Africa Research in Sustainable Intensification for the Next Generation

East and Southern Africa Regional Project: Proposal for a second phase, 2016 – 2021

(Sustainable Intensification of Key Farming Systems in East and Southern Africa)

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by:
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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 US government's Feed the Future (FTF) initiative.

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

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

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Executive summary

The East and Southern Africa (ESA) Region Project is one of the three regional projects operating in Tanzania, Malawi and Zambia under the title "Sustainable Intensification of Key Farming Systems in East and Southern Africa". It is managed by the International Institute of Tropical Agriculture, IITA.

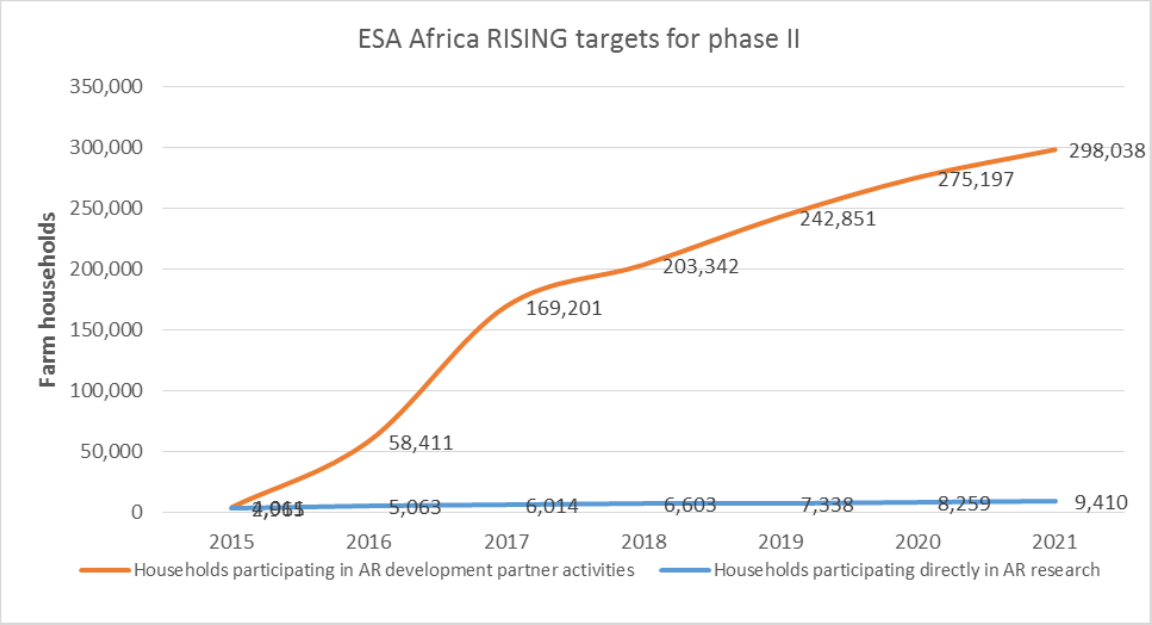
During Phase I, research partnerships made positive strides towards fulfilling the project's objectives to develop strategies and initiatives that would help smallholder farmers to address poverty, hunger, and environmental degradation. Participatory and multi-disciplinary research was operationalized to facilitate (i) implementation of baseline studies that generated a critical mass of data and information that is available to guide prioritization, planning, and implementation of Phase II, (ii) new technology introductions that addressed immediate and obvious cause-effect situations – including new environment-smart and nutrition-improving crop varieties, livestock fodder, and approaches to reduce food waste and spoilage, and (iii) generation of scientific evidence necessary to define technology packages that address more complicated relationships requiring the integration of multi-disciplinary practices – including technologies driven by crop ecology, integrated soil fertility management, landscape scales and livestock integration. Results were communicated in different formats, but mainly in publications, reports, and success stories, and a few technologies were taken to pilot scale for uptake and adoption. Phase II proposes to build its continuity on the solid research partnership foundation but also on harmonized activities within ESA along common research and development outcomes. The ESA Project will strengthen strategic partnerships with development institutions, and leverage on their entrepreneurial approach for success in taking technologies to scale.

Vision of success

The ESA Project subscribes to the purpose and theory of change expressed in the umbrella document. The project will continue to generate research outputs that will support the farm-based households of smallholders to improve their livelihoods by increasing income and improving diets. Dependent on the livelihood strategy there will be different roles of farming, ranging from subsistence to enterprise-oriented agriculture. This implies a diversity of intensification pathways that utilize different packages of technologies and practices to realise sustainable intensification. Action research will be supported by extension material and rural development strategies that will be developed to stimulate technology and educational dissemination activities, and extended to about 300,000 households by the year 2021. These activities are designed to respond to the goals of smallholder households by (i) accelerating adoption of technology breakthroughs that promote sustainable land management, (ii) increasing diversification of crop and livestock production to improve household diets in a manner that favourably affects the most vulnerable smallholders, particularly women and children, and (iii) increasing adoption of value addition to, and the marketing of farm products as a means to improve incomes. Different sustainable production approaches are likely to be required within contrasting agro-ecological zones and socio-economic settings in what are otherwise similar smallholder systems and these will be addressed through typology characterization and targeting.

Building on current, and developing more functioning partnerships between research and development will be the basis for the envisaged success of Phase II of the ESA Project. Reasons for our pilot partnership success were recognised in the Africa RISING mid-term review report (Annex 1). The Figure below shows numbers of beneficiary households that

the ESA Project is targeting directly through the research process and in partnership with development projects. The projections are increasing because of the 3-year partnership with NAFAKA in Tanzania which was initially planned to last up to 2017, targeting about 80,000 household beneficiaries. NAFAKA is a consortium of international and local NGOs, as well as government outreach institutions. In Zambia, partnership for "Africa RISING going to scale in Eastern Province of Zambia" is with NGOs[1] and projects - Profit+, COMACO, TLC, SAIOMA and Grassroots Trust. The 2-year activity is also initially to last up to 2017 and targeting about 49,000 households. In Malawi, partnership with ACE, FUM, CADECOM, CRS and MISST to bridge INVC activities is starting during 2016-17 and planned to last up to 2018, and targeting about 57,000 households In Phase II, the ESA Project will continue to explore research and development partnership opportunities with the curent development partners with whom the partnership extends beyond Africa RISING Phase I, as well as with new partners. For example, the partnership with NAFAKA will likely continue after 2017 as Africa RISING is reflected in NAFAKA's Phase II approved proposal as being important in contributing to the science and practice of agronomy and reduction of food waste and spoilage (post-harvest product management). CRS has expressed interest to work with Africa RISING to scale the doubled-up legume technology in Zambia and Malawi, and vegetable technologies in Tanzania. Exploration of new partnerships leads us to assume at least an annual 10% increase in our beneficiary targets over the Phase II period. This partnership mechanism also ensures that the project activities have impact beyond the project life through continued promotion of the technologies by the organizations.



Target beneficiary households for Africa RISING – ESA Project, Phase II

[1] The acronyms in this paragraph stand for: Profit+ (Production, Finance and Improved Technology); COMACO (Community Markets for Conservation); TLC (Total Land Care); SAIOMA (Strengthening Agricultural Input and Output Markets); ACE (Agricultural Commodity Exchange); FUM (Farmers Union of Malawi); CADECOM (Catholic Development Commission); CRS (Catholic Relief Services); MISST (**Malawi** Improved Seed Systems and Technologies); INVC (Integrating Nutrition in Value Chains).

Moving from Phase I to Phase II

Phase II of Africa RISING in ESA is underpinned by the research outputs of ESA Project Phase I, but also guided by the harmonisation with the other two projects based on the approaches and principles outlined in the umbrella proposal. Research outputs are generated under seven broad strategies representing viable entry points for technological integration, being (i) genetic integration involving introduction of new crops and varieties to overcome existing stresses, (ii) manipulation of crop ecologies to get more crops on limited land and maximise biological nitrogen fixation, (iii) integrated soil fertility management as a cost-effective approach to replenish soil fertility, (iv) introduction of land management technologies to reduce soil loss and enhance water utilisation, (v) improved livestock feed quality and quantity, (vi) introduction of post-harvest approaches to reduce food waste and improve food safety, and (vii) introduction of nutrient rich food crops for improved household nutrition. Details of the flagship technologies under these strategies are given in Annex II. Bringing these technologies together in creative ways will begin to tip the scales in favour of sustainable farming. There will be need for integration of scientific evidence generated in Phase I into decision-guides and principles that can be taught and scaled out as simple rules of thumb and packages targeting agroecosystem and socio-economic circumstances, defined by the SI domains (productive, economic, social, human and environmental). It is the scientific information backing these packages that will form the basis for engaging development partners with whom we plan to conduct R-in-D and quickly scale up to beneficiary numbers that Africa RISING alone is unable to achieve.

Phase II will also explore new research areas emerging from Phase I experiences and feedback. Notable are (i) labour-saving mechanization solutions for small-scale farmers, and (ii) focusing attention on climate-smart solutions. One complementary approach is to introduce crop insurance and insurance-linked credit mechanisms that have emerged as promising market-based solutions for safeguarding farmers against crop failure due to adverse weather and climatic conditions.

We have also learned the importance of gathering feedback from the farmers and other stakeholders which allows for adaptation and iteration of activities during the research process. The ESA Project will operationalize R4D/Innovation Platforms as one major vehicle for this process, making them more effective, autonomous, and inclusive, especially of the private sector, for sustainability. They are meant for research priority setting, design, and dissemination. This approach will make it possible for research to package and complete the development of SI innovations and support their delivery and adoption in the region to achieve the planned outcomes.

About the Africa RISING ESA Project

In tandem with the umbrella **purpose of Africa RISING**, the ESA Project acts through action research and development partnerships, to 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. This is guided by the unique characteristics of, and challenges and opportunities existing in the ESA project countries of Tanzania, Malawi and Zambia (Figure 1).

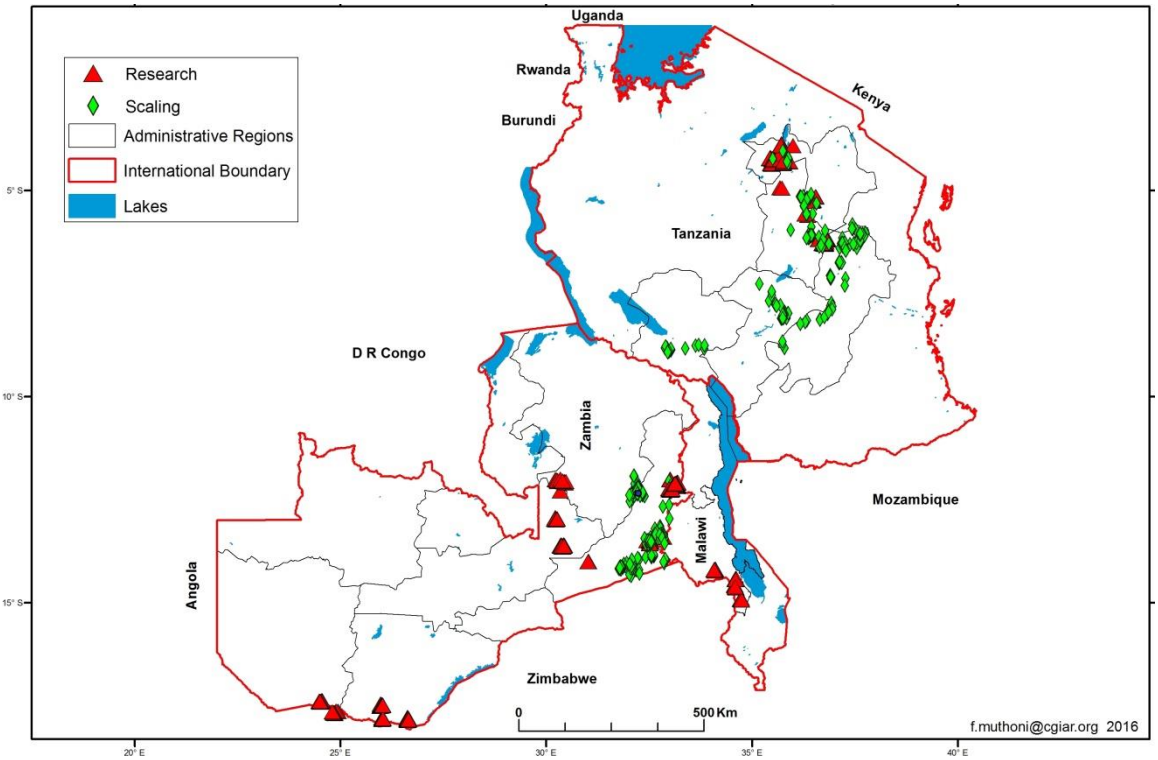


Figure 1: Africa RISING ESA Project countries and location of research/demonstration (learning) sites during Phase I

NOTE: In Figure 1 above, each plot represents a host-household except in Malawi where plots refer to action sites known as Extension Planning Areas. Plots for Tanzania and Zambia include both research and demonstration (research + development partnership learning) sites while those in Malawi are only research managed. Research + development partnership activities in Malawi are starting during 2016/17. During Phase II, activities will be extended to new sites while outcome studies will examine adoption on old sites based on surveys with site hosts, learners and non-beneficiary observers (spillover effects).

Characteristics of the project region

As in most of sub-Saharan Africa, agriculture is the main source of livelihoods for the majority of the population in Tanzania, Malawi, and Zambia (AGRA, 2013)[2], the three Africa RISING countries in East and Southern Africa (ESA). The sector employs over 80% of the population and contributes 25% to the GDP of the countries (Table 1). However, despite some achievements over the past ten years[3], productivity of the sector is still low, especially for cereals – current mean yields are about half of their potential[4]. This in turn compounds food insecurity, poverty and malnutrition problems in the three countries.

Table 1: ESA project country information

Country	Population (2014, est. in millions)	Population growth rate (%)	Agricultural labor force (%)	Population below poverty line (%)	Agriculture as a percentage of GDP	Global Hunger Index	Cereal production (t/ha)
Tanzania	52	2.8	80	28.2 (2012)	31	28.7	1.4
Malawi	17	3.3	90	50.7 (2010)	33	27.3	2.1
Zambia	16	2.9	85	60.5 (2010)	10	41.1	2.5

Sources: World Bank (http://data.worldbank.org/) and IFPRI (http://ghi.ifpri.org/)

Smallholder livelihoods are predominantly farm-based and this agriculture is highly dependent on weather patterns, especially with respect to rain. A diversity of crops is grown; cereals and starchy roots and tubers are dominant. Cattle dominate the livestock sector in the ESA action sites in Tanzania; small ruminants dominate in the action sites in Malawi and Zambia. Poultry is an important component in the three countries. As the human population increases, production has been, for the most part, increasing as a result of land clearance for crops at the expense of land available for other production activities (e.g., livestock). With the challenges of poverty, malnutrition, population growth, and vagaries of weather exerting an impact on agricultural productivity greater attention needs to be shifted to sustainable agricultural intensification, potentially leading to increased productivity as one of the results necessary for improving the livelihoods of the population in the region, but also to minimize negative impacts on natural resources.

Challenges and opportunities

A number of key challenges affect agricultural productivity in the three countries. Notable among these are land degradation and (inherent) poor soil fertility; climate variability; crop pests and diseases; low adoption of proven agronomic practices as a result of inadequate access to information and unreliable agro-input supply systems; institutional barriers (poor markets for inputs and farm products and poor farmer organization); lack of quality livestock feed and pasture, management practices and breeds; postharvest management (losses) processing; and food safety.

Land degradation and poor soil fertility

The diverse agro-ecological zones in the three countries all face different levels of land degradation, with the arid and semi-arid areas exhibiting the highest levels characterized by

[2]Alliance for a Green Revolution in Africa (AGRA). 2013. *Africa Agriculture Status Report: Focus on Staple Crops*. Nairobi, Kenya.

[3]World Bank (2016).*World Development Indicators 2016*. Washington DC: World Bank

[4]Macauley, H & Ramadjita, T. (2015). Cereal crops: rice, maize, millet, sorghum, wheat. *Background paper presented at the Feeding Africa Conference. (21- 23 October, 2015)*. Dakar, Senegal.

soil loss (Pingali *et al.,* 2010)[5]. The soils in the region are also inherently poor in terms of fertility making this a leading biophysical cause of low agricultural productivity (Sanchez, 2002)[6]. The situation is further compounded by low use of fertilizers and organic amendments (AGRA, 2013). In Babati District of Tanzania (one of our action sites), Kihara *et al.* (2014)[7] established that at least 52% of the fields had negative nutrient balances. In Kongwa and Kiteto, the baseline soil fertility indicators of soil organic carbon (0.3-1.9%), total nitrogen (0.03-0.15%), and cation exchange capacity (4.4-10.2 cmol(+)/kg soil) range from very low to low (http://www.slideshare.net/africa-rising/esarp2015-kimaro-51898813)

The weak demand for external inputs by small-scale farmers is due not so much to their limited capacity to invest in farm improvement but to their lack of know-how and information on management options (notably the organic and biological sources –increased use of legumes) that would allow low, efficient, and combined rates of application, lower external input costs, and enhance the value of locally available inputs. There is therefore an opportunity to demonstrate the role of integrated soil fertility management (ISFM) in maintaining the soils' integrity for posterity at affordable costs. Approaches to nutrient restoration and use efficiency must be tailored to meet variations in soil properties and management conditions.

Climate variability

The most potent manifestation of climate variability that has an immediate impact on agricultural productivity is the change in rainfall patterns – inadequate or uneven distribution of rainfall exacerbated by climate change and already being experienced across the three countries. The Intergovernmental Panel on Climate Change (IPCC) estimates that climate change in SSA will reduce crop yields by 8% by 2050 (Porter *et al.*, 2014[8]), with estimated yield losses of up to 20% in ESA for maize, a major crop in the region, and one of the most vulnerable (Zinyengere *et al.*, 2013[9]). Africa RISING scientists have opportunities to generate and make available climate-smart technologies that will help to assuage this problem. Scaling of information on weather and climate-smart technologies could make use of proven ICT-led innovations available in the region (AGRA, 2014[10]).

Lack of quality livestock feed and pasture, management practices, and breeds

Livestock development was envisioned as offering more opportunities for improving security in food, nutrition, and income in Tanzania where cattle rearing is predominant. Even here,

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[5]Pingali, P., Gingerich, C., and Wood, S. (2010, September). *Poverty and smallholder agriculture in sub-Saharan Africa: Targeting R&D.* Paper presented Invited paper presented at the 3rd Conference of the African Association of Agricultural Economists, Cape Town, South Africa.

[6] Sanchez, P.A. (2002). Soil fertility and hunger in Africa. *Science,* 295, 2019-2020.

[7] J. Kihara, L. D. Tamene, P. Massawe, and M. Bekunda (2014). Agronomic survey to assess crop yield, controlling factors
and management implications: a case-study of Babatiin northern Tanzania.NutrCyclAgroecosyst
DOI 10.1007/s10705-014-9648-3

[8]Porter, J.R., L. Xie, A.J. Challinor, K. Cochrane, S.M. Howden, M.M. Iqbal, D.B. Lobell, and M.I. Travasso, 2014: Food security and food production systems. In: Climate Change 2014: Impacts, Adaptation, and Vulnerability. Part A: Global and Sectoral Aspects. Contribution of Working Group II to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change [Field, C.B., V.R. Barros, D.J. Dokken, K.J. Mach, M.D. Mastrandrea, T.E. Bilir, M. Chatterjee, K.L. Ebi, Y.O. Estrada, R.C. Genova, B. Girma, E.S. Kissel, A.N. Levy, S. MacCracken, P.R. Mastrandrea, and L.L.White (eds.)]. Cambridge University Press, Cambridge, United Kingdom and New York, NY, USA, pp. 485-533.

[9]Zinyengere, N., Crespo, O. and Hachigonta, S. (2013). Crop response to climate change in southern Africa: A comprehensive review. *Global and Planetary Change,* 111, 118-126.
https://doi.org/10.1016/j.gloplacha.2013.08.010

[10]Alliance for a Green Revolution in Africa (AGRA). 2014. *Africa Agriculture Status Report: Climate Change and Smallholder Agriculture in sub-Saharan Africa*. Nairobi, Kenya.

however, only those systems that integrate livestock, mainly cattle and poultry, in the crop production systems are considered under the Africa RISING mandate. Although several problems were identified (including availability of appropriate breeds for high productivity and postharvest handling of livestock products to allow better market access), the main challenge is how to ensure profitable production on the limited natural resource base. Thus, the choice entry point is the provision of better quality and increased fodder and feed, given that livestock have access to as little as 30% of the required feed during the dry season, and are not fully fed even during the wet season (http://www.slideshare.net/africa-rising/esa-rp2013-babati-26159104?qid=0db12836-c2d8-4383-9502-87658d34ee43&v=&b=&from_search=10).

The research opportunity is in demonstrating that the establishment of high quality fodder species on underutilized land patches, such as field boundaries and contour hedges, would not only allow an increase in both the quality and availability of feed and improve feeding regimes when combined with chopped maize stover for better digestibility but also contribute to the physical management of soil and soil-water resources. Livestock manure could be efficiently utilized in soil fertility management. These activities would maximize locally available resources for developing quality feed.

Postharvest management and processing; food safety challenges

According to the World Resources Institute, approximately 23% of available food in sub-Saharan Africa is lost or wasted (Lipinski et al. 2013[11]). This is equal to the loss of 545 kilocalories per person, per day across a sub-continent where 24.8% of the population is undernourished (FAO 2013[12]). Mycotoxins contamination is, in part, caused and/or increased by poor handling of produce and storage practices. In a maize-based farming system in semi-arid areas of Central and Northern Tanzania, quantitative pre- and postharvest losses of economic importance occur in the field (15%), during processing (13-20%), and during storage (15-25%[13]). Many simple tools and approaches exist for reducing postharvest loss and spoilage; however, uptake and adoption by smallholder farmers remain limited, in part due to lack of awareness of these alternatives and skills to use them. The ESA Project has the opportunity to demonstrate and promote access to effective technologies that reduce product spoilage and degradation during handling and storage, and allow farmers to hold their crops for extended periods of time, also contributing to better returns from sales during periods of low availability. Produce saved can also reduce the rates of acquiring and committing more land area to agriculture.

Adoption of proven technologies

Agricultural productivity for farming systems in the ESA region could be enhanced if the available technologies were adopted and scaled up. However, the current extension system in the three countries is ineffective for several reasons, including inadequate funding and human resources, poor facilitation/motivation, low use of ICTs to complement interpersonal methods, and insufficient access by extension workers to up-to-date information. The increase in numbers of extension staff in the three countries has not matched that of farmers over the years and as a result less than 30% of farmers are served by national

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[11] Lipinski, B., Hanson. C., Lomax, J., Kitinoja, L., Waite, R. and Searchinger, T. (2013). *Reducing Food Loss and Waste*. Washington, DC: World Resources Institute

[12]Food and Agriculture Organization. *Food security indicators. 2011-2013*. Retrieved from: http://www.fao.org/economic/ess/ess-fs/ess-fadata/en/#.U3OF8ygSdqI

[13]Adebayo B. Abass, Gabriel Ndunguru, Peter Mamiro, Bamidele Alenkhe, Nicholas Mlingi and Mateete Bekunda (2014).Post-harvest food losses in a maize-based farming system of semi-arid savannah area of Tanzania. Journal of Stored Products Research 57:49-57.

extension systems in developing countries including the three ESA countries (Bell, 2015[14]). The ESA project team has an opportunity to partner with key stakeholders in each country (local government, NGOs, and donor-funded bilateral development projects) to adopt and adapt technology dissemination approaches that have the potential to take proven technologies to scale.

In addition to lack of information, there are other institutional barriers which, in retrospect, affect the adoption and scaling of proven technologies. These include unreliable agro-input supply systems which perpetrate the promotion of counterfeit inputs, poor markets for farm products, and poor farmer organization. In the three countries, Africa RISING scientists have had the opportunity to identify promising models of agro-input networks, marketing, and farmer organization that could be further examined and adapted for scaling the proven technologies.

Access to markets and poor farmer organization

Sustainable intensification requires the proper functioning of the marketing system. Indeed, it is difficult to sustain output and productivity growth without efficient output markets which offer a means of absorbing surpluses resulting from improved farm technology (AGRA, 2013[15]). Studies conducted in ESA and elsewhere show that a well-functioning marketing system is necessary for the adoption of improved agricultural technologies (Kassie *et al.*, 2013[16]; Kassie *et al.*, 2015[17]). Farmers as producers of different crops and livestock, depend on markets to sell their products and to spend their income as consumers of various products including farm inputs. In fact, selling and buying are intertwined within agricultural production and hence weakness of the marketing system at one point of the value chain will affect performance at the others.

The marketing systems (both output and input) are poorly functioning in ESA and (Eskola, 2005[18], ASARECA, 2008[19], Jayne *et al.*, 2010a[20]). This is linked to complex problems including poor infrastructure and weak institutions. The region is characterized by a poor road network. Most of the good roads are limited to major marketing centers and most rural towns are not connected by good roads (Eskola, 2005, Ondiege, 2013[21]). Village roads are impassable by vehicles particularly during rainy seasons and the cost of transport is pushed up in these areas. Postharvest facilities for grains and other agricultural commodities are also poor. Farmers use traditional means of storage which are vulnerable to storage pests and moisture; most processing activities (winnowing, de-hulling, drying, sorting, and

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[14]Bell, M. (2015). ICT – Powering Behaviour Change to a Brighter Agricultural Future. *MEAS Discussion Paper*. October 2015.

[15] Africa Agriculture Status Report: Focus on staple crops. Alliance for Green Revolution in Africa, Nairobi, Kenya. 2013.

[16]Kassie, M., Jaleta, M., Shiferaw, B., Mmbando, F., and Mekuria, M. (2013). Adoption of Interrelated Agricultural Practices in Smallholder Systems: Evidence from Rural Tanzania. Technological Forecasting & Social Change, 80: 525-540.

[17]Kassie, M., Teklewold, H., Jaleta, M., Marenya, P., and Erenstein, O. (2015). Understanding the Adoption of a Portfolio of Sustainable Intensification Practices in Eastern and Southern Africa. Land Use Policy, 42: 400–411

[18]Eskola, E. (2005). Agricultural Marketing and Supply Chain Management in Tanzania: A Case Study. ESRF Study on Globalisation and East Africa Economies, Working Paper Series No. 16

[19] ASARECA (Association for Strengthening Agricultural Research in Eastern and Central Africa). (2008). Responding to the food price crisis in Eastern and Southern Africa: Policy options for national and regional action. ASARECA, Entebbe.

[20] Jayne, T. S., Sitko, N., Ricker-Gilbert, J., and Mangisoni, J. (2010a). Malawi's Maize Marketing System. Unpublished report, February 2010. http://fsg.afre.msu.edu/malawi/Malawi_maize_markets_Report_to-DFID-SOAS.pdf, accessed on 19 April, 2016.

[21]Ondiege, P., Moyo, J.M and Verdier-Chouchane, A. (2013). Developing Africa's Infrastructure for Enhanced Competitiveness.The Africa Competitiveness Report 2013.World Economic Forum.

shelling) are carried out manually (Abass et al. 2014[22]). These poor facilities have contributed to postharvest losses and seasonal gluts that dampen producers' incentives.

Agricultural products in ESA are also constrained by a lack of institutions that can reduce transaction costs; these include inadequate quality standards, weak inspectorate mechanisms at various levels, and weak enforcement of agricultural marketing regulations (Eskola, 2005; Kawa and Kaitira, 2007[23]). Moreover, most smallholder farmers are not organized, have very little information on markets, including output prices, have little market orientation and few entrepreneurial skills, and cannot gain access to credit to enable them to store their produce when prices are low and sell out when prices get better (Eskola, 2005, Kawa and Kaitira, 2007 and Jayne *et al.,* 2010b[24]). As a result, their bargaining power on prices and marketing modalities is very limited. The position of smallholder farmers as market participants is further weakened by their pressing necessity to meet cash needs after harvesting. Sometimes marketing problems are manifested by the unpredictability of macro-level institutions limiting long-term investment in marketing facilities. For instance, Malawi, Zambia, and Tanzania banned maize exports in 2008 which made trading firms suspend investment in developing durable marketing networks across regions (Jayne *et al*., 2010b).

The poor marketing system affects smallholder farmers in two ways. First, prices become highly volatile which, in the absence of adequate information, is most likely to reduce the mean revenue among smallholder farmers from product sales. Secondly, the poor marketing system increases costs of both production and marketing. The impact will be low net income from agricultural production which results in lower incentives to adopt improved agricultural technologies.

Despite these challenges, there are huge marketing opportunities in the region. Domestic demand for agro-processed products, particularly food products, has increased both in rural and urban areas of ESA countries and has resulted in the emergence of supermarkets and fast-food outlets (Eskola, 2005). Moreover, the possibility of regional integration which expands demand for agricultural products and the expansion of ICT to support information flow among marketing actors make opportunities available to improve agricultural marketing in the region (Khandelwal, 2004[25]). However, smallholder farmers and other domestic market actors have not been able to take advantage of these emerging marketing opportunities. Research on value addition, how various stakeholders (including smallholder farmers, processors, traders, and consumers) are effectively interlinked, and alternative marketing information channels, among other things, will help to exploit emerging market opportunities.

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[22]Abass, B.A. Ndunguru, G., Mamiro, P. Alenkhe, B. Mlingi, N., and Bekunda, M. (2014).Post-harvest food losses in a maize-based farming system of semi-arid savannah area of Tanzania. Journal of Stored Products Research, 57: 49-57.

[23]Kawa, I.H. and Kaitira, L.M. (2007). Enhancing Smallholder Farmers' Market Competitiveness in Tanzania. Case study #6-7 of the program: "Food Policy for Developing Countries: The role of the government in the global food system."

[24] Jayne, T.S., Mason, N. Myers, R. Ferris, J., Mather, D., Lenski, N., Chapoto, A. and Boughton, D. (2010b). Patterns and Trends in Food Staple Markets in Eastern and Southern Africa: Toward the identification of priority investment and strategies for developing markets and promoting smallholder productivity growth. MSU International Development Working Paper No. 104. http://ageconsearch.umn.edu/bitstream/62148/2/idwp104.pdf (accessed on 19/4/2016).

[25]Khandelwal, P. (2004). COMESA and SADC: Prospects and Challenges for Regional Trade Integration. IMF Working Paper, WP/04/227

Project vision of success

ESA Project II vision of success is based on the premise that technology breakthroughs occurring through research can improve the lives of the smallholder farmers if they are fine tuned to more site-specific agricultural and socio-economic settings, and mechanisms are developed to put these technologies into farmer practice. ESA Project research partners have, and will continue to develop proven SI technologies, and their operational approach with development partners (R-in-D) who have expertise in design and implementation of integrated community-based scaling will seek to meet impact targets as described below. These approaches have been piloted during Phase I; research and development partners successfully worked together to assist farmers to access and better use farm inputs, cropping and livestock management technologies and practice natural resources conservation. As a result, the beneficiary households at the end of the ESA Project Phase I (2016) are about 58,000, which is more than 10 times the original targets set for the research component (Figure 3, Table 2).

Impact targeting

The mandate for research partners was to identify and evaluate candidate technologies through participatory, on-farm approaches which, by their nature engage few farm households. During the latter part of Phase I, researchers realised that combining the best performing interventions into information and technology packages and field testing them through networks of development projects would create an opportunities for identifying the most effective interventions that would be mainstreamed into wider rural development programs beyond ESA Project zones of influence.

Partnerships were developed, initially with FtF supported development projects whose visions of success required availability of informed productivity enhancing innovations for scaling-up and -out in the target communities. Both research and development projects are cognizant of the mutual benefits and synergies that would accrue from joint undertakings; Africa RISING generates these innovations as its outputs and development partners provide opportunities for learning through action research (R-in-D) and scaling-up and -out of the research innovations. In Phase II, the ESA Project will continue to explore these opportunities with the curent development partners with whom the partnership extends beyond Africa RISING Phase I, as well as new partners (including non-USAID supported – Table 2) and thus increase the return to investment by USAID Feed the Future in the three countries' zones of influence. The success of these partnerships form the basis for the proposed beneficiary targets are given in Figure 2 and Table 2.

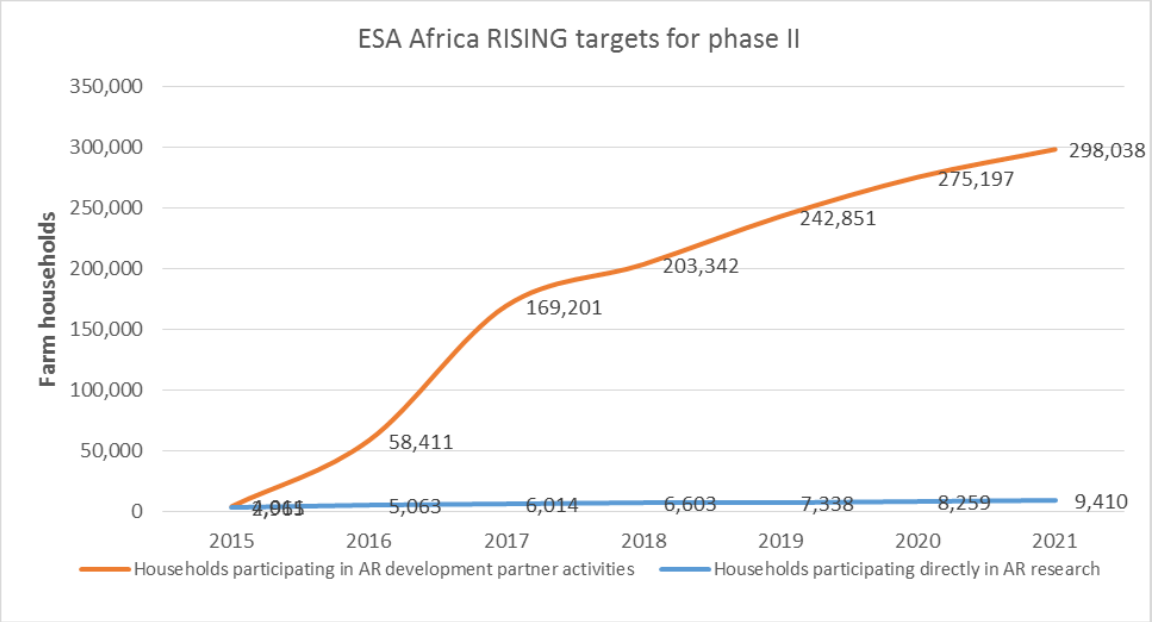

Figure 2: Target beneficiary households for Africa RISING – ESA Project, Phase II

Table 2: Impact targets (households in FtF – ZoI) and progress toward impact (beneficiary households) for the ESA Project, 2015-2021

Impact targets	2015	2016	2017	2018	2019	2020	2021
Households participating directly in AR research	**2,965**	**5,063**	**6,014**	**6,603**	**7,338**	**8,259**	**9,410**
Tanzania	1,659	1,710	1,773	1,852	1,950	2,073	2,228
Malawi	1,306	1,633	2,041	2,551	3,188	3,986	4,982
Zambia		1,720	2,200	2,200	2,200	2,200	2,200
Households participating in AR development partner activities	**4,011**	**58,411**	**169,201**	**203,342**	**242,851**	**275,197**	**298,038**
Tanzania	2705	16,070	82,800	91,080	100,188	110,207	121,227
Malawi	1306	12,796	39,645	65,506	95,907	118,234	130,055
Zambia		29,545	46,756	46,756	46,756	46,756	46,756
Total households in FTF zones of influence	**2,192 million**	**2,656 million**	**2,740 million**	**2,823 million**	**2,906 million**	**2,988 million**	**3,072 million**
Tanzania	1,004 million	1,037 million	1,070 million	1,102 million	1,135 million	1,167 million	1,200 million
Malawi	1,188 million	1,226 million	1,265 million	1,303 million	1,341 million	1,379 million	1,417 million
Zambia		392,893	405,229	417,566	429,903	442,240	454,577

Building on current, and developing more functioning partnerships between research and development will be the basis for the envisaged success of Phase II of the ESA Project. Reasons for our pilot partnership success were recognized in the Africa RISING mid-term review report (Annex 1). The Figure below shows numbers of beneficiary households that the ESA Project is targeting directly through the research process and in partnership with development projects. The projections are increasing because of the 3-year partnership with NAFAKA in Tanzania which was initially planned to last up to 2017, targeting about 80,000

household beneficiaries. NAFAKA is a consortium of international and local NGOs, as well as government outreach institutions. In Zambia, partnership for "Africa RISING going to scale in Eastern Province of Zambia" is with NGOs Profit+, COMACO, TLC, SAIOMA and Grassroots. The 2-year activity is also initially to last up to 2017 and targeting about 49,000 beneficiaries. In Malawi, partnership with ACE, FUM, CADECOM, CRS and MISST to bridge INVC activities is starting during 2016-17 and planned to last up to mid-2018, and benefitting about 57,000 beneficiaries. In Phase II, the ESA Project will continue to explore research and development partnership opportunities with the current development partners with whom the partnership extends beyond Africa RISING Phase I, as well as with new partners. For example, the partnership with NAFAKA will likely continue after 2017 as Africa RISING is reflected in NAFAKA's Phase II approved proposal as being important in contributing to the science and practice of agronomy and reduction of food waste and spoilage (post-harvest product management). CRS has expressed interest to work with Africa RISING to scale the doubled-up legume technology in Zambia and Malawi, and vegetable technologies in Tanzania. Exploration of new partnerships is expected to leads to an annual increase of at least 10% in beneficiaries over the Phase II period. This partnership mechanism also ensures that the project activities have impact beyond the project life through continued promotion of the technologies by the organizations.

Phase I achievement and lessons

Achievements

The mid-term Africa RISING evaluation report rightly observed that projects achievements were primarily focused on research and validation of technologies (Table 3) but that trials are producing important knowledge, and participants welcome and value them. Some of the technologies are transferrable across sites and this has guided Phase II advocacy for implementation of research through Communities of Practice. It is common that during validation exercises, flagship technologies in one category are combined with (an) other flagship technology (ies); i.e. integration to enhance sustainability.

The status that Africa RISING is at during Phase I is explained in the research to impact pathway of Africa RISING described in the Program umbrella document. In line with impact pathway logic that comprises a continuum that aims to carry research to development to enhance sustainable intensification for smallholder farmers, the ESA Project piloted adaptation and dissemination of validated technologies, in partnership with development partners, and is poised to reach more than 60,000 beneficiaries by the end of Phase I. More details of Phase I achievements are given in Annex II.

Table 3: List of validated technologies ready for promotion to development partners

Broad category	Validated flagship technology	Validation sites
Genetic integration involving introduction of new crops and varieties to overcome existing stresses	Drought tolerant maize, groundnut, bambara nut, millet, sorghum	Kongwa/Kiteto
	Climbing beans	Malawi, Babati
	Short-duration pigeon pea	Malawi
Manipulation of crop ecologies to get more crops on limited land and maximise biological nitrogen fixation	Doubled-up food legumes	Malawi, East Zambia
	doubled-up food and fodder legumes	Kongwa/Kiteto
	Cereal-legume intercropping, crop rotations	All four sites
Integrated soil fertility management as a cost-effective approach to replenish soil fertility	Optimised fertilizer rates Composts	Babati, Malawi, Kongwa/Kiteto
	Livestock manure	Kongwa/Kiteto, Babati
	Cover crop composts	Babati
Introduction of land management technologies to reduce soil loss and enhance water utilisation	In-situ water harvesting	Kongwa/Kiteto, Babati
	Physical erosion barriers (fanya chini) and shelterbelts	Kongwa/Kiteto
	Cover crops	East Zambia, Babati
	Conservation agriculture	East Zambia
Improved livestock feed quality and quantity	Introduction & utilization of forages Stover quality improvement	Babati, Kongwa/Kiteto Malawi
	Poultry feeds with vegetable rations	Babati, Kongwa/Kiteto
	Livestock feed with fodder rations	Malawi
Introduction of pre- and post-harvest approaches to reduce food waste and improve food safety	Shelling, Drying, Storage	Babati
	Aflasafe application	Babati, East Zambia
Introduction of nutrient rich food crops for improved household nutrition	Vegetables	Babati
	Quality protein maize	Kongwa/Kiteto East Zambia, Malawi

*Validation action sites are 2 in Tanzania (Babati, Kongwa/Kiteto), 1 in Malawi and 1 in East Zambia

Lessons learned

Farmer interest was high in the SI technologies being tested on-farm by the researchers of Africa RISING. Profit potential was highest for horticultural innovations, such as new vegetable varieties, intensified management, and cropping patterns. Field crop technologies generally were observed to have narrow profit margins but were widely preferred owing to their importance to the food security of smallholder farmers. Improved varieties of maize and grain legumes and intensified planting patterns were the preferred SI technologies to be tried out by farmers across all Africa RISING sites. Women and men farmers equally experimented with improved technologies and showed particular interest in legume crops, nutritional education, and postharvest technologies. Labor constraints continue to be one of the major challenges for the adoption of many SI technologies, and require more attention in the next phase.

Fertilizer use by farmers depended on the biophysical and socio-economic context, but there is preliminary evidence of increased adoption at all sites in Malawi and several sites in Tanzania. Rainfall patterns and climate risk remain a challenge where targeted use of fertilizers can help to improve yield stability but attention to soil management is required along with fertilizer use and education. Crop-livestock integration was addressed through different approaches depending on the area, with innovations in community-level institutions in areas with farmer-herder conflict and attention to forage quality technologies in areas with intensified zero-grazing systems. Crop-livestock integration highlights the need for integrated approaches that consider trade-offs and synergies associated with SI technologies at the household and community levels. Whole-systems thinking and gender-sensitive research are at the early to intermediate stage, as reflected across diverse partners and research approaches, and will be improved in the next phase through attention to SI indicators, participatory research conducted at scale, and the use of modelling tools.

Visualisation of the extent to which the SI domains are being addressed is given in Figure 3 showing a bias toward collecting matrix data that address productivity improvement strategies and less of social issues of sustainability. Phase II will plan to enhance measurements of indicators in more of the other SI domains in an effort to better explain the complex dimensions of sustainability.

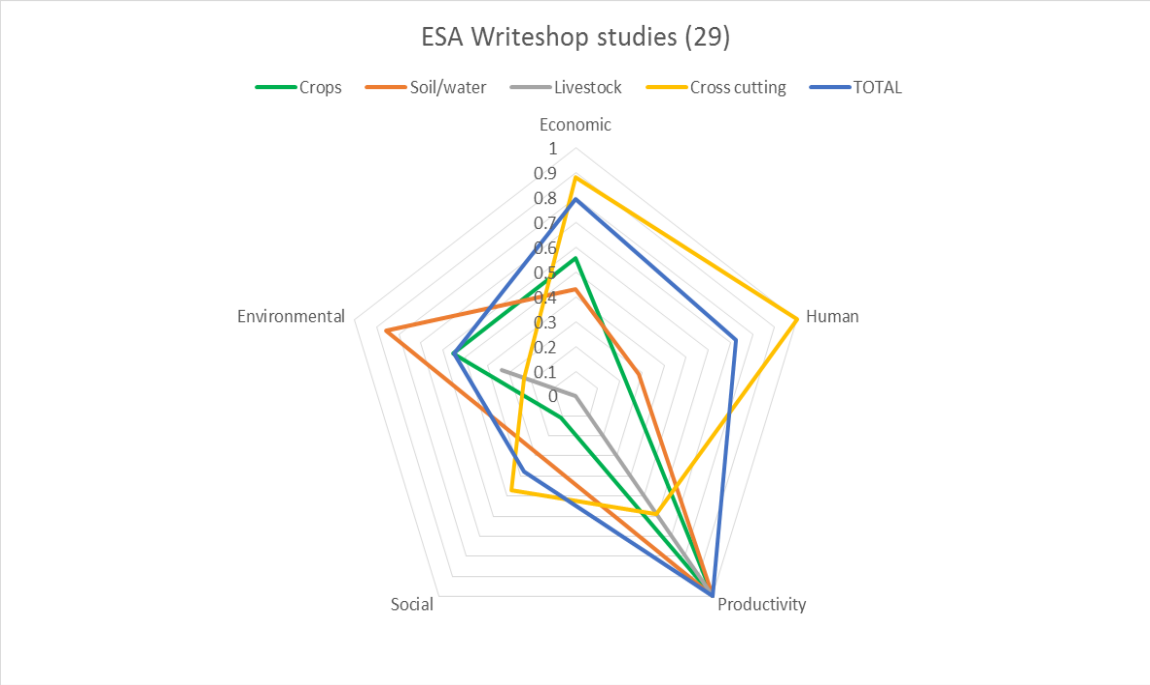

Figure 3: Illustration of the extent to which multidisciplinary Phase I research in ESA is measuring indicators of sustainable intensification

Research backstopping is a concept that is beginning to take hold through R4D/Innovation Platforms and feedback meetings where experimental results are shared and local development actors and scaling partners can present priorities, reflect with researchers and farmers on findings, and plan the next research activities. The progress that has been made under this arrangement needs to be consolidated and expanded through the proposed Research-in-Development (R-in-D) approach in Phase II. Next steps include developing more detailed SI indicator protocols, working instructions, and conducting training that supports research teams in working with development partners to implement R-in-D. More evidence may be needed on the most effective scaling approaches and whole-[systems research to achieve impact. This may include systematic assessment of the different types of Africa RISING research in development, including R4D/Innovation Platforms, decision guides, and gender-sensitive participatory extension. Africa RISING teams in Phase I have experimented with a range of approaches and some of these have shown considerable potential to date, as indicated by farmer adaptation and adoption of SI technologies. The assessment of technology adoption and its impact on SI indicators is a crucial next step to help inform in an iterative manner Africa RISING farming systems research and support trajectories of sustainable, intensified production for different socio-economic groups and communities.

The vagaries of weather continue to be the main challenge to consistent research plans. The drought in Southern Africa over the last cropping season is considered to have been the worst in over three decades with seasonal rains delayed by up to 50 days and higher than normal temperatures recorded during the maize planting season. This has resulted in a very poor maize crop for the region, including in Malawi and Zambia. However, this also presented the opportunity for show-casing performance of the drought-tolerant maize variety in Tanzania. Africa RISING research must continue adapting research plans so as to generate SI technologies that are climate smart. For example, it is important that new crop varieties are evaluated under drought conditions so that they may be more effectively targeted in the future. Secondly, basic soil conservation field practices, particularly the

establishment of tied ridges, trash lines, ditches, and contour bunds, will be incorporated into best-fit management practices, as appropriate.

Better understanding of the added value of R4D/Innovation platforms under different conditions is needed. As with many open-ended processes, we lack insights in what exactly makes R4D platforms effective in changing mainstream practices depending on policy environment, the range of issues involved or the scales (e.g., strategic, operational) at which the platforms operate. We still have to appreciate how these platforms function when organized around constructs other than just value chains.

Phase II, moving on from Phase I

Phase II of Africa RISING in ESA is underpinned by the research outputs of ESA Project Phase I, but also guided by the harmonisation with the other two regional projects based on the approaches and principles outlined in the umbrella proposal. Loose ends of SI technologies not addressed in Phase I, especially in regard to generation of data addressing SI domains (Figure 3), will be tied in Phase II. Then integration of scientific evidence into decision-guides and principles that can be taught and scaled out as simple rules of thumb and packages targeting agroecosystem and socio-economic circumstances will be implemented. Key changes in Phase II are summarized in Table 4.

Table 4: Africa RISING in the ESA Region: moving from Phase I to Phase II

Operational issue	**Phase I**	**Phase II**
Geographic area of operation	Initially in few districts (3 in Tanzania, 2 in Malawi, 3 in Zambia)	Expansion to more districts while conducting R-in-D with development partners in their different areas operation
Research approach	Generic - on technology identification, testing, and validation.	Generic, adaptive & adoptive - to backstop scaling initiatives with development partners. Technology validation based on the SI framework.
Partnerships	Primarily with disciplinary experts and farmers, and piloting with development partners.	Strengthen development and private sector partnerships.
Technology scaling	Ad hoc dissemination and scaling arising from technology generation and demonstration activities. Pilot technology scaling with FtF-supported development projects.	Systematic horizontal and vertical scaling of Phase I innovations with development partners beyond those supported under the FtF initiative.
Targets	Mainly direct beneficiaries engaged in technology development.	Direct beneficiaries engaged in technology development and those via development partners, and numbering hundreds of thousands of individuals (low cost per beneficiary). Address spillover identification.
Research-for-development platforms	Implemented mainly at district levels (strategic level).	Extending to village (community) levels (operational level).
Capacity development	Focused on short-term farmer and extension staff training, and on long-term graduate students conducting research to support action research interventions.	Strengthen development of capacity for private and public-sector extension and farmers with specific attention to women and youth.
Site coordination teams	Based in the area with specific responsibilities for the research conducted in that action site.	Cross-site and cross-region integration through communities of practice ob specific topics.
Monitoring and evaluation	*Ad hoc* monitoring via field visits. Largely opportunistic.	Greater quantitative emphasis. Formal beneficiary tracking system to capture formal/informal technology dissemination and adoption. Implementation of the SI indicator framework.

Activities that need to be further addressed during Phase II in order to have better informed SI innovations were identified as being:

- Integration of scientific evidence generated in Phase I into decision-guides and principles that can be taught and scaled out as simple rules of thumb and packages targeted by agroecosystem and socio-economic circumstances. The SI technologies require sound economic and environmental benefits, thereby forming bases for engaging development partners with whom we plan to conduct R-in-D.
- Developing more linkages between crop-livestock diversification and human nutrition.
- Developing a coherent capacity building strategy for different levels – farmers, extension agents, research, universities, etc., – and leveraging them to buil human resources for sustainable intensification (stakeholder capacity building approaches).
- Engaging in purposeful inclusion of gender and youth concerns and involvement in the SI process.
- Full implementation of the Africa RISING data management and sharing plan, and having communication outputs that reflect more of the integrated outputs that better address SI.
- Operationalizing R4D/Innovation Platforms, making them more effective, autonomous, and inclusive, especially of the private sector, for sustainability. They are meant for research priority setting, design, and dissemination.

Phase II will also explore new research areas and the utilization of tools emerging from Phase I, identified as follows:

- Utilize knowledge generated from farm-based livelihood systems analyses and typology characterization to inform research targeting and technology dissemination.
- Evaluate trade-offs and synergies associated with SI technologies across the five SI domains (productivity, environment, economics, human condition, social situation) and generate integrative solutions to perceived tradeoffs.
- Strengthen crop-livestock integration involving different livestock species.
- Propose small-scale mechanization (labor-saving) solutions for small-scale farmers.
- Focus attention on climate-smart solutions. One complementary approach is to introduce crop insurance and insurance-linked credit mechanisms that have emerged as promising market-based solutions for safeguarding farmers against crop failure due to adverse weather and climatic conditions.

Phase II target outcomes

We have learned the importance of gathering feedback from the farmers and other stakeholders which allows for adaptation and iteration of activities during the research process. This approach will make it possible for research to package and complete the development of SI innovations and support their delivery and adoption in the region to achieve the following outcomes.

Outcome 1: Productivity of crop-livestock systems in selected semi-arid and sub-humid agro-ecologies of ESA enhanced

Underpinning SI is the need to increase productivity per unit of input. This outcome will address options for the optimization of integrated crop-livestock systems that will increase diversity and allocative efficiencies in farm households. Previous research has not given appropriate attention to the interactions and trade-offs between crop and livestock components at household, community, and landscape scales while maintaining the natural

resource capital (soil and water). Focus will be on options that reduce drudgery and improve labor efficiency in a gender-sensitive manner. The specific objectives under this outcome are as follows:

- **Objective 1.1** Refine and test scalable integrated crop-livestock technologies that equitably optimize productivity for specific agro-ecologies.
- **Objective 1.2** Develop functional linkages between crop and livestock enterprises that ensure increased availability of diverse crop and livestock products for consumption and income.
- **Objective 1.3** Adapt and disseminate cost-effective, labour-saving, and gender-sensitive technologies.

Outcome 2: Community adoption of technologies that will lessen hunger and poverty under conditions of climate change

Reduction of household and community vulnerability to ever-increasing uncertainty on the onset and volume of rain and in-season droughts is needed for these groups to become more resilient and adaptive. n addition to stress-tolerant crops and water harvesting practices, small-scale irrigation has the potential to buffer households and communities from their overdependence on rain-fed production systems, reduce off-season food and nutritional insecurity, and create income—, potentially providing opportunities for women and the youth. Elite vegetable varieties have been evaluated and adopted by several beneficiaries under rain-fed conditions. Introducing off-season supplemental irrigation can result in even higher incomes. Although there are technologies on supplemental irrigation, little or no effort has been made to transfer these to farmers in many regions. Under Phase I, a number of SI innovations were developed at project sites. In Phase II, there is need to assess beyond the tested sites their opportunities and constraints/feasibility that meet the criteria for sustainability and equity. The specific objectives under this outcome are set out to build on existing practices and incorporate new approaches to providing water for crops and livestock during dry periods of the year.

- **Objective 2.1** Test opportunities and constraints for supplemental irrigation in rain-fed mixed farming systems to reduce vulnerability to weather variability and improve livelihoods.
- **Objective 2.2** Enhance soil and water resources to meet food, feed, and nutrition needs in a sustainable and equitable manner.

Outcome 3: Options for equitable food and feed safety, nutritional quality and income security of target smallholder families improved

Traditional food production and consumption can be lacking in diversity and this is reflected in poor nutrition in certain elements of households and communities (e.g., stunting and wasting in children, anaemia in mothers). This outcome sets out to address how more nutritious food can be produced and consumed in a more equitable manner (intra-household and community). Researchers have already developed enriched crop and feed varieties with high potential to address some nutritional challenges and some have already been introduced in the Africa RISING sites.

In terms of food safety, postharvest management of cereal grain and crop residues is often associated with high losses through spoilage by pests and microorganisms (Abass et al. 2014). Attacks on crop and harvest products by pathogens such as *Aspergillus flavus* result in

food and feed contamination with aflatoxins. This outcome targets addressing contamination of stored produce through generating evidence of drivers, risks, and solutions. Superior options for mitigating aflatoxins and other hazards in fresh foods (e.g., vegetables) need to be researched and scaled up to reach wider communities. In Phase I, activities for the promotion of nutritional education were undertaken but little was done on behavioural change communication, e.g., promotion of recipe development.

- **Objective 3.1** Investigate production and consumption drivers of diverse crop and fodder varieties to improve food, feed, and nutrition status at household members.
- **Objective 3.2** Investigate the drivers of equitable adoption of postharvest technologies to improve food/feed supply for different household typologies, and assess product economic value.
- **Objective 3.3** Investigate acceptability and utilization options for enriched crop varieties and livestock feed resources.
- **Objective 3.4** Test production options for enhancing food safety while maintaining nutritional quality in different agro-ecological contexts of the target countries.

Outcome 4: Functionality of markets, institutions, and partnerships associated with SI technologies through providing mechanisms that improve household linkages to markets improved

During Phase I of the ESA Project, emphasis was on the development of technological packages but with limited consideration of linking farmers to functional markets as potential drivers to their adoption. Individual farmers are not competitive in the market because of low volumes of produce (low bargaining power) and inability to meet quality standards for high value markets. In Phase II, more emphasis will be on providing functional market information and support systems. In addition, best-fit/inclusive business models will be developed that will provide better market access to smallholder families. Furthermore, the majority of farmers lack knowledge in recognizing farming as a business. Specific attention will be given to the opportunities for gender-transformative approaches to markets.

Modern development and penetration by ICT, even in remote areas, provide an enormous potential for strengthening existing market linkages and creating new ones. Research will be undertaken on value chain upgrading strategies that maximize net benefits to farm families and other value chain actors. The specific objectives under this outcome include the following:

- **Objective 4.1** Increase the involvement of market stakeholders in the market technology development processes.
- **Objective 4.2** Determine how farmers understand markets and how this translates into production decisions.
- **Objective 4.3** Improve market efficiency through collective action.
- **Objective 4.4** Assess to what extent and in which contexts gender transformative approaches can result in more equitable benefits from sustainable intensification.

Outcome 5: Delivery and uptake of SI innovations through building functional partnerships among research and development institutions enhanced

A key element of Phase II is to take to scale, in collaboration with development partners, technological packages developed in Phase I and already validated. Low adoption of technological packages presents a key challenge to scientists and development practitioners.

Working with development partners will significantly increase the opportunity for the successful adoption of technologies. Delivery mechanisms remain unclear and, in this program, the effectiveness of different dissemination approaches may be evaluated using modelling and geo-spatial analyses and other techniques. Farmers need information related to potential risks and existing opportunities to make informed decisions on technology adoption. An important part of this outcome is to use typologies (biophysical and socio-economic) developed under Phase I.

The specific objectives under this outcome are the following:

- **Objective 5.1** Identify and deploy efficient gender-sensitive pathways/networks for the delivery of validated technologies for adoption across different biophysical and socio-economic contexts.
- **Objective 5.2** Enhance learning among research and scaling actors for necessary adaptation across the delivery pathways.

Implementation

Conceptual framework

System conceptualisation

A conceptual representation of the agricultural systems in the case study areas is presented in Figure 4. The socio-institutional landscape consists of social groups, markets, supply chains, businesses and organisations. Interactions within this landscape represent exchanges of information, money, etc. The agro-ecological landscape consists of fields and livestock of the farm, and the landscape elements and processes within the surrounding landscape. The farmer households are connected to both the socio-institutional and agro-ecological landscape. The decisions of household members on farm management and other livelihoods are dependent on life stage and goals and influenced by processes in farm components and landscape. Within the household there are differences in roles, power, goals and resource access.

In Phase I, the emphasis on research activities has been on crop, livestock and broader farm activities. In Phase II, the focus will be on the household and how its members attain their livelihood. For many smallholders this will be strongly dependent on the farming activities, but in addition, alternative income sources are used. Moreover, besides the entrepreneurial role of the farm as a business, the farm usually has multiple functions for instance as food source, capital stock (in land and livestock) and for cultural purposes and rituals.

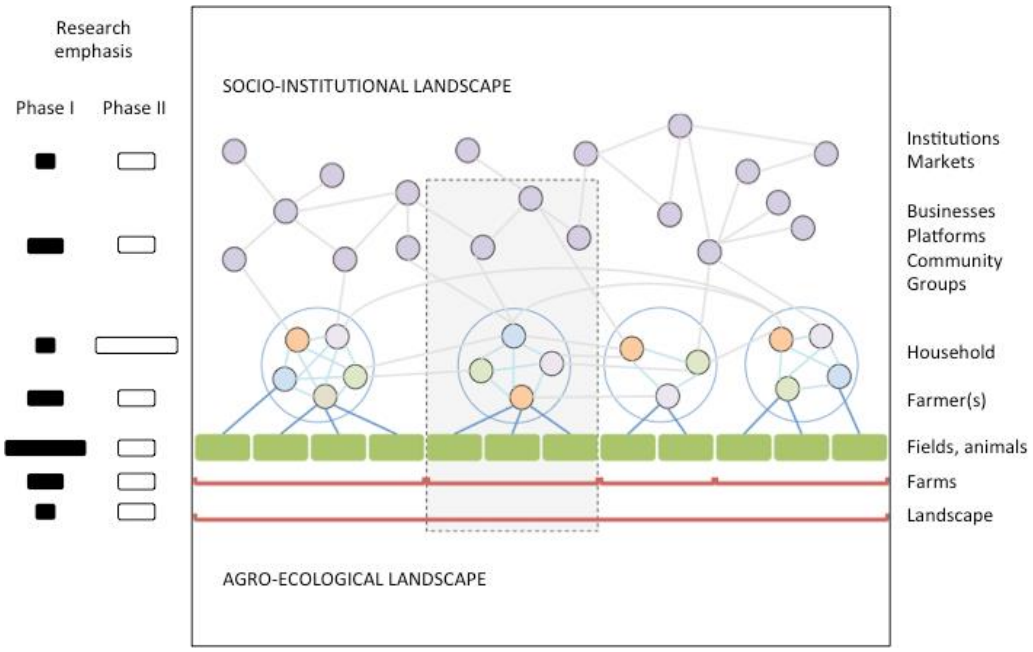

Figure 4: Conceptual representation of the agricultural landscape system investigated by the project

NOTE: In Figure 4, the unit of analysis in the research is indicated by the dashed rectangle. Lines represent interactions among actors including resources, financial and information (grey) and management of farm components by the farmers (blue). The width of the bars under research emphasis denotes the degrees of emphasis within Phase I and II (limited, intermediate, strong).

System diagnosis and redesign

In Phase I, the farming systems and production activities (crops, animals, etc.) have been diagnosed based on problems and promising technologies and practices have been tested in various settings. This diagnosis-oriented research has investigated the structure of and processes in farm components to understand their functioning and purpose, and the performance in the field. Phase II will be more oriented towards using the acquired knowledge for redesign to support the household livelihoods and goals, starting from the desired purposes and functions that are delivered by the structure and processes of assembled suitable components and practices. This will lead to the on-farm implementation and further out-scaling.

Research process

The research methods encompass:

- Participatory qualitative data collection, action research.
- Quantitative research: on-farm observation, farm and household modeling, complementary experimentation.
- Project implementation by multidisciplinary teams that support co-innovation in case study areas.

The research will be conducted in multidisciplinary small teams that combine biophysical (crop, animal, postharvest, landscape) and social scientists (economists, sociologists, anthropologists).

Trade-offs, synergies and integrative solutions

The project will use a goal-oriented perspective and analyze trade-offs in outputs rather than in terms of resource allocation. The performance in terms of productive, economic, social and environmental indicators and their stability (resilience) is determined by the choices regarding land use and farm management, but may also include decisions on alternative livelihoods. The performance indicators can improve by re-arranging farm components and their management, or re-allocating resources and labour, or introducing new practices and technologies.

By focusing on outputs and performance indicators (goal-oriented), it is hypothesized that sub-optimal choices on resource use and farming practices (means-oriented) are avoided, and integrative solutions that overcome trade-offs can be identified (i.e. synergies). Integrative solutions go beyond trade-offs and compromises, and by creatively considering fundamentally better options, seek to find innovative and longer-lasting solutions. For example, decisions about utilization of crop residues for cooking, heating, building or mulching are rephrased into objectives to prepare the food, heat the house, build a house and improve soil health, opening the possibility to look for alternative solutions like use of solar power, alternative building materials and using living mulch. By explicitly separating farm and household economics and by considering the farm as one of the possible enterprises of the household, an appropriate analysis of the impacts and benefits from farming and the possibilities for alternative, off-farm activities can be made.

Research questions

A number of research questions will guide both R4D and R-in-D investments for delivery of the outcomes described above and provide information on impact realization. These questions have been formulated to allow achieving the objectives and expected outcomes at the project level but also to feed into the research questions at program level, which guided the clustering. Some deal with the cross-cutting issues of gender and equity, capacity building, communication, nutrition, and M&E that the project will address in support of achieving the intended objectives and outcomes.

A. Trade-offs and synergies
   1. Considering differing agro-ecologies and weather variability, what are the perceived tradeoffs and potential integrative solutions to overcome these to improve livelihoods while building the natural resource base and enhancing equity from household to community scale?
   2. What are the ranges of options to implement efficient and diversified crop-livestock systems that can increase productive, socio-economic and environmental performance in smallholder production systems?

B. Adaptation/adoptability
   3. Which support tools do farmers need (women, men, and the youth) to make informed decisions about the risks and opportunities associated with validated technologies?
   4. What are the associated constraints to and opportunities for the adoption of SI technologies at farm typology and intra-household levels?
   5. What factors determine market stakeholders' interest and engagement in the development of SI technologies to meet their production-to-market and utilization needs?

C. Livelihoods and equity
   6. How do gender and formal and informal arrangements from household to community levels influence sustainable and equitable access to and use of land and water for production and how can these be improved?
   7. What are the social institutions (written and unwritten rules) that permit or restrict women and men from benefiting equally from agricultural innovations?
   8. How can we track and monitor progress on the uptake of validated technologies by women, men, and the youth over time among direct and indirect project beneficiaries?

D. Enabling conditions
   9. What collective-action approaches, when deployed, enhance the development of SI technologies in a sustainable manner and facilitate a reliable supply of high quality produce to markets?
   10. Under what condition(s) does adoption of crop and fodder diversification and postharvest technologies lead to improved food and nutrition security and the safety of farm households?

E. Markets, institutions and partnerships
   11. How can linkages and partnerships with public, private, and civil society initiatives be made more efficient to support and facilitate the registration, release, and delivery of validated technology packages?

12. How can we harness generated knowledge on scaling approaches to enhance learning, improve technology delivery mechanisms, and foster better adoption?

Generic research activities

The driving premise for the Phase II approach is that improved technology integration will result in outputs that offer increased productivity, sustainable natural resource management, and improved market efficiency interacting within an enabling environment with functional policies and institutions. These lead to improved farm-based livelihoods. To overcome the challenge of low productivity of rain-fed agriculture in water-stressed environments, the project will seek to raise water productivity in selected Phase I sites and build capacity of local institutions to generate, use, and share new technologies at the landscape level. Ultimately, these innovations will enhance opportunities for food security and income generation that will benefit male and female farmers. Below we propose five major outputs and associated research activities that lead to these goals.

Enhanced/improved productivity outputs

There is low agricultural productivity within ESA (Barron *et al.,* 2003[26]; FAO, 2012[27]). Enhancing agro-ecosystem productivity—gaining more yield and value from water and land resources—is an effective means of intensifying agricultural production and reducing environmental degradation. Demand for food and feed crops will nearly double in the coming 50 years (CAWMA, 2010[28]). The two main factors driving how much more food will be needed are population growth and dietary change. To meet the demand for food and fiber while sustainably managing scarce land and water resources, the project proposes the following outputs and associated activities:

a. Proven integrated crop-livestock technologies for improved productivity, diversified diets, and incomes in target agro-ecologies delivered.

Activities:

- Assess and iteratively improve crop-livestock combinations from Phase I.
- Evaluate and implement pathways that are effective at improving access to seeds and clonal materials of modern varieties of legumes, cereals, vegetables, and forages.

b. Climate-smart crop and crop-livestock technologies in targeted landscapes and semi-arid areas delivered.

Activities:

- Farmer participatory experimentation with crop and soil management and integrated crop-livestock technologies in on-farm situations.
- Use farm trial data to apply crop simulation models and assess performance over space and time, including assessment of climate-smart technologies to establish the potential for adaptation and mitigation.

c. The awareness and use of locally available organic nutrient resources (manure, crop residues, etc.,) and fertilizer at community level enhanced.

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[26]Barron, J., Rockstrom, J., Hatibu, N. and Gichuki, F. (2003). Dry spell occurrence and maize yields for two locations in semi-arid East Africa. Agricultural Forest and Meteorology, 32, 8.

[27]FAO. (2012).Coping with water scarcity: An action framework for agriculture and food security. FAO Technical Reports 38. Food and Agriculture Organization of the United Nations, Rome.

[28]CAWMA (Comprehensive Assessment of Water Management in Agriculture). (2007). Water for Food, Water for Life: A Comprehensive Assessment of Water Management in Agriculture. London: Earth Scan, and Colombo: International Water Management Institute.

Activities:

- Establish adaptive field experiments with mineral and animal-derived organic manure.
- Demonstrate the use and impact of crop residues, forages, and other organic resources as animal feed and nutrient resources.
- Use crop-livestock models for trade-off analysis.

d. The impact of crop residues, forages, and other locally available organic resources on productivity quantified and disseminated.

Activities:

- Conduct extrapolation domain analysis based on GIS, agro-ecology, and crop model-generated information to establish the potential of technologies for geographical reach.
- Disseminate best-fit integrated crop-livestock technologies to reach and have effect on small-scale farmers in a landscape context.

e. Labor-saving and gender-sensitive technologies in target areas to reduce drudgery while increasing labor efficiency in the production cycle delivered.

Activities:

- Support local partners through training on appropriate drudgery-reducing technology delivery.
- Co-adapt existing mechanization options with target communities.

Sustainable land and water management outputs

More diversified water management options will reduce the yield losses from dry spells which can claim well over 20% of harvests in sub-Saharan Africa (CAWMA, 2007). This gives farmers the security they need to invest in other options such as market-driven technologies, integrated soil fertility management (ISFM), and high yielding varieties. More often than not, small-scale farmers are averse to taking risks with the few resources they have, such as buying inputs for a crop that may fail for lack of water. Hence, buffering the agricultural management of water resources provides viable options for these challenges while unlocking the food security potential in the ESA sub-region.

For many smallholder farmers in ESA, many technologies to manage existing water resources are available but their adoption is limited. Part of the problem revolves around the lack of information with economic qualifiers for farmers to take up technologies they know would be profitable. Hence, increased availability of water alone can't produce the required quantum benefits we are looking for to transform these agro-ecosystems. We surmise that land and water management can be improved substantially when technologies are used that are driven by demand and are scalable for different contexts. The proposed outputs and associated activities for sustainable land and water management are the following:

a. Opportunities for enhancing water resource management to reduce community vulnerability in various contexts analyzed.

Activities:

- Characterize current practices in ESA through identifying formal and informal arrangements for access to and use of water and land resources.
- Identify opportunities for using supplementary irrigation in different farming systems of the ESA target country agro-ecologies.

b. Demonstration and learning sites on innovative options for land and water management in selected farming systems established.

Activity:

- Set up demonstration and learning sites in target ESA communities.

c. Improved and inclusive approaches and methods for delivery at scale of innovative water resources management available for stakeholders.

Activity:

- Conduct and evaluate participatory and inclusive testing of approaches within the demonstration sites for improving access to and use of water resources for supplementary irrigation to address rainfall variability.

Food and feed safety, and postharvest management outputs

Agricultural productivity and yield for food and feed are often very low with high on-farm losses, a detrimental factor that compromises regional food security (Barron *et al.,* 2003). This in turn has a negative impact on the well-being and health of vulnerable populations, resulting in malnutrition. For example, stunting for the new- born exceeds 15% in Tanzania (Alderman *et al.,* 2005[29]). The project proposes interventions that will achieve the following outputs along with associated activities:

a. Capacity of farm families and local partners to adopt diverse crop and fodder species improved.

Activity:

- Conduct packaging and delivery of crop and fodder varieties and associated management practices through community and development partnerships with iterative reviewing and refining.

b. Postharvest losses due to adoption of improved technologies reduced.

Activity:

- Conduct packaging and delivery of postharvest technologies through community and development partnerships with iterative review, refining, and follow-up.

c. Nutritional quality due to increased accessibility and use of nutrient-dense crops by farmers improved.

Activity:

- Promote and deploy nutrient-rich crop varieties and livestock feed resources in target communities.

Markets, institutions, and partnerships outputs

Inherently weak human and institutional capacity results in weak institutions and market integration in these predominantly rain-fed rural landscapes. It has been reported that numerous interventions in the ESA region have not provided adequate returns on investment for crop productivity due to limited value addition and inadequate linkage to markets on a sustainable basis (Kaplinsky and Morris, 2001[30]). The project seeks to foster innovative integrated approaches that take into consideration market-linkages for outputs across multiple partners and institutional hierarchies (local communities, district, and

[29]Alderman H, Hoogeveen H, and Rossi M. (2005) Reducing Child Malnutrition in Tanzania: Combined Effects of Income Growth and Program Interventions. July 2005. Science Direct.

[30]Kaplinsky, R. and M. Morris (2001) A Handbook for Value Chain Research, Prepared for the International Development Research Centre (IDRC), p.4-6 (Accessed 19/02/16) Sustainability, UNEP and UN Global Compact.

national officials). To achieve this goal, the project proposes the following outputs and activities:

a. Business models for improved markets' functionality developed.

Activities:

- Conduct comprehensive value-chain analysis with specific focus on SI technologies.
- Conduct a value chain stakeholder analysis (stakeholder mapping).
- Develop a value chain enhancement strategy (including collective action approaches, contractual arrangements, and standardization).

b. Collective action models and alternative approaches linking farmers to markets developed and pilot tested.

Activities:

- Identify and evaluate existing mechanisms that inform farmers about dynamic market needs.
- Conduct an analysis of the existing baseline survey data and supplement them with qualitative surveys from target regions.

Outputs from research based on scaling of technologies and networking

Scaling up is a means by which appropriate technologies and innovations that result in communal benefits are further extended to more people in a wider area (IIRR 2000[31]). This requires a clear understanding of self-reliance and good governance for effective institutional set-up to empower decentralized decision-making and stimulate learning along with a team spirit at both the local level of communities and higher up in the institutional hierarchy. For example, channels of delivery may include pilot demonstration sites and field days and knowledge exchange and learning hubs within the Phase II ESA target areas. To achieve this goal, the project proposes the following outputs and activities:

a. Understanding of the social, economic, and institutional constraints to and opportunities for technology adoption from different farm typologies improved.

Activity:

- Conduct cost-benefit and gender analysis coupled with other socio-economic analyses to identify and quantify adoption constraints and opportunities for different farmer contexts.

b. Improved mechanisms for effective linkages and strategic partnerships with public, private, and other initiatives for the release, diffusion, and adoption of validated technologies established.

Activities:

- Map and assess relevant stakeholders to establish dialogue for the exploration of mutual synergies for scaling delivery of validated technologies.
- Leverage/link and integrate (engagement and outreach) with existent initiatives including Government extension systems to support and encourage the delivery pathways.

c. Gender-sensitive decision support tools for farmers to assess technology-associated risk and opportunity developed tested and launched.

[31]IIRR (International Institute for Rural Reconstruction). (2000). Going to scale: Can we bring more benefits to more people more quickly? IIRR Workshop, Silang, PH.114 p.

Activity:

- Identify and communicate gender-sensitive decision support technologies in the context of different farm typologies.

d. A technology adoption, monitoring, and evaluation framework for use by the project team and scaling partners developed and released.

Activity:

- Monitor and modify the progress of technology adoption process towards scaling.

e. Knowledge sharing centers and learning alliances within existent local and regional institutions including development actors developed.

Activity:

Establish knowledge-sharing and learning alliances among scaling actors.

Research partnerships

In the main, the research partnerships that have been built over Phase I will form the core for the continuation of R-in-D during Phase II, but with membership being assessed on the basis of past performance and relevance. New partners will be sought where need is identified, for example, in the area of modelling for purposes of analyzing, interpreting, and developing simulated insights from the large ESA region datasets.

Currently functioning partnerships with development institutions

Enhancing partnership among Africa RISING and NAFAKA Programs for fast-tracking delivery and scaling of agricultural technologies in Tanzania

Overview

Africa RISING and NAFAKA (Tanzania Staples Value Chain Activity) are collaborating to address persistent constraints to smallholder agriculture productivity and rural well-being in Tanzania by introducing resilient crop varieties, diversifying and increasing their food supply and income sources, and improving nutrition and quality of degrading smallholder cropland. Both are FtF projects. The collaboration is based on their visions of success that are driven by the need for informed yield enhancing and pre- and postharvest innovations for scaling-up and -out to be available in the target communities. The partners are cognizant of the mutual benefits and synergies that will accrue from joint undertakings; Africa RISING generates and provides informed innovations and technologies that increase the productivity of crops that NAFAKA is promoting and those that improve storage and food safety, while NAFAKA's established network of Village-based Agricultural Advisors (VBAAs) and farmers' associations, agro-dealers, agro-input companies, and processors provides a platform to transfer and adopt/adapt research outputs. NAFAKA also provides Africa RISING with opportunities for learning and generating new information through the R-in-D process, and scaling-up and -out of research innovations.

Project Approach

Through partnerships with seeds, fertilizer, crop protection, local government authorities, food processors, and agro-dealers, NAFAKA and Africa RISING are collaborating to introduce and promote:

- improved and resilient varieties of food crops (maize, legumes, rice, and vegetables);

- best-bet agronomic management packages; and
- postharvest management technologies to reduce losses and bring quality up to market standards.

The partners adopted a scaling methodology that is driven by community empowerment. Demand-driven innovations and capacity services are extended by Africa RISING to members of the NAFAKA consortium, leadership of grassroots farmer associations, and other development institutions in the scaling process at the "mother" learning centers hosted by farmers. These, in turn, provide capacity services to farmers who host the next level of learning centers, the "baby demonstration sites" (BDS - equivalent to the network of VBAA sites for NAFAKA), and cascade into grand-baby learning centers (see Figure 5). Particular attention is given to special opportunities available to women farmers as technical and nutritional innovators. At all stages of the scaling process, scientists from Africa RISING provide scientific back-up and conduct research on feedback-based technology adaptation and the actual process of scaling.

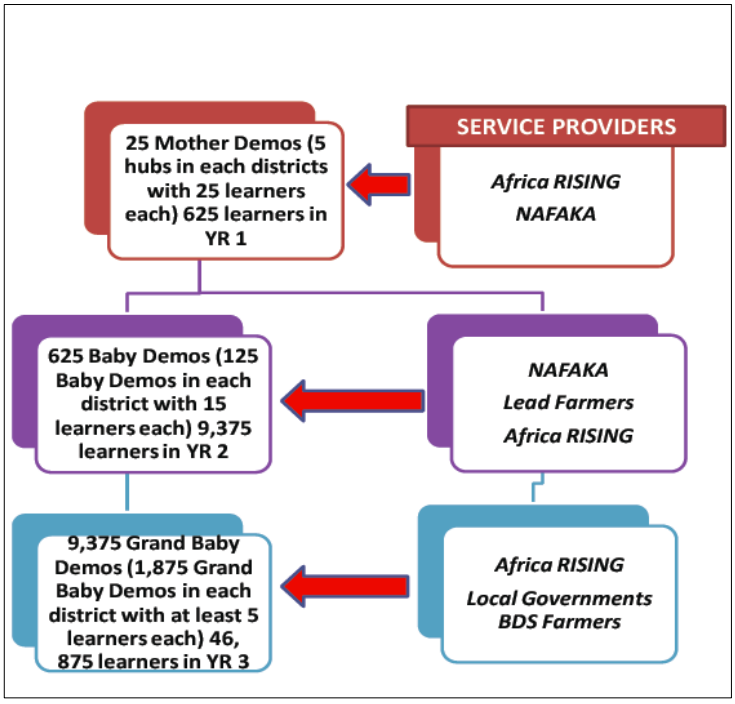

Figure 5: Africa RISING NAFAKA Scaling Model

Project targets

Using the scaling model above, the project targets to raise productivity and incomes, and improve the nutrition of 47,000 smallholder maize farmer beneficiaries who will be introduced to improved technologies, better management practices, and new crops and varieties, in a period of 3 years (2014-2017). During the same period, locally adapted and nutrient-rich vegetables for increased household nutrition will be introduced to about 4000 households. A packaged program of storage in hermitic bags following improved mechanical shelling and solar drying of grain will minimize food waste and exposure to aflatoxins in 14 pilot villages in Morogoro, Dodoma, Mbeya, and Iringa, targeting 5,000 households. A target of 10,000 ha of smallholder rice farms will be operating under improved technologies and management practices as a result of program assistance during 2015-2017. Fifteen multi-disciplinary scientists from international and national research centers form the Africa RISING consortium that is implementing this activity.

Africa RISING going to scale in the Eastern Province of Zambia

Summary
This project component aims at bringing to scale validated agricultural technologies and delivery mechanisms, outputs of four USAID FtF projects (2011-2015), and filling existing research gaps with semi-mature technologies within the next two years. One aspect of the project focuses on making high quality legume seeds accessible to smallholder farmers. This requires the support of ZARI and private seed companies to disseminate improved legume seeds and complementary crop management practices; Africa RISING partners (IITA and ICRISAT) produce the foundation seeds. Secondly, the project will take to scale the integration of agriculture and nutrition-marketing approaches for addressing Vitamin A Deficiency (VAD) using orange-fleshed sweet potato (OFSP) as a key entry point in building capacity among partners to contribute towards improving diet diversity, increasing vitamin A intakes, and reducing the food insecurity of 8,000 farming households. Thirdly, the project builds on the achievements of the past SIMLEZA-Africa RISING collaboration which identified a range of sustainable intensification technologies (e.g., improved maize/legume rotation and intercropping systems; direct seeding; herbicides and improved stress-tolerant germplasm), and is collaboration with development partners Total Land Care, Catholic Relief Services, and COMACO to reach many farmers in the next two cropping seasons (2016-2017). Lastly, the project is to ensure that the two developed Zambian Aflasafe products (Aflasafe ZM01 and ZM02) are made available for deployment in Zambia through developing a business plan and demonstrating product value as well as efficacy in several agro-ecological zones of the country. It is estimated that over the 2-year activity period, 45,000 households will benefit from the various technologies being scaled and 350 agro-dealers will be established for purposes of multiplying and distributing new technology inputs. Over 20 research and development institutions are engaged in this activity.

Identifying and promoting new partnerships in research and with development institutions

We shall seek new partnerships for purposes of closing gaps in research expertise or for disseminating our technologies. The partnership described in 6.5.1 started during 2014 while that in 6.5.2 started during 2015 and these address technology dissemination. There are new developments with the USAID Mission in Malawi with potential for partnerships with institutions such as Catholic Development Commission in Malawi (CADECOM)), Agricultural Commodity Exchange (ACE), and Farmers Union of Malawi (FUM), and these may start during 2016. For Phase II, we have identified and mapped potential partners (list not exhaustive) with whom we can engage (Table 5).

Table 5: Potential R-in-D partners for engaging in Phase II of Africa RISING

Outcome	Country	**Research Partner**		**Development Partner**	
		National	International	National	International
Resources	Tanzania		IWMI	ELAM	African Conservation tillage network
	Malawi	LUANAR	CIAT, ICRAF, ICRISAT, MSU, IFPRI, WUR, IITA, IWMI,	DAES	CADECOM, Concern Universal,
	Zambia	ZARI	CIMMYT		Total Land Care, CRS, COMACO
Productivity	Tanzania	ARI Selian ARI Hombolo	CIAT, ICRAF, ICRISAT, MSU, IFPRI, WUR, IITA, IWMI	DAICOs, HORTI Tengeru, Seed companies (e.g., Meru Agro East African Seed), ARIs: (Selian, Mikocheni, Ilonga, Uyole, Dakawa, KATRIN), MoALF, Minjingu, YARA, TOSCI, ASA, Kick start, CARMATECH, NANDRA, SIDO	Farm Africa, CARE, Land O' Lakes, ASARECA , IFDC, CRS
	Malawi	DARS- APSA (maize), LUANAR	CIAT, ICRAF, ICRISAT, MSU,IITA, IWMI		ADIN
	Zambia	ZARI-APSA (legumes)	CIMMYT AGRA		
Markets and Institutions	Tanzania	UDOM, SUA and UDSM	IFPRI	Dairy cooperatives, e.g., Tanga fresh, NFRA-National Food Reserve Agency, Farm radio, Kibaigwa Flour Mills, AtoZ, East African Grain Council, WFP	Farm Concern, Kilimo Trust, SAGCOT
	Malawi	Malawi Legumes Trust, Universities	IFPRI, MSU,	ACE (auction, commodities exchange) NASFAM, FUM	INCV ADIN*
	Zambia	Indaba Agric. Policy Research Institute	IFPRI	Profit+, EPFC, Farmers Cooperative	COMACO
Food, Feed, and Nutrition	Tanzania	UDOM, SUA, UDSM		Mwanzo Bora Project, Tanzanian Food and Nutrition Center, PPTL TANSACK, NMAIST	

	Malawi	LUANAR, Nkhoma Hospital, DAES	MSU, ICRAF (Feed), CRP-A4NH, ICRISAT	DAES	ADIN, World Vision
	Zambia	UNZA,	MoL and fisheries, CIAT, CIP	SSO-SUN (Scaling up nutrition)	CRS
Scaling	Tanzania		NAFAKA	District Councils, MVIWATA, Chamber of Commerce, RUDI, FIPS, CARMATECH, E-soko, Equity Bank, CARITAS	Farm Radio International, One Acre Fund
	Malawi	DARS, Farm Africa, LUANAR, DAES	CIAT, MSU, IFPRI, WUR	DAES, FUM, NASFAM	CADECOM, Concern Universal
	Zambia	UNZA	CIMMYT, DoA, SeedCo	EPSC	Total Land Care, CRS, COMACO, Profit+

Monitoring and evaluation

IFPRI has program-level responsibility for M&E. Nevertheless, monitoring responsibilities are shared between the ESA project and the IFPRI M&E team, while evaluation tasks are the sole responsibilities of the IFPRI M&E team. Data collection at the household and community level will continue, with a midline survey in Malawi and Tanzania planned for 2017, crucial to evaluate the response to the research activities at different levels. The M&E team will support the research teams in micro-data analysis and survey interpretation, maintain the centralized, open-access data collection system, provide data management and analysis, conduct modeling for forward-looking impact projections, impact assessment, and intensification pathway analysis, and supervise the collection of indicators. FtF and custom indicators will be monitored over time by using both the Project Mapping and Monitoring Tool (PMMT) web-interface and the traditional off-line spreadsheet system. The M&E team will still keep the responsibility of reporting FtF indicators to the USAID FtF Monitoring System (FTFMS), given that the PMMT design is already consistent and compatible with FTFMS.

In addition to the indicators, the team will set up the Beneficiary Tracking System (BTS), for which the template will be shared with the research teams. The BTS will encompass tracking the activities conducted by the research teams at the household level, allowing data collected at different times by different actors to be matched and, eventually, made interoperable. For this important activity, in addition to the other M&E tasks, efficient and timely action by the local IFPRI-recruited M&E Coordinator for ESA will be essential. In the three ESA countries, he will assist the research teams with monitoring tasks, ranging from collecting indicator data to be uploaded onto the PMMT and beneficiary data to be submitted to the M&E team to monitoring project-generated data for sharing and uploading onto the Africa RISING data repository CKAN. The M&E Coordinator for ESA will continue to report to the M&E team, although he will be fully embedded in the ESA regional team with joint supervision by the Chief Scientist. The role and responsibilities of the M&E team in ESA will be altogether consistent with the program- and project-level roles, as illustrated in the program document to which reference is made.

The ESA Research Team will provide for the project to be continuously monitored internally to allow identification and discussion of any shortcomings, and consequent implementation of appropriate actions. The Team will develop a detailed logframe and monitoring matrix that will include benchmarks against which the performance and success of the project will be measured. It will form an important input to periodic and other reports distributed to USAID and other interested stakeholders.

Site-level Research Teams will meet with project stakeholders through the now developing R4D/Innovation Platforms to improve and validate the site plans and matrix for the project. Particular attention will be paid to the input of stakeholders who will include representatives from local leaders, community members, Government departments, NGOs operating in the area, and the private sector. Platform Committees may be created with a mandate of conducting monitoring and submitting reports to Platform plenary sessions.

Through experience of our partnership with NAFAKA and given our R-in-D approach, part of the monitoring and internal evaluation will be addressed in annual surveys. The project will develop data collection instruments (questionnaires and interview schedules) that will be used to collect the data electronically. Annual site-planning and review meetings will be conducted to share results of the internal M&E, and review and refine project plans and targets. Annual stakeholders' meetings will be conducted to assess project performance and share experience across the three project countries and with colleagues in West Africa and Ethiopia.

External evaluation teams will be hired to conduct mid-term evaluation of the project. In consultation with USAID, the project Coordination Unit will develop Terms of Reference (ToRs) that will guide the selection of evaluators and implementation of evaluations. The midterm review will enable stock of the project to be taken and assessed on whether it is on the right track as planned as well as providing guidelines for ensuring the achievement of project goals and objectives. The final evaluation will establish the extent to which project objectives and midterm review recommendations were achieved as well as documenting lessons learned which could be useful for future programs.

Communications and knowledge sharing

Communications and knowledge management (CKM) will continue to be an integral part of implemented R-in-D activities in Phase II of the project. Already a strong culture and awareness of its value exist among project partners, thanks to considerable efforts invested as part of a planned strategy that was implemented in Phase I. The aim of the CKM team at program and project levels in ILRI and IITA will, therefore, be to leverage the aforementioned achievements as a springboard to enhance uptake of best-fit technologies identified for scaling from Phase I research.

A refreshed communication and knowledge management strategy will be developed for the regional project. It will capitalize on lessons learnt from the previous phase while also being responsive to how CKM will be a facilitative function for achieving the research and development objectives of the project going forward. Key result areas in the refreshed strategy will include the following:

I. Communicating with and for actors on the ground for scaling out technologies and practices
II. Communicating and knowledge-sharing for policy influence to multiply Africa RISING outcomes

III. Communicating about the program, the science, and results throughout the program life cycle
IV. Communicating, engaging, learning, and sharing for effective partnerships across scientists and development actors
V. Communications for donor relations

Various communication channels and tools, for example, radio, video, television, infographics, websites, social media, and posters and pamphlets (produced in local languages of the communities) will be used for the different audiences who will invariably have different communication needs and contexts in the project countries. Some of the CKM functions that worked very well in Phase I and are intended to be continued in the next phase include facilitation and organization of annual learning events and regional review and planning meetings, maintenance of an online repository where all Africa RISING outputs can be found, publishing success stories about the project activities on the Africa RISING website, and maintaining the Africa RISING wiki as an enabling tool for project partners to plan and share early documents, organize early events, and hold meetings with research communities to report back on findings of data collected.

Use of innovative ICT for scaling Africa RISING technologies

New opportunities and dimensions for scaling have arisen with the increase in access to Information and Communications Technologies (ICTs) in Africa. Even among smallholder rural farmer communities, such as those whose livelihoods Africa RISING is aiming to improve, the use of ICT tools is no longer an exception – 71% claim to have used ICTs to improve their farming practices and 91% say ICTs have helped to boost yields and improve their incomes[32]. The CKM team intends to exploit this exciting prospect for greater scaling and adoption of technologies presented by ICTs in Phase II of the project.

Opportunities will be explored for partnerships with other institutions, which have a successful track record in designing and implementing ICT-based interventions that result in the adoption of new farming practices and technologies. Radio is the main ICT that will be used in this regard. Other ICTs such as cell phones, bulk SMS messaging systems, and beep-to-vote systems, if used, will be linked with radio to boost the interactivity. This is because radio offers the best alternative to face-to-face, peer-to-peer discussion in rural Africa today and has reached remote areas that television does not reach; use does not require literacy and it is intensely personal for both the audience and those presenting[33]. Up to 80% of African famers regularly listen to the radio and it is estimated that it can lead to the uptake of more effective and productive farming practices by up to 48% (on average 21%) of farming families in listening areas[34].

We therefore expect that the introduction of ICT tools will complement and add impetus to the scaling activities which have already been established in Tanzania through the project funded by the USAID Tanzania mission; "*Enhancing partnership among Africa RISING, NAFAKA and TUBORESHE CHAKULA (TUBOCHA) Programs for fast-tracking delivery and scaling of agricultural technologies in Tanzania."*

[32] eLearning Africa Report: Farmers want more tech - http://www.elearning-africa.com/press_releases_html/ELA.php?year=2014&ts=undefined&pr_id=164
[33] FRI data show that between 70-80% of small-scale farm families regard radio as a primary source of information
[34] Agricultural Radio That Works, see http://farmradio.wpengine.netdna-cdn.com/wp-content/uploads/Farm-Radio-Agriculture-Radio-That-Works.pdf

Cross-cutting issues

Gender

Gender cuts across all the research outputs of Africa RISING. It comprises several core elements: gender analysis; integrated systems improvement; monitoring and evaluation; scaling and gender capacity.

Gender analysis

Men's and women's varying opportunities and livelihoods in agriculture relate to intra-household differences in access to and control over resources such as land and labour. Unequal decision-making power among household members may affect a number of important outcomes such as nutrition. Africa RISING seeks to improve the income and food security of particularly women and children and therefore takes interest in the gendered distribution of resources and responsibilities in households and how this allocation could interact with its activities. A focus on the household alone, however, may not suffice to support transformation, since gender norms are often reinforced and perpetuated by rules of other institutions such as the community, markets or the state (Kabeer, 1994)[35]. Africa RISING therefore aims to combine gender analysis of intra-household resource allocation with an analysis of the gendered effects of other institutions.

In East and Southern Africa, the gender component received limited attention in Phase I but picked up later with staff coming on board in 2015. In Tanzania several gender studies have been conducted (e.g. on mechanization, value chains, maize-fertilizer packages) using quantitative, qualitative and mixed-methods approaches. In September 2016 a broad qualitative gender evaluation of Africa RISING communities in Malawi will be launched based on the above-mentioned combination of gender and institutional analysis. It will feed into planning for Phase II. A gender action plan, developed for 2015/2016, captures various project activities, also in the field of communications where guidelines for gender-sensitive reporting will be published later this year.

A gender value chain baseline survey in Africa RISING communities in **Tanzania** shows that there is no pronounced gender division of labour for particular crops, rather than a gendered division of income[36]. Men tend to receive income from staple crops (such as maize) or cash crops (such as pigeon pea), while women are more likely to receive income from vegetable sales.

Communal customary law still determines the allocation of land in rural Tanzania, with men being considered 'traditional landowners', while women gain access to land by virtue of their relationships to husbands, clans or communities. In all 295 male-headed households of the sample, only one woman was the documented owner of a piece of land. Women in male-headed households appeared to face more difficulties in accessing land than their counterparts in female-headed households.

Differences between male and female respondents emerged in relation to market performance (with a focus on vegetables) and willingness to accept trader prices. Male-heads were more reluctant to accept traders' offers than female respondents living in male-

[35]Kabeer, N. 1994. Reversed realities: gender hierarchies in development thought. Verso, London.
[36] Gundula Fischer, Andreas Gramzow and Alaik Laizer (2016). Gender, Vegetable Value Chains, Income Distribution and Access to Resources: First Insights from Surveys in Tanzania (submitted to Acta Horticulturae in July 2016).

headed households. Women in female-headed households were most willing to accept trader prices without negotiation. Africa RISING Phase II will include marketing skills in training for female farmers.

Further differences between women in male- and female-headed households emerged in terms of access to credit and extension services. Males have the lowest levels of access to credit. Only 3.8% of men confirmed to having received credit, as compared to 5.1% of female respondents in male-headed households and 10.9% in female-headed households. In response to questions regarding having met extension officers in the last four months, male and female household heads most met with extension officers, to the disadvantage of women in male-headed household.

The situation in **Malawi** in many ways is similar to that in Tanzania. Women are the main subsistence producers in Malawian smallholder households and contribute much of the labour force for food and cash crop production (70%): work on their husbands' fields, as well as on self-managed land parcels, mainly for the cultivation of crops for home consumption (AFDB 2005). Men, in turn, tend to focus on cash crops and generally have most say on issues related to production, consumption and expenditure, as well as resource allocations within the household (Mathiassen *et al*., 2007).

A higher proportion of women in Malawi, than in Tanzania, possess official land titles (32%) due to the large number of matrilineal communities. However, the hidden male dominance in matrilineal systems largely excludes women from participation in land-use decisions (AFDB 2005), except for women in female-headed households. Nonetheless, women's access to land is notably better relative than in the other project countries, and some gender assessors deny the existence of a gender gap in relation to land access (e.g. Mathiassen *et al*., 2007).

Moreover, extension systems do not take into account low literacy levels among women, time constraints facing women and other socio-cultural challenges in interacting with the mostly male extension officers. This leads to low levels of participation by women in extension meetings, training and field demonstrations, with consequences for women in terms of technical knowledge, access to information, and the adoption of available technologies (AFDB 2005).

Africa RISING East and Southern Africa will seek to lessen these challenges by encouraging both husbands and wives to participate in training sessions, ensuring the training content and materials are appropriate to the language needs and education levels of participants, scheduling meetings at times and venues suitable to women, and employing women as trainers.

However, further gender analyses needs to be undertaken prior to, during and after agricultural interventions, as well as during scaling up, to ensure technologies are tailored to specific gender groups and farm typologies. Opportunities for transforming gender relations need to be identified. In phase II, the focus will be broadened to capture a variety of social differences that might impact negatively on the success of the program. There will be continuous assessment, especially within communities prone to conflict (gender, ethnicity, religion etc.).

Gender interventions

Integrated systems improvement: The long-term adoption of innovations depends among other factors on their gender-responsiveness. In the field of mechanization, animal health, multi-purpose trees, and fodder, Africa RISING scientists have assessed how the technologies interact with gender relations at household level. To assist this kind of assessment, the gender team will develop or modify existing tools. In Phase II, the gender team will work more closely with the biophysicists to integrate gender in all research protocols and to support the evaluation of available data. The information generated from this analysis will inform the design and adaptation or modification of interventions that enhance the ability of women and young people to participate in decision-making, strengthen women's access to and control over productive resources, and save their labour and energy expenditure.

Monitoring and evaluation: These activities support internal learning processes and ensure that progress is made against set gender indicators. In phase I, qualitative follow-up studies in Tanzania revealed farmer-gendered perceptions of change in the context of interventions. However, gender-responsive M&E needs to be strengthened through a clear framework with quantitative and qualitative indicators included in the work plans. More emphasis will be placed on the collection of gender/sex-disaggregated data, as well as their analysis and reporting. To ensure a fair representation of women and young people, quotas for participation will be defined. Women's empowerment level and gender parity will be systematically monitored.

Scaling: The question of how men and women can be reached by extension messages has been explored for several Africa RISING sites. The results of these studies will be used to employ appropriate communication channels for women and other marginalized groups, such as videos, mobile phone voice and text messages, women's groups, radio, and information centres. However, obstacles to adoption are not limited to information sharing, but include norms that constrain women's access to resources and benefits. Therefore, different gender transformative approaches will be applied and investigated. Partners with the mandate to deliver on gender will be identified and engaged with at different levels. Partners' capacity in integrated systems approach will be enhanced to maximize impact.

Gender capacity: The gender capacity of Africa RISING and its partners is a key success factor for mainstreaming gender throughout the project. In 2014/2015 the gender teams conducted an individual and organizational capacity assessment with the aim of developing a gender capacity development plan, establishing a baseline against which training efforts can be measured, and providing the management with data to make strategic decisions[37]. In Phase II, there will be strategic gender training, as well as gender training integrated with other disciplines. The target group for gender capacity development includes researchers and other partners, such as extension workers, development agencies and farmers. Africa RISING envisages more holistic training packages for farmers that combine technical issues with gender awareness, entrepreneurship and nutrition.

Africa RISING gender analysis training will emphasize Kabeer's social relations framework (1994) and prepare the ground for transformative approaches. The development of a gender training manual was commissioned in July 2016. Pilot training in Tanzania and Malawi is planned for early 2017.

[37] A detailed action plan has been developed for West, Southern and East Africa. In addition, a gender capacity assessment report for Africa RISING West, East and Southern Africa projects has recently been completed.

Africa RISING shall build upon these developments in implementing Phase II activities, noting that gender is inclusive of wider social concerns, including the youth as the next generation of agricultural entrepreneurs. Accordingly, rather than treat it as a separate section within this proposal, we have embedded gender in the R-in-D activities above for purposes of inclusivity. In this way, this project will address constraints to gender participation in agricultural innovation by taking into account the different roles, needs, and perceptions of women, the youth, and men in the planning and implementation of intervention packages for improving agriculture production.

Nutrition

ESA has been addressing and will continue to address nutrition from the agricultural production viewpoint, having identified that productivity and yield for food and feed are often poor in quality, low in quantity, and aggravated by high on-farm losses, a detrimental factor that compromises regional food security. This in turn adversely affects the well-being and health of vulnerable populations, resulting in malnutrition. This section is designed to address this issue. Crop diversification, introduction of nutrient-dense crops, postharvest management, and better utilization (especially household preparation) of the introduced and other locally grown crops to improve diets, will be the primary activities in this project.

Policy

Our activities will focus on advice for policy and institutional support for the adoption and enable the spread of SI innovations and practices associated with the promising farming systems. The driving output will be to document and share with the NARS, development partners, and other national stakeholders, mature technologies together with their cost-benefit, gender, and targeting analysis, and conditions under which they can go to scale. This, together with improving links and encouraging two-way communications with these partners, will potentially benefit policy reform.

Inviting stakeholders in the project areas (local government extension services, local leaders, local private sector, other NGOs, farmer associations, farmers, and community-based organizations) to field days and meetings will be useful for showcasing the project outcomes with the potential on decision-making for adoption, adaptation, and scaling within the maize/livestock farming systems of ESA.

Capacity development

Human and institutional capacity development is a fundamental component at all stages of the ESA project to assure the relevance, success, and sustainability of on-farm and community-based SI research and development activities. All project partners will share responsibilities for the necessary capacity development at the different levels: graduate students, professionals and para-professionals, and community.

Graduate students' field work will be coordinated so as to provide specific research results in a timely manner to complement project activities and contribute to intervention decisions. Activities that require graduate student assistance include baseline and follow-up surveys, and testing specific research questions that arise during the project that require closely-controlled experimental conditions. Institutional guidelines of the mentor will apply to the students' training.

Professional (e.g., government and development partner staff) and para-professionals (e.g., lead farmers) will require refresher training on relevant areas of SI research and scaling that

support the project activities. Throughout the project, specific capacity- building activities will be needed to help these individuals to increase the effectiveness of their on-farm and community-based activities and to ensure that their messages and recommendations are consistent with those of the project.

Community training will be carried out through participatory learning and inquiry processes with farming households, with a special emphasis on women farmers and the youth. Capacity building of farmers will focus on improving their decision-making skills that result in improved and sustainable agricultural production and community health. Training at this level is integral to all project activities, from early discussions (planning stage) with farmers to help them prioritize farming and health concerns, to the provision of results on communities' nutritional needs and to help them choose the SI technologies to adopt.

Project Management and Coordination

The ESA project is embedded in the Africa RISING program which has two basic levels: the three regional projects and the entities for program coordination, communication, M&E, and scientific advice (Figure 6).

A Project Steering Committee provides advice and oversight of research, budget, work plan, M&E, and communications, ensuring that each project conforms with the program objectives and core principles defined in the program document. CGIAR representatives will be appointed by the Chair, advised by the Project Manager.

The Terms of Reference of the ESA Steering Committee are as follows:

- Provides advice on and oversight of project activities;
- Provides guidance on science to project implementers to ensure conformity with core program principles and objectives;
- Guides project planning and activities;
- Approves project work plans and budget;
- Liaises with MET to oversee project-level M&E; keeps PCT informed on all reporting;
- Keeps PCT informed of activities via the Project Coordinator/Manager;
- Reviews and makes suggestions to Project Coordinator/Manager on semi-annual technical progress reports to USAID; and
- Decisions of the PSCs are made by consensus during an annual meeting in person and occasionally as called by the Chair.

Composition of ESA PSC:

- Chair: IITA
- Project Manager, serves as Secretary
- Project Chief Scientist
- Research partners: CGIAR, sub-regional research organizations (ASARECA/SADC/ CCARDESA), NARS, and others as designated
- Project M&E lead
- Project communications lead

The Project Manager is the contact point for the donor on all project matters and the official representative of the project on behalf of IITA, the implementing institution. S/he provides leadership and long-term project vision and is ultimately responsible for the implementation of the project by all participating partners. S/he is in charge of partners' contracts and monitors partners' reporting and compliance with agreements. The Project Manager acts as Secretary of the Steering Committee and is a member of the Program Coordination team. S/he oversees the implementation of the project in the three countries, reviews work plans before approval by the PSC to ensure alignment with the program framework, assigns budgets for country-level research, and coordinates the strategic direction with the other two regional projects in West Africa and the Ethiopian Highlands. S/he is the link to the M&E team at IFPRI and the Program Communication Group at ILRI and is also responsible for the financial management of the project. Ensuring quality technical and financial reporting to the donor, Steering Committee, PCT, Science Advisory Group (SAG), and CGIAR CRPs are part of the duties. Together with the Chief Scientist s/he identifies the needs of national and international staff and coordinates international recruitments, and also identifies the required partners for project implementation. S/he facilitates communication among project

partners and acts as mediator in conflict situations. All internationally recruited IITA project staff are co-supervised and guided by the Project Manager.

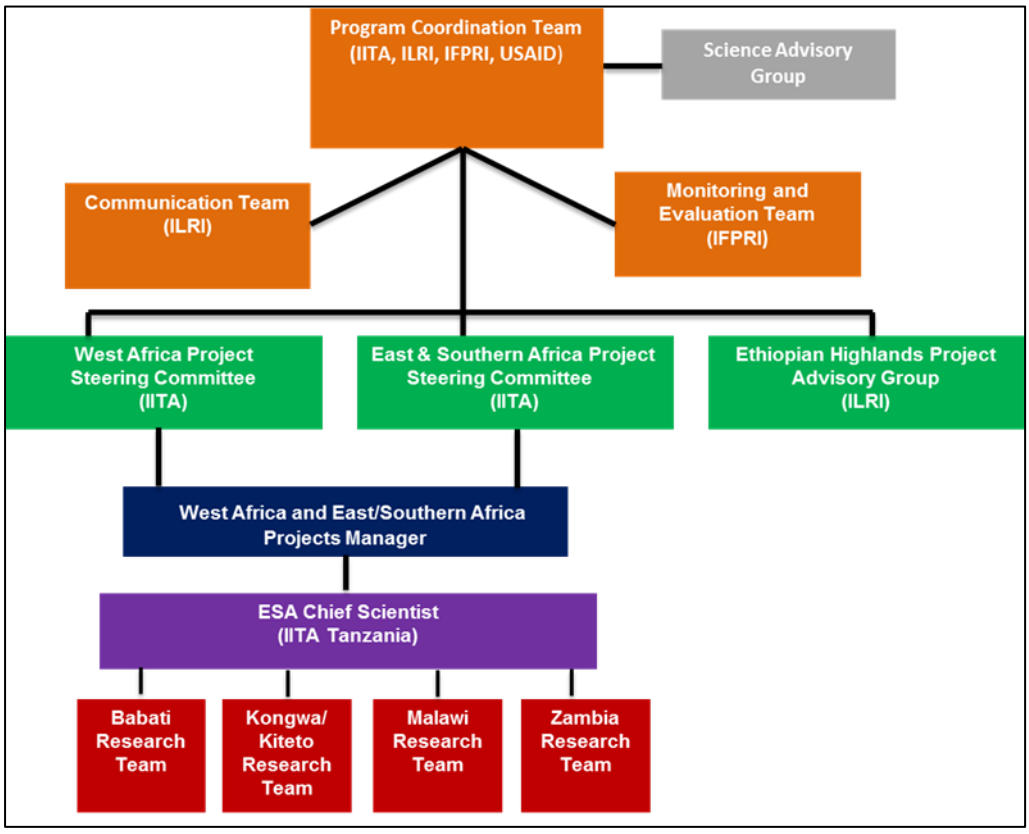

Figure 6: Africa RISING program and ESA project management structure

The Chief Scientist is responsible for the planning and implementation of research in Babati and also oversees implementation in Kongwa/Kiteto, Malawi, and Zambia, and advises the Research Coordinators at these sites. S/he leads the development of the work plans of all partners in Babati and assists the other implementation teams in Kongwa/Kiteto and in Malawi and Zambia to develop their work plans to ensure compliance with the program strategy and cross-country alignment. Together with the Project Manager, the Chief Scientist revises the work plans before submission to the PSC. During implementation, s/he monitors progress and assists partners in problem solving. S/he supervises all IITA national project staff in Tanzania and national staff working on behalf of international institutions not present in the country. The Project Manager and Chief Scientist agree on fund allocation to the teams who then divide the amount among themselves according to the costs of proposed and agreed activities.

The Chief Scientist is the first contact point for the USAID mission and related research and development projects in Tanzania. S/he manages the Project Office in Arusha.

Budget summary

Budget item/Year		**2016/17**	**2017/18**	**2018/19**	**2019,20**	**2020/21**
IITA Personnel		585,000	655,000	713,000	795,000	887,000
IITA staff Travel		90,000	90,000	90,000	90,000	76,000
Workshops		110,000	110,000	110,000	110,000	110,000
Operations		1,935,669	1,859,669	1,806,669	1,837,335	1,655,669
Administration		92,000	98,000	103,000	110,000	117,000
Training		38,000	38,000	28,000	8,000	5,000
Indirect Costs (19.3%)		550,1790	550,179	550,179	550,179	550,179
Subtotal		**3,400,848**	**3,400,848**	**3,400,848**	**3,400,449**	**3,400,448**
CSP (2% of total allocation)		69,405	69,405	69,405	69,405	69,405
Total		**3,470,253**	**3,470,253**	**3,470,253**	**3,470,254**	**3,470,253**

Annex 1: Excerpt from the Africa RISING mid-term evaluation report, April 2016

Successful scaling: Africa Rising – NAFAKA relations

Africa RISING's relationship with NAFAKA stands out as an important scaling success story achieved through different parties identifying mutually advantageous terms of engagement through which significant scaling could occur. The goal of the relationship was to accelerate the scaling and delivery of agricultural technologies to improve smallholder maize-farming systems, household nutrition, and dietary practices in Tanzania. This win-win situation appears to have been achieved through open and honest dialogue that accepted that each party had strengths and weaknesses, and that by playing to each other's strengths, each party stood to benefit. This dialogue allowed an agreed approach and mandate for the partnership to be reached, with roles and responsibilities clearly articulated and agreed upon. Key to moving the relationship from talk to action was the allocation of resources to ensure staff were specifically available to work through and move partnership actions forward. Significantly, both parties spoke of the importance of viewing each other as equal partners, recognizing that each brought a unique 'value add' to the relationship. Constant review of progress was also seen as important, as was a willingness to end non-functional and non-productive partnerships. In addition, personalities and timing were seen as integral, as was active encouragement from the US Mission in Dar es Salaam.

Annex 2: Summary of Phase I achievements

Functional partnerships

During the life of Phase I, research partnerships made positive strides towards fulfilling the project's objectives to develop strategies and initiatives that would help smallholder farmers to address poverty, hunger, and environmental degradation. Participatory and multi-disciplinary research was operationalized to facilitate (i) implementation of baseline studies that generated a critical mass of data and information that is available to guide prioritization, planning, and implementation of Phase II, (ii) technology transfers that addressed immediate and obvious cause-effect situations, and (iii) generation of scientific evidence necessary to define technology packages that address more complicated relationships requiring the integration of multi-disciplinary practices. Partnerships were initially formed at the site level, two in Tanzania and one each in Malawi and Zambia (Table 6). These partnerships sub-involved other institutions, especially the public sector and NGOs at district level, and also engaged other stakeholders through the facilitation of R4D and/or Innovation Platforms for purposes of stimulating stakeholder engagement, collaboration, and collective action. Within each site team thematic-based sub-teams evolved, dependent upon a major discipline as the rallying point for research integration. Although the themes were not common across the four sites, they addressed the immediate challenges. Results were communicated in different formats, but mainly in publications, reports, and success stories. Phase II proposes to build its continuity on this solid partnership foundation but also on harmonized activities within ESA along common research and development outcomes described in the next section.

Table 6: Phase I principal research partners in ESA

Research Team	Partners
Tanzania: Babati	IITA, CIAT, ALRI, AVRDC, CIMMYT, TALIRI, ARI-Selian
Tanzania: Kongwa/Kiteto	ICRISAT, ICRAF, CIMMYT, UDOM, ARI-Hombolo, SUA
Malawi	MSU, CIAT, ICRAF, LUANAR, DAES
Zambia	CIMMYT, IITA, ZARI, NARES, GART, UniZa, TLC, MAL, CIP
Cross-cutting	IFPRI, WUR

Baseline and situational analysis studies achievements

Tools and protocols were compiled and used for baseline surveys and typology identification at the three country levels and results have been compiled (see summaries at http://data.ilri.org/portal/dataset/tza_arbes for Tanzania and http://data.ilri.org/portal/dataset/mwi_arbes for Malawi). Different farm types have been identified through systematic quantitative and/or statistical analysis of the baseline data (http://africa-rising.wikispaces.com/typologies; https://cgspace.cgiar.org/bitstream/handle/10568/42331/AR_Report_mar2014.pdf?sequence=1&isAllowed=y) and will be validated in Phase II for suitability to target and scale innovations, and also used for ex-post assessment for explaining trends and farmer 'behavior' (functional characteristics, including sustainable intensification indicators). Because these results were produced later than anticipated, several themes conducted situational analyses/surveys to enable them to identify better targeted research entry points. Some of the outputs are identified below:

- Farming Systems characterization. The objective of the first phase of farming systems analysis within the Africa RISING project was to find the diversity of constraints and

entry points for sustainable intensification and innovation at the farm level. The study identified five main constraints and six consequent entry points (https://cgspace.cgiar.org/handle/10568/42331)

- Survey of postharvest losses in Babati provided relevant information regarding the causes and extent of food waste in the project area, and the information served as a basis for the introduction and testing of improved storage technologies (Abass *et al.,* 2014)[38].
- An agronomic survey concluded that the cropping systems used in Babati District should be preferentially supplemented with mineral fertilizers while optimizing plant density, increasing manure application, and making appropriate varietal choice to reduce the yield gaps (Kihara *et al.,* 2014)[39].
- A contingent valuation experiment with 400 households in Babati estimated farmers' willingness to pay (WTP) for hybrid maize seed and local inorganic fertilizer. Farmers' WTP was found to be 61.6% higher for hybrid maize seed and 14.7% lower for inorganic fertilizer compared to their average market prices locally available in 2013. The follow up survey also estimated the impact of credit constraints on farm productivity and found that the average cost of credit constraint in the study area was about 19% loss in agricultural productivity.
- An assessment of the maize yield gap and major determinant factors between smallholder farmers in the Dedza District of Malawi demonstrated that closing the yield gap in maize mixed farming systems required an integrated approach to addressing agronomic, biophysical, and socio-economic constraints (Temene *et al.,* 2015)[40].
- A gender-awareness study of drivers of farmer experimentation in Central Malawi found almost 600 examples, with over two-thirds of these being carried out by women farmers and the vast majority involving new crop varieties. Integrated nutrient management was another area of farmer experimentation. (M. Hockett, MS thesis; manuscript submitted to RAFS).
- Some baseline studies that have been concluded but not published can be found in the ESA Project Annual Reports and include the following: (i) Gender studies (disaggregated baseline data to inform technology design, testing and deployment, and implications for technology uptake), (ii) Market analysis for vegetables, (iii) Feed Assessment (FEAST), (iv) Mapping of MLN incidence and severity in northern Tanzania, (v) Identifying key diseases and pests of maize and legumes in Tanzania.

Technology transfers that address obvious cause-effect relationships

Africa RISING recognises that SI involves the transfer of technologies to address prevailing situations but which become, as follows:

- Components of integration (e.g., new food and feed crop varieties). Several improved crop varieties were introduced including (i) high yield and stress- tolerant elite vegetables varieties, (ii) dryland legume and cereal varieties (iii) nutrition-improving varieties, such as QPM and OFSP, and (iv) species of fodder grass and legume trees for quality feeds especially during the off-season. They have since been utilized as components of the SI research.
- Subjects of study to improve their desirability and adaptation. Post-harvest technologies and Aflasafe management fall under this category.

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[38]Abass et al - footnote 11

[39] Kihara et al – footnote 5

[40]Lulseged Tamene, Powell Mponela, Gift Ndengu, Job Kihara (2015).Assessment of maize yield gap and major determinant factors between smallholder farmers in the Dedza District of Malawi. DOI 10.1007/s10705-015-9692-7

- Tools to develop new technologies, particularly those in the preparation of quality feeds – stover choppers, feed mixers, bailers.
- Tools to reduce drudgery. The use of labor-saving planting techniques under conservation agriculture, including planting with a dibble stick or seeding with an animal ripper or direct seeder, can reduce farm labor by 25-35 days and preferentially benefits women (Mupangwa et al. 2016[41]; Thierfelder et al. 2016[42]).

Integrated research achievements

SI recognises the necessity to integrate disciplinary practices, and scientists have continued to generate scientific and socio-economic evidence in support of these complicated relationships. Some of the integrated technologies are being tested for uptake and adaptation at the pilot scale, as below.

- **Intercropping two legumes**. The pigeonpea/groundnut doubled-up legume system is the most advanced in development (Smith et al. 2016)[43] to the extent that appropriate approaches have been recommended for farm typologies based on land size. Doubled-up legume trials under conservation agriculture are being tested for additional benefits as the plant population of groundnut can be increased to more optimal spatial arrangements, increasing the yield of groundnut by at least 50% without compromising the pigeonpea yield. An innovative doubled-up legume arrangement involving *Gliricidia*, pigeonpea, and maize intercropping is being validated for the extra production of fodder and wood.
- **Integrated soil fertility management**. Maize was intercropped with improved varieties of several legume crops (common beans, pigeonpea, soybean, groundnut, lablab, *Gliricidia,* and *Tephrosia*) with the aim of fitting these varieties into appropriate ecology and management options (space and time). In some cases, these were complemented with fertilizer applications at recommended or micro-dose rates (for enhanced efficiency of fertilizers), or rates established following implementation of fertilizer response trials.
- **Soil water management**. In-situ water harvesting and retention tillage technologies were evaluated in the semi-arid study sites and the resulting higher soil moisture storage increased yields by over 25% and reduced runoff losses by two- to four-fold.
- **Soil erosion contro**l. ESA scientists mobilized communities to implement soil erosion control measures at the landscape level. Physical structures (*fanyajuu*) and biological windbreaks were applied. Biological windbreaks can also be managed to be sources of fodder. Recommendations were generated for combinations of slope management and slope length that would determine structure spacing to reduce soil losses below a threshold value.
- **Integrated soil, crop and livestock production**. A range of technologies are available to increase farm productivity, but rather than focus specifically on farm components, the broader management practices should focus on investments that could lead to increased system productivity and help to protect the natural resources. Improved forage species were introduced and are being evaluated for their one-stop contribution to soil fertility improvement (N-fixation, erosion control),

[41]Mupangwa, W., Mutenje, M., Thierfelder, C., Nyagumbo, I., 2016. Are conservation agriculture (CA) systems productive and profitable options for smallholder farmers in different agro-ecoregions of Zimbabwe? Renewable Agriculture and Food Systems, 1-17.
[42]Thierfelder, C., Matemba-Mutasa, R., Bunderson, W.T., Mutenje, M., Nyagumbo, I., Mupangwa, W., 2016. Evaluating manual conservation agriculture systems in southern Africa. Agriculture Ecosystems and Environment 222, 112-124.
[43] Alex Smith, SieglindeSnapp, John Dimes, Chiwimbo Gwenambira, Regis Chikowo (2016). Doubled-up legume rotations improve soil fertility and maintain productivity under variable conditions in maize-based cropping systems in Malawi. Agricultural Systems 145: 139–149.

increased crop productivity through intercropping and complementary supply of quality feed for increased milk production and quality manures. In Babati, there has been continued measurement of soil loss and runoff in relation to these treatments as well as slope gradients and slope lengths, and also estimates associated with seasonal labor demands for soil and water conservation measures. The results will be tested against the sustainable intensification framework. Proof of concept requires long-term trials and these are expected to continue in Phase II.

- **Vegetable production**. Originally introduced for purposes of increasing variety in crop production and, therefore, nutrition security, the combined use of healthy seedlings with good agronomic practices increased tomato production by 3.4 times and of African eggplant and Amaranth by 2.8 times each. This turned out to be more of an economic venture and generated extra interest in identifying methodologies for storing the increased product quantities better and accessing viable markets. Livestock nutritionists have started using non-edible components of the vegetable plants as feed components in the poultry rations.

Technology delivery and scaling

- Participatory mother-baby trials. Participatory trials are, by their nature, unintended approaches to scaling because farmers observe and learn from these trials, in addition to the scientists gaining from farmer knowledge. Trials designed to generate basic science are the mother trials. When the farmers are enabled to implement their preferred treatments on their own farms thus becoming baby trials, this offers additional potential for technology adoption as wider communities are exposed to the technologies and educational support, but it is also a learning opportunity on technology adaptation and challenges to adoption. For the most part, the ESA Project adopted this approach, implementing, for example, 32 mother trials and 1,400 baby trials in Central Malawi and 240 mother and 688 baby trials in Babati District of Tanzania over the project period.
- Scaling through research and private/public institutional collaboration (Tanzania, Malawi). Partnership approaches in these two countries have the potential to extend our reach to about 100,000 households by the end of 2017, delivering selected technologies and knowledge from the outputs of Africa RISING research. We shall build upon this experience, develop new partnerships, and reach many more households in Phase II.

Capacity building

- Students. Two undergraduates, 24 MSc, and 7 PhD students have been attached to the ESA project for their research work. Partnership with Innovative Agricultural Research Initiative (iAGRI), also a USAID-supported activity, facilitated mentorship of some of the students by Africa RISING scientists in Tanzania (http://iagri.org/wp-content/uploads/2015/05/iAGRI-Annual-Report-FY-2013.pdf).
- The project has conducted short-term training and knowledge-sharing forums for more than 1000 stakeholders annually; these include officials from partner research and development organizations, public institutions, and lead farmers. Our partnership with NAFAKA is expected to raise this number by more than 10-fold during 2016.

Annex 3: Key personnel

Dr. Irmgard Hoeschle-Zeledon
International Institute of Tropical Agriculture (IITA), PMB 5320, Ibadan, Nigeria
Mobile: +234 8039784490; E-mail: i.zeledon@cgiar.org

Role in Africa RISING Phase 2	Manager, Africa RISING West Africa and East and Southern Africa Projects

Nationality	German				
Profile	Thirty-two years of experience in development cooperation and agricultural research for development in Africa, Latin America, and Asia. Good understanding of small-scale farming systems, particularly in Africa, and value chains. Extensive experience in project management/monitoring/evaluation, team leadership, coordination of program activities and staff of different cultural and professional backgrounds across projects and institutions. Solid experience in the development of project proposals, fund raising, networking, in-service training of staff, partnership building and fostering.				
	Year	Qualification	Specialization	Institution	Country
Education	1984	PhD	Plant Protection	Univ. of Hohenheim	Germany
	1979	Dipl. ing. agr.	General Agricultural Sciences, majoring in Plant Production	Univ. of Hohenheim	Germany

Employment	Period	Job title	Employer
	10/2011 to date	**Manager**, Africa RISING, West Africa and East Southern Africa Projects	IITA
	07/2008 to 12/2012	**Coordinator**, CGIAR Systemwide Program on Integrated Pest Management (SP-IPM)	IITA
	05/2002 to 05/20083	**Coordinator**, Global Facilitation Unit for Underutilized Species	GTZ/Bioversity International
	09/1986 to 04/2002	**Field Staff** member in different positions in agricultural development projects in Africa, Asia and Latin America	GIZ (formerly GTZ) Germany
	12/1984 to 05/1986	**Research Assistant** in Ethiopia	Univ. of Hohenheim
	10/1979 to 11/1984	**Research Assistant**	Univ. of Hohenheim
Awards	2013	IITA Management Award	

Selected publications	**Hoeschle-Zeledon I.**, S. Padulosi, A. Giuliani and U. Al-Haj Ibrahim, 2009. Making the Most of Wild and Relict Species – Experiences and Lessons. In: Bocconea 23: 129-143
	Hoeschle-Zeledon, I. and H. Jaenicke, 2010. A Strategic Framework for Research and Development of Underutilized Plant Species with Special Reference to Asia, the Pacific and Sub-Saharan Africa. In: Özgüven, A.I. (ed.). Proceedings of the First International Symposium on Pomegranate and Minor Mediterranean Fruits. Acta Horticulturae 818, ISHS, 333-342, ISBN 978 90 6605 249 9, ISSN 0567-7572
	Hoeschle-Zeledon, I., P. Neuenschwander and L. Kumar, 2013. Regulatory challenges for biological control. SP-IPM Secretariat, International Institute of Tropical Agriculture (IITA), Ibadan, Nigeria.

	43pp. ISBN 978-978-8444-28-2
	Chikowo, R., S. Snapp, J. Odhong, **I. Hoeschle-Zeledon** and M. Bekunda, 2015. Farm typologies and sustainable intensification trajectories: insights from participatory action research in Malawi (submitted to Outlook on Agriculture)
	Saaka, M., A. Larbi, S. Mutaru nd **I. Hoeschle-Zeledon**. 2016. Magnitude and factors associated with appropriate complementary feeding among children 6-23 months in Northern Ghana. BioMed Central Nutrition. DOI: 10.1186/s40795-015-0037-3
	Muthoni, F., Z. Guo, M. Bekunda, H. Sseguya, F. Kizito, F. Baijukya, and **I. Hoeschle-Zeledon**, 2016. Identifying sustainable recommendation domains for scaling agricultural technologies in Tanzania. (submitted to land Use Policy)

Prof. Mateete Bekunda
International Institute of Tropical Agriculture (IITA) Arusha, Tanzania
c/o AVRDC – Eastern Africa Regional Center, P.O. Box 10, Duluti, Arusha, Tanzania
Mobile: +255 682 059 802; Email: m.bekunda@cgiar.org

Role in Africa RISING Phase 2	Chief Scientist, Africa RISING East and Southern Africa Project

Nationality	Ugandan				
Profile	Nearing 38 years experience in research and capacity building in soil and natural resources directed toward crop nutrient management, agronomy and environmental dimensions for sustainable smallholder low-input farming systems in East Africa, and also consulting in broader fields relating to integrated management of natural resources. Experience in implementation and supervision of field activities, development of project proposals, coordinating donor funded programs, and forging multi-discipline and multi-institutional partnerships for action.				
	Year	Qualification	Specialization	Institution	Country
Education	1988	PhD	Soil Fertility	The Australian National University	Australia
	1981	M.S.	Soil & Plant Analysis	Wageningen University	The Netherlands
	1978	B.S.	Agriculture	Makerere University	Uganda

Employment	Period	Job title	Employer
	2012 to date	**Chief Scientist**, Africa RISING – East and Southern Africa Project	IITA
	2003 to 2010	**Professor** of Soil Science, Makerere University, Uganda, **and Dean**, Faculty of Agriculture (2003-2008)	Makerere University
	1998 to 2003	**Associate Professor & Director** Makerere University Agricultural Research Institute, Uganda	Makerere University
	1992 to 1998	**Senior Lecturer**, Department of Soil Science, Makerere University	Makerere University
	1981 to 1998	**Lecturer**, Department of Soil Science,	Makerere

		Makerere University	University
Awards/ Honors	1999-2000	Visiting Scientist, Dept. Agricultural & Environmental Sciences, University of Newcastle upon Tyne, UK	
	2005-2007	President, The African Crop Science Society Council	
	2008	World Professor, College of Agriculture and Life Sciences, Iowa State University	
	2009	Fellow, Uganda National Academy of Sciences	
	2010	Guest Faculty, Brown University International Advanced Research Institute	
Research project management	– **Principal Investigator (PI)** of the Rockefeller Foundation supported projects on: Better banana-based agriculture in Uganda (BETBAN); Biological management of Water Hyacinth Wastes from Lake Victoria; Integrating soil fertility and pest management for enhanced productivity of field peas in the highlands of South-western Uganda (under RUFORUM). – **Co-PI** of EU-funded projects on: Integrated nutrient management to attain sustainable productivity increases in East African farming systems (INMASP); Enhancing soil fertility in Africa: From field to policy maker; Potentials of low-external input and sustainable agriculture (LEISA) to attain productive and sustainable land use in Kenya and Uganda (LEINUTS) and Improving soil fertility in Africa: Nutrient networks & stakeholder perceptions (NUTNET). – Also managed **various other projects** supported by the Dutch Government, IDRC, SCOPE, IUCEA, AGRA, IMPHOS, USAID-CRSP and Makerere University.		
Selected publications	Chikowo, R., Zingore, S., Nyamangara, J., **Bekunda, M.**, Messina, J. and Snapp, S. 2015. Approaches to reinforce crop productivity under water-limited conditions in sub-humid environments in Africa. pp 235-253 In: Sustainable Intensification to advance Food Security and Enhance Climate Resilience in Africa. Lal**,** R**.,** Singh**,** B.R**.,** Mwaseba**,** D.L., Kraybill**,** D**.,** Hansen**,** D.O**.** and Eik**,** L.O. (Eds**).** pp 235-253. http://www.springer.com/us/book/9783319093598		
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	bench terraces in SW Uganda. *Agroforestry Systems* **87**:45–58.
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	Bekunda, M. and Woomer, P.W. 1996. Organic resource management in banana-based cropping systems of the Lake Victoria Basin, Uganda. *Agriculture, Ecosystems & Environment* **59**:171-180.