



Africa RISING research protocols for the Ethiopian Highlands project

Produced by

International Livestock Research Institute

Published by

International Livestock Research Institute

April 2014

www.africa-rising.net



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



This document is licensed for use under a Creative Commons Attribution-Noncommercial-Share Alike 3.0 Unported License

This document was made possible with support from the American people delivered through the United States Agency for International Development (USAID) as part of the US Government's Feed the Future Initiative. The contents are the responsibility of the producing organization and do not necessarily reflect the opinion of USAID or the U.S. Government.

Contents

Introduction	1
Theme 1: Feed and forage development.....	2
Participatory evaluation of techniques to improve the utilization of crop residues by farm households.....	2
Pilot study on supplemental irrigated fodder production for fattening sheep at Lemo	2
Theme 2: Field crop varietal selection and management	4
Addressing the yield gap challenge in the Ethiopian highlands through improved management practices	4
Participatory variety selection of wheat, barley, faba bean and potato combined with double cropping of short duration crops	4
Stepwise intensification options for small-scale Faba Bean / forage production systems	5
Theme 3: Integration of high value products into mixed farming systems.....	6
Integration of high value multipurpose trees with soil and water conservation measures for improved livelihood and reducing land degradation.....	6
Cultivating women's income and watershed resilience in market gardens.....	7
Theme 4: Improved land and water management for sustainability	8
Mainstreaming land/soil management practices that counteract soil fertility depletion	8
Assessing the severity, spatial pattern and major drivers of soil erosion to recommend appropriate and sustainable land management options.....	8
Enhancing food security and environmental stability through landscape based integrated water and land management	9
Testing permanent raised bed systems for soil and water conservation and crop intensification..	10
Relay cropping of high value crops through supplementary furrow irrigation using mounted motorized pumps.....	11
Bridging yield gaps through soil test-based nutrient amendments	11
Theme 5: Improving the efficiency of mixed farming systems through more effective crop-livestock integration	13
Integrating tree lucerne in the crop-livestock farming systems of the Ethiopian highlands for multiple products and services	13
Facilitating change in cropping systems to improve nutrition, income and food security.....	13
Enhancing the productivity of enset system through Integrated Disease and Pest Management (IPM) approaches.....	14
Theme 6: Cross cutting problems and opportunities	16
Creating linkages between farmer agribusinesses with key buyers for potato in the Africa RISING Ethiopia project.....	16
Facilitating establishment of potato seed businesses in the Africa RISING Ethiopia project	16
Decentralized system for community-based seed production and extension provision	17
Giving power to Africa RISING farmers through small mechanization.....	17

Pilot a system for decentralized, community-based seed potato production system, combined with a Farmer-to-Farmer extension service provision through Model or Lead Farmers and Farmer Field Schools.....	18
Promotion of diffused light storage for potato	18
Promotion of quality seed for potatoes.....	19
Economic impact of market facilities in Central and Northern Highlands of Ethiopia	19
Building capacity of researchers and stakeholders to collect, analyze and interpret sex/gender-disaggregated data and understanding of the local culture.....	20
Diagnosis and characterization of the most important constraints hindering women and marginalized groups from achieving full productivity potential and income generation	20
Integrating nutrition actions in to the crop/livestock farming systems of the Ethiopian highlands for improved nutrition outcomes	20
Theme 7: Knowledge management, exchange and capacity development	22
Integration of Africa RISING activities into a coherent project program.....	22
Adoption and impact of improved food legumes in Bale Highlands: Intra and inter-household empirical analysis.....	22
Analysis of existing technologies and management practices addressing sustainable intensification of the farming system in the Ethiopian Highlands.....	23
A three dimensional assessment of the perceptions of sustainability, and their role in the success of project interventions	23
Design and pilot processes to enhance facilitation, communication and coordination of innovation platforms.....	24
Design and pilot processes and tools for monitoring and evaluating the impact of innovation platforms.....	24

Introduction

To implement the Africa RISING rolling work plan that was developed in 2013, a set of research protocols targeting the main problems and opportunities identified are being implemented. These are summarized in Table 1 under the seven research themes of the work plan.

Most of the previous activities implemented by Africa RISING in the Ethiopian Highlands focused on exploratory diagnostic studies. This has given a sound base on which to plan action-based on-farm research, which is reflected by the shift in emphasis in the current batch of implemented research protocols. Currently, 22 action related protocols alongside 11 exploratory protocols are being implemented. These latter have changed in emphasis somewhat with the key focus now on:

- Exploring some more generic issues around sustainable intensification (e.g. research on indigenous perceptions of sustainability);
- Looking at knowledge management and exchange issues around SI to support the equitable and effective, ground-up scaling activities that is implemented from early 2015 (e.g. research on innovations platform communications procedures and the study on gendered constraints to adoption);
- Support of our scaling activities, to explore enabling environments for successful adoption (e.g. the historical adoption study).

Table 1. Summary of thematic areas and research protocols

Africa RISING research thematic areas	Protocols under the thematic areas	Research type
Feed and Forage Development	2	action
Field Crop Varietal Selection and Management	3	action
Integration of High Value Products into Mixed Farming Systems	2	action
Improved Land and Water Management for Sustainability	6	5 action and 1 exploratory
Mixed Farming Systems through more Effective Crop - Livestock Integration	3	2 action and 1 exploratory
Cross Cutting Problems and Opportunities (seed system, VC, market, nutrition, gender)	11	8 action and 3 exploratory
Knowledge Management, Exchange and Capacity Development	6	exploratory
Total	33	22 action and 11 exploratory

Theme 1: Feed and forage development

Participatory evaluation of techniques to improve the utilization of crop residues by farm households

In the mixed crop-livestock farming systems of Ethiopian highlands, crop residues (CR) constitute an important part of livestock diet, particularly in the dry period when green forage is scarce. In most cases CR are stored as heaps in the open air and feeding takes place by spreading a portion on the ground. These traditional management practices result in considerable loss of CR biomass and quality due to weather, pests, contamination and prolonged storage. The adoption of improved methods of storage and feeding practices will minimize wastage, improve the nutritive value could be a cost-effective feed resource to overcome feed shortage in the dry season. It is also hypothesized that farmers with better livestock market orientations can readily adopt improved CR utilization for increased livestock productivity. Participatory action research and laboratory testing is therefore required to document local practices and CR nutritive value and assess the impact of the adoption of improved techniques by farmers on:

- CR wastage and quality deterioration during the storage period
- The proportion of CR refusal during feeding
- The need for a supplementation plan for CR diets

If farmers adopt cost-effective techniques that improve the quality and utilization of CR, it will increase their farm/livestock productivity. Moreover, documenting the relationships between livestock market access/orientation of farmers and their CR management and readiness to adopt new techniques will provide valuable input for future technology interventions.

The expected outcome of this research is that farmers in the research sites will be acquainted with and adopt new technologies that minimize wastage of crop residues during storage and feeding, while at the same time improving the palatability and the feeding value of the residue. The techniques will help farmers to effectively utilize the available crop residue biomass and increase their farm productivity. During the evaluation process, forums will be created where farmers within and outside the group will share knowledge and experiences on how to further improve the handling and utilization of CR. This will in turn increase awareness among farmers, and enable to scale out better practices of CR utilizations identified in the participatory evaluation.

CGIAR and Associated Partners: ILRI, ICARDA

Pilot study on supplemental irrigated fodder production for fattening sheep at Lemo

Small scale irrigation practices are vital to the intensification of crop-livestock mixed farming system in the Ethiopian highlands. In the Lemo Africa RISING site a number of farmers have shallow wells and started to practice small scale irrigation to produce vegetables, using treadle and hip pumps distributed on loan through Africa RISING project. In Angacha district farmers have also previous experience in using rope & washer pumps for vegetable production. Integration of the small scale irrigation with livestock rearing through production of irrigated fodders and fattening practices may diversify and increase the income of farmers. Sheep fattening by supplementing locally available feeds with fast growing irrigated fodder plants (oat and vetch) may be a viable option for intensification, especially with farmers who have limited land space and cannot allocate large areas to grow fodder for large ruminants. Moreover, there are good fattening sheep types in the area (Doyogana sheep) and the demand for fattened sheep is high during major holidays. This practice may also allow efficient conversion of locally available feed resources including unmarketable (low-

grade) vegetables and crop residues into a high value product (meat) and increase the intake of crop residues which have poor intake rate when fed alone. A participatory action research exercise is therefore required to investigate the effect of this practice on the income of farmers and the trade-offs in the utilization of irrigation water for supplemental fodder production. Women tend to be less involved in fattening due to lack of feed and labour requirements. Therefore they sell younger sheep (yearling) and earn less unlike the men who bring bigger sheep to the market. Therefore this project has great potential to increase women's participation in fattening and benefit more from the sheep value chain through increased access to and control of fodder.

Income diversification and increased integration of crop-livestock systems is important to improve the livelihood of smallholder farmers. This pilot project will enable to explore the available opportunities for farmers with regard to sheep fattening using irrigated fodder as a supplement to crop residues and other locally available feeds. The project will enable to establish the feasibility of irrigated fodder production during the dry period to diversify the income of farmers and to further integrate mixed crop-livestock systems. Farmers will get opportunities to acquaint themselves with improved management of cultivated fodder of fattening sheep and share experiences on how to effectively utilize locally available feed resources. Major value chain actors and constraints for sheep fattening and marketing in the districts will be identified. The practice would contribute to increased access to and control of fodder by women and disadvantaged groups. The lessons learned from this pilot project will be used as valuable inputs to scale out irrigated fodder-fattening practices within and outside the Africa RISING sites.

CGIAR and Associated Partners: ILRI, IWMI

Theme 2: Field crop varietal selection and management

Addressing the yield gap challenge in the Ethiopian highlands through improved management practices

Matching crop-specific fertilizer regimes, including types and amounts, with local soil and seasonal climate conditions coupled with the use of improved crop varieties has the potential to greatly reduce the existing yield gaps in AR sites. While local resources such as crop residue and manure are used by many farmers, additional knowledge on their appropriate management including combination with external resources such as fertilizers is needed at the local level to increase their use efficiency. On-farm demonstration and experiential learning where farmer experiment on own field with 1 or 2 selected practices can result in widespread adoption and adaptation of technologies, under varied farmer management and local conditions. Thus by applying the principle that yield is a function of genotype, environment and management, we seek to move farmers from the current practice of low input use to a profitable use of improved seed, optimal fertilizer amounts, nutrients (organic and inorganic), while adapting the technologies to the varied local conditions. Applying this concept can significantly help address the yield gap observed on many smallholder farmers' fields, while at the same time, equipping farmers with needed skills to improve farming.

This work will provide information on the missing links in soil and crop management in AR sites (initially in two sites) in Ethiopia. It will demonstrate best management approaches for improved varieties in different configurations of rotations. Through this, a yield increase of at least 25% is expected among practising farmers. A catalogue of technologies that have potential for profitability under local conditions in each of the villages will be developed. The findings of the research will be presented at a community workshop for validation and dissemination. By linking with proposed soil fertility and alternative erosion management activities (3.1.1-3 and 4.1.1-2) under Theme 4 and results of work on varietal selection, technology packages that will be demonstrated stand a high chance of success. The work will also enhance the capacity of existing extension personnel who will continue to have impact on the villages beyond the project life.

CGIAR and Associated Partners: ILRI, ICARDA

Participatory variety selection of wheat, barley, faba bean and potato combined with double cropping of short duration crops

The Ethiopian highlands are characterized by cereal-food legume production system where the productivity is very low due to pests, poor agronomic practices and growing of unimproved cultivars. Potato is becoming an integral parts of the production system of the highlands. Sustainability of cereals (wheat and barley) and potato is maintained through regular rotation with food legumes in small and main rainy seasons of the highlands. During the implementation of AR in Bale highlands and other projects, it was possible to identify high yielding cereal, faba bean and potato cultivars that can provide high yield and contribute to food security. However, many varieties are not tested in all the four AR sites. Moreover, there are early maturing legumes that can be used in double cropping with cereal and potato to increase land productivity in the highlands. Most of the wheat, barley, potato and faba bean cultivars released are developed with little or involvements of farmers and hence there is a need to put these varieties under PVS where farmers' inputs will be considered. Therefore, this study/intervention is designed to evaluate cultivars of the four commodities following PVS approaches as well as testing double cropping to increase land productivity.

A Participatory Variety Selection (PVS) trial, consisting of 3-5 released cultivars, each for food barley, malt barley, faba bean, potato and bread wheat will be conducted (all varieties of one crop /farmer and five farmers/site) in the four Africa RISING sites. Each cultivar of each crop will be planted on a minimum of 100m² plot of land. Immediately after harvest, double cropping systems will be tested by superimposing short duration crops on the PVS treatments. For this, short duration varieties of chickpea, lentil, barley and possibly potato will relayed into / doubled-cropped after the PVS crops. The double cropping component will be implemented in Sinana, Lemu and Endemehoni sites (4 farmers/site). All field trials will be jointly managed by participating farmers, Researchers from Sinana, Debre Birhan, and Endemehoni and AR site coordinators. All agronomic, insect pests, diseases, yield and gender data will be collected and training of extension and farmers as well as field days will be organized. Participating farmers in this action search will be drawn from the IP-clusters established in each AR action kebeles. Selected cultivars will be further evaluated during the small rainy season and supplementary irrigation in North Shoa and Bale highlands in 2015.

CGIAR and Associated Partners: ICARDA, CIP, CIMMYT

Stepwise intensification options for small-scale Faba Bean / forage production systems

The demonstration activities with faba beans undertaken at the Africa RISING research sites during the Meher season of 2013 highlighted the differences between farmers' existing practices and those required for the successful adoption of improved bean variety / management packages. Most significantly, we have observed farmers in SNNPR and Amhara regions weeding their bean crops very late leaving volunteer wild oats, other grass weeds and *Trifolium* sp. to create an *ad hoc* forage – bean intercrop. As a source of forage, these “weeds” are significant. A preliminary study conducted at Lemo has indicated that up to 2 tonnes (average: 1.4 tonnes) of wild oat forage dry matter may be made available within a growing season. Moreover, the establishment costs for the forage component are, effectively, zero making this a very cost effective source of what is actually quite high quality forage. This protocol proposes a systematic exploration of a set of possible intensification trajectories for the forage – bean intercrop. This needs to include the identification of (1) competition-tolerant bean varieties that can recover after the forage crop is removed under farmers' existing practice, (2) the possibility of identifying alternative forages to increase productivity whilst retaining the cost benefits of the volunteer-based forage crop and (3) options for stepwise intensification towards specialised bean production for those farmers who begin to appreciate the benefits of market participation.

This research will lead to a clear view of the relative benefits of a range of options for intensification of a sub-system that generates food, forage and cash income for farmers. These options will differ in the extent to which farmers need to make an initial commitment to intensification; from interventions that require minimal changes in management practices (other than a change of variety) and are, therefore, more likely to be adoptable in the short term to interventions that require significant change of practice but have the potential to generate a greater overall returns. Farmers participating in the research will provide an evidence base that the concept of flexible intensification trajectories and including a robust trade off analysis will constitute sound basis for future scaling of the innovations within and beyond Africa RISING research sites.

Theme 3: Integration of high value products into mixed farming systems

Integration of high value multipurpose trees with soil and water conservation measures for improved livelihood and reducing land degradation

Most of the Ethiopian highlands have complex topography and are sensitive to different land degradation processes. The Africa RISING research sites are situated above 2100m asl where there is a high potential to grow high value crops including apple, pear, peach, olive, plum, avocado plant species for essential oils and other products. At present traditional annual crop- livestock farming systems are practiced in these fragile areas and annual crop yields are very low due to frost and poor soil fertility. Because of this and other associated reasons, most smallholder farmers in the AR sites are facing problems of food insecurity and under-nutrition, among others. Thus, introducing high value crops in the AR sites would contribute 1) to improve food security, feed, nutrition and health, 2) to diversify and increase source of income, 3) to mitigate the problems of soil erosion, nutrient depletion and degradation and 4) to convince farmers to manage their livestock better to protect their valuable crops from open grazing. However integrating multipurpose trees, particularly, temperate fruit trees, is relatively new in the AR sites in particular and in Ethiopia in general. According to the local knowledge studies carried out in AR sites, multipurpose trees integration into the mixed crop-livestock system was one of the farmers' priorities and government's interest. However, introducing multipurpose trees has some challenges including, but not limited to, 1) Inaccessibility and unavailability of quality germplasm at a required quantity, 2) lack of technical knowhow in propagation and management techniques (both NARS and farmers particularly in temperate fruit trees), 3) open grazing system, 4) lack of awareness and familiarity with the potential opportunities that high value trees can contribute, and 5) lack of water sources for irrigation. This intervention will respond to the local demand and government's initiative to introduce high value trees and campaign for their wider adoption.

Smallholder farmers in the sites have not benefited from multipurpose trees because of several reasons including those mentioned above. This intervention will raise farmers' knowhow and awareness on the benefits of integrating multipurpose high value trees to the mixed crop-livestock systems. The integration will improve farmers' productivity, income, nutrition, soil fertility and other products and services. Government extension, EIAR, regional research institutes, NGOs and CBOs will recognize the benefits derived from introduction of high value multipurpose trees and will mainstream to their development programs. Decision-makers will be better informed and recognize on women's role on fruit production and develop gender sensitive policy options. Wider adoption of fruits will be facilitated through an increased awareness by farmers and recognition by development partners (including the government, EIAR, NGOs, and CBOs). This will also lead to mainstreaming of high value trees to the national system and scaling-up through creating partnership and information sharing platform at different levels. Farmers will be convinced to implement controlled grazing system. Project sites, interventions and activities will be properly geo referenced and documented for future monitoring and evaluation. Partnerships, innovation platforms and publications will enhance awareness and encourage adoption. These will ultimately help design other projects as well as government initiatives to expand interventions to other regions.

CGIAR and Associated Partners: ICRAF, IWMI, CIAT, ILRI, Private sector

Cultivating women's income and watershed resilience in market gardens

Communities in Ethiopian highlands are trapped in a vicious cycle of resources degradation, weak institutional capacity and lack of financial resources to overcome these challenges. The pressure on the natural resource base also poses challenges and often leads to increased conflicts between the various land uses and users across the landscape. Such conflicts often arise when some of the essential services or functions of the landscape are partially or entirely lost or when benefits are not shared appropriately. There are successful bright spots in Ethiopia, whereby few communities have undergone a substantial livelihood change by intensively managing small patches of land within the farm for growing market-oriented produces (market gardens) as well as testing and integrating food security crops, particularly Enset, Sweet Potato and Potato and highland fruits. A market garden is a business-oriented, relatively small patch of land within a farm or a landscape providing wide range and steady supply of fresh produces throughout the year. These gardens are commonly small plots around the house or watering points. Such areas generally receive 'preferential management' as they could be fertilised by household refuse, manure, crop residue and night soil, have higher soil organic matter, higher soil water holding capacity and support healthy and high yielding crops. Given the limited amount of inputs required, higher returns of per unit of labour and water investment, low risk of gardens in terms of theft and land tenure, market gardens could be used as an incentive to improve watershed management. They serve the nutritional requirements of children and women through a year round production of legumes, vegetables, fruits and greens. There is thus a possibility to enhance the food security and nutrition requirements of households especially women and children by re-organizing land use across landscapes. A more convincing evidence for developing this proposal emanated from a successful market garden development experience in a drought-prone region in Northern Ethiopia, Bati, which was severely affected by recurrent drought of the 1980s and heavily relied on food aid for about 20 years. Farmers adopted a combination of home garden interventions along with water harvesting and conservation agriculture. In ten years' time, they have moved from food aid to food security and in another 10 years they have increased their income from desperate poverty to an average household income of 5500 USD per year (<http://www.raw.info/latest/when-water-is-scarce>). The watershed has also changed towards an ecologically sustainable farming system.

The anticipated outcome of this study would be:

- Increased child nutrition, household income and resilience of resource-poor farmers, particularly women, through integration of market garden innovations;
- Improved market linkages of resource poor farmers using market gardens as entry points;
- Institutional and socio-economic incentives identified for development, management, expansion and adoption of market gardens;
- Investment costs of market gardens in various market scenarios established;
- Strategies for facilitating improvements in landscapes developed and disseminated;
- Evidence for policy makers and investors developed and widely shared;

CGIAR and Associated Partners: ICRISAT, ICRAF, CIAT

Theme 4: Improved land and water management for sustainability

Mainstreaming land/soil management practices that counteract soil fertility depletion

Surveys carried out by Africa RISING in 2013 revealed that inappropriate soil fertility management in the eight selected kebeles in general, and absence of rational use of mineral fertilizer in the Gudo Beret kebele (Amhara Region) and Jawe kebele (SNNPR Region) in particular, lead to soil mining and a loss of soil fertility. However, more in-depth information of major soil fertility constraints at sub-regional scale is missing. In addition, there is no adequate information on appropriate fertilizer recommendations that address issues of soil health while at the same time are acceptable by the farming community. Likewise, it is currently unknown what incentives would be required for smallholders to adopt sustainable land management practices, if such entail tradeoffs that currently provide disincentives for farmers to change business-as-usual practices. Computer simulation tools, such as crop-soil simulation models, provide options for fast and wide-scale assessment of soil fertility dynamics and impacts of organic and/or inorganic fertilizer management practices in a predictive fashion. They are ideal tools to carry out scenario (what-if) analyses under current and best-bet, sustainable intensification conditions. These can also be used in combination with other models (livestock production models, household consumption models), to analyze soil fertility – agricultural production – livelihood tradeoffs.

Projected outcomes include:

- National Ethiopian scientists will be in a better position to improve fertilizer management recommendations while accommodating soil fertility constraints, the sustainability of intensified crop production, as well as farmers socio-economic constraints
- Farmers in the selected kebeles consider soil fertility management in their planning
- Sustainably increased crop production
- Reduced vulnerability and production risk (risk of investment in inputs) of smallholders in the selected kebeles
- Informed decision making by local, regional, and national stakeholders will strengthen
- Communicating results in workshop will strengthen stakeholders buy-in
- Reports, training manuals and articles

CGIAR and Associated Partners: CIAT, ICRISAT, ATA, ICARDA, ICRAF

Assessing the severity, spatial pattern and major drivers of soil erosion to recommend appropriate and sustainable land management options

Soil erosion is a serious problem in Ethiopia affecting food security, infrastructure and development activities. Various processes initiate and aggravate soil erosion including rainfall intensity, terrain, surface cover, land-use and management practices. Different endogenous and exogenous drivers such as population pressure, climate change, deforestation, overgrazing, land tenure, farmer's livelihood and coping strategies also dictate the severity and spatial dynamics of soil erosion. It is thus crucial to map the spatial variability of soil loss, understand the key drivers and identify the major hotspot areas to plan for priority areas of intervention and corresponding sustainable land management (SLM) options. In this study, participatory and modeling approaches will be used to map the severity and spatial dynamics of soil erosion and identify appropriate land use and management options to tackle soil loss at representative kebeles of each Africa RISING woreda. The potentials of mosaics of interventions across the landscape will be evaluated in order to understand

synergies and trade-offs. As there is evidence that many implemented SLM and conservation measures have not succeeded as anticipated, policy, institutional and other socio-economic setups required for success will also be investigated.

The research will provide information on the severity and driving forces of soil erosion and identify hotspots that require priority management intervention. The modeling and simulation results will help identify site-specific and problem-oriented SLM and SWC options that reduce soil erosion risk and improve productivity. The participatory approach will equip farmers' understanding and perception of soil erosion and its drivers and thus increase their awareness and adoption of feasible and acceptable SLM and SWC technologies. Socio-economic and trade-off analysis results under theme 4.1 will also inform best-bet and acceptable technologies suited to arrest soil erosion. Local and regional stakeholders as well as other partners understand the severity and spatial dynamics of soil erosion and evaluate the significances of different of land-use and management options. Presentation of modeling outputs will help farmers and regional officers understand the benefits and trade-offs of site-specific and problem-oriented management options vis-à-vis stakeholder preferences. Community level partnership will allow implementation of identified SLM options targeting selected erosion hotspots. Based on the outputs of the research, provisional recommendations will be made on necessary policy and institutional setups for the proper implementation and effectiveness of SLM and SWC options. The whole approach used in the study will be documented and made available to guide up- or out-scaling to other sites. In 2015 and beyond, more elaborated in situ testing of the "promising approaches" identified in this study and suggested from other AR themes will be tested and demonstrated on selected hotspots.

CGIAR and Associated Partners: CIAT, ICRISAT, ICARDA, ICRAF, Mekelle University

Enhancing food security and environmental stability through landscape based integrated water and land management

Rainfall variability, poor soil fertility and soil erosion are serious challenges of food security to rural communities in different parts of Ethiopia. With population pressure and climate change, the severity and impacts of these challenges will likely increase. Sustainable intensification at farm scale cannot be achieved unless land improvement measures are taken through sustainable water and land management. A number of natural resources management efforts have been implemented in Ethiopia since the 1970s. However, most of the introduced technologies were not based on combining scientific and traditional knowledge, and as a result performance was far below expectations. In addition, the top-down approach followed created less incentive and community participation. Recent evidences show that participatory landscape based integrated natural resources management is useful approach to reduce resources degradation and improve agricultural productivity. Considering that different potentials and constraints exist across the landscape continuum, it will be essential to design and implement targeted interventions geared to specific landscape and socio-economic conditions. In this study, community based participatory approach will form the basis for improving food security through targeted interventions such as soil/water conservation, afforestation, enclosures, agroforestry, water storage options (peculation systems, check dams, ditches, etc.), water harvesting strategies (river diversion and borehole), horticulture and home-gardens across different landscape positions. Emphasis will be given to awareness creation, community mobilization, capacity building, partnerships and multidisciplinary approaches to enhance technology adoption and sustainable use. "AR Landscapes" will be created to demonstrate and implement integrated land and water management technologies in a participatory way. Hydrological model and community evaluation will be used to assess impacts of intervention and facilitate out-/up-scaling. This protocol will contribute to and benefits from various AR themes.

The implementation of this project is expected to have the following outcomes:

- Community awareness resulted in ownership and increased participation for implementation.
- Communities implemented sustainable afforestation, SWC and water harvesting measures.
- Soil moisture increased and soil erosion decreased as a result of integrated SWC efforts.
- New springs emerged and existing ones discharged more, harvested water provided irrigation.
- Livestock feed availability and soil health improved.
- Diversification such as fruits/vegetables and home-gardens improved nutritious food for household, especially for the youth and women.
- More resilient communities and landscapes to climate change and other external pressures
- Improved upslope-downslope community interaction to sustain conservation efforts.
- Integrated water and soil management model developed for extension officers, MoA and other partners for up-scaling.
- AR and USAID will have effective, functional demonstration sites.
- Training manual and guidelines developed to aid up scaling and technology dissemination.

CGIAR and Associated Partners: CIAT, ICRISAT, IWMI, ICRAF, ILRI, Mekelle University

Testing permanent raised bed systems for soil and water conservation and crop intensification

Multispecies cropping systems (relay or double cropping systems) require more soil moisture than monocrops. While residual soil moisture in conventional cropping systems may suffice in years with average or above average rainfall, water may limit crop growth in years with below average rainfall – this is likely to occur more frequently due to climate change. It is therefore critically important to introduce technologies allowing farmers to maximize the availability of residual soil moisture.

Conservation agriculture (CA) is being widely advocated to conserve (soil and) water, while maintaining soil organic carbon and cut on production costs. However, the application of CA is challenging under the conditions typical to African smallholders for a number of reasons including competition for biomass with livestock and unavailability of specialized seeders and herbicide. In this situation, the use of permanent raised beds shaped and reshaped annually by the local maresha ard plough – as developed on the vertisols of Northern Ethiopia by the University of Mekelle and CIMMYT – may represent an attractive option. Permanent raised bed allow for soil and water conservation with minimum surface mulch, as these structures increase soil rugosity and thus reduce runoff while increasing infiltration. In Northern Ethiopia, permanent raised bed resulted in a reduction of runoff by more than half, a reduction of soil losses through erosion by a factor more than 4, significantly higher soil organic matter content in the ploughed layer, and improvement in crop yields, albeit only from the fifth season onward. Permanent raised bed also allows for shallow mechanical weed control in the furrows, thus minimizing the need for herbicide or manual labour. For small grain crops (e.g. wheat) the use of raised beds enables reduce seed rates without decreasing grain yield and reduce logging. Raised beds also improve field access (e.g. allowing N application at 1st node and boot stages, when crop N use efficiency is the highest).

We anticipate that permanent raised bed will increase soil moisture, allowing for the production of a relay pulse (chickpea, grasspea or lentil). Outcomes will include cropping recommendations to save on energy (particularly draught power) and increase water-use efficiency, perception by farmers of such alternative cropping practices, and cost/benefit analysis.

CGIAR and Associated Partners: CIMMYT, CIP, ICARDA

Relay cropping of high value crops through supplementary furrow irrigation using mounted motorized pumps

Irrigated agriculture has been on the rise in recent years in the rainfed agricultural systems of Ethiopia both as a livelihood diversification and a climate change adaptation strategy. Abstracting, conveying and applying irrigation water is an important component of the total production cost in irrigated agriculture and affects the profitability of the irrigation technology and thus the economic incentives to farmers. Motorized pumps mounted on and powered by small multifunctional two-wheel tractors can be used to abstract and convey water to farm irrigation sites. As these tractors can also be used for land preparation, post-harvest operations and transport, we hypothesize that this type of mechanized irrigation is more adoptable for smallholders than mechanized irrigation using pumps powered by their own engine. On the irrigation site, irrigated water can be applied through furrows between raised planting beds, which is more efficient than flood irrigation on a flat surface. Raised bed can be shaped using a simple tool-bar based furrower pulled by the same tractor used to power the motorized pump. Raised bed also brings a number of benefits such as reduced seed rates and increased access to the field for weeding and fertilizer application.

Presumably, productivity and profitability can be increased as a result of supplementary irrigation. However, the profitability of mounted motorized pumps in relation to the capital and operational cost of the technology is unknown for the Ethiopian Highlands. This protocol proposes to fill this knowledge gap. It links directly with 2 other Africa RISING protocols:

- The CIMMYT-led 'Testing of permanent raised bed systems for soil and water conservation and crop intensification'
- The CIMMYT-led 'Giving power to Africa RISING farmers through small mechanization'

The work will deliver information to local communities, extension agents and policy makers on how to improve the profitability of mounted motorized pumps to contribute towards sustainable intensification. In addition to the selected sites an ex-ante assessment of instruments can improve cost effectiveness and profitability of the technology?

CGIAR and Associated Partners: IWMI, CIMMYT

Bridging yield gaps through soil test-based nutrient amendments

There is an increasing evidence that crop yield is not increasing in Ethiopia despite huge investments in soil and water conservation, import of chemical fertilizers, increasing investment in small scale irrigation and expanding efforts of the extension system to reach every household in the country. More over pests and diseases are becoming major threats of production, particularly for high value produces. Opening up new land replacing wetlands, forests and hills mostly satisfies the increasing food demand. Although land degradation and nutrient mining is a widely recognized production constraint, crops are rarely responding to the application of the conventional macronutrients, even in soils where application of chemical fertilizers is a first time experience. As a result, the objective of the Ethiopian government to increase yield per unit of land and labour and to improve food security remained to be a challenge. There is unproven local perception that crops in the Ethiopian soils are not responding to the application of fertilizer mainly macronutrients. As a result the Government of Ethiopia, the sole importer of farm inputs, has been importing only Nitrogen and Phosphorus fertilizers to the country. On the other hand, lack of response to Nitrogen and Phosphorus fertilizers could be largely due to the critical deficiencies of multiple micro and secondary nutrients, which are holding back the potential of rainfed and irrigated agriculture. When micro-nutrients become a limiting factor water, fertilizer and other high-energy production inputs may be wasted, since a plant will only grow and develop to the extent that its most limiting growth factor will allow (Mengel, 2012). Many times the hidden hunger for micro and secondary nutrients is not visible, however, such

deficiencies make plants vulnerable to attacks by pathogens and insect pests and also the symptoms are considered as disease symptoms. ICRISAT's participatory research for development approach using watershed and soil test-based nutrient management as an entry point activity in Bhoochetana, the state of Karnataka, India (ICRISAT, 2013) have shown that rainfed crops respond very well to application of deficient micro nutrients (zinc, boron and sulphur) and increased crop yields by 20 to 66% on 3.7 million hectares, with an economic impact of around US\$ 130 million. The economic returns of Bhoochetana revealed that benefit cost ratio for the farmers were 2.1 to 15:1 with full costing of the inputs added by the farmers (ICRISAT, 2013). Based on the evidence of strategic research undertaken by ICRISAT-led consortium in India and other countries in Asia we proposed to assess nutrient deficiencies and test particularly with reference to micro and secondary nutrients in Ethiopia and develop a scaling-up model in two districts of different agroecologies to achieve the impact in terms of increased agricultural production and improved livelihoods with sustainable intensification.

Key outcomes include:

- First-hand information of critical deficiencies of micro and secondary nutrients in the region which could be holding back the potential will be available.
- Soil health status maps for the selected region will be available to share the information with different stakeholders and enhance the awareness amongst the policy makers, development workers, researchers and farmers for increasing agricultural productivity
- A 'proof of concept' of scalable participatory research for development using knowledge-based entry point activity will be available for application in the region.
- Policy influence on the quality and type of import of fertilizers to Ethiopia
- Increased productivity of crops through enhanced nutrient and water use efficiency to benefit the farmers.

CGIAR and Associated Partners: ICRISAT, CIAT, ATA

Theme 5: Improving the efficiency of mixed farming systems through more effective crop-livestock integration

Integrating tree lucerne in the crop-livestock farming systems of the Ethiopian highlands for multiple products and services

Feed shortage, soil fertility depletion, lack of wood for various products and low income for smallholder farmers are, among others, critical challenges in the Africa RISING (AR) research sites of the Ethiopian highlands (PCA report, 2013). Identification of different options that enhance crop and livestock productivity as well as diversify income sources are priorities for Africa RISING project. Integration of multipurpose trees such as tree lucerne (*Chamaecytisus palmensis*) in the crop-livestock farming system can be one potential option to support fodder availability, improve soil fertility and enhance crop-livestock productivity. Tree lucerne is a nitrogen fixing species (100 kg N ha^{-1}) and adaptable for use in highland areas (2000-3000 masl). It has potential for use as livestock fodder (leaves with 20-30 % protein and 77-82 % IVDMD), fencing and housing as a component of livestock value chains. The plant also has potential for use as fertiliser, biological soil conservation, wind break and fencing as a component of crop value chains. Some farmers in AR sites such as Basona *kebele* have already started selling tree lucerne seeds to generate additional income. However, women have limited access to fodder which constrains investment in livestock as well as sustainable agricultural intensification. The integration of tree lucerne to the crop-livestock farming system could save labour and time spent to look for fodder and fuel. The intervention could be an incentive to women and marginalized groups to invest in mixed farming systems.

Research, extension and none governmental organizations have been trying to promote planting of multipurpose trees like tree lucerne in the highlands of Ethiopia. However, the success has not been as expected due to lack of approaches that consider farmers needs and realities. The participatory and targeted research approach and the training and experience sharing schemes from the current project will enable farmers to grow more tree lucerne plants and improve the availability of biomass for supplementary feed, soil fertility improvement and other products and services. The synthesis that we intend to write from the research approach can serve as a guide for the extension to promote growing of more multipurpose trees, covering more areas within and beyond the Africa RISING research sites and benefits more farmers. We expect increased women's access to and control of fodder and biomass, and labour-saving. Feed and forage combinations that are appropriate for men and women in different agro-ecological zones will also be available. Gender analysis will help us understand the areas to focus on so as to integrate men and women's issue, directly address them and also gauge who will benefit and how gender relations within the household will change.

CGIAR and Associated Partners: ILRI, ICRAF, ICARDA, CIP

Facilitating change in cropping systems to improve nutrition, income and food security

Food shortage in Ethiopia is predominantly taken as a function of limited access to food in terms of quantity, but it is rarely treated as a function of non-balanced nutrition. The current grain-based cropping system lacks real incentives for diversification of crops and nutrition-oriented innovative farming. Malnutrition of vulnerable groups could occur, even in good crop harvest years and in regions of high potential because of non-balanced food intake and lack of diversity. Studies showed

that about 45% of the children in Ethiopia are stunted and about 42% are underweight, associated with zinc, iron and vitamin A deficiency (www.bioline.org.br/request?nd09041).

Rural households rarely consume animal products as they are scarce sources of cash. Dietary supplements are also rarely available to the rural poor. Therefore, there is a need to establish the level of hidden hunger in the farming systems of Africa RISING districts across social categories and develop a strategy that would improve household nutrition with the existing land and water resources. One possible option to reverse the risk of malnutrition and low farm income is modifying the production system by reallocating cropland in favor of crops with high content of nutrients in deficit and high financial returns. Analyzing households' production of nutrients on farm across farming systems could be valuable in guiding intensification of those systems both in market-oriented and subsistence sub-systems (Amede and Delve, 2008) and to guide research and development investments. Participatory modeling tools would help to evaluate household level food security and cash income, and to assess trade-offs in water, nutrient and labour use while modifying the respective farming systems to achieve the intended production objectives. It will also help to identify farm and landscapes niches where interventions could be integrated across rainfall gradients, market opportunities, gender categories and wealth groups. The tool would also be used to establish whether communities in the various farming systems are currently above or below poverty line (1.25 USD per day) with the existing production practices and create production scenarios that could lift these communities out of vicious poverty cycle.

The anticipated outcome of this study would be:

- Improved household nutrition of communities through altering cropping systems
- Policy awareness on the link between farming systems and hidden hunger (nutrient insecurity) in Ethiopia at household, community and higher scales;
- Guideline for development actors to target best-bet crop commodities with higher nutrient density to farming systems in deficit, without radically changing the food habit, market preferences and farmers' choices;
- Improved local capacity in participatory modeling for improved resource use and food security

CGIAR and Associated Partners: ICRISAT, CIAT, EPHI

Enhancing the productivity of enset system through Integrated Disease and Pest Management (IPM) approaches

Enset (*Ensete ventricosum*) is a food-security and high value crop in the southern and Oromia regions with increasing trend of expansion to other parts of the Country. The crop is a means of food, cash, feed, medicine, sources of fuel wood and other products and services for small holder farmers. It is an important intensifier of production systems given its compatibility with fruit crops, spices, planting materials and other crops when grown in association. Currently, the productivity and area coverage of the crop is declining due to various biotic and abiotic factors. Diseases such as bacterial wilt (*Zanthomonas campestri* pv. *musacearum*), pests (Enset root mealy bugs, leaf hoper, mole rat and porcupine) and soil nutrient depletion are some of the important production constraints of the crop in its growing localities. It is reported that up to 80% of Enset farms are currently infected by EXW, which directly affects the livelihood of more than 20 million enset growing farmers in the country. The effect is severe in less fertile soils. The traditional Enset processing practice for various products (Kocho and Bulla) is another challenge associated with Enset production, which is labour intensive and a workload for women. An action research initiative is proposed on Enset and its production system as the production constraints are repeatedly mentioned by farmers, development actors, researchers and policy makers in the southern region; there is evidence that EXW is reducing Enset yield and quality; loss of a single Enset plant in a family would mean loss of

one man's feed; production constraints have relevance across Enset growing regions; Enset is a women's crop; and there are best bet Enset production technologies and practices.

The anticipated outcomes of this study are:

- Less incidence of bacterial wilt and mealy bugs in AR Sites and beyond
- Benefit at least 5000 farmers in SNNPR
- Institutional capacity to manage complex pest and disease incidences
- Improved productivity of Enset systems
- Farmers food security and income will be improved through the disease and pest reduction and awareness creation on resources management interventions
- Change of roles of men and women
- Introduction of enset varieties that are disease resistant and preferred by men and women, IPM

CGIAR and Associated Partners: Areka Agricultural Research Centre, Hawassa University, Bioversity, ILRI, Woreda and Zonal Office of Agriculture, ICRISAT, CIP, ICRAF

Theme 6: Cross cutting problems and opportunities

Creating linkages between farmer agribusinesses with key buyers for potato in the Africa RISING Ethiopia project

Lack of structured markets is major challenge for many farmers and traders caused by lack of organizing production and marketing institutions. Many farmers suffer from the problem of small quantities that usually is unattractive to many traders or buyers. This is due to high transaction costs and information problems, which present challenges in coordination of supply chains often leading to use of inappropriate varieties, underinvestment in storage and handling facilities, undersupply of finance and large intra- and inter-seasonal price fluctuations which undermine market participation and competitiveness. These are some of the challenges identified in the recent value chain studies by the project in the project sites. One way of structuring the market is through ensuring that producer institutions are well organized for collective marketing and that the producers are also able to access identifiable high value markets. This reduces costs of transacting between farmers and marketers. Building linkages for ware potatoes by improving the capacity of existing agribusinesses (cooperatives and other farmer based institutions and groups) to better link to end markets for ware potatoes (large traders and processors). A focus on the complete value chain will ensure that other interventions at the farm level (such as water harvesting) support the market interventions. More important is that as farmers increase their production, they have defined markets for their ware potato. The absence of an appropriate platform to facilitate these trading interactions reduces returns from farmers' farm operations. Low production and unreliable supplies and failure to meet desired quality and food safety standards for different markets, undermine development of competitive and equitable potato value chains.

Key outcomes include:

- Market linkages between producers and buyers strengthened
- Reduced transaction costs due to agribusinesses collectively market their produce
- Better profit margins and incomes from their products through strengthened bargaining and post-harvest handling for better quality
- Increased demand for and utilization of market support services
- Business models that support sustainable market linkages promoted

CGIAR and Associated Partners: CIAT, ILRI, CIP

Facilitating establishment of potato seed businesses in the Africa RISING Ethiopia project

Reliable supply of quality seed is necessary to sustain high productivity among the farming communities. However, in many places, seeds of self-propagating and self-pollinating crops may fail to provide adequate incentives for private sector to invest in their supply. Thus seeds and planting materials that are released from the research process fail to reach the intended users due to lack of sustainable seed supply systems. The private sector feels that the returns on such investments are not assured. One of the challenges facing potato as an upcoming commodity enterprise is lack of consistent supply of planting materials, as shown by the recent value chain study in the project sites. The current system relies heavily on the public sector; however, a focus on seed supply as a business enterprise would link better the public sector (foundation seed) with the production of ware potato. A sustainable seed enterprise should be able to contribute increased potato production and consequently food incomes of households.

Key outcomes include:

- Quantity of seeds of user demanded varieties increased
- Profitability of seed businesses improved
- Increase access by farmers to seeds of demanded crop varieties
- Entrepreneurial capacity of farmer agribusinesses to produce quality seeds enhanced
- Linkages between seed businesses and producers and seed traders improved

CGIAR and Associated Partners: CIAT, ILRI, CIP

Decentralized system for community-based seed production and extension provision

Unavailability of quality seed of commonly grown crops was identified as one of the priority constraints to increased agricultural productivity in the four Africa RISING sites (PCA, 2013). The effectiveness of the national extension system is still low due to problems such as high turnover of staff which renders training efforts largely ineffective, poorly motivated extension staff and limited technical know-how of the frontline staff.

It is the aim of this activity to develop a system whereby these two constraints can be addressed simultaneously and in a sustainable manner, as far as possible relying on private initiative and community interest rather than being dependent on extension / input support provided by BoAs line agencies and/or NGOs. The approach will build on the Model Farmer (MF) concept and to combine it with a Farmer Field School (light) approach that promotes farmer-to-farmer extension. The MF concept is widely promoted by the GoE as a complementary, informal extension system aiming at bridging the existing 'last-meter gap' between the research system and farmers.

Based on the experiences made during the pilot phase (Belg season 2014) in 2 sites with the production of potato seed, the approach will be expanded to 4 AR sites, adding wheat and a legume (e.g. faba bean). In addition, to reduce post-harvest losses and to maintain seed quality, improved seed storage facilities for seed potatoes and grains will be introduced and tested.

The outcome of this study is an approach for decentralised seed production and extension service provision, increasing the local availability of good quality seed, addressing national key constraints for increased agricultural productivity. Information on farmer-acceptable, improved seed storage techniques will be generated. In collaboration with other centers (CIMMYT, ICARDA) templates for local seed supply systems are produced and seed supply systems for key Africa RISING crops (wheat, faba bean, potato) are established via Innovation Platforms and other partners. Experiences of the activity are documented and constraints identified as well as opportunities for wider scaling.

CGIAR and Associated Partners: CIP, ICARDA, CIMMYT

Giving power to Africa RISING farmers through small mechanization

Sustainable intensification (through the use of improved germplasm or relay/double cropping) will require more power, e.g. to handle the extra harvest and/or transport it to the market. Moreover, as identified during previous diagnostics, availability of farm labour is a serious constraint in CLP systems. A consequence of low farm mechanization is high labour drudgery, which affects women disproportionately (in, e.g. weeding, threshing, shelling and transport by head-loading). Moreover, labour drudgery makes farming unattractive for the youth.

This calls for the participatory testing of labour saving devices such as seeders, threshers, forage choppers and trailers. These could be powered by small, cheap, multipurpose and easy to maintain tractors such as single-axle two-wheel tractors (2WT).

Although these tractors are not powerful enough to plough, they can be used for seeding, either in a ploughed field or in an unploughed field (i.e. conservation agriculture).

Several seeders are commercially available from China and other countries. Moreover, CIMMYT and its partners recently produced a mobile multi-crop sheller/thresher for 2WT that can be converted into a trailer. We are proposing to participatory test this equipment in one pilot site of AfricaRISING sites.

Outcomes will include a better understanding of the demand for mechanization, suggestions by farmers and manufacturers to improve equipment being tested and simple cost/benefit analysis of the technologies tested.

CGIAR and Associated Partners: CIMMYT, CIP, ICARDA

Pilot a system for decentralized, community-based seed potato production system, combined with a Farmer-to-Farmer extension service provision through Model or Lead Farmers and Farmer Field Schools

Unavailability of quality seed of commonly grown crops was one of the priority constraints to increased agricultural productivity identified during the PCA. It is the aim of this activity to develop a system whereby this bottleneck can be addressed in a sustainable manner, as far as possible relying on private initiative and community interest rather than be dependent on extension / input support provided by BoAs line agencies and/or NGOs. The approach will work closely with the Model/Lead Farmer concept (1 to 5) which is widely promoted by the GoE with a Farmer Field School (light) approach that promotes farmer-to-farmer extension.

The anticipated outcome of this study is that decentralised seed systems are being piloted and documented at kebele level, increasing the local availability of good quality seed potato. In collaboration with other centres, design templates for seed supply systems are produced and pilot seed supply systems for key crops (wheat, faba bean, pea) are established via Innovation Platforms and other partners. Experiences of the pilots are documented and constraints identified as well as opportunities for wider scaling. Information will be collected regarding farmer perception of this decentralized seed production system and a participatory cost-benefit analysis will be carried out.

CGIAR and Associated Partners: CIP

Promotion of diffused light storage for potato

Storage losses including impaired quality are partly caused by harvested crops not being stored in a product specific manner. Diffused Light Storage (DLS) is a post-harvest technology which uses natural indirect light instead of low temperature to control excessive sprout growth of potato seeds, extend their storage life, reducing associated storage losses and improving productivity. It is a low cost method which provides a new opportunity for farmers to preserve the quality of seed potato. Quality Declared Planting Material (QDPM) is a value added product and must be stored in DLS.

The anticipated outcome of this study is that seed specific storage technologies are adopted within decentralised seed systems established at kebele level, increasing the overall quality of seed produced locally by farmers. Attention must be paid to specific threats to stored product (rodents, tuber moth, theft). Via the IPs, the potential for wider adoption of post-harvest technology will be established. Farmer feedback will be collected via key informant interviews to determine farmers' perception of this technology and potential bottlenecks for wider adoption.

CGIAR and Associated Partners: CIP

Promotion of quality seed for potatoes

Quality seed is more expensive than ordinary seed. While farmers in most communities demand access to quality seed, few farmers are actually willing to pay the premium associated with seed of better quality. It is therefore necessary to promote the merits of quality seed so as to create a farmer-based demand and market for quality seed.

Data will be collected to answer the following research question: Does quality seed increase yield and income convincingly for farmers to pay higher prices for better seed? The results will be documented and constraints and opportunities for wider scaling identified to improve supply systems via Innovation Platform.

CGIAR and Associated Partners: CIP

Economic impact of market facilities in Central and Northern Highlands of Ethiopia

Lack of market infrastructure significantly undermines the market margins farmers generate from their agricultural products and elevate the prices they pay for agricultural products when involved as buyers. The transaction costs of agricultural markets in general are quite high due to, among others, poorly structured and irregular supply, short shelf life of products, lack of transport facilities that force marketers to trek their animals, lack of feed and watering services in and around the markets, lack of veterinary services around markets, lack of storage facilities, and lack of market information. High transaction costs and information problems present challenges in coordination of supply chains which often lead to underinvestment in storage and handling facilities, undersupply of finance and large intra- and inter-seasonal price fluctuations which undermine market participation and competitiveness. Low production and unreliable supplies and failure to meet desired quality and food safety standards for alternative uses (food, feed and other), undermine development of competitive and equitable value chains. It is therefore imperative to emphasise the need for understanding the potential impact of delivery of key market facilities on the marketing performance of smallholder farmers. This study will employ state-of-the art scientific procedures to quantify the added monetary advantage smallholder farmers are going to get from accessing key market facilities in selected markets of the central highlands of Ethiopia.

The identification of key challenges market actors are facing and development of alternative institutional innovations will certainly bring about significant behavioral change both among consumers and traders in the agricultural markets. Informed smallholder marketers would make smart marketing decisions and hence would generate higher market margins. This will happen among other essentially through reduced transaction costs. This in itself will increase the efficiency of the markets such that markets will play indispensable role in increasing the speed and efficiency of resource allocation. Concomitantly, smallholders' livelihoods will improve as a result of improved market performance both as sellers and buyers. The findings will also help in increasing the relevance and effectiveness of agricultural market extension programs and interventions. This will be made possible as this study will chart the information on existing markets and underutilized value chain opportunities for smallholders to raise their incomes through reduced transaction costs and hence better prices for their produces.

CGIAR and Associated Partners: ICARDA, ILRI

Building capacity of researchers and stakeholders to collect, analyze and interpret sex/gender-disaggregated data and understanding of the local culture

To get a deeper understanding of the local context surrounding mixed farming systems, intensification, gender gaps, norms and agency, it is important to have trained researchers and local personnel who are able to collect, analyze and interpret sex/gender-disaggregated data and understand the local culture and sensitivity of the topic. Researchers need to understand the local context and cultural values that govern gender relations at household and community level since they influence men and women's capacity to invest in economically productive activities. Therefore, there is need to enhance the capacity of implementing partners and local staff to collect sex/gender disaggregated data, conduct a gender analysis and use of the data to address gender-based constraints in agriculture. It is also important that partners are exposed to gendered approaches in analyzing agricultural value chains. This will lead to better design of interventions and technologies that directly respond to the needs of men and women.

Stakeholders will be exposed to gender concepts and different tools to collect gender disaggregated data. Participants will be able to collect, analyze and interpret sex/gender-disaggregated data and understand the local culture and sensitivity of the topic. As a result of the training workshops, there will be increased frequency and quality of gender integration efforts across Africa RISING sites.

CGIAR and Associated Partners: ILRI, IWMI, IITA, ATA

Diagnosis and characterization of the most important constraints hindering women and marginalized groups from achieving full productivity potential and income generation

The status and role of men and women in mixed farming systems differ markedly across agro-ecological areas and Africa RISING action sites. A systematic literature review will provide a basis for understanding the key constraints that prevent women and other marginalized groups from investing in intensification and actively participate in project activities (including technology development, information sharing, meetings and trainings among others). This will provide a basis for testing and evaluating different approaches for increasing women's participation in and benefit from research for development interventions.

Gender-related constraints to intensification will be established which will be used to prioritize interventions and target appropriate technology clients. Research planning and implementation will incorporate information on constraints, needs and opportunities for gender-responsive innovation. Identification of social, economic and cultural barriers that prevent women and other marginalized groups from actively participating in various project activities. Structures and approaches that facilitate intensification, equal participation of men and women and more equitable benefit sharing will be established using gendered constraints and opportunities.

CGIAR and Associated Partners: ILRI, IWMI, EIAR, ATA

Integrating nutrition actions in to the crop/livestock farming systems of the Ethiopian highlands for improved nutrition outcomes

Investment in agriculture is often seen as a critical opportunity to reduce malnutrition. Leveraging this opportunity is even more crucial in communities dependent upon agriculture for income, livelihood, food and nutrition needs. The lancet series on maternal and child under-nutrition underscores the importance of multi-sectorial nutrition sensitive interventions in agriculture but

there are important knowledge gaps in understanding agriculture –mediated interventions that maximise nutrition outcomes for women and children in the critical first 1,000 days.

Acknowledging this, Africa RISING has set nutrition within its agriculture intensification agenda, as a key priority in Ethiopia, where 40% of children under five and many more suffer from widespread multiple micronutrient deficiencies. Poor nutrition amongst mothers and children in project sites is a product of interrelated factors; poor access to diversified nutritious foods, lack of processing, poor nutrition knowledge and care feeding practices, inadequate health/sanitation, intra-household food allocation patterns and gender dynamics. To address these issues, and ensure agriculture intensification positively impact nutrition outcomes, action research in 2 project sites will:

- Evaluate and document behaviours/practices, gender dynamics influencing nutrition in farming communities.
- Identify promising pathways to nutritional impact
- Integrate community based, tailored strategies (livestock/crop, post -harvest processing) to address nutrition through agriculture.
- Integrate effective Social Behavior Change approaches (SBC) to improve timely, safe, and appropriate complementary feeding, and utilization of other specific nutrition interventions
- Build nutrition capacity: Introduce farmer to farmer nutrition extension and training of nutrition champions: evaluate the impact of the model on key nutrition indicators (Participatory research and extension, approach)

The project will help improve nutrition outcomes in smallholder farm families and ultimately benefit women of child-bearing age and children. Evidence generated will also help guide policy formulation and future interventions that lead to:

- Improved nutrition outcomes for pregnant /lactating women and young children 6-59 months
- Improved nutrition related behaviours (knowledge, attitudes and dietary practices of farming communities
- Increased access to diversified nutritious foods through integrated approach
- Increased capacity of government extension to deliver nutrition sensitive agriculture interventions
- Increased understanding of the role of women’s empowerment in agriculture for improved nutrition outcomes

The interventions will also begin to identify the most promising pathways to influence nutrition outcomes across different AR household typologies.

CGIAR and Associated Partners: CIP, ILRI, EPHI (Ethiopian Public Health Research Institute), Woreda/Kebele /Zonal agriculture and health office, Debre Birhan University, Debre Birhan Agriculture Research Center

Theme 7: Knowledge management, exchange and capacity development

Integration of Africa RISING activities into a coherent project program

In 2013, participatory community analyses (PCA) were undertaken by multi-disciplinary facilitation teams in 8 *kebeles* in the Amhara, Tigray, Oromia and SNNPR regions, producing a list of priority farming enterprises, their current bottlenecks, as well as farmer-perceived opportunities for improving income, food security and/or reducing overall risks by intensifying farm enterprises. The PCA was carried out in discussions with kebele members and local leaders, with over 250 men, women and young people. Feedback on the results will be given to the farmers and future participatory planning and implementation of activities based on the results of the PCA and feedback sessions.

Contribute to the analysis of strengths, weaknesses and applicability of the methods used both alone and in combination. Contribute to the study of the adoption processes and common features of technologies and management practices currently used by farmers. Analyze synergies between contributing partners and programs.

CGIAR and Associated Partners: CIP, ILRI

Adoption and impact of improved food legumes in Bale Highlands: Intra and inter-household empirical analysis

Understanding the drivers of adoption and understanding the structure of the diffusion process are essential components of any research aimed at abating the challenges faced by resource poor households. So much has been done in developing improved varieties of food legumes (faba bean, field pea, lentil and chickpea) and in disseminating them in different parts of Ethiopia. Bale highlands are inhabited by resource poor farming communities depending enormously on legumes for nutrition, rotation in their cereal crops and animal feed. The decision to adopt a given technology is possible only if the utility (welfare benefit) derived from doing so is higher than not adopting. The willingness to adopt therefore varies depending on the level of perceived utility. This perception again varies across households and among different members within a household. Accordingly, the impact of the use of the adopted technologies varies depending on the characteristics of the users and the extent to which the technologies are used. This research aims at studying the driving forces behind the willingness to adopt (use or not in Belg and Meher seasons) and the intensity of adoption of improved legume cultivars considering differences among households – in terms of resource endowment, and differences within households (in terms of age and gender). The welfare impacts due to technology use will also be disaggregated based on resource endowments and gender differentials.

This research will identify the key driving forces – challenges and opportunities – that determine the willingness to use and the intensity of use of improved food legume technologies in Bale highlands. It would also empirically and comprehensively quantify the welfare impacts of the improved food legume technologies across households of different resource endowments and within households considering gender differences. The information to be generated will be communicated with the study communities and key stakeholders in agricultural extension and development in the area. The communication will be designed in such a way that the communities and stakeholders will be able to use the findings in fine tuning their decision making procedures for better efficiency and effectiveness. Extension workers and decision makers at different levels will be able to design suitable approaches that can facilitate the adoptability of technologies and the adoption ‘capacity’ of

farming households. The research procedure to be followed will also be meticulously documented and will be available for Africa RISING partners and other research and development institutions.

CGIAR and Associated Partners: ICARDA, CIAT

Analysis of existing technologies and management practices addressing sustainable intensification of the farming system in the Ethiopian Highlands

Some technologies applied by farmers arise through tradition and local knowledge, some are introduced through government or NGO led interventions and some filter down through media access. An investigation is required to explore:

- The means by which they were disseminated into the community
- The reasons why farmers chose to adopt them
- Their limitations
- Barriers to further adoption
- The enabling processes (based on a range of social, biophysical, economic and political factors) that we might be able to make use of to increase the adoptability of Africa RISING innovations.

If trends can be discovered and contextual variation in drivers of adoption can be understood the research may then be used for identifying enabling pathways for adoption of new technologies.

CGIAR and Associated Partners: ILRI, ICRAF

A three dimensional assessment of the perceptions of sustainability, and their role in the success of project interventions

Innovations usually bring with it some degree of benefit to its potential adopters but it equally creates some kind of uncertainties in the mind of adopters. This uncertainty is however reduced by the information embodied in the innovation itself in the form of the possible abilities of the Innovation to solve individual's perceived problems. The goal of the Africa RISING project is to introduce multiple interventions to achieve Sustainable intensification. This particular innovation has advantages as well as some challenges which need to be carefully examined to ensure that it benefits the poor farmers. The question to be addressed then is whether our interventions have the ability to solve Ethiopian farmers' perceived problems and alleviate poverty. For the project to be sustainable, it is equally important to consider the knowledge and perception of the farmers who are the potential adopters of our interventions. Farmers' perception and knowledge is crucial for successful research and development strategies. They further stated that many promising agriculture policies have failed because they were inappropriate to farmer's needs and perception.

Perception generally refers to how people select, organize and interpret information gained through the senses or experience. Sustainability of agricultural production is largely dependent on the action of farmers and their decision making abilities given the level of knowledge and information that is available to them. However, the role of perception has received very limited attention in studies regarding farmers' adoption of a new technology. Also, there has been a general failure of programs to address situations where farmers' knowledge is lacking and inadequate. Thus to prevent failure in our interventions through the Africa RISING Project and ensure sustainable intensification, a good understanding of the knowledge, needs and perception of the farmers is required in order to devise a systems approach of introducing the crop to them. Thus this study will focus on understanding the perception of farmers on issues of Sustainability with regards to their livelihoods and its coherence with research team members, as well as project definition of sustainability.

The study will bring out concrete understanding of role of perception of farmers in adoption of an intervention. The Study will also compare and contrast the coherence between the perception or definition of sustainability and its role in success of an intervention in creating Sustainable intensification. The study findings will be applied in future interventions by dealing with constraints to tech adoption.

CGIAR and Associated Partners: IWMI, ICRAF

Design and pilot processes to enhance facilitation, communication and coordination of innovation platforms

Innovation platforms have been established as a primary mechanism for realising the Africa RISING research for development approach. Innovation platforms have already been established in all four Africa RISING sites, however, there is some confusion regarding how these platforms will operate in practice. There is therefore a need for clear and practical guidelines which can be used to ensure a common understanding of the platform process among the various stakeholders and clear steps for platform establishment and on-going communication and coordination. In order for these guidelines to be successful they will need to be supported by good facilitation. Previous research has highlighted the importance of facilitation skills but there are limited practical recommendations for how to develop the facilitation skills of platform members (particularly at the local level). This research activity will design and pilot facilitation training events, and develop training guidelines. These processes will be piloted to test their effectiveness and impact on IP members' capacity to innovate. This research activity will contribute to scaling up platform processes to innovate and ensuring their longer-term sustainability.

This research activity will produce easy to use, practical guidelines for facilitating and coordinating IPs that can be used in other sites, and can be updated/amended based on information generated by the on-going research activities. This research will also build capacity of partners in the four sites to facilitate IPs, and through this gain a more detailed understanding of what support local partners need in order to sustain such processes in the longer term. The outcomes of this research will contribute to developing piloted and replicable processes for IP establishment in other sites and projects.

CGIAR and Associated Partners: ILRI, ICRAF, CIP

Design and pilot processes and tools for monitoring and evaluating the impact of innovation platforms

Innovation platforms are an increasingly used in research for development projects. The aim of IPs is to bring together a range of stakeholders to identify and take action to address common problems. By identifying their own issues and designing their own solutions stakeholders are more likely to take ownership and make changes than if solutions are externally driven. However, despite the potential of innovation platforms, it can be hard to demonstrate their impact. Attributing impact can be difficult because often the problems that innovation platforms attempt to solve are complex , results may be hard to measure, and benefits may be unforeseen or take time to develop. There is a recognised need to develop participatory, accessible and user-friendly tools that can be used to better monitor and evaluate the impact of IPs. M&E processes can also be an important way of encouraging an iterative process of action, reflection and learning which is key for platforms to operate effectively. This research initiative will aim to design and pilot tools and processes for monitoring and evaluating platforms in the four Africa RISING sites. The results will be documented and analysed over the course of the Africa RISING project in order to enhance understanding of the impact of innovation platforms.

The anticipated outcome of this study is a training manual and piloted process for monitoring and evaluating local innovation platforms. Enhanced capacity of local partners to manage, monitor and evaluate innovation platform process and results is another anticipated outcome. This research will also produce data which can be used to assess the impact of innovation platforms processes, and potential weaknesses/challenges. The research findings will potentially be applicable to other research processes using innovation platforms, both in terms of the processes that are designed and the results that are generated.

CGIAR and Associated Partners: ILRI, IFPRI