



## Technology Showcases Africa RISING project in the Ethiopian Highlands



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

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



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# Introduction

During its first phase (2012-2016), the Africa RISING project in the Ethiopian highlands implemented various action-based on farm research activities that align with the Ethiopian government effort. A total of 22 action related protocols alongside 11 explanatory protocols were identified and grouped under seven thematic areas.

- Feed and forage development
- Field crop varietal selection and management
- Integration of high value products into mixed farming system
- Improved land and water management for sustainability
- Mixed farming system through more effective crop-livestock system integration
- Cross cutting problems and opportunities
- Knowledge management, exchange and capacity development

This document presents some of the technology showcases which are proposed for scaling during the project second phase (2017-2021). Unlike the first phase, which was limited to two kebeles in each of the four regions, the second phase is expanding to scale and reach more beneficiaries. This requires strong partnership and engagement with various development partners.

The technology show cases are summarized and structured in a way that they give a background and description of the technologies, evidences of benefits, alignment with Government of Ethiopia (GoE) / USAID Priorities, the planned partnerships for Scaling, the proposed beneficiaries and the planned activities.

# Theme 1- Feed and forage development

## Feed resource innovations—Scaling at farm and watershed levels

### Background and Description

In Ethiopia, livestock are key sources of livelihood for rural households, and this sector accounts for about 46% of the agricultural GDP nationally. Despite the huge livestock resource, the productivity has remained very low. Feed is one of the major constraints impeding livestock production in the country. In the highlands, where mixed crop-livestock farming is practiced, the feed resource base has been on decline due to the continual conversion of grazing lands to arable lands and concomitant loss of fertility on the remaining pasture lands. It is thus important to improve the feed resource base by introducing, among others, well-adapted and high yielding fodder crops and efficient utilization practices. Through action research and participatory on farm evaluations, the Africa RISING project in Ethiopia has been identifying forage innovations that would help to alleviate the problems of feed quality and quantity. The forage innovations identified for wider scaling include the following:

*Production of rainfed/irrigated oat-vetch mixtures supplements:* Oat-vetch mixed forage produces high quality (energy and protein rich) and quantity forage that can be used as a supplement to locally available feed resources for ruminant livestock. This forage mixture can grow in a wide range of soil types and environments and has a short growth cycle of 60-70 days, making it suitable for both irrigated and rainfed conditions. In the Africa RISING research sites, the intercropped fodder has yielded 11-19 tons/ha DM under rainfed condition, with 15% crude protein and 9.5 MJ metabolizable energy/kg DM. The forage can be used as a good rotation crop in areas where crop disease is a major problem due to mono cropping. Daily supplementation of 1-2 kg DM oat-vetch mixture to dairy cows has showed a potential to improve milk yield by more than 50%.



Photo 1: Integration of fodder trees and grasses in the cropping system to improve the feed resource base and protect environmental degradation

*Integration of Tree lucerne in the backyard and outfield growing niches:* Tree lucerne is a fodder and soil fertilizer leguminous tree that grows well in the highlands on well drained soils. Under good management, tree lucerne can reach up to 2 m of height and be ready for the first forage cut within 9 months of planting. The leaf and edible branches of the

plant contain high amounts of crude protein (20-25%) and digestible organic matter (70%) providing a nutritious supplement to ruminants (Figure 1). A cutting height of 1- 1.5 m gives fodder dry biomass yield of up to 7 t/ha under farmers' management condition. The plant

does not compete with other crops, and thus is suitable for strip cropping on soil bunds in watersheds and other niches.

*Production of sweet lupine as a feed and food crop in the highlands:* Highlands of Ethiopia suffer from shortage of land to allocate separate plots for food and feed. Intervention with sweet lupine, a leguminous food and feed crop that grows on well drained soils in the highlands proved to cater diverse farmers' needs at the same time. The grain of sweet lupine has high crude protein content (37%) for use as food and concentrate supplement to livestock. Sweet lupine produces as high as 2.6 t/ha of grain, in addition to the crop residue biomass of 3.8 t/ha. Currently, there is a wide spread disease problem with faba bean and field pea crops. Inclusion of sweet lupine in the cropping system therefore helps to break disease cycles and offer alternative pulse grain for different purposes.

*Integration of desho and other grasses on soil bunds, back yard and outfield growing niches:* Desho grass has proved to be an effective indigenous grass that grows well on soil bunds in watersheds. It stabilizes the soil bund through its root system, thereby prolonging the life of the soil bunds. The grass has also good nutritional quality (about 11% crude protein), and can be harvested 3-4 times per year depending on availability of rainfall and produce 4-5.5 ton DM/ha. Desho grass can easily be propagated using root splits with almost hundred percent survival rate in the highlands. Therefore, scaling this feed innovation is useful both to protect the environment and improve livestock productivity and generate additional income for smallholders.

*Intercropping forages with faba bean:* Farmers in Ethiopian highlands depend on crop thinning and weed outs from crop fields for feeding their livestock during the crop growth season when stored feed stock is depleted and most of the arable lands are covered with crops. Intercropping cultivated/improved forages with food crops like faba bean showed that farmers can harvest quality forage from their crop fields during critical feed shortage time while maintaining the balance between grain and fodder. When oat forage is intercropped with faba bean, it is possible to obtain about 2.6 tons of good quality forage DM/ha (10% CP) without significantly affecting the grain yield of the faba bean. Economic analysis of this practice also showed that intercropping indeed improves whole plot productivity.

*Production of alfalfa forage where there is access to irrigation water:* Growing alfalfa forage has a potential to offer substantial income from small area of land at backyards. Once established and with good management (manuring and irrigation) alfalfa is harvested in 4-5 weeks interval and produces 7-10 tons DM/ha forage containing 20-24% crude protein. It contains high calcium content and provides more calcium per hectare than any other forage, making it an ideal supplement for dairy cows and poultry. Thus, alfalfa forage contributes significantly to home garden intensification by producing high quality protein supplement for poultry and dairy production, improving livestock productivity, income and nutrition of households.

*Postharvest feed resource handling:* Proper utilization of available feed resources is one of the ways to cope with feed shortages. In the Africa RISING research sites, wooden feed troughs and feed storage sheds reduced feed wastage during utilization and storage by about 30–50%. The technology also reduced work load on women and youth by minimizing labour demand for feeding and taking care of animals. Mixing locally available feed resources and fodder supplements on feed troughs allowed formulation of balanced rations



for improved livestock productivity. Promotion of these technologies is therefore important to implement a sustainable cut-and-carry feeding system in the highlands.

## Evidence of Benefits

Application of the above-mentioned technologies at household and watershed level primarily improves feed resource availability and quality, which directly improves livestock productivity and income of farmers. Despite serious feed constraints nationally, adoption of improved forage cultivation and utilization practices remained very low. This appears to be due to low level of awareness, inaccessibility of the technologies and poor extension system. Africa RISING project has developed an effective technology promotion method through the establishment of farmer research groups and innovation platforms, where farmer groups learn from each other by testing new technologies and communicating results at a community level. Another benefit from application of these technologies is the contribution to environmental sustainability of the mixed farming system in the highlands by reducing soil erosion, controlling runoffs and improving carbon sequestration.

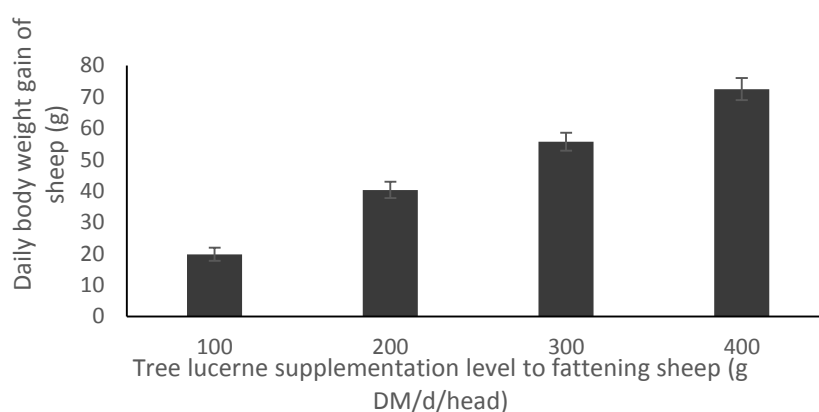


Figure 1: Effect of supplementing tree lucerne leaf to crop residue diets on the performance of fattening Menz sheep

## Alignment with Government of Ethiopia (GoE) / USAID Priorities

In its second growth and transformation plan (GTP II), the government of Ethiopia has given special emphasis to the livestock subsector with the objective of adequately exploiting its potential for rural poverty reduction, food security, export earnings, and job creations for youth and women. Improving animal feed resources is one of the main strategies to realize these objectives. The proposed technologies thus align very well with current government development agenda and environmental protection initiatives.

## Partnerships for Scaling

Scaling partnerships have been formed with district level public sector offices including the bureau of agriculture and natural resources, livestock and fisheries as well as non-government organizations (InterAide , CRS, Send –a–Cow, World Vision,) working in different localities. Joint planning and implementation plans have been developed where Africa RISING project provides technical backstopping through training and research and the scaling partners avail their manpower and resources to reach farm households with the technologies. The scaling partnership has been started in 2017 main cropping season and there is a plan to widen the network of partnership in the coming years.



## **Beneficiaries**

The end beneficiaries will be smallholder farmers in Africa RSING sites: Amhara, Oromia, Southern and Tigray regions. About twenty thousand farm households will be targeted directly over three years in each of the four regions. In addition, the same number of households will be reached indirectly through different technology dissemination methods including farmer to farmer experience/knowledge sharing arrangements and local media.

## **Activities**

The activities under this funding scheme will include: 1) capacity building of scaling partners to ensure that the resources involved (manpower and capital) in the technology scaling are properly managed, 2) establishment of Africa RISING technology village across the four regions, where farmers' validated technologies are implemented as a package and research evidences are generated. The Africa RISING villages will to be tailored to serve as laboratory of sustainable intensification of the smallholder system, 3) identify emerging research issues in the scaling process and conduct backstopping and action research.

## Theme 2: Field crops varietal selection and management

### Improved cereal and legume crop varieties for improved food security and increased income

#### Background and Description

Cereals (wheat, barley) and food legumes (faba bean, field pea, chickpea and lentil) are the most important commodities in mixed farming system of the Ethiopia highlands (Figure 2). These crops are used for food, and incomes to millions of smallholder farmers. Food legumes help to improve soil fertility, soil health and increase production and productivity of cereals. High yield gaps of cereals and food legumes are due to low adoption of improved crop varieties, diseases, poor soil fertility and weak seed delivery system. As a result, domestic production could not meet the demands of increasing population and provide raw materials for agro-industries as well as export markets. The introduction of farmer and industry preferred high yielding varieties of barley (food and malt), durum wheat and food legumes can diversify and assure sustainable production of bread wheat by reducing the threat of rusts, grassy weeds and improved soil fertility. Recent study showed that food legumes are more profitable than cereals. For example, faba bean is two times more profitable than *Tef* and wheat (<http://www.fao.org/sustainable-food-value-chains/library/details/en/c/383672/>).

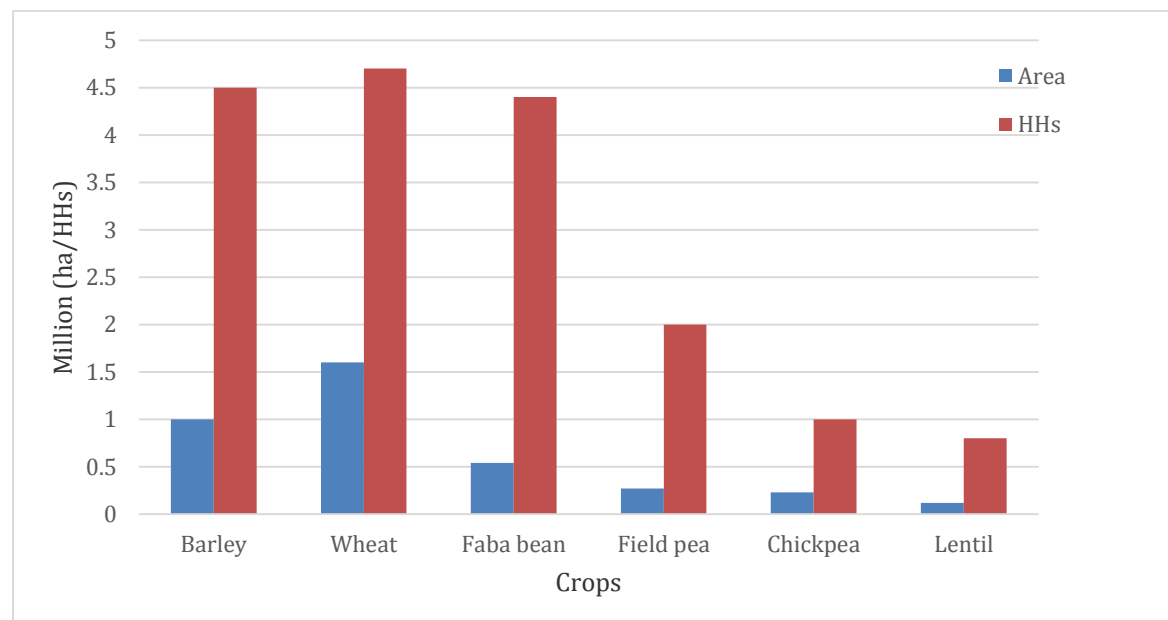


Figure 2. Area coverage and households (HHs) growing key crop commodities in cereal-legume cropping system in the highlands of Ethiopia

#### Evidence of Benefits

In the first phase of the project, farmer and industry preferred cereal and highland food legume varieties with wide and specific adaptations were selected in the four intervention sites where productivity of the cultivars were 2-3 times higher than the local cultivars (Figure

2). These cultivars are being adopted by farmers in the project and outside the project sites. In the 2015/16 cropping season, farmers selected durum wheat cv. *Utuba* and planted over 100 ha of land in three districts of Bale zone (<http://globalrust.org/blog/how-pasta-wheat-helping-ethiopian-farmers-escape-poverty>). Moreover, Gondar Malt Factory PLC, is scaling out (over 500 ha) malt barley cv. *Bekoji-1* selected by farmers from Africa RISING action research in 2017/18 cropping season in north Shewa. Farmers (male and female) income increase through adoption of new technologies giving an opportunity; to send their children to school, have better housing and health care. Ethiopia is spending millions of dollars to import bread wheat, durum wheat and malt barley to fill the gaps of food and raw materials for its growing agro-industries. The country also exports food legumes like faba bean and chickpea where Ethiopia fetches about 97 million dollars in 2013 (<http://www.fao.org/sustainable-food-value-chains/library/details/en/c/383672/>). So scaling of high yielding cereals and food legume technologies not only improve food and nutrition but also create job opportunities to youth in the agro-industries (Figure 3).

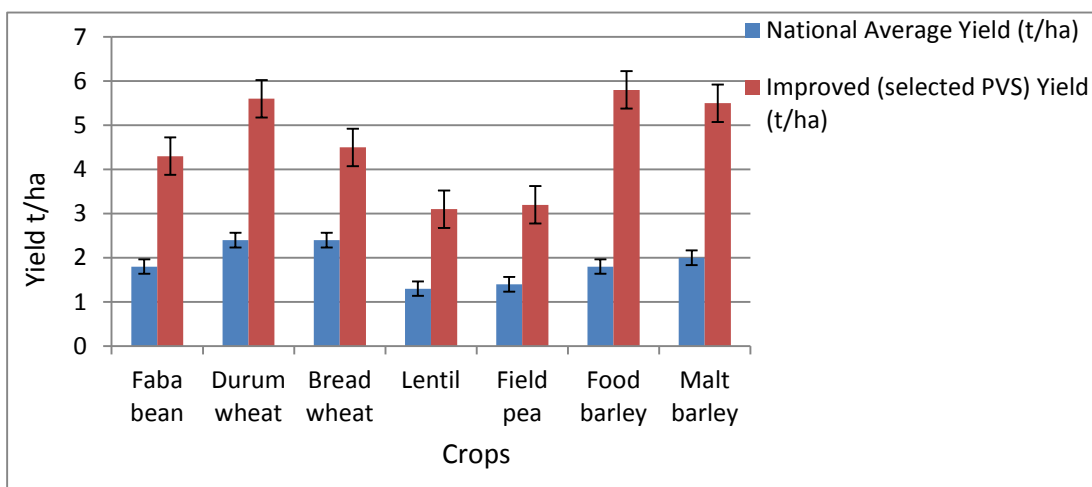


Figure 3. Mean productivity of farmer selected crop varieties across the four Africa RISING sites

## Alignment with Government of Ethiopia (GoE) / USAID Priorities

Cereals and food legumes are priority commodities of the Federal government and supporting extension of new technologies in Amhara, Oromia, Tigray and SNNPR for food, nutrition, incomes, raw materials and export. In GTP-II, the GoE is planning to increase the productivity of cereals from 2.1 to 3.1 and pulses from 1.7 t/ha to 2.3 t/ha in 2019/20. Technologies identified in Phase-I gave higher product than the new target by GoE. The technologies will play key roles to increase the productivity of wheat, malt barley and food legumes in major commercialization clusters developed by Agricultural Transformation Agency (ATA). Increasing the productivity of durum wheat, malt barley, large seeded chickpea and faba bean will help the country to compete in regional and international markets. The project train development agents; farmers and establish seed growers mainly for food legumes to increase access to seeds of new cultivars and will contribute to the ambitious plan of GoE to boost crop productivity and production.

## Partnerships for Scaling

Partnership was established through the Innovation Platforms (IPs) at the project sites where farmers, Bureau of Agriculture (BoA), research centers, Universities and input suppliers were involved in the planning and monitoring of the project activities. In Phase-II, the existing IPs will continue to play key roles in technology scaling in the project target areas. Currently the project is partnering with farmers, Farmer Unions, seed growers, BoA in the four Africa RISING action sites, Gondar Malt Factory, ISSD, Oromia Seed Enterprise (OSE) and Research Centers. ICARDA-USAID funded projects on malt barley, faba bean and chickpea is also linked to the project for greater impacts. BoA in the four regions are participating in the scaling of farmer and industry preferred crop technologies using their own resources. Africa RISING is provided initial seeds for multiplications and training of BoA experts. Malt factory is committed to further scaling technologies selected by farmers and ISSD is committed to strengthen seed growers to multiply and market seeds to farmers. Gondar malt factor created a linkage of its malt barley scaling activities in north Shewa (Amhara Regional State) where with Africa RISING-Phase-II and scaling malt barley cultivars in seven districts using their own resources. The scaling activities covered about 1731 ha where 3869 farmers (9% female farmers) participated. Oromia seed enterprise(OSE) is committed to multiply high yielding food legumes and durum wheat cultivars in Bale zone farm to be marketed to farmers. Currently OSE is multiplying 500 kg of Durum wheat cv. *Utuba* on their own farm and showed interest to engage in seed multiplications of farmer selected cultivars during the project period and play key seed provider to farmers.

## Beneficiaries

The beneficiaries of technology scaling and capacity (knowledge and skills) strengthening are smallholder farmers (male and female), seed growers, agro-industries, traders, researchers, development agents, input suppliers and policy makers. The four-major cereal and food legume growing regions (9 districts in Bale Zone; 9 districts in North Showa Zone, 4 districts in Hadya Zone and 5 districts in south Tigray) will be targeted. Over 30,000 HHs (150,000 family members) will be directly benefited from the intervention through technology, knowledge and skill transfers in 2018/19 cropping season. During the project period, 5-10 seed growers will be established in the four intervention regions and licensed by BoA to produce certified seeds and market to users.

## Key activities (2018-2021)

Key activities in scaling technologies, knowledge and skills that will be implemented with partners in the four Regional States are:

- Scaling of high yielding durum wheat and barley cultivars to diversify bread wheat mono-cropping
- Scaling of high yielding faba bean and field pea cultivars with Rhizobium inoculant in barley-legume cropping system
- Scaling of high yielding faba bean, field pea, kabuli chickpea and lentil cultivars with Rhizobium inoculants in wheat based cropping system
- Scaling of integrated legume parasitic weed management in the Northern highlands
- Scaling of PICS bags to reduce post-harvest losses of food legumes due to storage insects
- Scaling of barely and food legumes in *Belg* season in Bale and North Shoa zones
- Technology validation of new crop varieties and management practices through R4D for diversification and intensification, and conducting backstopping research
- Capacity strengthening of partners

# Improved potato varieties and technologies for improved food security and increased income

In the highlands of Ethiopia, potato is an important food crop and a major source of household income. It is a nutritious, high-value, short cycle crop and one of the few major food crops for the “hunger months” of July to Nov./Dec. before harvest of grains, providing cash for school fees in September. The production and area planted to potato have more than quadrupled since 1961. The CSA 2016 statistics show that over a million HHs produce about 3.6 million tons of potatoes on about 296, 600 ha during meher (long rain) and belg (short rain) seasons. Despite the increasing importance of potato, the sub-sector in Ethiopia is still underdeveloped with a mean yield of about 12 t/ha, although smallholder yields can reach 35 t/ha.

During AR Phase I, through a participatory variety selection (PVS), potato varieties that are disease resistant and yield three to seven times higher than local varieties were identified. Functional seed systems via decentralized community based-seed production (CBSP) were also established to increase the availability of quality seed of these improved varieties for increased productivity at the four sites. An innovative diffused light storage technology that improves the quality of seed potato was also successfully demonstrated at the target sites of the four regions.

The following technologies that were found appropriate and useful by farmers in phase I will be scaled in phase II.

- i. Improved potato varieties (Belete and Gudane) that have excellent performance (Plate 1)
- ii. Quality planting material, and
- iii. Diffused Light Stores (DLS) to obtain quality seed potato for increased productivity

These technologies are relevant to sustainable intensification because they enable to increase productivity per area, input and time. The varieties to be scaled possess resistance to late blight, requiring less chemical spray improving environmental health. Since potato has a short production cycle, it can escape effects of climate change, particularly drought.

## Evidence of Benefits

Use of quality seed of improved varieties that are more resistant to late blight than the local varieties will enable farmers to get high yields. Improved varieties: Belete, Gudane, Jalene and Gorebella yielded 3 to 7 times higher than local varieties (25-65 t/ha vs 8-10 t/ha) under good agricultural practices (GAP) in Lemo, Endomohani and Debre Birhan during phase I (Photo 2). The economic return from potato production is significantly higher than cereals and pulses. Preliminary studies showed that the net profit per ha from production of potatoes is three times higher than that of faba beans and seven times higher than that of barley and wheat (Photo 3), crops that share same agro-ecology with potato. Quality seed potatoes obtained from DLS reduce postharvest losses, as they produce short, green and sturdy sprouts that do not break off during transportation and planting compared to long etiolated sprouts. The high potato yields obtained from implementation of these technologies will improve food security, increase both domestic and export trade. The newly developed National “Horticulture Development and Marketing Strategy” shows that potato ranks first as an export crop among roots and tubers and prospects for increased export are very promising. According to CSA 2016 statistics, potato contributed over 870 m

USD worth revenue to the GDP. This can be significantly increased by increasing productivity using potato technologies this project intends to scale.



Photo 2: Excellent stand and high yield/plant of Gudene variety in Gumer (SNNPR)



Photo 3: Short, green sprouts of potatoes stored in DLS (left) compared to long, etiolated sprouts potatoes stored under dark conditions.

## **Alignment with Government of Ethiopia (GoE) / USAID Priorities**

In GTP II, agriculture especially smallholder agriculture will remain the most important source of economic growth. To improve food security and reduce poverty, GTP II prioritizes increased production capacity, improved productivity and production as well as improved quality of produce and competitiveness. High value crops, export crops, and crops that can be profitably produced under irrigation such as horticultural crops, of which potato is one, are given special attention. Another area emphasized is empowerment of women and youth.

Potato being a short cycle, very productive smallholder crop, suited to irrigated agriculture, and with high potential for export, is very well suited to contributing to the government's GTP II goal. This crop is both a garden and field crop that is widely produced by women. Since it is a highland crop, it is suitable for the governments' mountain initiative that focuses on creating employment for youth. This project is well aligned to the USAID's objective of "increased economic growth with resiliency in rural Ethiopia" and to USAID's support to food self-sufficiency and youth employment.

## Partnerships for Scaling

In the scaling process during phase II, CIP will collaborate and partner with the Ministry of Agriculture and Natural Resources (MoANR), Regional Bureaus of Agriculture and Natural Resources (RBoANR), Zonal and Woreda Agriculture Offices, Federal and Regional Research Institutes and Centers, and Agriculture Growth Programs (AGP) the four major regions, Oromia Irrigation Development Authority (OIDA), and with ATA's Agricultural Commercialization Clusters (ACC). CIP reached out to these partners and they agreed to provide and facilitate provision of technical backstopping, activity monitoring, data collection and more importantly to cover costs of inputs such as quality seed potatoes, materials for DLS construction, fertilizers and other needed chemicals.

International Potato Center will coordinate the overall implementation and provide training to woreda officers, crop experts and development agents (DAs) in a ToT approach. CIP will also provide technical backstopping together with other partners.

## Beneficiaries

The project will directly reach 40,000 farmers (240,000 people) in four years in Amhara, Oromia, SNNP and Tigray regions. The phase I sites will be the starting points for scaling and then other areas for scaling within the regions will be identified together with RBoANR. We expect that another 5,000 to 10,000 farmers, corresponding to 30,000 and 60,000 people, respectively will benefit indirectly. Since potato enjoys domestic and export markets and lends itself to processing, many more traders and processors will also be beneficiaries of the project. Going forward, a strong potato processing industry will substitute for imports of chips, saving the country hard currency. Export of chips and crisps to neighbouring countries will help Ethiopia earn foreign currency. All this will improve livelihoods of communities, aligning to GoE's and USAID's priorities.

## Activities

In AR phase II, scaling of potato technology will focus on:

- Training agricultural experts on selected technologies and overall potato production. These trainees will cascade the knowledge to producers at grassroots level.
- Supplying early generation seed potato for cooperatives, for them to multiply and sell quality seed to producers. The starter seed will be produced at research institutes first year only.
- Will demonstrate integrated potato bacterial wilt (BW) control. Potato BW is a major constraint that will cripple the potato industry if not contained. There are proven technologies to contain the disease, which will be integrated and demonstrated to the farmers where the disease has been recorded during phase I of AR.
- Some research will be conducted in the following areas to solve important problems. Details will be given during the development of the full proposal.
  - Conduct a survey to determine adoption of improved potato varieties, quality seed and DLS in AR phase I intervention areas.
  - Developing irrigation agronomy packages for irrigated potato production together with research centers and OIDA.
  - Conduct participatory variety selection (PVS) in areas that have not adopted improved technologies



- Determine effect of integrating early maturing potato varieties into cereal/legume cropping system on water use. This will be done with CIAT in selected watersheds.
- Effect of low-cost potato mechanization on potato productivity

## Giving power to Africa RISING farmers through small mechanizations

The benefits of small mechanization on planting (opening planting furrows, fertilizer application, seed placement and covering in one pass), threshing, spraying, irrigation and transport have been documented. Although single pass direct seeding using a two-wheel tractor (2 WT) appears profitable and ready for scaling out, it is evident that most Ethiopian farmers will not be able to purchase 2 WTs and implements individually. Still, they could access mechanization services, delivered by dedicated well-trained service providers. This model – which has been adopted in Bangladesh where a single two-wheel tractor can service up to 30 farmers for planting services – is the model successfully tested by CIMMYT and its partners in Ethiopia. For service provision to be viable as a business activity, mechanization use rates should be maximized. This means that a model of service provision depending on seeding only (few weeks of demand per year) is unlikely to be viable: other operations – allowed by the versatility of 2WT – should be considered, including operations that are less seasonal or time-bound such as threshing, water pumping and transporting. This guarantees that 2WTs are in productive use for a greater part of the year (benefit to the service providers) and reduce the unit cost of custom work (benefit to farmers receiving the service). The demand for threshing, water pumping and transporting is generally high, even at low labour wages.

The majority of field and farm operations are performed manually by smallholders and up to 80 % of the human labour is provided by women and children. Women have multi-task roles in smallholder farming families and technologies such as mechanization that reduce drudgery and free up time from women and children are critical for the development of smallholder agriculture in Ethiopia and other African countries. Additionally, mechanization offers an avenue for improved agronomic practices namely timely planting, precise application of fertilizer, achievement of the correct crop density as well as efficient utilization of soil moisture during the planting window at the beginning of the cropping season. Mechanizing harvesting and threshing or shelling reduces post-harvest losses and ensures quality of grain is controlled. Increased precision in field operations due to mechanization is critical for sustainable intensification of the smallholder farming systems of Ethiopia. Mechanization of farming operations will increase the productivity of both labour and land available to farming households in Ethiopia. Additionally, mechanization will help in reducing soil and land degradation by erosion on smallholder farms thereby protecting the environment in farming communities. The provision of different services based on the two-wheel tractor technologies creates employment in the rural communities of Ethiopia.

## Evidence of Benefits

Two-wheel tractors are multi-purpose and smallholder farmers, rural entrepreneurs and the whole community at large benefit from small mechanization technologies. For smallholder farmers reduced time for field operations, reduced drudgery and increased crop yields are the major benefits derived from the two-wheel tractor based technologies (Figure 4). The benefits of small mechanization on planting (opening planting furrows, fertilizer application, seed placement and covering in one pass (Photo 4), threshing, spraying, irrigation and transport have been documented. Service providers, both individual or operating in groups, can generate income through offering land preparation, planting, shelling and threshing, water pumping for irrigating high value crops, and transport services in the rural communities of Ethiopia. Farmers in different parts of the country can receive a specific range of services that are needed in their community, thereby making small scale mechanization applicable to different regions of Ethiopia. The multi-purpose nature of two-wheel tractor based technologies is good for smallholder farming communities in different parts of sub Saharan Africa.

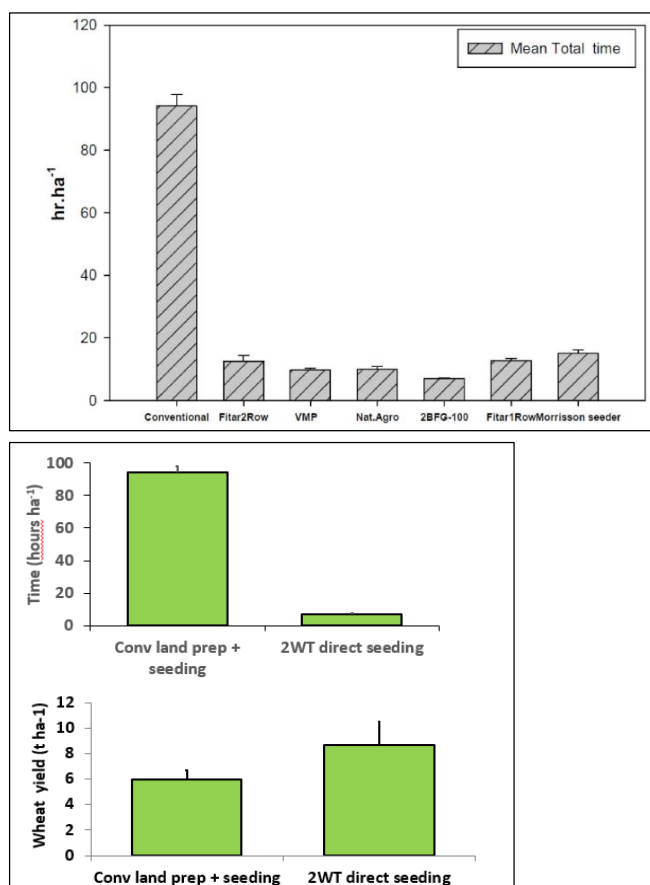


Figure 4. Total time taken for land preparation and planting using 2 WT based planters and wheat yield from direct seeding compared with conventional practice in Ethiopia.



Photo 4: Planting using the conventional animal drawn maresha system (left picture) and service provider planting teff using a 2 WT drawn planter (right picture) in Ethiopia

## Alignment with Government of Ethiopia (GoE) / USAID Priorities

The government of Ethiopia through the Ministry of Agriculture and the Ethiopian Agricultural Transformation Agency developed a national mechanization strategy in 2014. The aim of the strategy is to increase the farm power available to Ethiopian farmers 10 folds (from the current  $0.1 \text{ Kw ha}^{-1}$  to  $1 \text{ kW ha}^{-1}$ ) by 2025, with at least half of this power derived from fuel and electric engines. Large tractors (with four wheels and two axles) are well suited to large-scale and medium-scale Ethiopian farmers. But these farmers only represent about 10% of the estimated 14.7 million farmers in the country. Another form of mechanization, appropriate to the scale of the vast majority of Ethiopian farms is required. Aligned to the mechanization strategy is also an initiative on employment creation with a special focus on the youth. Small mechanization through two-wheel tractor based technologies offers an opportunity to create employment and also attract the youth to agriculture, which is one of the focus areas of the second Agricultural Growth Program (AGP) in Ethiopia.

Mechanizing farm operations reduces labour burden on women and children. This allows increased participation of women and the youth in economic activities as the freed labour can be used for other income generation enterprises in communities leading improved livelihoods in rural communities. Additionally, increased precision in field operations through mechanization increases the overall productivity of the smallholder farming systems leading to increased crop yields and household food security.

## Partnerships for Scaling

CIMMYT has developed partnership with the Department of Mechanization in the Ministry of Agriculture and Natural Resources (MoANR), Amio Engineering Pvt. Ltd., and the Ethiopian Institute of Agricultural Research (EIAR) in order to build the capacity of service providers and scale out small mechanization technologies in the different regions of Ethiopia. The current partnership has been strengthened by collaborating with other small mechanization initiatives in Ethiopia such as the ACIAR-funded project 'Farm Power and Conservation agriculture for Sustainable Intensification' and the GIZ-funded project 'Appropriate Mechanization for Sustainable Intensification of Smallholder Farming in Ethiopia'. More partners are still targeted and these include micro-finance organizations that

can give credit to service providers and farmers, International Potato Centre (CIP), International Water Management Institute (IWMI), other manufacturers and importers of agricultural equipment, non-governmental organizations (NGOs), farmer co-operatives/unions and private sector players involved in tractor hire services. Recently the MoANR through the Department of Mechanization imported 100 two-wheel tractors, disc ploughs, walking harvesters, shellers and threshers, and these have been distributed to different regions of Ethiopia. Amio Engineering Pvt. Ltd is setting up a network of spare parts dealers in areas where small mechanization is being promoted. The Ethiopia Institute of Agriculture Research through Melkassa Training Centre provides technical staff for capacity building of service providers.

## **Beneficiaries**

It is projected that the project will directly reach 20000 smallholder farmers over 4 years through various services from individual and youth group service providers. More smallholder farmers will indirectly benefit from the project through awareness and demand creation campaigns and on-farm demonstrations, and field days that will be conducted in Amhara, Oromia, SNNP and Tigray regions of Ethiopia. Service providers will benefit through business opportunities generated during and after the lifespan of the project. Initially the project targets to start working directly with at least 60 service providers spread across the Amhara, Oromia, SNNP and Tigray regions but this number will increase over the years. Previous experience from the small scale mechanization projects by CIMMYT has shown that each SP can serve at least 30 households when providing planting and transport services only. Local mechanics and spare parts dealers from project communities will have business opportunities from the machinery operated by the service providers. It is envisaged that increased demand for two-wheel tractor based services will open new business opportunities for equipment manufacturers and micro-finance organizations in the different regions of Ethiopia.

## **Activities**

The following activities will be implemented in collaboration with the different project partners;

- Demand/awareness creation of mechanization services derived from two-wheel tractor based technologies: This will be achieved through demonstrations of 2 WTs, planters, shellers, threshers, walking harvesters, trailers and water pumping at field days and exchange visits in different communities where service providers will be based.
- Capacity development – technical and agribusiness training of service providers, equipment operators and local mechanics
- Market linkages and stakeholder engagements – this will be achieved through round table meetings and workshops at various levels (woreda, regional and national levels)
- Information materials (flyers/bulletins) on 2 WT based technologies and available services will be developed, translated into local languages and distributed to farmers through the network of project partners
- Backstopping research

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

### High value fruit trees to improve nutrition and income diversification

#### **Background and Description**

The majority of the Ethiopian highlands have complex topography and are sensitive to different land degradation processes. 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 Africa RISING sites are challenged with food insecurity and under-nutrition, among others. High value trees including temperate fruit trees are untapped opportunities, especially in the high lands of Ethiopia. During the first phase of the project, ICRAF and its partners have introduced high value trees (mainly avocado, apple and walnut) and their management practices and characterized their performance through on farm, experimental trial, laboratory, socio economic survey and capacity building. During field visits and project evaluation meetings our partners have demanded the scaling out/up of high value trees within and outside the current intervention sites. Therefore, this intervention will respond to the local demand and government's initiative to scale out/up high value trees and campaign and facilitate for their wider adoption by addressing some of the 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 Development Agents (DAs), national research organisations, and farmers 3) lack of awareness and familiarity with the potential opportunities that high value trees can contribute.

#### **Evidence of Benefits**

The high value multipurpose trees having different uses and production cycles, are an essential component of sustainable agriculture because of the wide socioeconomic and ecological roles it plays in these systems. As shown in the pictures below (Photos 5, Lemo, Tigray and Sinana) avocados and apples fruits profusely within two years after planting. The benefits include improve and diversified household income, food, feed and nutrition, soil health and land productivity, empower women, job opportunity for youth and reduced migration, and resilience to climate shocks and climate mitigation when annual food crops fail during drought period since perennial trees persist and provide various products.



Photo 5. High value fruit trees farming in different Africa RISING sites of the Ethiopian highlands

## **Alignment with Government of Ethiopia (GoE) / USAID Priorities**

This intervention contributes to meet USAID mission in Ethiopia, all three System Level Outcomes of the CGIAR Strategy, SDG No.2, Ethiopia’s Growth and Transformation Plan (GTP-II) (1) reduced poverty, (2) End hunger achieve food and nutrition security, and (3) and substantially to improved natural resource systems and ecosystem services. Moreover, due to high export demand for avocado to France and China the government has requested us to scale up avocados widely.

## **Partnerships for Scaling**

We have multiple partners in the four regions. In the first phase of the Africa RISING project, our collaboration with extension, research, universities and farmers was strong and has laid an excellent ground with success stories of our research on HVT which has been implemented at homestead and farm levels. Our partnership with government offices offers huge opportunity for scaling up because they reach millions of small holder farmers at all levels. They will provide input and extension service for scaling up/out. In Lemo woreda, the scaling up process has already initiated with farmers contributing their own money, however the challenge is lack of availability of quality seedlings. In Bale, the scaling process has already been started in partnership with Sinana Agricultural Bureau, Sinana research centre, Madawalabu University and Agricultural Growth program (AGP). The Ministry of Agriculture and Natural Resources (MoANR), Ministry of Environmental, Forest and Climate Change (MEFCC), Ethiopian Institute of Agricultural Research (EIAR), Ethiopian Environment and Forest Research Institute (EEFRI), partners at Woreda, Zonal and regional level in Tigray Region, Amhara Agricultural Research Institute (ARARI), Second Phase Sustainable Land Management Program (SLMP-II) are ready to scale up fruit trees and our intervention approach in all regions. We will partner with local and international NGOs (including World Vision Ethiopia, Ethiopian Orthodox Church’s Development & Inter-Church Aid Committee, and Relief Society of Tigray) which ICRAF has been partnering with in the DryDEV project which targets 40,000 farmers in six districts in Oromia and Tigray regional states of Ethiopia. Development partners, such as SUNARMA which is a local NGO working in North Shewa Zone will be included in the second phase of the project to assist with the implementation and scaling-out of the evidence based technologies and approaches. The main contribution of the local NGOs will be in facilitating access to inputs including seeds, seedlings, implement the interventions.

## Beneficiaries

The main beneficiaries are smallholder farmers in four regions, especially women, who play key role in scaling-out and –up of improved and tested high value trees. We target about 700, 000 potential beneficiaries and 125, 000 direct beneficiaries.

## Activities

**Scaling up and scaling out of High value trees:** This relates to scaling up and scaling out of improved apple and avocado varieties and their management practices that have been validated by Africa RISING, from homestead to landscape. Five high yielding varieties of avocado (Hass, Furete, Bacon, Pinkreton, and Ettinger) which are propagated through grafting originated from superior seedlings

**Facilitate improving availability of quality planting material:**

In addressing the shortage of high quality planting material, the Africa RISING project has developed a strategy to strengthen existing nurseries or facilitating the establishment of demand driven community based multiplication and distribution centers. For instance, in Bale (Photo below), scaling up process has already been started in partnership with local partners. This approach will effectively improve accessibility, affordability, and availability of quality planting material which will be obtained at affordable prices due to proximity and reduced transport and distribution costs.

We built shed nets and planted mother blocks at Shaya nursery site. The nursery has a capacity to produce 500, 000 to one million seedlings of multipurpose trees ( fruit, fodder, fuel wood, soil fertility trees) that will benefit more than 50, 000 households if each household plant about 20 multipurpose trees.

**Capacity development:** Lack of capacity is another major challenge and this requires continuing training of agricultural extension agents (DAs) who work with farmers, nursery workers and farmers. We will continue building capacity, for example, in cultivar-rootstock selection, propagation, site species matching and fruit management practices including pruning, tree training, and crop load managements, disease resistance and growth which determines the final quality harvest. Capacity development in propagation and multiplication techniques and distribution processes will provide quality seeds and seedlings for homestead intensification, restoration of multifunctional landscapes, and as a source of income.



## Theme 4: Improved land and water management

# Enhancing food security and environmental stability through Integrated Watershed Management

### Background and Description

Low agricultural productivity and poor water/land management coupled with rainfall variability are among the critical challenges to agricultural intensification in Africa. Comprehensive evaluations of over 25 years of SLM/SWC and water harvesting interventions in northern Ethiopia demonstrate that implementation of context specific linked technologies following the landscape continuum is the key for successful environmental management, increasing water availability (in-situ and ex-situ), enhancing productivity, and creating climate resilient communities/watersheds. We generally argue that watershed management requires integrated approaches whereby *package of best-bets* are implemented across the landscape continuum. We thus do not 'list' single items as suggested options; rather we propose a '*mosaic of site- and context-specific options that match particular landscape and household typologies*'. Noting that there is complementarity between farm/plot-level intensification and landscape-level restoration, the management options also 'cross-boundaries' and should be complementary but 'staggered' across space considering specific local conditions. In this document, we briefly state key technologies tested under the Africa RISING Ethiopian highlands and are being scaled to other locations. Options are generally implemented following the spatial organization of the landscape whereby afforestation/reforestation is implemented at the upper part of the landscape, terraces combined with biological measures at the middle and gully rehabilitation, water harvesting and irrigation are key interventions at the lower parts of the landscape (Figure 5).

*Reforestation* and *enclosures* (complemented with appropriate soil and water conservation (SWC) measures where necessary), are primarily targeted at degraded areas in the upper and steep slopes. Across agricultural and grazing areas, *stone and/or soil bunds* (of different forms and types based on site-specificity) integrated with *multipurpose biological measures* (grasses, agroforestry trees, fruit trees) can be implemented. This is to reduce runoff/erosion and/or conserve soil moisture. The type and design of these options depend on slope, soil type, land use and the problem at hand (e.g., whether to reduce erosion, conserve moisture or both). In the middle and lower parts of landscapes, *gully rehabilitation measures* may need to be in place. Depending on the width, depth, and status (whether collapsing, drained or not) of the particular gully, different options can be implemented. Examples include: reduce excess runoff upslope, control further gully development using vegetative and structural measures, reduce runoff and sediment flow using barriers (check dams) of stone/wood/earth, trap sediment and store water by constructing earth embankment across deep gully, reduce gully incision and bank erosion using artificial grassed waterway, and create buffer against collapse due to erosion and/or animal trampling using biological measures such as bamboos, jatropha, vetiver and other herbaceous and woody plant species. In the lower parts of landscapes, *soil moisture conservation*, *water harvesting* and *irrigation* are vital interventions. These include *deep trenches*, *percolation pits*, *check-dam ponds*, *micro-catchments/ponds*, and *small reservoirs*. Throughout the landscape, *improved grazing land management* and *homestead development* are key for system diversification and improving food and nutrition security.

The above interventions should be guided by and supplemented with income generating options such as *timber, fuelwood, bee-hives, high value fruits, vegetables*, improved crop varieties and *multipurpose feed species*.

## Evidence of Benefits

The improved landscapes enhance overall system productivity and improve provision of ecosystem services due to decreased soil erosion, improved soil health and improved soil moisture on site. The biological options integrated across space provide economic and social benefits as well as improve biodiversity and ecosystem gains. The landscapes would ultimately be climate-resilient which will then sustain their long-term multifunctionality. The upslope interventions (biophysical and biological) increase baseflow, which helps expand irrigation area and/or increase the frequency of irrigation. Such diversification improves both food and nutrition security, especially to women and children. Integrated watershed management also reduces sediment yield, and sustains both irrigation and power supply. When SLM interventions are integrated with income generating options such as timber, fuelwood, and beehives, income and nutrition security increases. These sustain adoption of landscape level interventions.

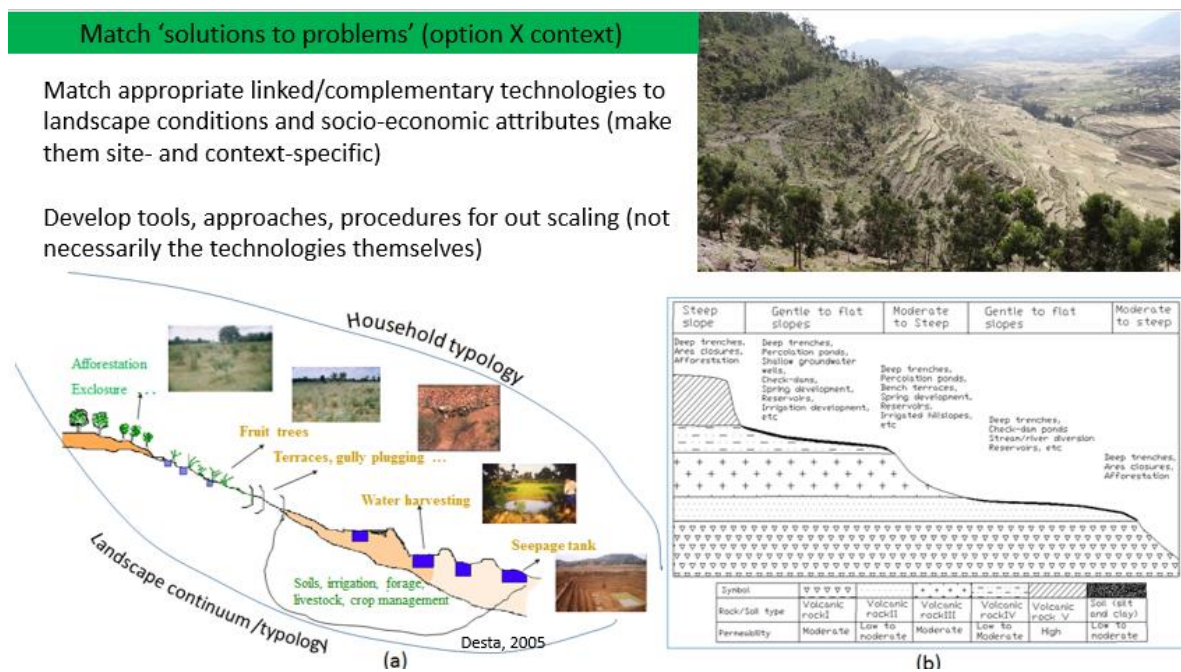


Figure 5. Matching options with context to implement site- and niche-specific measures across landscapes

## Alignment with Government of Ethiopia (GoE) / USAID Priorities

The government of Ethiopia aspires the country to reach middle-income status by 2025. To achieve this, various policies, strategies and programs are designed: Growth and Transformation Plan, Sustainable Land Management Program (SLMP), Productivity Safety Net Program (PSNP), and the Climate Resilient Green Economy (CRGE) strategy, among others. Different activities such as intensification, diversification, irrigation, and mechanization are some of the activities planned to achieve the above programs/strategies.

Under its SLM, PSNP, and CRGE, the main emphasis revolves around integrated land and water management to create multifunctional climate-resilient landscapes and communities.

## **Partnerships for Scaling**

We have various partners who are interested to collaborate with us and scale technologies and approaches. Some include the SLMP, Amhara Region Agricultural Research Institute (ARARI), InterAid (NGO), Wukro St. Mary (NGO), Ethiopian Institute of Agricultural Research (EIAR), Participatory Small-scale Irrigation Development Program (PASIDP), Ministry of Environment, Forest and Climate Change (MEFCC). The various partners contribute in-kind resources such as gabions, seeds, and expert-time. The NGOs implement packages of technologies in their watersheds at their expenses (with our training and capacity development support). Communities in the study and scaling sites contribute ‘free-labour’ to implement and manage land and water management options. The SLMP uses its resources to implement watershed management technologies and with some matching funds, we can strengthen their activities such as quantitative evidence generation.

## **Beneficiaries**

The beneficiaries from this project are mainly local communities, government institutions, research/knowledge institutions and the private sector. Within the coming five years, we aim to scale our interventions across 42 watersheds. Within each watershed, we will consider landscapes of around 1,000 ha where the integrated practices will be implemented. With this, we will cover about 42,000 ha of land. Considering average land holding in Amhara, Tigray, SNNPR and Oromia, there will be more than 50,000 direct beneficiary households. We also expect to have over 1 million indirect beneficiaries.

## **Activities**

- Community mobilization and stakeholder engagement
- Identify priority areas of intervention and develop land-use plan
- Develop similarity maps and recommendation domains
- Co-identify site- and context-specific interventions
- Match options to locations considering option by context approach
- Facilitate and co-implement options/technologies across landscapes
- Developing scaling framework and scale options to other areas
- Build capacity of stakeholders and partners (short- and long-term)
- Build database and knowledge management
- Communication and disseminations of results (frameworks, tools, models)
- Generate evidences and conducting backstopping research

# Resilience building through water and energy efficient water lifting and delivery system in sustainable intensification for smallholder farming systems in Ethiopia?

## Background and Description

With increasing interest to narrow down yield gaps and meet the food demand supply balance, the Government of Ethiopian (GOE) is highly committed to improving agricultural water management. These initiatives involve development and investments for sustainable agricultural production and productivity through increased access to stored, surface and/or groundwater for full or supplementary irrigation. Ethiopian government plan and programmes such as the Growth and Transformation Plan (GTP I and II) and climate resilient green economy (CRGE) initiatives clearly reflects these initiatives. In support to these endeavors, during phase I, Africa RISING project has tested and piloted several technologies related to water lifting and delivery, and on field water management for improved precision. An exemplary work in this regard is the introduction and testing of solar pump based water lifting for smallholder's irrigation. With its six imported solar (PV) sets, the project demonstrated and evaluated the performances of solar pump based water lifting technologies under smallholder setting in Ethiopia (Photo 5). With additional four solar (PV) demonstrated by the Livestock and Irrigation Value Chain for Ethiopian Smallholders (LIVES) project, the solar (PV) based water lifting technology was linked to different water delivery and application systems (e.g., furrow, drip and overhead application) to test which application methods lead to most efficient and maximum benefits with limited environmental impacts and less drudgery for women. The technology was also tested on a variety of crops including pepper, cabbage, carrot and fodder.

## Evidence of Benefits



Photo 6. Solar pump linked to drip system

A feasibility analysis based on one cropping season data illustrate a strong financial viability of investments in solar pump based irrigation, but with clear differences across crop type and water application techniques. Based on evidence from previous experiment, the maximum irrigable land size varies between 4431, 2188 and 2797 m<sup>2</sup> if supported with drip, farrow and overhead water application techniques, respectively. This implies that the capacity of the solar pump can be doubled if drip system is attached to it. Moreover, it gives an opportunity for smallholders to share the

initial investment cost or open an option for water delivery service provision for those who have capacity to invest but have limited land to irrigate. However, the level of feasibility proxied by the Net Present Value (NPV) and Internal Rate of Return (IRR) are different based on the level of discount rate and water application method.

## **Alignment with Government of Ethiopia (GoE) / USAID Priorities**

Following Phase I, there are number of initiatives to pilot solar (PV) based irrigation. For example, the Agricultural Transformation Agency (ATA) and IFAD and Ministry of Agriculture and Natural Resources, as part of PASIDP II, has a plan to develop decision support tool (e.g. suitability mapping) and piloting solar(PV)–drip based irrigation systems. A private sector called Solar Development PLC recently started to supply solar pump for irrigation in Ethiopia. From different sources IWMI has also allocated resources to develop solar pump suitability map and business model and the report on these will be ready the latest end of March 2017.

## **Partnerships for Scaling**

The water and energy efficient water lifting and delivery techniques proposed for out scaling under phase II is in line with the new initiatives of piloting solar (PV) based irrigation system by ATA in eight districts of Ethiopia. IWMI team in Ethiopia has been contributing to the review and planning process of these new initiatives and more consultation going on. In principle ATA has agreed to use our skills, knowledge and evidence generated during Africa RISING Phase I. They also agree on the need of backstopping and proper monitoring to answer key issues suggested under backstopping research questions above. ATA is well aware of the decision support tool (solar suitability map) being developed by IWMI to support proper targeting of potential areas. Hence, knowledge created through Phase II will be used as input to support ATA's initiative to further scale out solar (PV) beyond the current plan of 8 pilot districts.

Proper and sustainable scaling out of water and energy efficient technology proposed here requires sustainable supply chain and continuous support in terms of provision of spare parts and installation of the technology. IWMI team is in continuous consultation with Solar Development PLC and the later to deliver the services. Currently Solar Development is importing three containers of sunflower solar pump models. MoU is signed between IWMI and Solar Development PLC and most likely this will be extended to three parties involving supplier (Solar Development PLC), implementer (ATA) and back stopper (Africa RISING-IWMI). Africa RISING/IWMI will contribute through research, knowledge sharing, monitoring and evaluation (M&E), capacity building.

## **Beneficiaries**

This proposed work has three key modalities of implementations: i) implementations of ATA in eight districts located in SNNPR and Oromia regional states. ii) Solar Development PLC will directly promote its solar (PV) based water lifting and thus will access more farmers beyond the targets of ATA and thus link to us to provide further service. iii) PASIDP II will pilot solar (PV) based irrigation system where IWMI can potentially contribute as service provider. In addition to the two regional states targeted by ATA, the second and third implementation modalities will probably link us to the remaining Africa RISING regions namely: Amhara and Tigray. Therefore, the basic figure we will use on estimating the Targets / Zone of Influence will be the number of solar pump units Solar Development PLC imports and assuming that three rounds of import will be fully sold out within the project period. The first batch of import in three containers is about 200 units and in five years this will be about 1000. Assuming an irrigation capacity of 0.5 ha when attached to drip system and about 0.25 ha irrigable land holding per household 5 head per a farm per household a total of 10 000 people will be benefited directly and indirect beneficiaries will be about 40 000. This over all figures in fact does not include the number of beneficiaries from PASIDP project.

## Activities

The following are major activities:

- Knowledge sharing and awareness creation based on AR PHASE I experiences (partly done)
- Support in targeting land scape (solar suitability map) and farm typology with key stakeholders?
- Support in matching technology packages (solar (PV)-water delivery and application systems; crop type, inputs to landscape and farm types)
- Develop and test monitoring data collection tool for backstopping
- Implementation and collection of data related to research questions for backstopping
- Monitoring and evaluation

## Provision of service delivery and drip kits for enhanced water access and irrigation efficiency: out scaling experiences from phase I

### Background and Description

Agricultural mechanization is seen as one of the strategies for agricultural transformation in Ethiopia. The current mechanization strategy outlines implementation strategies to increase mechanization in Ethiopia, one of which is identifying the most impactful mechanized technology opportunities and increase accessibility of financing services to farmers for mechanization technologies and service (ATA, 2014).

With increasing interest to ensure water access for irrigation, the government of Ethiopian (GOE) is engaged in construction of water reservoirs, mainly large dams. The regional government and farmers are also developing small scale water harvesting structures tapping into ground- and surface water for full or supplementary irrigation. The Growth and Transformation Plan (GTP I and II) and Climate Resilient Green Economy (CRGE) strategy clearly reflects these initiatives. However, these initiatives may not ensure water access to every farmer, especially in areas water scarcity is severe, unless the initiative is complemented with water service delivery. This initiative will also yield successful outcome if water delivery service is complemented with drip irrigation, to enhance water use efficiency, which increases productivity due to mechanization.

In support to these endeavors, during Phase I, Africa RISING project/IWMI has tested and piloted water delivery in Lemo, (Southern Nations, Nationalities and Population (SNNP) regional state, using motor pump mounted two-wheel tractors (2WTs). The water delivery service was linked to different application systems (drip and overhead application) to test which application methods lead to most efficient and maximum benefits with limited environmental impacts and less drudgery for women. The on-farm action research tested on three crops namely: cabbage, carrot and fodder.

## Evidence of Benefits

The results, based on one cropping season monitoring and analysis, illustrated a strong economic feasibility with clear disparity across crop types and water application techniques. Water delivery service combined with drip irrigation yields to most feasible outcomes measured by Net Present Value (NPV) and Internal Rate of Return (IRR) indicators. From the on-farm action research better insights were also gained on the distance to water source and whether farmers will be able to pay for water (Hagos et al. 2016, Photo 6).



Photo 7. Drip System with water delivery

### *Anticipated benefits from the widespread uptake of these innovations*

- Building resilience through increases productivity and mitigation of crop failure through supplementary irrigation or full irrigation,
- Creates job for youth and female farmers as service providers,
- Diversify sources of income (e.g. transportation) to the service providers and beneficiary households,
- Increase land productivity and contribute to food security of smallholders, and
- Ensures access to nutrient dense food such as vegetables and fruits and animal products under irrigation condition.

## Partnerships for Scaling

There are initiatives to promote 2WTs by MOANR in collaboration with CIMMYT and regional bureaus in Debre Birhan (Amhara), Bako and Assela (Oromia) and Adwa (Tigray) in Ethiopia. IWMI team in Ethiopia has been contributing to planning this new initiatives and consultation is still ongoing. The team with the regional microfinance organizations and MOANR will design a financing mechanism for out scaling. There is need of backstopping and proper monitoring by experienced institutions, such as IWMI and CIMMYT.

Proper and sustainable out scaling of water delivery and efficient irrigation proposed here requires innovative financing mechanism for farmers to access the tanker and drip kits. The team proposes a revolving fund to target households. The seed money for the revolving fund will be provided by the project.

Proper and sustainable out scaling of water delivery and efficient irrigation proposed here requires also sustainable supply chain and continuous support in terms of provision of spare parts and installation of the technology. IWMI team is in continuous consultation with iDE, particularly in supporting the installation and implementation of drip facilities and tankers, to deliver this task. Discussions with Bruf Tesfa, another partner engaged in the supply of micro-irrigation technologies are still ongoing.



## Beneficiaries

This proposed work will run in four districts in four Africa RISING regions namely: Amhara, Oromia, SNNPR and Tigray. The crops targeted are high value vegetables, which have food security and nutrition benefits. 2WTs (in total 8 2WTs) are already imported and allocated to each site. The 2WTs are equipped with 500L tanks and a motor pump so that service providers can transport water. Drip kits and tankers will be provided on loan by the project for the beneficiaries to receive water from service providers and produce vegetables efficiently. One 2WT can serve 30 households in each site. The total households served will, thus, be 120 households, consisting on average of 600 population in the lifespan of the project (Table 1). The unit cost is drip kits cultivating 100 m<sup>2</sup> and 400 L tanker is 2400 USD. The first 12 units will cost roughly about (including 10% miscellaneous expenses) USD 30000, which will be financed by Africa RISING. Other farmers will be benefit by involving the local microfinance organizations and MOANR.

Moreover, the project will provide in-kind contribution through expertise for technical training of service providers, mechanics, co-operative members and other partners.

Table 1. Expected beneficiaries in the four regions

Region	Kebeles	Directly engaged households	Potential beneficiaries in Zone
<i>Solar based water lifting, delivering and application technologies</i>			
Amhara	1	30	150
Oromia	1	60	300
SNNPR	2*	6	42
Tigray	1	30	150
<b>Total</b>		<b>120</b>	<b>600</b>

\* Two kebeles were target kebeles in phase I and will not be included in the calculation.

## Activities

Monitoring and evaluation will be an important component of this proposed project and the mechanism for data collection on actual implementation is also indicated earlier. The indicator for process monitoring will evolve along implementation but an example may include:

- Number of drip sets implemented and farm households engaged;
- Areas of land irrigated and typed and diversity of crops grown and their productivity performances;
- Number of events on experience exchange between the intervention and domain farmers;
- The cost of 2WTs and the services it provided,
- Cost of fuel and labour time used in the service,
- The amount of capital invested as seed money and cost-sharing mechanisms (could be in kind); and
- Impact on livelihoods using food security and nutrition indicators.

Another activity envisaged is supply chain analysis of water delivery and drip technologies. This will help mapping the role of private sectors in the supply of these technologies and identifying bottlenecks.

# Bridging yield gaps through soil test -based nutrient amendments

## Background and Description

Successive Ethiopian governments financed the import of chemical fertilizers, with the volume of the import increase from 200,000 to 894,000 tonnes between the years 1994 and 2014. However, despite these increasingly large investments there is no convincing evidence showing that increased fertilizer application led to proportionally increased crop and livestock yield per unit of inputs. The challenge the country has been facing are: 1) Given the huge diversity of the country, in terms of soil types, cropping systems and landscape positions, the types of fertilizers currently imported in large amounts and the recommendation domains suggested by ATA did not bring about the expected benefits; and 2) The fertilizer plants may not be able to produce the required type and quality of fertilizer blends for the specific landscapes unless additional information is generated on the agronomic and economic efficiency of the various fertilizer blends for specific locations and production systems.

## Evidence of Benefits

Taking the more integrated and targeted approach to fertilizer use that the work proposed here aims to support (i.e. as part of a broader set of interventions aimed at enhancing system productivity) could improve the agronomic and economic benefits. This project is now seeking to encapsulate its findings into sets of decision support tools for fertilizer recommendations for various soil types, crops and farming systems and other specific situations and institutionalize them to be used for scaling-up approaches. By doing so, cereal crop yield could increase by 30 to 80%, depending on the agroecologies and crop types with significant cost reduction due to targeted input applications. This input efficiency could also significantly reduce the costs of import of fertilizers, while improving productivity.

## Alignment with Government of Ethiopia (GoE) / USAID Priorities

The Africa RISING project has been instrumental to steer-up national discussion on how to improve fertilizer recommendations in the country, which became also a major input for development of the new Ethiopian Soils Strategy, currently being developed by the Ministry of Agriculture and Natural Resources. ICRISAT-Africa RISING has been a key member of the task force to develop the soils strategy.

## Partnerships for Scaling

The Africa RISING project, working on appropriate input delivery has been engaged with multiple national and regional partners to scale-up its tools and methods to various regional and national institutions at scale. To mention few:

1. On November 3<sup>rd</sup>, 2015, following a recommendation made by an EIAR senior staff, EIAR DG has asked ICRISAT to present the experiences of Africa RISING project on niche specific soil fertility management to the soil scientists of EIAR at the headquarters. Almost all the Directors and senior staff participated in the seminar, chaired by the Director General, Dr Fentahun Mengistu;

2. On Dec 18<sup>th</sup>, 2015, a follow-up workshop was conducted based on the recommendation of the DG of EIAR and other senior directors a nation workshop entitled 'Decision support tools for appropriate fertilizer recommendation in Ethiopia'. It was organized by Africa RISING-ICRISAT, EIAR, CIAT and GIZ team by inviting all the major stakeholders in fertilizer and soil fertility research in the country, including representative of regional research institutes, ATA, GIZ, multiple Universities, MoANR and other stakeholders;
3. On December 1<sup>st</sup> and 2<sup>nd</sup>, 2016 ICRISAT and CIAT have organized the second national workshop in collaboration with EIAR and GIZ to evaluate progresses made in developing decision guides for fertilizer application and develop a database by bringing the available soil-related data together and analyze trends and benefits;
4. On December 5<sup>th</sup> ICRISAT, EIAR and ATA have agreed to re-analyse the data generated by EIAR and ATAT in 65 districts of the country following Africa RISING methodologies and approaches. It is a work in progress.
5. On January 23<sup>rd</sup>, 2017, our team held a meeting with the Minister of Agriculture and Rural Development, His Excellence Dr. Eyasu Abrha to discuss about institutionalizing best approaches and practice on soil fertility management.

## **Beneficiaries**

Besides the extension system at regional, woreda and kebele levels, small scale farmers dependent on crop-livestock systems are the major beneficiaries of these interventions. Our objective is to directly reach about 14,000 farmers in the second year of scaling, which would be cascaded to more communities over time.

## **Activities**

- 1) Develop a revised farming system-based soil fertility management maps created for the target zones and widely shared
- 2) In the second year ensure that at least 14,000 farmers would be awarded Soil Health certificates, along with recommendations per farm units.
- 3) Validating the decision support tools with 3500 households with appropriate use of fertilizer inputs in targeted landscape positions
- 4) Quantify benefits in terms of increased yield of grain and crop residue and nutritional quality in targeted landscapes / woredas, in the target zones
- 5) Validate the recommendation domains and suggest policy measures for disseminating targeted use of inputs for intensification in the target zones
- 6) Disseminating technology and institutional recommendations through various communication channels