


Figure 13: Household dietary diversity



We note that efforts aimed at increasing agricultural production and productivity may need to go hand in hand with efforts to improve nutrition. One potential approach to ensuring a "nutrition-sensitive" agricultural intervention could be through nutrition promotion and education. When the local context allows, efforts that integrate the crop and livestock sectors could also help improve nutrition, as the latter sector could improve the availability of nutrient-dense animal-source foods.

2.9.3 Soil Nitrogen Management and Farming Systems Analysis in Malawi

Poor soil fertility and limited nutrient availability present biophysical limitations to agricultural production for smallholder farmers in Africa, and an association exists between soil infertility and poverty. Practices that support soil organic matter formation can improve the efficiency with which farmers use their nitrogen fertilizer. This study examines how farmers manage their soil nitrogen and explores the potential simulated trade-offs associated with changes in soil nitrogen management practices. This study combines household survey data analysis (from Africa RISING) with cropping systems simulations to document different calculations related to farming systems design in Malawi. To capture the possible production and environmental effects of a range of soil nitrogen management practices, under spatial and temporal variation, we use DSSAT. A summary of nitrogen management practices (Figure 14) shows inorganic nitrogen fertilizer use among 17% of the households. We find that systems that combine organic and inorganic nitrogen sources have the potential to improve simulated profits (Figure 15).

Figure 14: Surveyed household nitrogen management practices

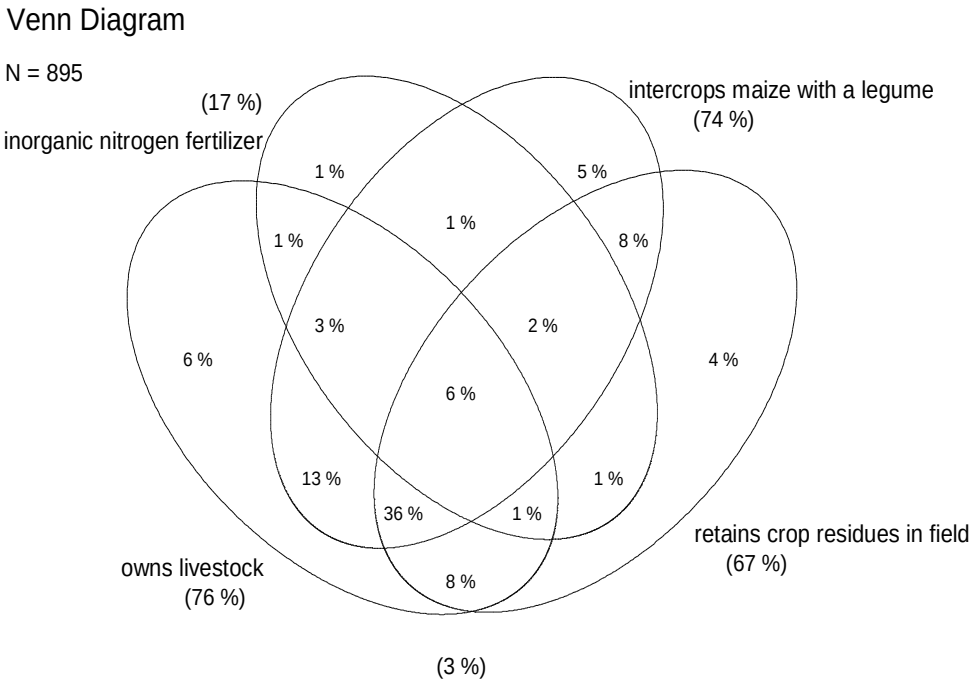
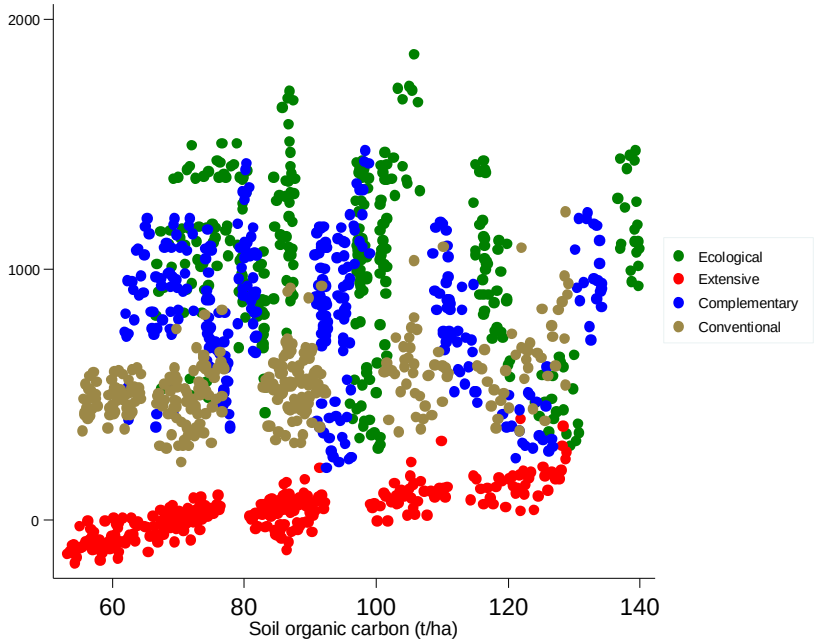


Figure 15: Simulated association between soil carbon and profit for four systems



Note: Each marker represents the simulated combination of system profit and soil carbon content. Each marker is the average of 5 different 20-year simulations (each with a different starting year) in a specific year of the simulation in one of 16 different 100km2 grid cells. Profit accounts for all variable costs and prices for the system as a whole (crops and livestock). Calculated in US $/ha with an exchange rate of 350 MWK=1 US $. Soil carbon content is the organic soil carbon at crop maturity (t/ha).

Ecological: maize-fallow-cowpea-fallow rotation, no inorganic fertilizer applied, 50kg/ha organic nitrogen from livestock manure, all crop residues retained in the field as a mulch. **Extensive**: maize-fallow-maize-fallow rotation, no inorganic fertilizer applied, no organic nitrogen from livestock manure, all crop residues removed from the field to feed livestock. **Complementary**: maize-fallow-cowpea-fallow rotation, 20 kg/ha inorganic fertilizer applied as urea, 25kg/ha organic nitrogen from livestock manure, 50% of crop residues retained in the field as a mulch and 50% removed from the field to feed livestock. **Conventional**: maize-fallow-maize-fallow rotation, 40kg/ha inorganic fertilizer applied as urea, no organic nitrogen from livestock manure, all crop residues removed from the field to feed livestock.

2.9.4 Production and Consumption Diversity in Northern Ghana

In this study we examine a potential causal link between production diversity and dietary diversity in the Africa RISING Ghana project. The study examines the production and dietary outcomes of Africa RISING beneficiary households with similar outcomes of non-beneficiary (control) households randomly drawn from the target population. After controlling for observable characteristics, we find program beneficiaries to have more diverse agricultural production *and* more diverse consumption relative to control households. We measure production diversity by the count of unique crops and animal-source food items produced, while we measure dietary diversity by the count of unique food items consumed within the household over a period of one week.

2.10 Ongoing Research Papers, Proposals, and Concept Notes

The M&E team worked on a number of research papers during Fiscal Year 2015, many of which are under review or revision at a peer reviewed journal. Research among M&E team members included the targeting of SI innovations to particular farmers and the implications of that targeting to eventual efforts to offer these innovations to larger groups. In the same vein, the M&E team has been examining the economic decisions that farmers must make in order to adopt SI technologies, including their willingness to pay for them, the biophysical and economic constraints that they face, and the alternatives to AR SI technologies which farmers might choose instead. Additionally, the M&E has looked beyond production at the end results of SI adoption on households, such as available nutrition. These research activities will continue during Fiscal Year 2016. For more details, see Appendix B.

2.11 Tanzania Africa RISING Follow-up Survey August-September 2015

The M&E team has conducted an experimental study in Babati district in Tanzania on farmers' willingness to pay and adoption of improved agricultural technologies. Africa RISING projects have been testing various systems-based agricultural technologies, but it is not clear whether small holder farmers would be willing to pay for these technologies, and what factors determine their informed demand for technologies. It will also be important to analyze the determinants of technology adoption under multiple binding constraints. These can shed lights on the sustainability of promoting agricultural technologies and may

help policy makers on promoting technology adoption. We would also like to evaluate causal impacts of adoption of agricultural technologies on productivity, food security and poverty outcomes.

To address these research questions, we initiated a field experiment where 400 farm households were recruited from three villages (Long, Sabilo and Seloto) in Babati district in Tanzania. At the first stage, 403 participants were recruited randomly at the village and sub-village level to attend a field day in June 2013. About half (201) farmers were randomly selected, via public lottery, to receive one time free inputs (local inorganic fertilizer called Minjingu mazao and improved maize seed) via coupon distribution.

We engaged the services of a Tanzanian survey firm, Savannas Forever Tanzania (SFTZ) to conduct the survey with 400 pre-selected households. The survey was started in August and finished in September 2015.

Figure 17: Team in the field for data collection

Figure 16: Data collection in progress

2.12 Production of Target Numbers (Tanzania and Malawi)

The M&E team has collected the number of farmers directly benefitting from Africa RISING. A targeting exercise has been done to estimate the potential number of farmers that can be reached in the next five years. This exercise could be useful for planning for phase 2 of AR.

To help the strategic planning of Phase II, the M&E team collected information on the current number of beneficiaries across each project country and projected the target number of beneficiaries to be reached directly through Africa RISING and indirectly through the establishment of partnerships with other organizations. This effort helps in defining the vision of the project's success. Since Africa RISING is an R4D project, it does not aim to reach a very high number of farmers directly through its activities, but rather to influence other organizations to diffuse the technologies that AR has proved most effective.

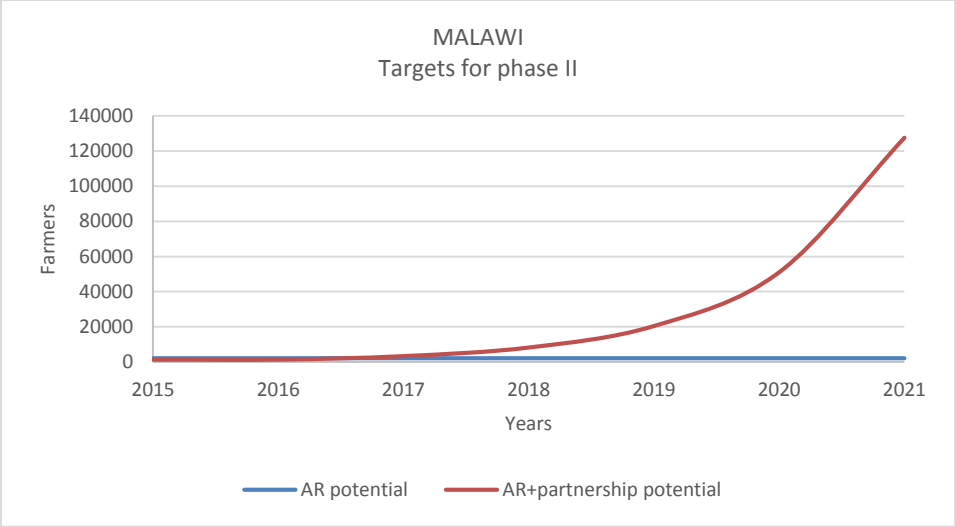
Consequently, the target numbers for direct and indirect beneficiaries reflect these considerations. Table 9 and Figure 18 illustrate the targeting efforts, with the example of Malawi.

Table 9: Target numbers of beneficiaries in Malawi

	2015	2016	2017	2018	2019	2020	2021
AR potential	1,306	1,633	2,041	2,551	3,188	3,986	4,982
AR+partnership potential	1,306	1,307	3,268	8,169	20,423	51,059	127,646

Source: Authors' projections based on ARBES 2013, ARBES 2014

Figure 18: Target number of beneficiaries in Malawi during Phase II



2.13 Africa RISING Program Coordination Team Retreat

The M&E team hosted the program coordination team retreat held 2-5 June, 2015 in Washington, D.C. Its objectives were to:

(1) Assess the strengths and weaknesses of Phase I, with a view toward improving efficacy and efficiency of the program for the remainder of Phase I and in a potential Phase II.
(2) Outline a possible Phase II
(3) Discuss the importance of SI with USAID and come up with a framework for assessing it.
(4) Assign roles and responsibility for the Science Symposium in October 2015

During the meeting, initial results from Malawi and Tanzania were shared amongst attendees. In addition to discussion about Phase I deliverables to be delivered, the Science Advisory Group (SAG) composition and initial meeting schedule were decided. Although most of the meeting took place at IFPRI headquarters

in Washington, D.C., retreat attendees spent one day in a joint program meeting at USAID headquarters. There, they presented the program as a group and took questions and comments from USAID staff.

Further details about the retreat can be found here.

2.14 Africa RISING Program Strategy Workshop

The M&E team co-organized the program strategy workshop that was held in Bamako, Mali from 6-8 October 2015.[5] The workshop was aimed at taking stock of the program's results, outcomes and lessons; reviewing and agreeing on key elements of an updated Program Framework, and agreeing on key elements and directions for a possible Phase II proposal.

Details about the workshop can be found here.

2.15 Country studies on typologies

In order to better assess the effectiveness of the Africa RISING technologies, the M&E team did a study to identify different typologies of farmers among the project beneficiaries. The obtained typologies will help:

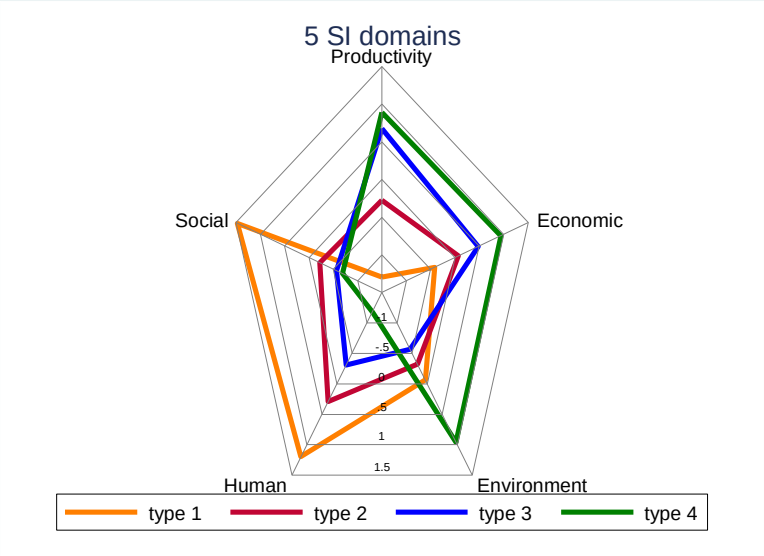
- Identify suitable farms to target innovations (ex-ante): we assume that not all innovations are appropriate for all farms, and that grouping them would support the identification of technology-specific suitable farming systems.
- Scale out innovations: on the basis of the heterogeneity in a population we can formulate extension messages, policies and other incentive schemes to further spread the use of designed innovations.
- Assess agro-economic effects (ex-post): Explaining trends and farmer 'behavior' (functional characteristics, including sustainable intensification indicators) and verification of the agro-economic effects of the interventions for different farm types.

After careful examination of the methodological options, the M&E team finally decided to use a combination of factor and cluster analysis, which are statistical methods that can be applied systematically to the data from each country. Variables capturing information on the five sustainable intensification domains were constructed and harmonized across all the baseline surveys, and a first typology classification has been produced for the case of Ghana. Once the M&E team has received all feedback from the country teams about this first draft, it will apply the same method to produce typologies for each of the five countries. Figure 19 shows the performance of the four types obtained in Ghana in each one of

[5] This meeting combined the annual M&E meeting (the M&E has been organizing for the last three years) and the program learning event (the communications team has been organizing in the past).

the five domains. Types 1 and 2 are the groups of farmers with the lowest levels of capital endowments, thus they are the worst performers in terms of productivity and economic well-being. Nevertheless, these types are the ones with the highest levels of human endowments (measured in terms of years of education) and of social endowments (measured in terms of gender equality). The opposite is true for the groups with higher capital endowments (type 3 and type 4). Finally, what appears from the classification is that except for the richest group (type 4), all the others perform quite poorly in terms of environment conservation practices.

Figure 19: Typology Characterization in Ghana



3. IFPRI's Updated Scope of Work (SOW) for Monitoring and Evaluation (M&E) of Africa RISING

Based on feedback received from AR colleagues and USAID about IFPRI's M&E activities thus far, the M&E team developed a Scope of Work (SOW) for 2016 and beyond. The draft SOW was shared with AR colleagues as well as USAID and subsequent revisions were made. Based on the experience over the period 2011-15, the IFPRI M&E team has recommended refreshing its mandate and overall SOW to closely reflect the role the Institute is best suited to play, avoid possible misalignments of expectations and deliver high-quality products that could effectively serve the program.

The M&E team has proposed to engage in activities where it has a comparative advantage, such as rigorous economic and geospatial analysis and research on food security, using both ex-post and ex-ante impact assessment methodologies. At the same time, it should shift away from areas and tasks on which the team (and IFPRI in general) does not excel or possess the effective capacity of delivering, including a constant presence in all AR countries and time- and resource-intensive monitoring of researchers' outputs. To assist with day to day monitoring activities, IFPRI has held discussions with IITA and ILRI about transferring some resources to the latter institutions so that they can recruit a local M&E coordinator and data manager.

4. M&E Challenges during Fiscal Year 2015

In spite of the several achievements, there were some challenges faced by the M&E team during Fiscal Year 2015.

- Given that the systems-based innovations tested by AR are highly context specific, require considerable adaptations, place greater demands on farmers to learn new skills, revisit longstanding beliefs about agricultural practices, and adopt an experimental and empirically minded approach to farm management, accurately quantifying and attributing their effects is an inherent challenge. Previous studies on the subject are relatively rare, indicating that empirical evidence remains in short supply. The M&E team has been trying to fill this gap in the literature using a mix of empirical methods.
- IFPRI's inability to recruit (and retain) local M&E coordinators to actively work with each and every research team across the Program was also a challenge. The team hired in January 2015 a post-doctoral fellow (staff position) based in Arusha (Tanzania), and a Senior Research Assistant based in Washington, DC in April 2015 to assist the M&E team with cleaning, analysis and management of ARBES and other data collected through the PMMT. The SRA has also assisted with the management of the PMMT and provide overall guidance related to the management of data collected by the M&E and the research teams. In addition, IFPRI has discussed transferring funds to IITA and ILRI so that these centers might hire on-the-ground M&E officers.
- Incomplete information and data on which specific SI innovations have been tested and adopted (in which villages, by which households). This was a major problem during the planning and implementation of baseline surveys and continues to be a problem for the analysis of AR projects. Proper documentation and details of SI innovations being tested is crucial to understanding the diffusion mechanism of the Program and to adequately capture potential spillovers. This is a serious challenge for which collaboration among IFPRI's team, AR researchers and stakeholders is key. The beneficiary tracking system that IFPRI intends to develop with the research teams is designed to address this challenge.
- With a dearth of information about program beneficiaries, reporting on FtF indicators and other project-specific data has also been a challenge. For example, a huge investment was made by IFPRI to develop a web-based user-friendly project mapping and monitoring tool (discussed before) through which AR researchers can report FtF indicators data and additional details about their project. While part of this challenge has been explained by poor local internet connection, it was evident that even AR researchers who were able to log into the system reported incomplete and sometime inaccurate information which in turn caused a significant challenge while uploading FtF indicators data onto the

USAID's FtF monitoring system using pre-populated template (that has a in-built consistency checks). IFPRI has addressed this challenge by building in offline functionality to the PMMT. The M&E team then aggregates inputs from the research teams to the FtFMS.

5. M&E Activities Planned for Fiscal Year 2016

For 2016, the M&E team envisions accomplishing the tasks below, pending discussion with USAID regarding IFPRI's future M&E scope of work.

5.1 Cataloguing of AR Data through ILRI's CKAN

In collaboration with ILRI, the M&E team will continue facilitating the uploading of all AR data collected onto ILRI's CKAN since the program's onset. The team has already developed and distributed a metadata template to all AR researchers. Upon receiving populated templates from researchers, the team will work with ILRI to ensure uploading of the metadata onto CKAN. Afterwards, a link will be created for each metadata file submitted by AR researchers and shared with them to enable them upload the associated data files.

5.2 Research and Communication

The M&E expects to spend significant time in 2016 pursuing and expanding various research studies initiated in 2014 and 2015 (See Section 2.9). Results from these research studies will be communicated with researchers (both within and outside of Africa RISING) and the general public using various outlets. Building upon evidence generated over time and using spatially-explicit biophysical and socioeconomic data, the M&E team plans to study the spatial diffusion of AR innovations, taking the statistical representativeness of AR communities into account. The analysis will take advantage of nationally-representative household surveys to construct synthetic cohorts of households similar to AR beneficiary farmers. The different SI innovations will be assessed along several agronomic and environmental dimensions (e.g. productivity, income, poverty, nutrition, and the environment).

5.3 Attend Program- and Project-level Meeting and Field Trips

The M&E team will continue to actively participate in various Program- and Project-level meeting and field visits to project sites to better understand the research activities. The team's continued presence and participation in these meetings will facilitate communication between the research teams and the M&E team about research activities on the ground. It will also help the M&E team tailor M&E activities to the needs of the research teams.

5.4 Reporting of 2015 FtF Indicator Data

The M&E team expects to work with the research teams to compile 2015 FtF indicators data through the PMMT for reporting to donor. Using submissions to the updated data entry application of the PMMT, the M&E team plans to continue aggregating FtF data submitted by individual researchers by mega-site and

then uploading aggregated data onto USAID's FTF Monitoring System portal. After verifying data submitted through the PMMT, the M&E team will aggregate data to mega-site level and upload data onto the FtFMS portal.

5.5 Partnerships and Collaborations

The M&E team will continue pursuing and exploring collaborations with organizations working in areas of common interest. These collaborations will likely culminate in research outputs for internal program use and for the public. Many research collaborations with AR researchers on various research topics of common interest are already in progress (See Appendix A). Multiple organizations operating in the AR regions of interest have been contacted, and with most of them there is an active collaboration, both on methods and data collection. Partner institutions include FAO, MSU, World Bank, Wageningen University, Georgetown University, Conservation International, and the Earth Institute at Columbia University (Vital Signs project). With the Food and Agriculture Organization of the United Nations (FAO), for example, the M&E team is collaborating with the Economics of Sustainable Agricultural Systems Team (ESAS) on CSA themes of mutual interest. Potential collaborative activities include analysis of data to provide empirical evidence on topics such as determinants of adoption of CSA practices and effects of such strategies on agricultural output such as yield and ecosystem services.

5.6 Development of Beneficiary Tracking System

Over the course of Fiscal Year 2016, the M&E team will work with the research teams in all mega sites to develop an offline beneficiary tracking system. This system will allow the M&E and research teams to track AR beneficiaries using the same identifiers. The system is expected to assist with program beneficiaries and linking of outcomes with various (mixes) of technologies and management practices that are being tested as part of the program.

The plan is to create a unique program beneficiary identifier that build upon internationally recognized and used geographic identifiers.[6] Each identifier should include the country code (GHA for Ghana, MWI for Malawi, etc.) followed by the country's government codes for the different administrative units. For example, for Ethiopia, each beneficiary would be assigned an identifier made up of codes for the country, region, zone, woreda, and kebele. In addition, there would be a code to designate the wave during which the relevant household became program beneficiary. For example, first wave program beneficiaries could be identified with an "A", second wave beneficiaries could be identified with a "B", etc. The final digits

[6] For example, the International Organization Standard (ISO) country codes.

of the identifier would include a household-specific number. As the M&E team has already created unique household IDs for each household in the ARBES, these could serve as program-wide IDs for beneficiaries.

6 Summary and Conclusion

Monitoring and evaluation of Africa RISING is aimed at supporting effective project management, providing data for timely reporting to project management, helping stakeholders learn about the program's successes and failures to help inform the design and implementation of new interventions, as well as catalyzing adjustments to ongoing activities that might enhance efficiency and effectiveness. The FY 2015 was a productive year for the M&E team, with a considerable effort and investment made to analyze baseline data from three program countries (Ghana, Malawi, and Mali). Household and community data collected through these surveys as well as those from Ethiopia and Tanzania have been (partially) cleaned and shared with several research teams within and outside the Africa RISING Program (IAMM, Michigan State University, Wageningen University, ILRI, IITA, ICRISAT, BioSight-IFPRI, Texas A&M University) for household characterization as well as analysis of various agronomic outcomes of Program beneficiary households.

Documentation of project locations and activities through Africa RISING Project Mapping and Monitoring Tool (PMMT) is enabling users to understand where and how Africa RISING activities are taking place, and improve project strategies and partnerships for greater impact in their work. Its features and functions have been designed to inform strategic and project management decisions. The PMMT can help inform decisions by allowing users to take geographic information about AR sites into account, e.g. location of markets, related projects and partners, travel time, annual precipitation, or maize crop yields. The PMMT is also useful to communicate programmatic projects to key stakeholders. Understanding how programmatic efforts relate to other projects as well as to useful agricultural information will be crucial. A primary benefit to PMMT users is to intersect the spatial layout of AR activities relative with a suite if biophysical and socio-economic contextual characteristics. Users have the ability to add their projects to the PMMT database and then visualize them in a variety of ways, as well as to browse and map other people's projects alone and alongside their own. This functionality provides the framework for multiple organizations to communicate vital strategic information in a coordinated fashion.

The M&E team is aware that there is still the need to integrate M&E actions into the program's activities on the ground. A still controversial issue is whether and how the program should/can be evaluated using traditional impact evaluation methods. Systems-based innovations, like those promoted by AR, involve complex sets of tangible and intangible elements combined with scientific guidance to bring about desired outcomes. While some elements of these innovations may be discrete and easy to identify (for example, a specific crop variety or inorganic fertilizer), what characterizes such systems-based approach is the way individual elements interact in a system to create synergistic effects, augmenting productivity and sustainability outcomes more than the sum of their single increases. These innovations are highly context

specific, require considerable adaptations, place greater demands on farmers to learn new skills, revisit longstanding beliefs about agricultural practices, and adopt an experimental and empirically minded approach to farm management. While there are sound practical and theoretical reasons to believe that these systems-based innovations can be beneficial, there is yet insufficient evidence on their social and economic impacts. Because of the unique features of these innovations, accurately quantifying and attributing their effects is very challenging. Each mix of innovations must be readily identifiable and consistently applied by farmers for its impact to be measured and compared across individuals, farms and households.

The IFPRI's M&E team is confident that its continuous efforts will have high payoff and be highly informative of the targeting criteria and the expected impact across program countries, the characteristics of adopters of sustainable intensification innovations (relative to the underlying population of smallholders), the agronomic and economic effects of these innovations, as well as the implications of targeting for scaling up. M&E past and current actions could establish a proof of concept according to which similar methods and approaches can be applied not only within AR but also in other similar systems-based sustainable intensification programs.

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Appendix A. Africa RISING Data Requests

Table 10: Africa RISING Data Requests

Requestor - name	Requestor - organization	Requested data - country
Hatem Belhouchette, Guillermo Flichman	IAMM (France)	Malawi
Dave Harris	ICRISAT	Malawi
Sieg Snapp	MSU	Malawi
Mirja Michalscheck	WUR	Malawi, Ghana
Gregory Sikumba	ILRI	Tanzania
Bekele Kotu	IITA	Malawi, Tanzania
Bekele Kotu	IITA	Ethiopia, Ghana, Malawi, Mali, Tanzania
Vine Mutyasira	Colorado State University	Ethiopia
Mirja Michalscheck	WUR	Ethiopia
Mary Ollenburger	ICRISAT/WUR	Mali
Neville Clarke	TAMU	Ethiopia, Ghana, Malawi, Mali, Tanzania
Mirja Michalscheck	WUR	Ethiopia
Davie Kampadyakeni		Ghana
Gundula Fischer	IITA	Tanzania
Jean-Claude Bizimana	TAMU	Tanzania
Mirja Michalscheck	WUR	Ghana
Isaac Jambo	WUR	Malawi, Tanzania

Appendix B. Description of Ongoing Research Papers

I. Characterization and Targeting Analysis

Developing-country initiatives on sustainable intensification (SI) and climate-smart agriculture (CSA) revolve primarily around the promotion of complex systems-based technologies and management practices that simultaneously improve yields and conserve natural resources. Many agronomic evaluations of these technologies have been conducted under near-perfect experimental conditions to provide precise measures of physical inputs and outputs. However, few evaluations have been run under analogous social experimental conditions in which farmers make constrained optimization decisions. As a result, researchers, policymakers, and donors are involved in sustainable intensification programs that rely on studies administered among purposively selected group of farmers, typically those who are more likely to successfully adopt the proposed technologies for a sustained period of time. This approach opens the door to potentially serious biases and provides a poor basis with which to assess the prospects for large-scale replications across a wider population of farmers. Yet the complex nature of these technologies often conflicts with the use of randomized controlled trials that address sample selection bias. To overcome this limitation, the M&E team employed a quasi-experimental approach integrated with geographic information systems to evaluate various SI innovations within Africa RISING.

Using socioeconomic survey data from Malawi (and Tanzania), the team analyzed the characteristics of adopters of SI innovations and estimated predicted effects on yields and value of crops cultivated. Findings show higher expected maize yield and value of harvest across all quantiles of the distributions for AR beneficiaries, compared to control households, and systematic potential targeting of villages and households. Overall, these findings point to the need to rethink how SI/CSA initiatives identify and select project beneficiaries, something that could bear potentially severe implications upon scaling up. Preliminary descriptive statistics results based on Malawi and Tanzania have been shared with researchers and policy makers at the Integrated Systems Research for Sustainable Intensification in Smallholder Agriculture. More results (including from regression results) from Malawi will be shared at upcoming conference in Oxford (the 2015 Center for the Study of African Economics conference) and Milan (the 29th International Conference of Agricultural Economists).

II. Farmer Attitudes toward Agricultural Technology: Willingness to Pay Study in Tanzania

The M&E team has been conducting an experimental study in Babati district in Tanzania on farmers' willingness to pay and adoption of improved agricultural technologies. Africa RISING projects have been testing various system based agricultural technologies, but it is not clear whether small holder farmers

would be willing to pay for these technologies, and what factors would determine their informed demand for technologies. The goal of this study is to elicit willingness to pay (WTP) and demand for improved agricultural technologies among farmers using a stated preference experiment that will be conducted in Babati district in Tanzania. The demand elicitation could shed light on cost-benefit analysis and scalability of promoting agricultural technologies. Determinants of informed demand could guide policy makers on technology adoption.

Estimates of farmers' WTP for these improved seed and fertilize are becoming important determinants of adoption of these technologies. One of the most important WTP valuation method is contingent valuation (CV) that involves field experiments and a survey to elicit stated preferences of participants. Farmers' WTP depends on a number of interrelated factors, including socio-economic and demographic characteristics, attitude toward risks, awareness etc. We will explore WTP for both improved maize seed and fertilizer separately and then analyze correlation between them.

In the simplest CV with dichotomous choice model the individual is asked if she/he would be willing to pay a stated amount. The problem is that the individual provides very little information with respect to her WTP, implying that in order to obtain accurate estimations of WTP, relatively large samples are needed. Hanemann et al. (1991) suggest an alternative to improve the efficiency of the estimation. This alternative is known as dichotomous CV with follow-up or double-bounded CV model which we will be using in this paper. In this method a follow-up question is asked after first dichotomous choice question. Another improvement as recommended by Cooper (1993) and Kanninen (1993) is that variation of bid prices among the survey participants can eliminate bias that could result from the impression of initial bid price. In our context, farmers in Babati received 4kg of improved seed and 50kg of Minjingu mazao fertilizer in 2013-14 under the Africa RISING program. The advantage is that Babati farmers are knowledgeable with the commodity (seed and fertilizer) to be valued. They were provided awareness and training along with field demonstration trials. Since the farmers already have exposure to the technologies which are marketable goods rather than a hypothetical good, the stated preferences with double-bounded CV approach appears most appropriate in our context.

III. Bio-economic Modelling of Household Farm Production and Its Linkages to the Environment

During 2014, IFPRI (through the BioSight project) has been engaged with key partners at the Institute for Advanced Studies of Agronomy in the Mediterranean (CIHEAM-IAMM) in Montpellier, France, to develop a new dynamic, household-farm bioeconomic simulation model which we call "DAHBSIM". This effort represents an evolution from previous models build by the researchers at CIHEAAM-IAMM,

and incorporates closer feedbacks between crop productivity, soil conditions and farm-level profitability, and also incorporates livestock in a much better way. Malawi was chosen as a case-study country, in order to provide a "proof-of-concept" for how to advance bio-economic modelling of household farm production and its linkages to the environment. The "DAHBSIM" model has been constructed around household-level data from the USAID-funded Africa RISING project for Malawi, and contains distinct typologies of farm-households that capture the heterogeneity observed in the sample of farm households. Using DHABSIM, we will assess the responses of farm households to different scenarios of changes in agricultural and environmental policies and technological innovations as well as their subsequent economic, ecological and consumption impacts. Those scenarios will be a combination of individual or combined effects of two main types of driving forces: i) socio-economic, policy and market changes (e.g., prices of inputs and outputs, availability of land and labor, agricultural and water policies), and ii) with or without alternative technology options (e.g., new technologies and innovations believed to be suitable for the production systems such as new maize variety, improved maize fertilization, conservation agriculture, rotation with forage and food legumes, agroforestry.

With DHABSIM those scenarios will be evaluated and compared by calculating a multi-perspective set of economic (e.g., farm income, total cost, labor cost), social (e.g., total labor by task, female labor, hired labor), environmental (e.g., soil fertility, soil water content, water stress) and nutritional (e.g., total consumption, total protein, consumption by product) indicators of the sustainability and multi-functionality of agricultural systems, policies and innovations to enable trade-off analysis. This bio-economic modelling effort will provide another way of carrying out ex ante evaluation on various technologies, and has created a strong partnership between the BioSight and Africa RISING research groups, and powerful synergies between the evaluation work being carried out by both teams. Pending availability of resources, the teams expect to expand DAHBSIM analysis to other Africa RISING countries to capture different economic and agro-ecological contexts.

IV. Assessing Farm-level Trade-offs between Organic and Inorganic Nitrogen Fertilizers

Using Africa RISING data from Malawi as a case study, the M&E team is collaborating with crop modelers and other researchers in IFPRI (Spatial Data and Analytics and BioSight) initiated a research project that combines crop modelling (DSSAT) with economic analysis to provide empirical evidence on the following topics: the least cost method to produce a fixed quantity of maize or obtain a specific profit, how changes in the costs of fertilizers and organic materials change the input mix, the degree of complementarity between organic and mineral nitrogen, the sensitivity of input mix to changes in rainfall and soil type, the environmental benefits of organic systems, and whether more organic systems can

reduce yield variability or down side risk, among research questions. Using DSSAT results from Malawi, the M&E expects to expand similar work to other Africa RISING countries.

V. Study on the Impact of AR Technologies on Production and Consumption Diversity in Northern Ghana

The M&E team, with the collaboration of Bekele Kotu from IITA Ghana, is conducting a rigorous econometric analysis of the impact of the Africa RISING project on production diversity and consumption diversity of the beneficiary households. The objective of this study is to evaluate the early impact of the project and to estimate the technologies' potential in terms of nutritional outcomes. Figure 20 shows the average number of food types produced and consumed in different groups within the GARBES survey. What appears clear is that Africa RISING beneficiary households (AR2013) produce more diverse crops and consume more diverse food. In order to establish causality we must look at the econometric results. Table 11 reports the results from several regressions, which all confirm that the Africa RISING interventions significantly increased the number of crops cultivated by the farmers. Table 12 reports the results on dietary diversity. Here we find that dietary diversity is positively associated with the program so far. These results are not surprising since the GARBES dataset was collected only one year after the beginning of the project, which is rather early to already observe a significant impact on nutrition. Nevertheless, since we have evidence that AR significantly increases production diversity among farmers and that, in turn, production diversity is positively associated with dietary diversity, we can state that the project has the potential to have a positive impact on dietary quality. To have the empirical confirmation of this statement we must wait for the midline data collection in 2017.

Figure 20: Production and Consumption Diversity across AR Groups in Ghana

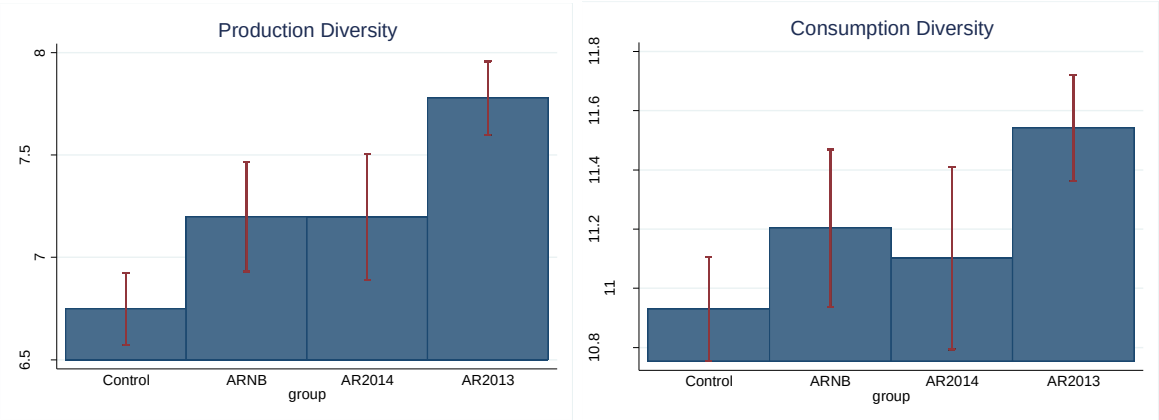


Table 11: Econometric Results: Effect of AR on Production Diversity

	Production Diversity (count)		
	OLS	IV	IV-GMM
	coef/se	coef/se	coef/se
Treatment	0.739***	0.946**	1.022**
	(0.200)	(0.416)	(0.411)
Household size	-0.015	-0.020	-0.016
	(0.023)	(0.023)	(0.023)
Head==female	-0.238*	-0.251*	-0.254*
	(0.136)	(0.148)	(0.148)
Number of children in the household	0.059	0.057	0.053
	(0.047)	(0.049)	(0.049)
Number of females in the household	0.009	0.014	0.007
	(0.034)	(0.033)	(0.033)
Mean years of education in the household	0.005	0.007	0.011
	(0.034)	(0.032)	(0.032)
Max years of education in the household	-0.002	-0.002	-0.002
	(0.017)	(0.017)	(0.017)
Total land size (Ha)	0.155***	0.156***	0.157***
	(0.024)	(0.023)	(0.023)
Agricultural wealth index without land	0.285***	0.294***	0.295***
	(0.068)	(0.079)	(0.079)
Non-agr. wealth index	-0.059	-0.049	-0.043
	(0.070)	(0.075)	(0.074)
Amount of off-farm income (GHC)	-0.000	-0.000	-0.000
	(0.000)	(0.000)	(0.000)
Travel time to seed supplier(min)	0.004	0.005	0.005*
	(0.002)	(0.003)	(0.003)
Agricultural labor used (person-days)	0.000***	0.000***	0.000***
	(0.000)	(0.000)	(0.000)
Annual rainfall (mean) (mm)	0.010***	0.011***	0.012***
	(0.003)	(0.004)	(0.004)
Growing Period (mean) (days)	-0.046***	-0.053**	-0.058**
	(0.017)	(0.026)	(0.025)
Distance from the hh to the closest plot	-0.059		
	(0.045)		
Total Pop. Dens. '12 (persons/sq. km.)	-0.000		
	(0.001)		
Constant	1.160	3.018	3.145
	(1.900)	(2.058)	(2.055)
Number of observations	962	962	962

Source: Authors' calculations based on ARBES 2014

Table 12: Econometric Results: Effect of AR and Production Diversity on Dietary Diversity

	Dietary Diversity (count)		
	OLS	IV	IV-GMM
	coef/se	coef/se	coef/se
Production Diversity (count)	0.842***	3.155	4.248**
	(0.118)	(2.179)	(1.993)
Treatment Status (ARB vs Controls)	-0.284	10.391	12.349
	(1.010)	(9.561)	(9.430)
Treatment X Production Diversity	0.171	-2.328	-2.765
	(0.174)	(2.078)	(2.048)
Household size	-0.209***	-0.140*	-0.126*
	(0.064)	(0.076)	(0.075)
Head==female	0.977**	0.937	1.089*
	(0.373)	(0.578)	(0.565)
Number of children in the household	0.178*	0.124	0.087
	(0.096)	(0.130)	(0.126)
Number of females in the household	0.111	-0.030	-0.062
	(0.100)	(0.153)	(0.150)
Mean years of education in the household	0.227**	0.146	0.120
	(0.112)	(0.134)	(0.132)
Max years of education in the household	-0.069	-0.020	-0.007
	(0.051)	(0.064)	(0.063)
Total land size (Ha)	0.081	-0.077	-0.190
	(0.073)	(0.215)	(0.196)
Agricultural wealth index without land	0.306	0.163	-0.148
	(0.191)	(0.450)	(0.374)
Non-agr. wealth index	0.554***	0.514**	0.634***
	(0.145)	(0.213)	(0.191)
Amount of off-farm income (GHC)	0.000	0.001	0.001
	(0.001)	(0.001)	(0.001)
Percentage of food value from own	-0.967*	-3.378	-4.933*
	(0.571)	(2.811)	(2.517)
weekly nonfoodexp	0.010***	0.008*	0.006
	(0.003)	(0.004)	(0.004)
Growing Period (mean) (days)	-0.013		
	(0.035)		
Frequent interactions with local farmer group	0.562*		
	(0.298)		
Distance from the hh to the closest plot	0.072		
	(0.128)		
Total Pop. Dens. '12 (persons/sq. km.)	-0.006		
	(0.005)		
Constant	9.905*	-2.533	-6.852
	(5.453)	(8.533)	(7.792)
Number of observations	962	962	962

Source: Authors' calculations based on ARBES 2014

VI. Climate Smart Agriculture

The IFPRI team is collaborating with the Economics of Sustainable Agricultural Systems Team (ESAS) of the Food and Agriculture Organization of the United Nations (FAO) on CSA themes of mutual interest. Potential collaborative activities include analysis of data to provide empirical evidence on topics such as determinants of adoption of CSA practices and effects of such strategies on agricultural output such as yield and ecosystem services.

VII. Land Cover Changes and Poverty Dynamics

Africa RISING technologies do not only aim to increase productivity of the beneficiary farmers, they also try to achieve sustainability through better soil conservation practices. Indeed, Northern Ghana has been affected by land degradation over the past few decades and the area of cultivated land has increased significantly, which could cause the progressive disappearance of important natural vegetation cover, such as forest or shrubs. Given these circumstances, the M&E team is conducting a research project to evaluate the impact of changes in land cover over the past few decades on the current welfare of Africa RISING participants and control households. To do that, the M&E team classified the entire surface of Northern Ghana in 30 square meter pixels according to 7 land classes (water, forest, shrubs, grassland, cropland, bare land and urban), both for the years 2014 and 1993. The latter was done by processing historical satellite images with GIS software. Subsequently, we linked the land cover classification to the households in GARBES using the GPS location contained in our surveys. Currently, we are in the process of analyzing the obtained dataset to draw some conclusions on how the observed changes in land cover types around the GARBES households have affected their welfare, measured as total consumption and poverty rates. Figure 21 shows a map of the land cover classification for 2014 and Figure 22 correlates the land cover types where households are located with their level of total consumption. We can see that higher consumption is associated with living on crop land, as well as shrubs and savannah areas compared to bare land. This can give us some initial insights on the negative effects of desertification. The econometric analysis that we plan to conduct will shed some light on the direct causal effects of land cover changes on household welfare and poverty.

Figure 21: Land Cover Classification of Northern Ghana in 2014

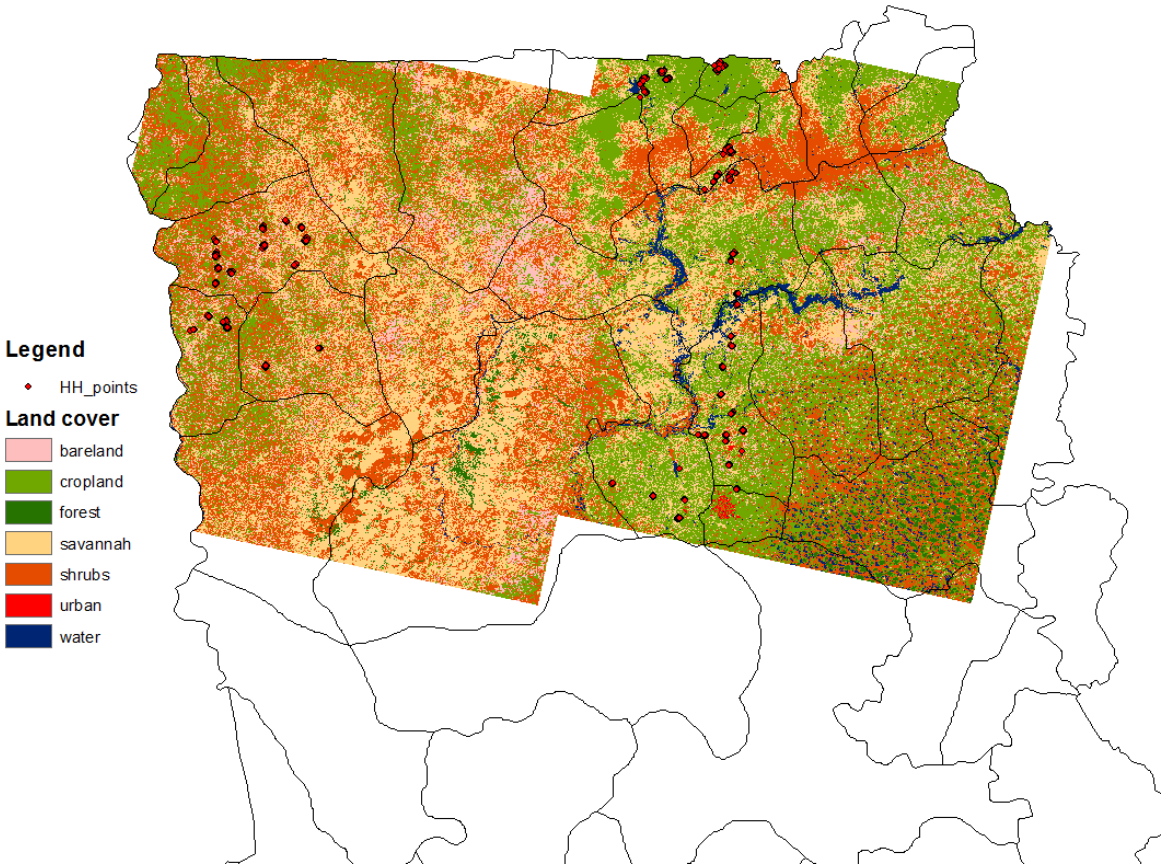
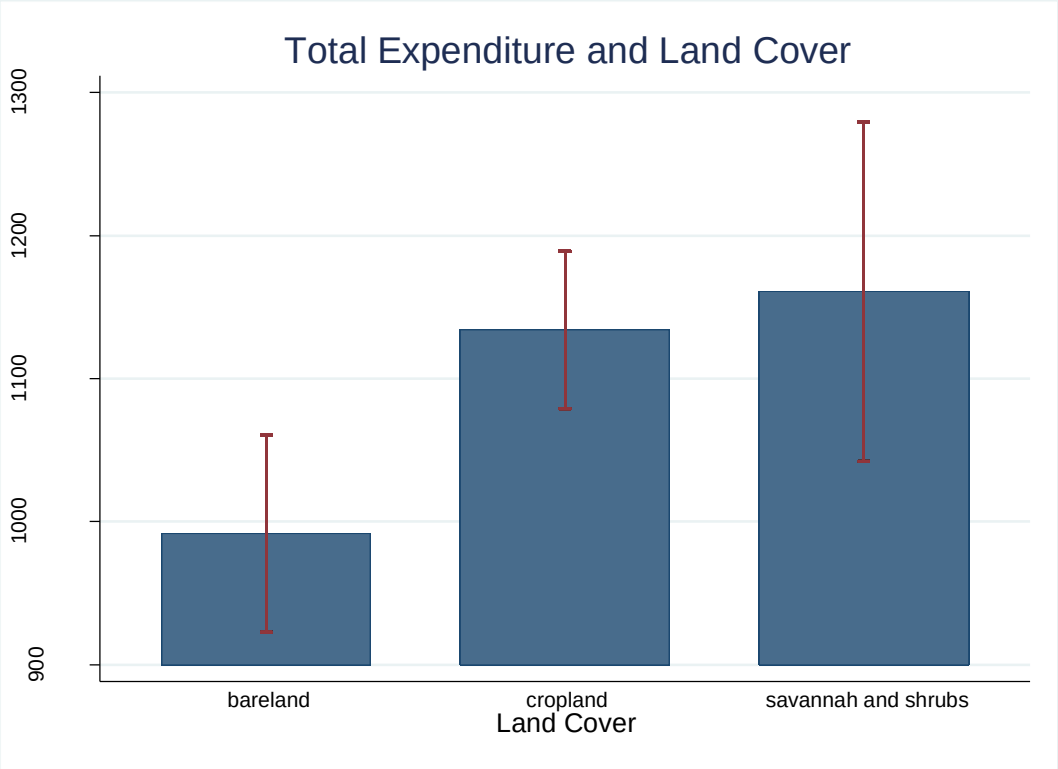


Figure 22: Correlation between Land Cover Type and Household Expenditure



VIII. Adoption of Maize and Fertilizer in Tanzania: a Multivariate Approach to Complementary Technologies

With Tanzania's economy being heavily dependent on agricultural production, there is no alternative to increasing agricultural productivity through yield-increasing technologies such as improved seed and fertilizer. Farmers' constraints to technology adoption can be categorized as individual factors and institutional/market factors. The major findings in the literature of microeconomics of technology adoption about the individual factors are: adoption and schooling are positively correlated, larger and wealthier farmers are more likely to adopt new technology, Individual farmers' technology adoption is positively correlated with the extent of prior adoption by his neighbors, risk averse farmers are less likely to adopt. The institutional factors constraining technology adoption are market imperfections in access to information and awareness, credit market, labor market, technology supply, and covariate weather and other shocks.

Much of the technology adoption literature assumes that farmers have complete information and face unconstrained access to technology (Neill and Lee, 2001; Dimara and Skuras, 2003; Edmeades at al., 2008; Kassie et al., 2011). Such studies consider all non-adopters as being uninterested in the technology

and adoption response is modelled as logit and tobit type models. These studies fail to model the difference in desired (willingness to pay) and actual demand for improved technologies leading to inconsistent parameter estimates (Coady 1995, Croppenstedt et al. 2003, Shiferaw et al. 2015). In fact, farmers often either lack reliable information and knowledge or they fail to realize their desired demand potential due to various constraints mentioned before. We will consider various individual and market-level constraints that prevent farmers from translating their willingness to pay into adoption, and analyze how these constraints affect farmers' adoption decision.

The simultaneity issue in technology adoption has gained little attention in the literature. Many sustainable intensification projects in Africa often promote hybrid maize seed and fertilizer in fixed-size packages as part of productivity-enhancing innovations. These technologies are complementary. Farmers also allocate lands between hybrid and OPV (Open Pollinated Variety) seeds. Hence, farmers' adoption volume decisions should be determined in a system of equations. For some farmers the optimal adoption choice will be censored at the corner solution. We employ a multivariate tobit model with simultaneous maximum likelihood estimation to answer the following questions: Do households make adoption decision on fertilizer and hybrid seed simultaneously or sequentially? What is the optimal path of adoption? Farmers might be more likely to adopt hybrid maize seed if they adopt fertilizer first or vice versa. We employ a recursive probit model to check this feedback effect.

IX. Risk Rationing, Rural Credit Demand and Agricultural Technology: Evidence from Tanzania

An important element in agricultural production system is credit. When credit is scarce, liquidity can become a binding constraint in agriculture leading to suboptimal production that prevent technology adoption in agriculture. Credit constraints may have negative impacts on poor households that can force some households fall into poverty traps (Zimmerman and Carter 2003; Carter and Barrett 2006). Credit constraints prevent households from undertaking profit maximizing activities, preventing farmers from applying desired agricultural inputs such as seed, fertilizer, pesticides etc. resulting in low agricultural output. Feder et al. (1990) find that in China, a one percent increase in average liquidity of credit-constrained households would increase farm output by 0.04% of the total output. Foltz (2004) finds that credit constraints have a negative effect on farm profits of Tunisian farmers. Similarly, Guirkinger and Boucher (2008) find that credit constraints lower the value of output by 26% in Peruvian agriculture. Fletschner et al. (2010) also investigated efficiency in Peruvian agriculture and found that credit constraints reduced substantial profit (-17% to 27%) and financial efficiency (-23%). Using a direct

elicitation survey in China and India, Kumar et al. (2013) find that credit constraints negatively affect food consumption, farm input applications, and health and educational attainments.

The economic theory and empirical evidence discussed above suggest far reaching consequences of credit constraints. However, identification and impacts of different types of credit rationing and their underlying causal factors are scarce. Asymmetric information along with contract enforcement problems give rise to three types of non-price rationing in credit market. Non-price rationed households are those who would like to borrow at the ongoing interest rate, but they either cannot qualify due to supply side constraints (quantity rationed) or are afraid to borrow because of risk of collateral loss (risk rationed) or are discouraged from borrowing by transaction costs (transaction cost rationed). Price rationed households, on the other hand, include both borrowers and those who choose not to borrow because they do not need capital or find the cost of capital to be very high. Quantity rationing has gained the bulk of attention in economics literature, even though all three types of non-price rationings are the consequences of lenders' efforts to deal with moral hazard, adverse selection and contract enforcement problems.

Understanding risk rationing is important to distinguish between farmers with no demand for credit and those with potential demand, but who risk rationed themselves by not participating in credit markets. We discern this by using a direct survey method. Rural credit policies will be limited if risk rationing is ignored in the analysis. Although there are a few studies that have analyzed risk rationing in developing countries, no research has studied the prevalence of risk rationing in Africa.

X. Plant different, eat different? Insights from participatory agricultural research

Ensuring access to nutritious food for a rising population, while relying on increasingly scarce resources, is an urgent problem in the global policy agenda. Sustainable intensification (SI) is one potential tool to support this goal. SI aims to increase agricultural production (and, thus, food production) using increasingly limited resources, such as land, while minimizing some of the negative environmental consequences of agriculture activity. In particular, it focuses on context-specific packages of technologies, requiring adjustments to current farming systems (Garnett *et al.*, 2013; Pretty *et al.*, 2011). These packages are expected to be nutrition-sensitive, so that agronomic and environmental benefits translate into improved nutrition and health among adopters.

We use data from a non-random, participatory SI research program in Malawi to examine possible causal links between agricultural production and dietary quality, measured by food consumption diversity. Endogeneity due to non-random selection in the program and simultaneity between production and consumption decisions are corrected using the following system of equations:

$$Prod_i = \alpha_0 + \alpha_1 Treat_i + \mathbf{\Phi}' \boldsymbol{X}_{1i} + d + \epsilon_i \quad (1)$$

$$Cons_i = \beta_0 + \beta_1 Prod_i + \beta_2 Treat_i + \beta_3 (Treat\text{x}Prod_i) + \mathbf{B}' \boldsymbol{X}_{2i} + d + \varepsilon_i \quad (2)$$

where i indexes a household. Equation 1 models agricultural production ($Prod$); $Treat$ is an indicator that takes value one for beneficiary household and zero otherwise; $\boldsymbol{X}_1$ is a vector of covariates that could affect diversity and value of agricultural production and includes household size, age and gender of the head, index of distance to basic services, non-agricultural wealth index, total land area operated, indicator for ownership of at least one axe, agricultural labor and fertilizers used, and travel time to the nearest agricultural input supplier; d represent district fixed effect; and ϵ_i expresses a random error term. If the participation decision is not random (but correlated with ϵ_i), $Treat$ would be endogenous and ordinary least squares (OLS) estimation of Equation 1 would produce biased and inconsistent estimates.

Equation 2 models food consumption ($Cons$) taking the dependent variables defined above. Variable $Treat\text{x}Prod$ is the interaction term between $Treat$ and $Prod$, capturing possible systematic difference in agricultural production between beneficiary and control households; $\boldsymbol{X}_2$ is a vector of covariates that could affect household food consumption and consists of all the variables in $\boldsymbol{X}_1$ (except agricultural inputs) and an indicator of whether the household faced food shortage during the three months preceding the interview; ε_i is a random error term. If production and consumption decisions are made jointly (non-separable) or the two decisions are affected by unmeasured or unobservable factors, $Prod$ will be endogenous, as will $Treat$ if participation decision is not random with respect to ε_i.

As a robustness check, three estimators are employed: instrumental variables (IV) using two-stage-least-squares (Wooldridge, 2013), IV using Generalized Method of Moments (Baum et al., 2007; Hansen, 1982), and three-stage-least-squares (Zellner and Theil, 1962). Instrumental variables results show that households participating in the program and testing alternative technology options (beneficiary group) report a more diverse agricultural production, relative to randomly drawn non-participating households (control group). While we observe both a positive association between participation in the program and production diversity, and a positive association between production diversity and dietary diversity, it unclear whether the positive relationship works through treatment.

Though differences in dietary diversity due to own-consumption and purchases of more diverse food cannot be disentangled using the system of equations, other methods to explore the composition of household consumption for different expenditure levels and market prices can be used. Given the non-linear shape of the Engel curves for starches, fruits and vegetables, pulses, animal-source food (ASF), and other foods, the quadratic almost ideal demand system (QUAIDS) is used to estimate food expenditure and price elasticities. Pulses –the program's main focus crop– are found to be the least responsive to

expenditure, while ASF the most, likely due to their progressive role as cash crop, with statistically insignificant differences in responsiveness between beneficiary and control households.

XI. The Determinants of Technology Take-up in Tanzania

The M&E team has begun a collaboration with Georgetown University students to study technology take-up in Tanzania ARBES and control communities. Although this paper is still in its beginning stages, the Capstone Team has identified three main research questions:

1) What factors predict usage of agricultural technologies,
    a. In the full sample of 435 AR treatment households?
    b. In the 270 comparison households?
2) How does exposure to AR affect usage patterns in the program's 107 treatment households, relative to 270 comparison households, in Babati, Kiteto, and Kongwa?
3) What is the impact of providing access to technologies on the usage behaviors of the participants of the Babati field day lottery?

In this paper, the M&E and Capstone teams hope to identify some characteristics that influence households' decisions to take up new technologies. Doing so should provide evidence to AR about which types of households might be most amenable to participating in the country project as it scales up. It also could provide clues to which incentives might need to be adjusted for other potential beneficiaries.

Appendix C. Example Feed the Future Indicator Data for East and Southern Africa

Reporting Organization	USAID
Bureau	Bureau for Food Security
Operating unit	USAID/BFS HQ
Implementing Mechanism	ARP- CGIAR-Sustainable Intensification: East and Southern Africa
Prime Partner	IITA
User	Beliyou Haile
User Role	Implementing Partner
Submission Date	November 25, 2015

Indicator data

Indicator / Disaggregation	Baseline Year	Baseline Value	2015		2016	2017	2018
			Target	Actual	Target	Target	Target
4.5.2(2): Number of hectares under improved technologies or management practices as a result of USG assistance (RIA) (WOG)		0	741	648	1,080		
Technology type		0	741	648	1,080		
crop genetics			7	108	208		
cultural practices							
pest management			7	8	8		
disease management			30	12	12		
soil-related fertility and conservation			30	514	843		
irrigation				1	2		
water management (non-irrigation)				1	2		
climate mitigation or adaptation			50	4			
other					5		
total w/one or more improved technology		0	741	648	1,080		
Disaggregates Not Available			617				
Sex		0	741	648	1,080		
Male				46	30		
Female				15	10		
Joint							

Association-applied							
Disaggregates Not Available		0	741	587	1,040		
4.5.2(5): Number of farmers and others who have applied improved technologies or management practices as a result of USG assistance (RIA) (WOG)		0	3,940	2,573	3,729		
Producers		0	3,940	2,573	3,729		
Sex		0	3,940	2,573	3,729		
Male		0	878	427	850		
Female		0	1,142	301	669		
Disaggregates Not Available			1,920	1,845	2,210		
Technology type		0	3,940	2,573	3,729		
crop genetics							
cultural practices							
livestock management							
wild fishing technique/gear							
aquaculture management							
pest management							
disease management							
soil-related fertility and conservation							
irrigation							
water management (non-irrigation)							
climate mitigation or adaptation							
marketing and distribution							
post-harvest - handling and storage							
value-added processing							
other							
total w/one or more improved technology		0	3,940	2,573	3,729		
Disaggregates Not Available							
Others							
Sex							
Male							
Female							
Disaggregates Not Available							
Technology type							
crop genetics							
cultural practices							
livestock management							
wild fishing technique/gear							
aquaculture management							
pest management							
disease management							

soil-related fertility and conservation							
irrigation							
water management (non-irrigation)							
climate mitigation or adaptation							
marketing and distribution							
post-harvest - handling and storage							
value-added processing							
other							
total w/one or more improved technology							
Disaggregates Not Available							
4.5.2(7): Number of individuals who have received USG supported short-term agricultural sector productivity or food security training (RIA) (WOG)		0	8,474	1,793	2,405		
Type of individual		0	8,474	1,793	2,405		
Producers			3,660	1,715	1,165		
People in government			7	56			
People in private sector firms							
People in civil society							
Disaggregates Not Available		0	4,807	22	1,240		
Sex		0	8,474	1,793	2,405		
Male		0	2,803	831	760		
Female		0	1,124	962	445		
Disaggregates Not Available			4,547		1,200		
4.5.2(11): Number of food security private enterprises (for profit), producers organizations, water users associations, women's groups, trade and business associations, and CBOs receiving USG assistance (RIA) (WOG)		0	13	15	17		
Type of organization		0	13	15	17		
Private enterprises (for profit)				5	5		
Producers organizations							
Water users associations			2	4	4		
Women's groups			3	3	4		
Trade and business associations							
Community-based organizations (CBOs)		0	1	3	4		
Disaggregates Not Available			7				
New/Continuing		0	13	15	17		
New		0	3	1			
Continuing			2	7	7		
Disaggregates Not Available			8	7	10		
4.5.2(12): Number of public-private partnerships formed as a result of FTF assistance (S)		0	4	9	12		

Agricultural production		0	1	4	5		
Agricultural post harvest transformation		0	1	5	7		
Nutrition		0					
Multi-focus		0					
Other		0					
Disaggregates Not Available			2				
4.5.2(27): Number of members of producer organizations and CBOs receiving USG assistance (S)		0	10	205	256		
Type of organization		0	10	205	256		
Producer organization		0	5	5	6		
Non-producer-organization CBO		0					
Disaggregates Not Available			5	200	250		
Sex		0	10	205	256		
Male		0					
Female		0					
Disaggregates Not Available			10	205	256		
4.5.2(39): Number of technologies or management practices in one of the following phases of development: (Phase I/II/III) (S)							
Phase 1 Number of new technologies or management practices under research as a result of USG assistance		0	2	5	5		
Phase 2 Number of new technologies or management practices under field testing as a result of USG assistance		0	11	9	8		
Phase 3 Number of new technologies or management practices made available for transfer as a result of USG assi stance		0	0	8	9		
Disaggregates Not Available				5	5		
4.5.2(42): (4.5.2-28) Number of private enterprises (for p rofit), producers organizations, water users associations, women's groups, trade and business associations, and CBOs that applied improved technologies or management pr acticies as a result of USG assistance (RIA) (WOG)		0	3	23	27		
Type of organization		0	3	23	27		
Private enterprises (for profit)							
Producers organizations							
Water users associations							
Women's groups							
Trade and business associations							
Community-based organizations (CBOs)		0		3	3		
Disaggregates Not Available			3	20	24		
New/Continuing		0	3	23	27		

New		0		8	2		
Continuing				4	12		
Disaggregates Not Available			3	11	13		

FEED THE FUTURE

Appendix D. Example Feed the Future Indicator Data for West Africa

Reporting Organization	USAID
Bureau	Bureau for Food Security
Operating unit	USAID/BFS HQ
Implementing Mechanism	ARP- CGIAR-Sustainable Intensification: Sudano-Sahelian Zone
Prime Partner	IITA
User	Beliyou Haile
User Role	Implementing Partner
Submission Date	November 25, 2015

Indicator data

Indicator / Disaggregation	Baseline Year	Baseline Value	2015		2016	2017	2018
			Target	Actual	Target	Target	Target
4.5.2(2): Number of hectares under improved technologies or management practices as a result of USG assistance (RIA) (WOG)		0	213	468	413		
Technology type		0	213	468	413		
crop genetics				262	215		
cultural practices							
pest management				29			
disease management					34		
soil-related fertility and conservation				45	54		
irrigation							
water management (non-irrigation)				92	10		
climate mitigation or adaptation							
other				40			
total w/one or more improved technology		0	213	468	413		
Disaggregates Not Available		0			100		
Sex		0	213	468	413		
Male				297			
Female				157			
Joint							

Association-applied							
Disaggregates Not Available		0	213	14	413		
4.5.2(5): Number of farmers and others who have applied improved technologies or management practices as a result of USG assistance (RIA) (WOG)		0	1,932	2,138	2,160		
Producers		0	1,932	2,138	2,160		
Sex		0	1,932	2,138	2,160		
Male		0		1,187	47		
Female		0		909	43		
Disaggregates Not Available			1,932	42	2,070		
Technology type		0	1,932	2,138	2,160		
crop genetics							
cultural practices							
livestock management							
wild fishing technique/gear							
aquaculture management							
pest management							
disease management							
soil-related fertility and conservation							
irrigation							
water management (non-irrigation)							
climate mitigation or adaptation							
marketing and distribution							
post-harvest - handling and storage							
value-added processing							
other							
total w/one or more improved technology		0	1,932	2,138	2,160		
Disaggregates Not Available							
Others							
Sex							
Male							
Female							
Disaggregates Not Available							
Technology type							
crop genetics							
cultural practices							
livestock management							
wild fishing technique/gear							
aquaculture management							
pest management							
disease management							

soil-related fertility and conservation							
irrigation							
water management (non-irrigation)							
climate mitigation or adaptation							
marketing and distribution							
post-harvest - handling and storage							
value-added processing							
other							
total w/one or more improved technology							
Disaggregates Not Available							
4.5.2(7): Number of individuals who have received USG supported short-term agricultural sector productivity or food security training (RIA) (WOG)		0	1,148	3,077	2,150		
Type of individual		0	1,148	3,077	2,150		
Producers		0		3,038	180		
People in government				39			
People in private sector firms							
People in civil society							
Disaggregates Not Available			1,148		1,970		
Sex		0	1,148	3,077	2,150		
Male		0		1,908	96		
Female		0		1,094	84		
Disaggregates Not Available			1,148	75	1,970		
4.5.2(11): Number of food security private enterprises (for profit), producers organizations, water users associations, women's groups, trade and business associations, and CBOs receiving USG assistance (RIA) (WOG)		0	126	110	83		
Type of organization		0	126	110	83		
Private enterprises (for profit)				6			
Producers organizations				69	17		
Water users associations							
Women's groups			25	25	10		
Trade and business associations							
Community-based organizations (CBOs)		0	25	10			
Disaggregates Not Available			76		56		
New/Continuing		0	126	110	83		
New		0					
Continuing				88	20		
Disaggregates Not Available			126	22	63		
4.5.2(12): Number of public-private partnerships formed as a result of FTF assistance (S)		0	20	49	35		

Agricultural production		0		40			
Agricultural post harvest transformation		0		1			
Nutrition		0		5			
Multi-focus		0		1			
Other		0		2			
Disaggregates Not Available			20		35		
4.5.2(27): Number of members of producer organizations and CBOs receiving USG assistance (S)		0	1,658	1,936	2,120		
Type of organization		0	1,658	1,936	2,120		
Producer organization		0		1,785	150		
Non-producer-organization CBO		0		151			
Disaggregates Not Available			1,658		1,970		
Sex		0	1,658	1,936	2,120		
Male		0		1,035	80		
Female		0		755	70		
Disaggregates Not Available			1,658	146	1,970		
4.5.2(39): Number of technologies or management practices in one of the following phases of development: (Phase I/II/III) (S)							
Phase 1 Number of new technologies or management practices under research as a result of USG assistance		0	0	59	42		
Phase 2 Number of new technologies or management practices under field testing as a result of USG assistance		0	0	42	18		
Phase 3 Number of new technologies or management practices made available for transfer as a result of USG assistance		0	0	5	7		
Disaggregates Not Available			213				
4.5.2(42): (4.5.2-28) Number of private enterprises (for profit), producers organizations, water users associations, women's groups, trade and business associations, and CBOs that applied improved technologies or management practicies as a result of USG assistance (RIA) (WOG)		0	86	73	62		
Type of organization		0	86	73	62		
Private enterprises (for profit)				3			
Producers organizations				30	20		
Water users associations				2			
Women's groups				25	20		
Trade and business associations							
Community-based organizations (CBOs)		0		13	2		
Disaggregates Not Available			86		20		
New/Continuing		0	86	73	62		

New		0		1			
Continuing				46	40		
Disaggregates Not Available			86	26	22		