Report from a cross learning visit to Africa RISING project sites 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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Contents

Acronyms

AHI – African Highlands Initiatives

CIAT- Centro Internacional de Agricultura Tropica/ International center for Tropical Agriculture

CIP- Centro International de la Papa/ The International Potato Centre

ICRAF- International Council for Research in Agroforestry / International Centre for Agroforestry

ILRI – International Livestock Research Institute

IWSM – Integrated Watershed Management

NARS – National Agricultural Research Systems

SCRP – Soil Conservation Resources Project

SLM – Sustainable land management

SWC – Soil water conservation

SNNP – Southern Nations Nationalities and Peoples

WAP – Wide area planning

Introduction

Land degradation and drought have been serious problem in Ethiopia and these have negatively affected productivity, nature of landscapes, vegetation, availability and quality of water. Increased land degradation and droughts experienced in the 1970s and early 80s necessitated the Ethiopian government to embark on restoration efforts in form of soil water conservation (SWC) and sustainable land management (SLM). Substantial investments were made to reverse the situation through research and development activities on the watersheds development. These watersheds development initiatives went through four evolutional phases, the first phase (1974-1990) and was based on food for work targeting the most food insecure areas, phase two (1990 – 1995), a period that saw the reduction in restoration activities, where most successes/work done in phase one were not followed up, phase three (1996 -2004) was the regeneration time where regional governments reverted to restoration work focusing on SWC, and finally phase four (2005- to date), where highly coordinated restoration work at national and regional scale is undertaken based on guidelines and frameworks.

Throughout the evolutional phases of the restoration efforts, different projects and research initiatives have been involved. The first was the Soil Conservation Resources Project (SCRP) in 1981, focusing on rehabilitation of degraded landscapes using physical soil and water conservation structures, and then followed the Joint Vertisols Project (1986) which had a comprehensive and integrated approach to land restoration than the first. Major objectives of this project were, establishing drainage technologies, undertaking soil erosion control studies and general crop and livestock production improvement. Later there was the Ethiopian Institute of Agricultural Research (EIAR) which established model watershed management, and finally the African Highlands Initiative (AHI), which established the watershed management research program with the NARS in 2008/2009. It zeroed in on development of approaches and methods of watershed management in a much integrated manner than before.

The earlier approaches to land restoration took a top down- approach, which proved to be less successful as it did not fully involve the people on the ground. However, later participatory and more inclusive approaches were adopted. To successfully implement this approach, the government took centre stage in raising awareness on the approaches to be followed in restoring the land, and benefits to be enjoyed if successful. As a result of such massive advocacy widespread successes in restoration work have been realised in different watersheds. Such susses stories include enhancement of infiltration, improvement of groundwater, improvement of base flows, emergence of new springs, regrowth of grass, and afforestation work in bare lands. The climax of restoration accomplishment is evident in Tigray where originally hopeless and unproductive lands have seen the revolution of ground water irrigation. In 1994 only 20ha of land was irrigated, while in 2014, 45,000 ha are dedicated to irrigation. In pursuit of the land restoration work in Ethiopia, different technologies have been employed and these include hill-stones terraces, check-dams, stone-bunds, trench bunds, area closure and IWSM, eyebrow basins, deep trenches, integrated gully trenches, contour ploughing and pits, and terraces.

Based on the concerted efforts the government has been putting in restoration work, but still with a substantial amount of challenging work still outstanding in food productivity (crop and livestock) and restoration process with the ever growing population, Africa RISING suggested intensification as a

solution to this. However, this could be successfully achieved unless there was some well-coordinated SLM and restoration work at landscape level. This then lead to the formation of the integrated watershed management as one of the thematic areas of intervention in the restoration work. CIAT took the lead to develop the protocol on the aforementioned theme in collaboration with ILRI, ICRAF, IWMI and Mekelle University. The team designed a strategy to collaborate with regional and district level Departments of Agriculture as well as other partners to co-implement the protocol. The main engagement was that AR leads the capacity development and demonstration of key technologies to help farmers realize the benefit of integrated watershed management within short periods of time, while the department of Agriculture plays the major role of mass mobilisation and co-implementation of site-specific technologies. Africa RISING project and the local partners have already identified model and collaborative watershed areas, and started implementation of the joint initiatives in Basona and Lemo AR sites.

Africa RISING project sites in Ethiopia include Tsibet and Emba Hasti in the Tigray region, Gosh Bado and Gudo Beret in the Amhara region, Ilu-Sanbitu and Salka in Oromia region, Upper Gana and Jawe in the Southern nations peoples (SNNP) region (**Fig 1**).

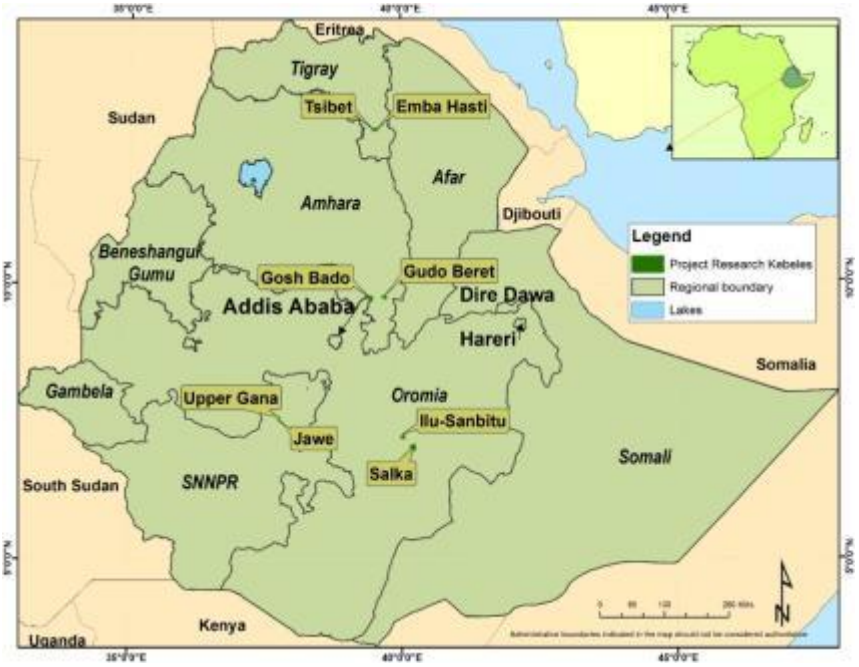


Figure 1 : Africa RISING project sites in Ethiopia

The evident success in the restoration work in Ethiopia, especially in lands that were originally described as unproductive (Tigray), has attracted the interest of scientists in different parts of the African content. It is interesting to note that similar land degradation problems are experienced elsewhere in Africa, but initiatives and approaches have been falling short of achieving the success registered in Ethiopia. Based on the Ethiopian case AR found it important to arrange for cross learning visits involving representatives from Southern Africa (SA), West Africa (WA), and East Africa (EA) AR projects to visit the Ethiopian highlands to learn from the project activities there.

This document is a report of the whole process of the cross learning visit between AR scientists from SA, EA, and WA. Starting with presentation of AR activities in Ethiopia through visits to sites where AR is carrying out its restoration efforts, up to the final day when reflections were done on the visit.

Throughout this visit ILRI took the leading role in facilitating activities, explaining the technologies to the visitors and language translation, together with CIAT, IWMI and Mekelle University. The personnel behind this were Mr. Aberra Adie (ILRI), Dr. Kindu Mekonnem (ILRI), Dr. Keflie Woldearegay (Mekelle University), Dr. Lulseged Desta (CIAT), Mr. Tesfaye Yaekob (CIAT), Dr. Zenebe Adimasu (IWMI). The visiting participants from SA, EA, and WA were Mr. Mulundu Mwila (Zamba), Mr. Kennedy Nganga (Kenya), Dr. Kelifa Traore (Mali), Mr. Gift Benjamin Ndengu (Malawi), Mr. Gilbert Botha (Zambia), Dr. Job kihara (Kenya), Mr. Elirehema Y. swai (Tanzania), Mr. Edward Mzumara (Malawi), Mr. Festo Ngulu (Tanzania), Dr. Davie Kadyampakeni (Ghana) and Dr. Zemadim Birhanu (ICRISAT). Appendices 1 and 2 show the program of activities during the visit and biodata of the participants, respectively.

Africa RISING activities in Ethiopia

The first presentation highlighted AR activities and successes in the four regions of the Ethiopian highlands. General and specific approaches to interventions were described starting with characterisation (diagnosis/ system understanding) of the underlying systems fully understand it, subsequently culminating into successful implementation of different SLM technologies at plot and landscape level (both physical and biological). The presentation also showcased evidences of successes in the efforts through improvement in the water recharge systems (increase in the base water flows), minimisation of soil loss and gradual filling up of previously wide gullies.

The other two presentations emphasised more on the principal approach followed in watershed management (ranking of critical problems to determine the entry point as surety for success of the intervention) and implementation processes. As already stated in the introductory section, Ethiopian Highlands watershed management was implemented in phases. Discussions on objectives, target groups, implementation approaches and shortfalls on each phase were covered. In the presentation it was as well learnt that despite the reported successes, the main challenge is management of multidisciplinary teams and innovation platforms (IPs) as these tend to have different interests and project life spans.

Then followed an academic project (PhD), focusing on determining effects of different landuse systems (grazing land, crop land and eucalyptus woodlots/plantations) on soil loss and hydrology. The approach of this intervention involved use of treated and untreated plots replicated in the watershed. This study is undertaken in the Gudo Beret research kebele of the AR project Preliminary results have shown success of technologies in reducing soils losses which have been quantified, ground water recharge has also improved significantly as indicated by moisture content persistence in the lower part of the watershed.

Discussions based on the presentations

Q: Members wanted to know the criteria that were used in coming up with risks identification

A: Image (sources from World view) satellite picture was used, where erosion risks based on C-factor, terrain, and landscape were used. This led to the development of two simple levels; high and low risk areas. For areas that are flat, wide area planning (WAP) approach was suggested to be appropriate. In WAP the area under study is clustered based on problem type, land use, terrain etc.

Q: participating members from other countries wanted to know the secret of success in the NRM activities.

A: The central factors in the northern Ethiopia (Tigray) were said to be hard experience and the common understanding on the issues of drought, land and water problems coupled with the following factors:

1. The measurement of success of the local leaders based on development achieved;
2. Advocacy through televisions indicating the need for land restoration as a pathway to increase productivity, as well as those showing success stories in land and water resources management works elsewhere in Ethiopia;
3. High political will on issues of land and water shown by the government; and

4. Obligatory but mutually accepted community work by citizens based on the number of days one has to contribute towards and development based on the need of that particular society.

Q: One member asked how the running costs of such a complex nature of work on the watersheds would be sustained after the project comes to an end, and how the innovation platforms (IP) are involved in this.

A: In answering this it was stated that the approach has taken a more sustainable approach, where different players are involved even from the grassroots levels. These come along with different interests and multidimensional approaches to problems. This kind of institutional diversity ensures continued involvement over longer period of time as they have different working periods in the area. The involvement of the local people through committees also ensures continuity as in the process they gain knowledge through experience and trainings which would be vital for them to stand alone once the project comes to an end. IP identification and documentation was said to in progress determining the appropriate ones based on the administrative structure (important for out-scaling and up-scaling) and nature of activity. Soil amendments issues (inorganic and organic) were to be taken into consideration during the work to improve fertility of the areas, where use of organic amendments is highly encouraged.

Africa RISING Intervention sites

Geda watershed in Basona district, Amhara region

The first site to be visited was Gudo Beret in north of Addis Ababa, in the Basona district of the Amhara region. Africa RISING is involved in a multidisciplinary on-farm research in the district. The site is within the Geda watershed, which has 41 micro-watesheds, and lies between 2865 and 3106 m above sea level. The annual rainfall ranges between 950 – 1100m. The main constraint of rainfall in this part of Ethiopia is its distribution. Restoration activities in this area are part of the government initiative on land and water management as well as initiatives in nongovernmental organisations. Serious work in the watershed started in 2013, where in the initial stages the main focus of soil water conservation (SWC) was on physical technologies. Later biological intervention measures were involved as well. Greater proportion of the work is done by the community (80%), with a small part by the government (20%) in form of technical backstopping.

The main objectives of the project work are research, development (improvement in the status of land and water resources), and capacity building for upscaling and sustainability once the project come to an end. A total of 1164 households are involved in the work in the land covering of about 1056 ha. To facilitate efficiency of the work in the watershed eighty farmers have been trained. In the upper land scape, physical Soil water conservation (SWC) technologies used include terracing, contour bunds, check-dams, percolation pits (staggered and unstaggred), water retarding basins (control basins), while biological ones include planting grass, and nitrogen fixing trees (tree Lucerne). Construction of the staggered percolation pits costs 80 man-days to complete. This is equivalent to 1520 Birr (US$76). Evidences of the impact of such intervention on improved ground water recharge and reduction in soil losses have been seen in form of improved base flow down streams, prolonged retention of soil moisture, reduction in soil loss and filling up of some gullies (**See Appendix 3)**. Some irrigation has sprouted where they were not there originally.

Management of the watershed is done in rotation between villages. Villages work together in collaboration. Much as there are great sign of success, the work has its own challenges inform of free grazing, as such biological intervention are threatened by livestock. The communities have however put in place by laws governing the control of livestock as to where to graze their animals and not, but also harmonise access of resources. Advocacy is emphasised to raise awareness in the farmers of the area about the importance of pursuing the restoration work and its shared benefits. Penalties have been put in place for those who fail to abide by the by-laws and agreements. This is said to be around 50 Birr (US$ 2.5), but figure varies from place to place. However, with time farmers gradually showing an understanding of negative impacts of free grazing, and this gives the hope of success in restoration process.

Lower landscape SWC technologies include use of water obstructions structures in form of sand bags, or constructed from tree logs (due scarcity of rocks) (**see Appendix 4**), redirection of gully erosion flows, all these aimed at reducing the velocity of the running water to minimise erosion and facilitate deposition of sediments on the gully bed. Gully banks have also been worked on. Results have indicated signs of gully filling and reduction in gully bank failures from bank erosion. Biological conservation measures are also being planned to compliment physical conservation efforts.

A group of the youth have organised themselves and came up with a plan to restore the originally rejected land by planting tree lucerne and eucalyptus. They have set aside this land for honey keeping. They are also planning to sell the seed and leaves of tree lucerne for propagation and fodder respectively. Tree lucerne will also be used as manure for soil improvement purposes. The seed of tree lucerne is a big business in Ethiopia, it goes at 260 Birr per kg (US$ 13).

In this watershade there is also some research work done by a PhD student studying effects of different landuse systems/technologies on soil loss (run-off trials) at plot and landscape level (**see Appendix 5**). The study aimed at comparing soil loss in treated and untreated landuse systems. Landuse systems/technologies are nested with each other over the landscape and replicated side by side to ensure similarity in slope and other soil factors affecting soil loss. The data collected in this study might also be used in modelling studies. Overtime the study will be linked with productivity functions to see impacts. The tested technologies in the watershed include terracing, trenching, terraces+ soil bunds + grass, and percolation pits. Terracing and trenching is spaced based on the vertical and horizontal distance, such that the distance from one terrace to the next is determined by finding a point along the slope where the upper reference point forms a vertical distance of 1 m from the ground, when measured from the initial lower point. This implies that the steeper the slopes the closer will be the trenches and terraces. Interestingly, one technician remarked by saying that they hardly face any challenges in designing the layout and estimating distance between terraces. Percolation pits are placed on the lower part of the watershed, at the centre they have a narrow pit in them to facilitate percolation of water. They also save the purpose of storing water as well (**See Appendix 6**).

Different grasses were tested, some failed to successfully establish themselves (Rhodes and Vertiver) but phalaris succeeded. In this technology, the planting of the grass is /was aimed at arresting soil loss on the bands. However, it has also proved to be a significant source of income for the farmer owning the field. Cuttings of the grass have been sold to other farmers as seed, earning him an equivalent of about US$1500. Security of the intervention from livestock provided by bylaws (where grazing is not allowed, but cut and feed) and the income earned have motivated the farmer, such that he intends to extend the planting of grass to include the current uncultivated areas as well, to facilitate land restoration and maximise profits. It is worth noting that all rehabilitated land is privately owned hence all development activities on this land belongs to the owner of the land. The plan is that on the constructed land and water conservation structures, highland fruits like apples, grasses, and multipurpose trees will be planted and managed by the farmers.

On technologies to be implemented in a plot/landscape, it was stated that the selection is based on their suitability to the environment. For instance, Tree lucerne (Chamaecytisus proliferus/ palmensis) and Phalaris species of grass are appropriate for biological techniques for restoration of the agro-ecology. After noting the importance of bio-ecological restoration, both Africa RISING and extension office are working on seedling production to embark on an extensive biological restoration work the coming rainy season.

The final stages of the visit to the Geda watershed intervention sites were characterised by questions, answers and comments and these were as follows:

- Member of the visiting team asked if complementarity existed between the different intervention efforts in the site. It was stated that complementarity exists between the different interventions efforts through fattening livestock from fodder generated, use of branches and leaves of lucerne for soil fertility improvement and others.
- The issue of eucalyptus being very good at drawing out water from the ground and whether this would negatively affect the efforts of improving the hydrology of the watershade as it is widely planted in the area. This was found to be a tricky issue as no other option has been identified at the moment. The tree is a proxy of wealth amongst the locals. The issue of its efficiency in water use is granted. However, until a good alternative has been identified it would be maintained. The tree provides almost all needs related to wood use, can easily be propagated and is fast growing. Nevertheless, caution needed to be exercised, supporting the continued searching of better options amongst the indigenous or exotic tree species. It was further explained that other studies have found the tree faring better in this than envisaged. It came seventh out of the fourteen water efficient removers. Farmers are now diversifying tree species to include apples. Advice was given on the considerations on the optimum spacing, species and suitability to the objective and site to achieve absolute success.
- Visiting members appreciated the abundant initiatives taken by locals in generating ideas in pursuit of solutions to their water, soil, and land degradation problems. They however, advised the need of technocrats not to take them aboard wholesomely but make modifications based on objectives, environmental suitability, and level of complexity. This would increase the level of success in the restoration efforts.
- The organisers expressed gratitude on the water shade and SLM work done by government and other projects such as Africa RISING focusing on land restoration, but asked for more support from researchers to join in the exploring of solutions to the problems in the area. He emphasised the need of providing support to activities of extension workers through research, and Africa RISING to play the role of capacity building, bringing all local stakeholders together through innovation platforms (IP). They also advised the visiting team to learn from the approaches or activities and determine the technologies or approaches which they can take and successfully implement in their respective home countries.

Visit to Africa RISING intervention sites in the SNNPR

On the third day facilitators and visiting participants went to the town of Hossana in the southern region and visited project activities in Upper Gana and Jawe Africa RISING research kebeles.

The first visit was to upper Gana where there is a stepwise intensification trial for faba beans. Five different varieties (C5-20DK, Walke, Dosh, Gebeleho and Tumsa) are understudy based on three different cropping systems (traditional system of leaving weeds between fallows, planting barley between faba-bean fallows, and sole faba bean) and two treatments (**See Appendix 7**). The experimental set up of the demonstration trials falls under randomised complete block design (RCBD). The aim of the trials is to determine the most beneficial cropping systems to the farmers of the site. Current observations on the trials show that the introduced practice of planting oats

between faba-bean fallows produces more forage within a short period than the traditional one of leaving weeds. In addition, the local practice tends to have other unpalatable elements growing together with the rightful fodder reducing the quality.

After appreciating the demonstration trials a discussion followed based on the observations, and the issues tackled were as followed:

- Participants wanted to know whether or not some data has been collected from the trials. In response to the question, it was revealed that two types of data had been collected prior to the visit (development and biomass data).
- The issue of planting sole crops to determine the land equivalent ration came up, where the response was that such data already exist and as such there was no need, the major a focus was on faba-bean production showcasing the best productive practice. The inclusion of fodder production was merely to include the local practice, and explore its effects on the bean productivity.
- When the visited farmer was asked about his observations between the practices and varieties in his demonstration trials, he said so he did not any see significant differences in the faba- bean vegetative growth, between the different varieties, but significant differences had been noted in fodder production between the newly introduced system (planted with oats between faba-bean fallows) and traditional one (leaving weeds between faba-bean fallows). In terms of faba-bean production he said it was premature to compare at the moment the trial was visited, but later when they have produced.
- Some members asked if the weed population seen in the field was the ideal one. On this it was said that as the crop was under irrigation it would be difficult to conclusively say something about the observed weed population. Observation during the rainfed crop would be compared with the current and a conclusion about the ideal weed population would be made. It was further explained that the cutting/harvesting of the fodder is done before it flowers, this reduces seed bank, resulting in less and less weeds as years go by, providing less fodder for animals. This was the reason they had to introduce the planting of oats in-between fallows/open spaces or rows of faba-beans.
- Delayed weeding was said to cause lodging of the faba-beans, but the effect was not significant.

On the same day a farmer called *Tefera* was visited in the same area of upper Gana. The farmer is engaged in three protocols:

1. Avocado farming, where forty farmers are involved;
2. tree lucerne farming along with forty farmers; and
3. forage research together with 33 other farmers.

The visited area is renowned for avocado pears growing, but for a long time they have been growing late maturing varieties. The joint government, USAID and Israel embassy horticultural nursery in Butajira town has of late introduced new fast maturing dwarf varieties, which have been grafted with the local varieties. It is believed this will improve yields of the avocado fruits in the Kebele. The advantage of the newly introduced varieties is that they start fruiting at two years as opposed to seven for the local varieties. To facilitate the out scaling process, farmers are involved in nurseries

where they are taught how to graft and propagate so that they can establish nurseries for themselves. Social-economic, tree development and biophysical data are collected at the moment aimed at determining social economic performance and adaptability.

The Kebele is not only succeeding in fruit production, but is also involved in the fattening project, where improved forages are grown under irrigation. Results have indicated that feeding animals with improved forages significantly improved weight of livestock. This has motivated farmers to diversify the activity to include dairy cattle for milk production. In response to this, the project implementers are planning to block farmers based on factors such as meat, dairy, production to provide function specific interventions. Cross residue management has also been introduced to improve quality of feed and also reduce wastage (**Appendix 8**). In doing this tailor made residue shades and troughs specially designed for this purpose has been introduced. In addition, different types of crop/plant residues (tree lucerne) are mixed together to improve nutrient quality and given to livestock as feed. These high values fed have significantly reduced feed intake by livestock, while at the same time providing all the needed nutrient needs. In line with this objective, tree lucerne has been introduced to farmers with fourfold uses: livestock feed, hedge, and firewood.

After this, the group visited site where CIAT has installed a weather station for the area, fully automated with a data logger aimed at generating weather data (**Appendix 9**). Almost All basic data essential for modelling purposes are generated, which include rainfall, humidity, wind speed, wind direction, temperature, and solar radiation. Much as this data is owned by CIAT, it can be shared to other users on request. At this weather station some participating members sentiments on the closeness of the device is to obstructions, but in response it was stated that the location was based on providing optimum safety to the device, while at the same time maintaining integrity of the data collected, so far there is no evidence that the data collected is compromised by issues raised.

Then followed a visit to the farmer involved in Irish potato farming and storage technology research (**Appendix 10**). Africa RISING and CIP are working on maximising production and storage (shelf-life) of Irish potatoes in the area. In pursuit of this goal they have introduced different high yielding varieties in the area, through demonstration plots, and farmers had to select the varieties they preferred through participatory variety section (PVS). The visited farmer expressed her satisfaction on the productivity of the introduced varieties. She said the new variety has earned her 23,000 ETB (USD 1150) from sales of potato seed/tubers. Not surprisingly, she described the crop as the most profitable such that she has already planted some at a bigger scale to increase the income. When asked about whether or not she rotates her crops, she said she rotates potatoes with wheat but could not explain why she does so. Interestingly, disease infestation has not been a major concern, as the crop has been sprayed courtesy of CIP. To ascertain the effects of diseases on yield as a function of chemical spraying frequency, a study on the effects spraying frequency to control diseases is done in the area, where fields receive different spraying treatments (once, twice, three times, four times).

On the issue of potato storage, participants were privileged to visit an Irish potato storage system made form locally available resources owned by one of the farmers. The storage system works under the principle of diffusing light to inhibit the efficiency of budding, hence called the diffuse light store. The store is constructed in such a way that no incident light enters but, only that which is diffused. It has the ability to store potatoes over a period of 6 months. This was seen as great innovation as, it

would spread income generation over a longer period, unlike using local methods where the produce is quickly sold at low price, since it highly perishable and difficult to keep for long.

Visit to Africa RISING landscape/watershed interventions in SNNPR

On this day the team visited the Jawe Kebele, some few km west of Hossana. Here the farmer called Ababa Jara is involved in land reclamation work after visiting the Tigray region, where such activities have been a success. A previously degraded land has been successfully reclaimed, such that grass is growing and soil moisture is retained over longer periods than before. As years go by grass yield has also been increasing too. It is now three years since this work started. Africa RISING and ELAV have now joined hands with the locals extending the reclamation activity in the area. An area of land equivalent to 339 ha has been worked on, and 12 km of trenches dug for reclamation purposes. All this work has been done in the space of 12 days only, involving 400 farmers who fall under several developmental groups. The ultimate goal of the people in the area is to improve the agro-ecology and ground water recharge which would consequently improve the availability of water in their streams and increase productivity. So far 342 ha of land have been reclaimed from these activities. Technologies used include trenching (**Appendix 11**). Results show that restoration work has increased yield of teff to 3tons/ha from less than a 1 ton. At the moment Africa RISING is intending to work on the watershed to quantify the hydrological, soil, and yield increase as aftereffects of the interventions over time. It was also commented by one of the visiting participants that the project should also consider studying the effects of the intervention on biodiversity (soil and terrestrial).

After the visit to the project on land restoration the group also visited a protected well sank and constructed by a farmer called Beketech (**Appendix 12**). She took the initiative to embark of this work after being motivated by her experiences she saw in Tigray when they had a learning visit. 2000 Birr (US$100) were spent on sinking and construction of the well. Her intentions are to diversify the use of water to include irrigation. To ensure that the water levels are always good, she plans to dig an infiltration pond to aid in recharging the well. In addition to this, she is also involved in fruit farming where so far she has received six avocado tree seedlings, and intends to get additional ones to expand her fruit farming work. The interest of farmers in fruit trees has lead Africa RISING to plan a registration campaign of farmers who intend to buy tree seedlings, and also conduct trainings on grafting and other propagation methods. These will act as trainer of trainers.

Observations, lessons and suggestions

At the very end of the visit there was a feedback session where participants discussed observations, lessons, and suggestions for future improvements. This took place in Hawassa and the following were the contributions.

Observations

- Water management is a key element in reclamation of degraded lands
- Community driven initiatives such as done for water management in Ethiopia have great chances of success
- Whole landscapes can be changed to completely reduce on field surface flows and regulate stream flows
- Identification of constraints and appropriate solutions with involvement of all stakeholders.
- Innovative farmers are also researchers-example: the farmer in Upper Gana who is irrigating avocado using buckets.
- Farmers are innovative, courageous and skilled in organizing communities around SWC and planning activities on the ground.
- Gully healing techniques introduced in Ethiopian highlands is a novel and indeed is an effective technique in controlling runoff and recharging underground water.
- Natural resource base can be successfully restored by introduction of improved varieties and that soil fertility management interventions requires integration of both physical and biological soil erosion control measures.
- Multi-stakeholder engagement accelerates implementation of soil and water management practices. Their effective involved in Watershed management implies that it is will go beyond project life cycle.
- There is good collaboration between farmers, CGIAR centres, extension workers, universities, and Woreda (district) agricultural officials.
- Farmers have been given the necessary skills for sustaining the project beyond the project life. Examples include propagation of Avocado, irrigated fodder and fodder storage, and implementation of soil and water conservation structures.
- Farmer-participatory problem identification and planning process facilitates active commitment of the targeted community. Thus, farmers have the enthusiasm to carry on the various initiatives.
- There is strong integration of livestock production, irrigated fodder, crop production, and watershed management across the sites e.g. Jawe and Upper Gana Kebeles.
- Government willingness and active engagement in land restoration activities (soil and water conservation) is important to achieve progress and sustainability.
- The sensitization of communities on the importance of SLM and watershed conservation is outstanding.
- The scale of soil erosion control structures that have been built in degraded areas is quite inspiring. More so when you learn that this was a community driven effort.
- The adoption of improved varieties of forages and fruit trees seems to be helping farmers with small holdings intensify production. Quite prudent in the scenario of reducing land acreage.

- Farmer -exchange visits augments uptake of innovative technologies by targeted beneficiaries. Farmers exposed to novel practices being implemented by their peers seem to get really motivated and this facilitates transfer of the knowledge.
- Lack of forestry activities, agronomic approaches (i.e. land equivalent ratio calculations) have been identified as important gaps requiring filling up.
- Lack of capacity and exposure of the development agents.

Take-away lessons

- Integrated soil fertility management needs to be fully integrated with water management as a package so that it has greater chances of success. There is an opportunity to pilot this in countries where participants came from.
- Gully healing measures need to be emulated in the respective countries where such problems re existing.
- Leaving ties after every 10 metres along terraces i.e. Absorption channel terraces is of paramount importance in enhances infiltration and in turn it is effective in controlling water movement.
- Experience gained through learning visit will help refine approaches/ methodologies for engaging farming communities effectively in respective countries
- Essence of active involvement of policy makers in planning and implementation of landscape initiatives
- Need to strengthen R4D platform
- Importance of organizing farmer exchange visits
- Need to expand capacity building to farmers -especially on land conservation protocols
- The component of irrigated fodder for fattening sheep and dairy cattle is a very important factor in improving milk production, it therefore needs to be piloted in respective countries. This has been the missing link in the integrated crop-livestock-water management.
- The strong integration of the various research protocols and institutions coming up with different packages to the invention area is an important factor to succeed.
- It is vital to involve farmers and the community in research particularly SLM, to instil the understanding of the purpose of activities and how each activity contributes to the overall goal. This component is systematically neglected and leads to low rates of technology adoption. The case in Ethiopia clearly illustrates that conservation practices can only work when you have buy-in from the community.
- The means used to collect run-off data are interesting since they differed from the set-up known by the visiting group. Such variations are refreshing as they advance science and encourage innovation. Similarly for how certain SLM practices have been implemented. These could be explored as alternative techniques.
- The training of extension officers especially those engaged in SLM work is paramount. It was evident that the Ethiopian extension agents seem well versed in the rationale behind the various soil conservation structures and how they work. This was well illustrated by the detailed way they explained the construction of various structures going as far as explaining the justification for certain measurements and dimensions. This is an important factor in facilitating adoption of technologies.

- Approaches are more important than technologies as technologies application vary from place to place and from ecology to ecology.
- Identification of real gaps and look for appropriate entry points.
- Engagement and mobilization of communities.
- Focus on development for research.
- There high level of social cohesion in pursuing a common goal in the watershed management facilitated common understanding of the problems and benefits of the interventions.

Recommendations on landscape/WS management and cross-learning

- It is important to assess effects on water management on ground water quality under varied land-use and fertility management.
- Better integration of trees in the SWC system to maximize the benefits of the restoration activities.
- Conduct workshop specifically focusing on watershed/soil/water management for enriching our knowledge.
- Strengthening capacity of key implementers through cross country learning visits.
- For sustainability of Africa RISING initiatives soil & Water management should be part and parcel of all other interventions.
- Maintain close monitoring of the field activities
- Organize field days in selected on-farm research sites.
- The farmers using wells could be supported with small pumps for ease of accessing irrigation water.
- The program of the visit should be shared on time before the visitors arrive for proper planning and scheduling.
- Ethiopia needs to increase efforts in conservation approaches side by side with watershed management. These would include promoting minimum tillage as well as maintaining surface residue on soils.
- Another point is the inclusion of more SLM work alongside existing agronomic work. This will not only fill gaps in the work being done, but the collaboration could potentially result in innovative research outcomes.
- One recommendation for future Africa RISING exchange trips is a session of technology exchange between the participating groups to learn from each other. In this respect capacity can be built as participants would exchange professional experiences.
- Some capacity building in GIS analyses and satellite image processing is required. Many researchers have heard of these tools but few are proficient in their use, a situation that can be remedied by capacity building programs targeting researchers and their partners in the countries where Africa RISING projects are running.
- The IP approach can be a foundation for sustainability

Appendix 1: Program

Duration: 19-25 April 2015

Date	Time	Activities	Responsible person/s
19-Apr-15		Arrival in Addis Ababa	
20-Apr-15	9:00 - 9:10	Introduction of participants	Simret Yasabu/ Aberra Adie (ILRI)
	9:10-9:30	Africa RISING project of the Ethiopian highlands R4D highlights	Kindu Mekonnen (ILRI)
	9:30- 10:30	Watershed management initiative in Ethiopia	Zenebe Adimassu (IWMI) and Tesfaye Tesfamichael (CIAT)
	10:30-11:00	Coffee break	Simret Yemane (ILRI)
	11:00 - 12:00	Water harvesting and climate adaptation experience in Tigray, Northern Ethiopia	Kifle Woldearegay (Mekele University)
	12:00 - 12:30	Discussion	Simret Yasabu/ Aberra Adie (ILRI)
	12:30-14:00	Lunch break	
	14:00-15:00	Processes of managing collaborative model watersheds in Africa RISING sites	Lulseged Tamene (CIAT) and Kindu Mekonnen (ILRI)
	15:00-15:30	Africa RISING projects of west Africa , and south and east Africa R4D highlights and watershed management research experiences	Group representative/s from the two IITA led projects
	15:30-16:00	Coffee break	Simret Yemane (ILRI)
	16:00-16:45	General discussion	Simret Yasabu/ Aberra Adie (ILRI)
	18:00-20:00	Reception at at ILRI campus	Simret Yemane (ILRI)
21-Apr-15	7:00	Depart to Debre Birhan	Participants
	9:00	Arrival in Debre Birhan	Participants
	9:00-9:45	Coffee break	Temesgen and Shimeles (ILRI)
	9:45-10:00	Travel to Gudo Beret (Gina Beret)	Participants
	10:00-10:10	Meet local partners and Introduction of visitors	Temesgen and Shimeles (ILRI)
	10:10-14:00	Visit model watersheds and discussion	Temesgen, Shimeles and Aberra Adie (ILRI)
	14:00-14:30	Travel back to Debre Birhan	Participants
	14:30-15:30	Lunch break	Temesgen and Shimeles (ILRI)
	15:30	Back to Addis	Participants
	17:30	Arrive in Addis	Participants
22-Apr-15	7:00	Depart to Hossana	Participants
	12:00	Arrive in Hossana	Participants
	12:00-13:30	Lunch break	Workneh and Fikadu (ILRI)
	13:30-14:00	Travel to Upper Gana Africa RISING research kebele	Workneh and Fikadu (ILRI)
	14:00-16:30	Visit some of AR research activities and discussion with Africa RISING farmers	Workneh and Fikadu (ILRI)

	16:30-17:00	Back to Hossan	Participants
23-Apr-15	8:00	Travel to Jawe AR kebele	Participants
	8:00- 8:10	Introduction of the visitors to the local partners	Workneh and Fikadu (ILRI)
	8:10-12:00	Visit the collaborative model watershed site	Workneh and Fikadu (ILRI)
	12:00-12:30	Back to Hossana	Participants
	12:30-13:30	Lunch break	Workneh and Fikadu (ILRI)
	13:30-17:00	Visit watershed sites managed by SOS Sahel	Workneh, Fikadu and Aberra (ILRI)
	17:00-17:30	Back to Hosanna	Participants
	18:30-20:00	Reception in Hossana Lema International Hotel	Workneh, Fikadu and Simret Yemane (ILRI)
24-Apr-15	7:30	Depart to Addis Ababa	Participants
	13:00	Arrival in Addis Ababa	Participants
	13:00-18:00	Free time for interaction with CG centers and shopping	Participants
25-Apr-15		Departure of visitors to their respective destinations	Participants

Appendix 2: Participants

Dr. Davie Kadyampakeni has more than 12 years' experience as an expert in agricultural water management, soil management, crop production, plant nutrition and nutrient management in irrigated and rainfed systems. He has gained the experience in projects in the United States of America (Florida State), and in developing countries (Malawi, Tanzania, Kenya, Rwanda, Ethiopia, Madagascar, Burkina Faso, Mali, Ghana, Sri Lanka and India). He has consulted widely for several organizations including ICRISAT-Nairobi, ICRISAT-Bulawayo, USAID, CIDA and several NGOs in Malawi. He has published more than 43 articles in refereed journals, book chapters and conference proceedings. He worked for the Malawi Ministry of Agriculture and Food Security from 2002 to 2006 as an Irrigation Agronomist. In 2007, he joined ICRISAT as a Scientific Officer. Thereafter, he worked for the World Bank-IFAD funded Irrigation, Rural Livelihoods and Agricultural Development Project in 2008. Around August 2008, he joined the University of Florida as a Graduate Research Assistant until 2012 when he became a postdoctoral research associate up to November 2014. Dr. Davie Kadyampakeni started work as a Researcher-Agricultural Water Management from November 2014 at the International Water Management Institute (IWMI), in Accra, Ghana, a CGIAR-supported research institute headquartered in Colombo, Sri Lanka. He leads the IWMI components on 5 projects targeting sustainable agricultural water management, soil health and sanitation, small scale irrigation, and, climate change, agriculture and food security. Contact: d.kadyampakeni@cgiar.org

Gift Benjamin Ndengu has a Master of Science in Environmental Sciences (soil, land and Water Resources Management), PG Diploma in Computer Science (Designing, implementing and managing information systems) *and* Bachelor of Education Science (Physics**,** Mathematics and chemistry) all from the University of Malawi**.** He Worked as a part-time lecturer at St Luke's College of Nursing and Midwifery as a part time lecturer (2007- 2010) teaching Applied Physics and Chemistry, as well as Biochemistry. Between 2010 and 2012, he worked as a NIR- Technician in the AfSIS project for the southern African node. He was also involved in the study of Shire river catchment area to determine hot spots of land degradation leading to high levels of siltation at the intake of the hydroelectric power stations along the Shire River (2011). In 2013 he undertook a soil sampling survey and trained government employees and members of staff of Kwame Nkrumah University for Science and Technology (KNUST) in Ghana new AfSIS soils sampling and processing Protocols (2013). He is currently involved in Africa RISING project where participatory demonstration trials showcasing maize-bean integration, under different management and staking options has been set.His future research interest is in carbon sequestration potentials of soils, with special attention to effects of variations land uses and soil mineralogy. He also harbours interest in facilitating fighting soil loss and land degradation to reduce siltation of Shire River through a thorough study of the driving forces in its catchment areas (Biophysical and social-economic factors). g.ndengu@cgiar.org

Job Kihara is a soil fertility scientist at International Center for Tropical Agriculture (CIAT) with a lot of research experience in SSA. With a PhD in Agriculture from the Center for Development Research (ZEF), University of Bonn, Germany, Job is conducting research on the diagnosis of nutrient constraints to crop production including establishing a direct link between soil spectra and crop response, and is also involved in AgMIPs sub-Saharan activities. In AfricaRISING, Job has been involved in biophysical characterization and crop management efficiency aspects in Tanzania, and only recently co-opted into AfricaRISING Ethiopia. Job has published several papers in refereed journals and edited and co-edited several books on soil fertility management. Contact: j.kihara@cgiar.org

Kennedy Nganga is a GIS and Remote Sensing Analyst working with the Soils and DAPA teams in CIAT Africa. His main responsibility is the analyses of geospatial and other datasets to support various research projects. He works at the intersection of the natural environment and agricultural systems; finding ways to intensify productivity while also conserving the environment. In particular, He has a focus around ecosystem services valuation and sustainability. His work in this field through CIAT helped support the establishment of Africa's first water fund in Nairobi. He also has an interest in climate change, landscape ecology, and development of computer tools for assessing the environment. Contact: k.w.nganga@cgiar.org

Dr. Kifle Woldearegay Woldemariam is an academic staff at Mekelle University, Ethiopia. He has over 23 years work experience (teaching, research and consultancy) in the areas of water harvesting and site investigations for different projects. Kifle has a PhD in Engineering Geology from Graz University of Technology (Austria), an MSc in Engineering Geology from ITC (The Netherlands). He has been teaching several courses (undergraduate and postgraduate), involved in different research projects, and assumed different administrative positions (at Mekelle and Axum Universities). Dr. Kifle has been involved in several projects, among which are: (a) the study, design and construction of different water harvesting schemes (such as dams, diversion weirs and others) in Ethiopia, (b) assessing the hydrological effects of natural resources management in northern Ethiopia, (c) evaluation of the sustainability of small-scale irrigation schemes in Tigray, (d) Issues related to groundwater irrigation in Tigray, northern Ethiopia, and (e) water harvesting from roads.Currently, Dr. Kifle is leading (at national level) the following research projects: (1) Water Harvesting for Rainfed Africa: Investing in dryland agriculture for growth and resilience" (WAHARA) (EU funded: FP7-AFRICA-2010-1); (2) Optimizing road development for Groundwater Recharge and Retention (NERC, UK funded); (3) Watershed management and groundwater recharge in the Tekeze basin, Ethiopia (IGAD funded); (4) Sustainable water productivity enhancement for improved food and nutrition security in Eastern and central Africa (ASARECA funded); and (5) Ethiopia: Feeder road development for inclusive productive employment (NWO/WOTRO funded). Dr. Kifle is also a member of the Africa RISING project of the Ethiopian highlands. Contact: kiflewold@gmail.com

Festo S.Ngulu is an agricultural scientist, currently working with IITA Tanzania, as a Consultant-Agronomist attached to Africa RISING–ESA project, in Babati district, Northern Tanzania. He has MSc. in Plant Pathology, Advanced Diploma in Seed Pathology and BSc. in Agriculture. Prior to the current post, Ngulu worked for two years in the extension services and thereafter 33 years as plant pathologist mainly on cotton, coffee and common beans, under the Ministry of Agriculture. He joined Africa RISING–ESA project in 2013. His main task is to facilitate timely conduct of the various operations; essentially linking the researchers (who live outside Babati) with strategic stakeholders on the ground. It also entails advisory and timely communication of relevant information to the A-R Project Management, Researchers and other stakeholders regarding performance of the research themes. Contact: ngulufsale@gmail.com

Mr. Tesfaye Yaekob is a PhD student (CIAT) and his study topics mainly focused on Land Degradation Assessment and Eco-Hydro-sedimentation Modeling under Change Climate, Land use and Management. He received M.Sc. (2005) from the Wageningen University and Research, The Netherland in International Land and Water Management (with a specialization of Erosion, Soil and Water Conservation) and B.Sc. (2000) from the Mekelle University, Ethiopia in Soil and Water Conservation. His professional carrier started in Ethiopian Institute of Agricultural Research based at Jimma Research Center where he served more than 10 years starting from junior researcher up to associate researcher. His research activities focus on land degradation, soil and water conservation, erosion and sedimentation modeling, water pollution (coffee effluent) and watershed management. He has also consulted different organization on degraded land rehabilitation and pollution management related fields. Just before joining Addis Ababa University for his PhD study, Mr. Tesfaye has served as national case-team/program coordinator of integrated watershed management research, in Ethiopian Institute of Agricultural Research.
Contact: tesfayeyt@yahoo.com

Edward L.Mzumara is currently pursuing a Masters of Science in Agronomy at the Lilongwe University of Agriculture and Natural Resources, courtesy of a scholarship by the Africa RISING Malawi Programme. He has actively participated in the implementation of legume/cereal intensification trials in Malawi coordinated by Africa RISING. He also holds a position of a Crop Development Officer in the Ministry of Agriculture, Irrigation and Water Development of the Malawi Government since July, 2009. The major role in the Ministry is developing strategies for the implementation of crop production development programmes. Contact: edolmzumara@yahoo.com

Zenebe Adimassu is a Postdoctoral Researcher in Water and Landscapes at the International Water Management Institute (IWMI)**.** Prior to joining IWMI, Zenebe had been working at the Ethiopian Institute of Agricultural Research as Researcher (EIAR). Zenebe obtained a PhD in Land Management from Wageningen University and Research Centre (WUR). He obtained MSc degree in International Land and Water Management from the same university. He has also a BSc degree in Soil and Water Conservation from Mekelle University. He has more than 10 years of research experiences related to natural resources management such as soil and water conservation, water balance studies, watershed management, water harvesting, water balance studies, and conservation agriculture. He had a privilege to coordinate the National Watershed Management Research Programme at EIAR and African Highlands Initiative (AHI) programme. While coordinating these programmes, Zenebe led an interdisciplinary team in the development and implementation of participatory action and empirical research projects to improve livelihoods through the intensification of under-utilized and degraded areas in Ethiopia. Currently, Zenebe is conducting his postdoctoral research related to watershed management interventions in Ethiopia. Moreover, has been supervising several MSc and PhD students at different Universities in Ethiopia and overseas. Contact: Z.adimassu@cgiar.org

Dr. Kindu Mekonnen is a Crop-Livestock Systems Scientist working at ILRI. He has more than 20 years research experience in the National and International Research systems. Kindu has PhD degree in Natural Resources Management (NRM), MPill in forestry/agroforestry and BSc in plant sciences. Kindu's research experiences has been focused on integration of niche compatible high value trees and shrubs into different farming systems, landscapes and watersheds; nutrient cycling by trees and shrubs; organic resources characterization and utilization to manage soil fertility; screening of high value tree and shrub species for various products and services; soil and water conservation; water harvesting techniques; land-care and climate change adaptation interventions. In the last five years, he has been working at ILRI and involved in System wide Livestock Program (SLP), Dairy intensification, Nile Basin Development Challenge (NBDC), ILRI-UNEP-Wollo University watershed based climate change adaption, and Africa RISING projects. He has also consulted various individuals and organizations on R&D projects, supervised and examined MSC and PhD students of the different African and European Universities, coordinated national and regional research projects. Currently, he is spending most of his time on research and coordination in Africa RISING project of the Ethiopian highlands. Contact: k.mekonnen@cgiar.org

Kalifa TRAORE is a researcher in the Soil-Water-Plant laboratory. He holds a Doctorate degree in Soil Sciences from the University of Montpellier II, ENSAM, France. He started his research works since 1989 in the joint Project International Crops Research Institute for the Semi-Arid Tropics (ICRISAT) /CIRAD (Center of International Co-operation in Agronomic research for the Development) as research assistant. He continues with the same works in the Soil-Water-Plant laboratory of IER (Institute of Rural Economy) from 1996 to now. He has in charge research questions related to on farm runoff and erosion control strategies or technics development and soil fertility management to sustain cereals crops production. These tasks included chemicals fertilizers types identification, adequate fertilizer rate determination, and various combinations with organic manure (compost production) to control soil acidity and soil aggregate stability, identification of adequate period of application (synchronization of plants needs and nutrients availability). Other activities concerned studies of fast growing exotic trees species according to soil type and agriculture conditions (irrigation or rain feed plants) and greenhouse gases measurement for carbon credit as far as the climate change adaptive technologies development and implementation. Contact: ibosimon_1@yahoo.fr

Mr. Gilbert P. Botha is the Natural Resources Field Coordinator of Total LandCare Zambia. Total LandCare Zambia is implementing a reforestation and community support program. He holds a Diploma in Forestry and Certificate in Governance for forests, nature and people. Mr. Botha has 8 years of experience working with rural communities in Zambia. This gives him a privilege in handling issues that affect natural resource management in rural communities. His strong capability is assessing and analyzing issues/problems and resolving conflicts arising from natural resource management. Mr. Botha's experience has been focused on the following areas; tree planting, natural resources management, agro forestry interventions, community empowerment, training of (trainers, extension agents and farmers in agro forestry, conservation agriculture and Bee- keeping). Gilbert has also worked for Wild life Conservation Society (WCS) and Community Markets for Conservation (COMACO). He is also working with SIMLEZA- Africa rising project being implemented by IITA and CIMMYT in Collaboration with partners (Total LandCare (TLC) and Zambia Agriculture Research Institute (ZARI). Contact: gilbertbotha@gmail.com

Mr. Aberra Adie ILRI's research assistant with over 20 years of experience in livestock feed research (especially cultivated forages including multi-purpose trees, shrubs and herbaceous forages). Aberra worked for ILRI as a field supervisor for livestock and crop research on over 180 hectares of land and over 400 heads of large and small ruminants at Debre Zeit Research Station. He was also involved in the research projects involving food-feed crops (dual-purpose crops) in partnership with a variety of stakeholders both from the international and national research centers. His recent project engagements include: Fodder Adoption Project (FAP), Nile Basin Development Challenge (NBDC), Research in Sustainable Intensification for Next Generation (Africa RISING) and Innovation Laboratory on Small Scale Innovation (ILSSI). Aberra has a university diploma in Animal production technology from Addis Ababa University and a BA degree in Business Management. He is currently finalizing his master's degree on marketing management in Addis Ababa University. Contact: a.adie@cgiar.org

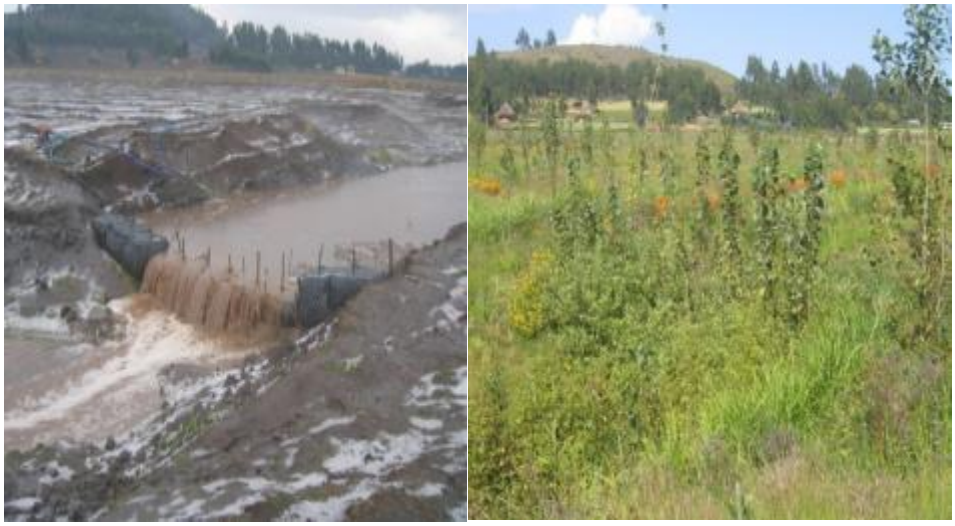
Lulseged Tamene Desta is a Research Fellow at the International Centre for Tropical Agriculture (CIAT). Lulseged holds PhD in 'Ecology and Resources Management', specifically on 'modeling sediment source areas and management options'. He has accumulated research and teaching experiences on land degradation and restoration, watershed management, and designing landscape planning and management tools. Dr. Lulseged is specifically interested in landscape restoration and ecological intensification, understanding spatial processes, their dynamics, interactions and feedbacks as well as socio-ecological modelling to understand best-fit options that can promote agricultural system transition to eco-efficient state. Dr. Lulseged has over ten years of working experiences in Ethiopia, Ghana, Burkina Faso, Germany and Malawi. Contact: lt.desta@cgiar.org

Mwila Mulundu is a Bachelors degree (BSc.) holder in Forestry from the Copperbelt University, Zambia. He is currently enrolled for the Master of Science (MSc.) Degree in Agronomy with the University of Zambia. He hopes that the MSc. Studies may be concluded by the close of the year 2015, having successfully defended his dissertation and incorporated changes recommended by Examiners. He has 15 years of experience in natural resource management and agriculture with small-scale farmers in various parts of Zambia. He is currently employed in the Farming Systems and Social Sciences Division (FSSSD) of the Zambia Agricultural Research Institute (ZARI). During his working life, he has collaborated with international partners including the International Potato centre (CIP), the International centre for Maize and Wheat Improvement (CIMMYT) as well as the International Institute for Tropical Agriculture (IITA) in among other things validating and promoting Conservation Agriculture and Diversified Agriculture. He is currently implementing the SIMLEZA/ AR Project with CIMMYT and IITA in Eastern Zambia.Contact: mmulundu@yahoo.com

Birhanu Zemadim is currently coordinating Africa RISING program in Mali with a total annual budget of $US 700,000. He was a postdoctoral research fellow at the International Water Management Institute (IWMI) in Addis Ababa until August 2010. In September 2013, he took a position as Scientist, land and water management in ICRISAT, West and Central Africa, Bamako, Mali. In his current work Birhanu is working towards the management of land and water resources from farm field to watershed scale across the different agro-ecological zones in Mali. Birhanu is also a principal investigator for the Global Climate Change Project in Mali, funded by USAID. He has authored more than 20 journal articles and book chapters and participated in many international conferences and consultancy publications. Contact: Z.Birhanu@cgiar.org

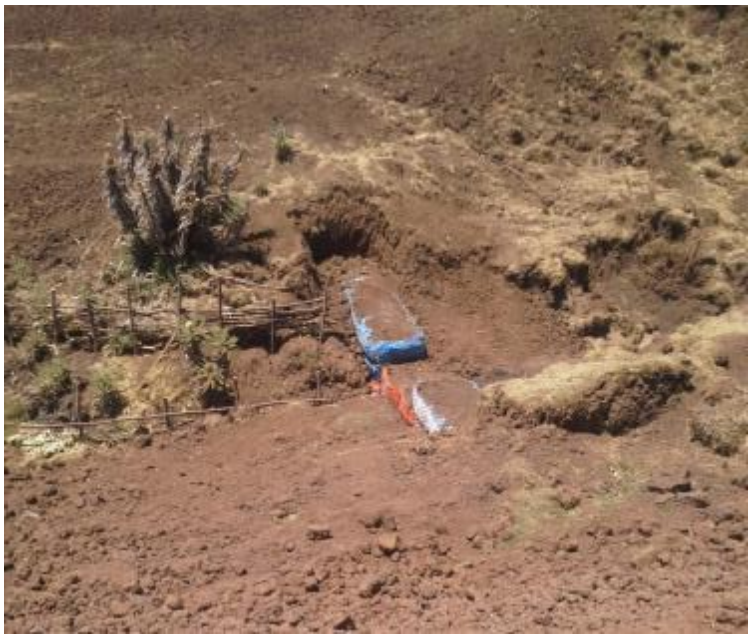
Mr Elirehema. Y. Swai holds Professional Master in Sustainable Agriculture and Natural Resource Management (GIS & Remote Sensing application) ; MSc in Soil Science and Land Management and BSc in General Agriculture. Mr Swai is currently Head of Special Program, Crop Research Central Zone of Tanzania. He is currently serving at capacity of Principal Agricultural Research Officer I with the Directorate of Research and Development of the Ministry of Agriculture, Food Security and Cooperatives. He is based at Agricultural Research Institute (ARI) Hombolo, Central Zone of Tanzania. From 1990 to date has been involved actively on field based research with wide range of experiences and skills on cropping systems; Soil and Water Management with a special attention on Insitu rainwater harvesting (IRWH) technologies; Climate change adaptation mainly focusing on Climate Smart Agriculture for semi-arid zones. From 2012 to date is participating in implementing Africa RISING Project at semi-arid zones of Kiteto District in Manyara Region and Kongwa District in Dodoma Region under Feed the Future Initiatives on project titled *"Intensification of maize-legume based systems in the semi-arid areas of Tanzania to increase farm productivity and improve farming natural resource base".* Specifically, through Africa RISING Project since 2012/2013 growing season to date has contributed on natural resource conservation research which aims at generating best bet IRWH technologies for imparting yield stability and concurrently control of soil erosion employing both physical barriers and biological control measures basically targeting at landscape level with fully engagement of farming communities to address serious land degradation in semi-arid areas of Kiteto and Kongwa Districts. Contact: eyswai@yahoo.com

Appendix 3: Evidence of restoration

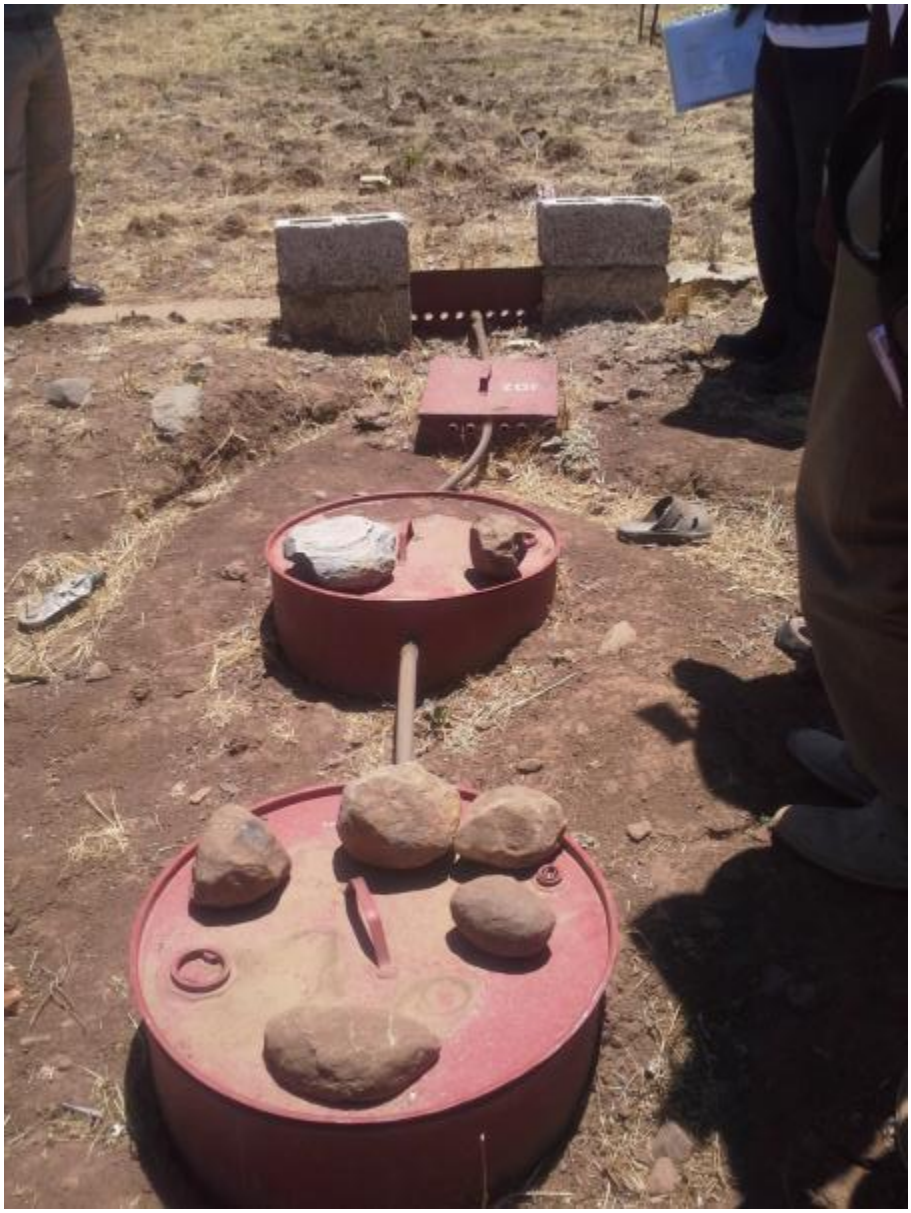


Before After

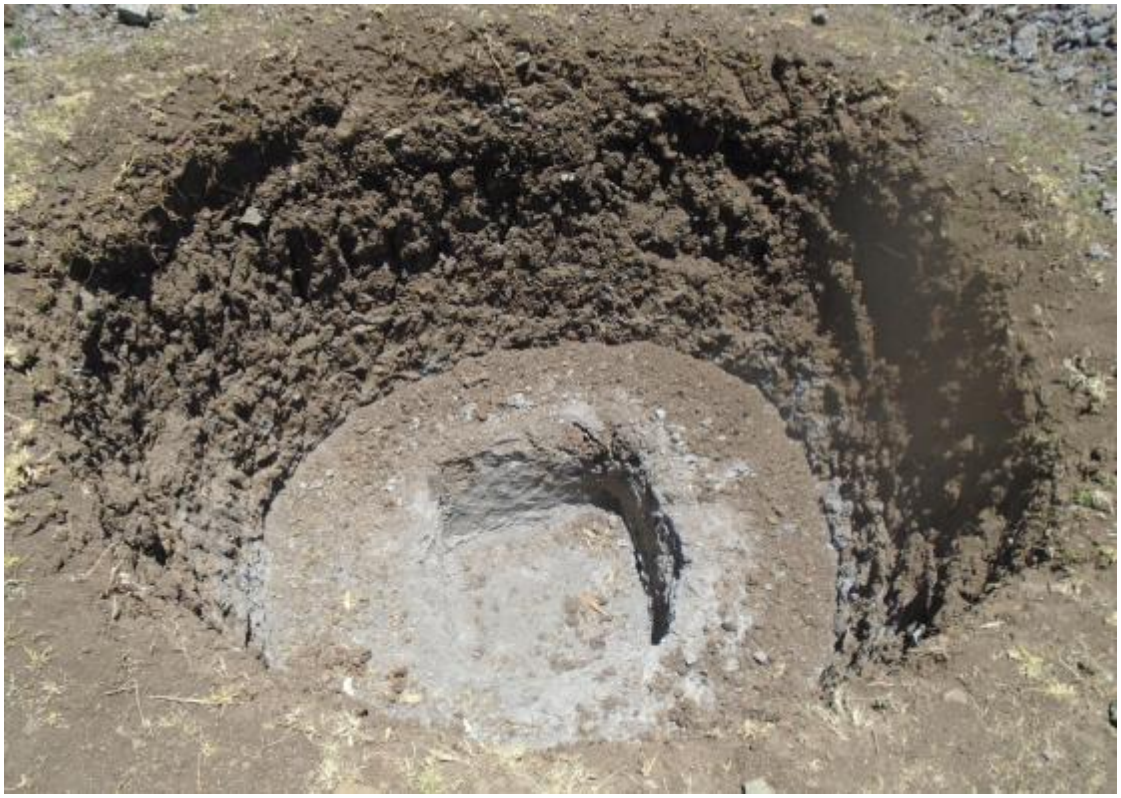
Appendix 4: Water speed reducing structures (water obstructions)



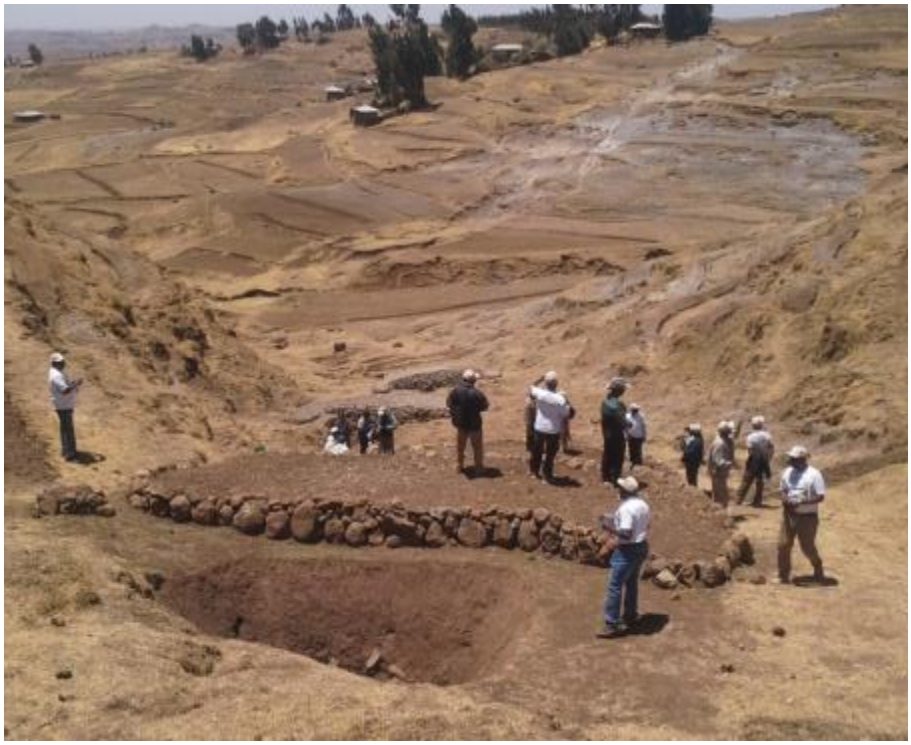
Appendix 5: Run-off and soil loss monitoring at plot level



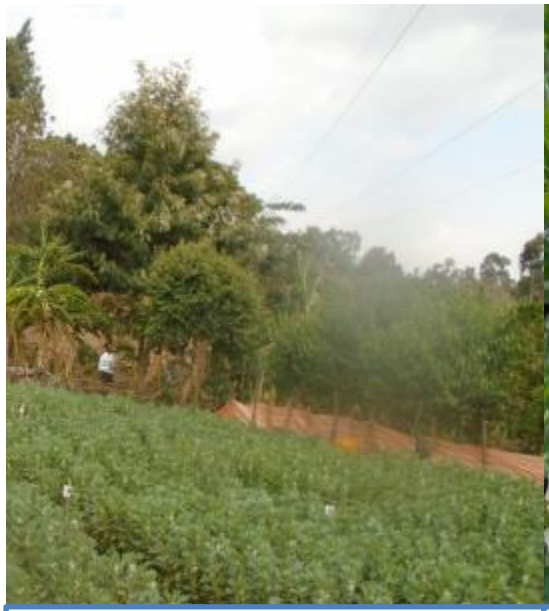
Appendix 6: Infiltration pit



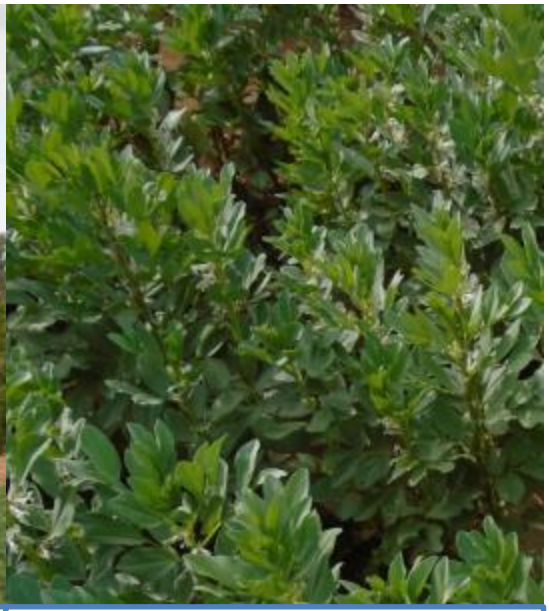
Staggered infiltration pits



Appendix 7: Faba bean trials in Upper Gana



Faba-bean plots



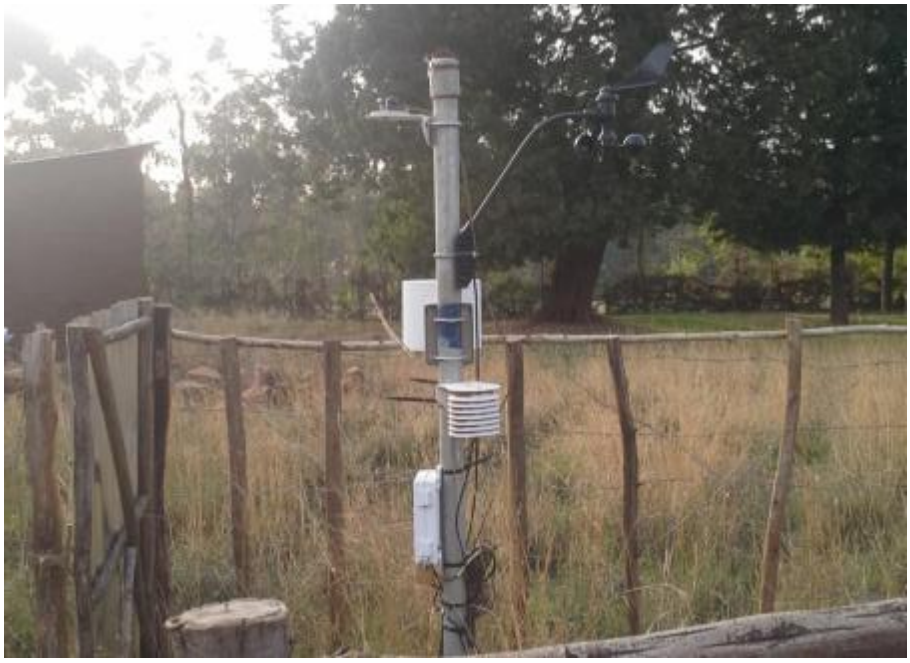
Sole Faba-bean plot

A plot of faba-beans with oats in between fallows

A plot of faba-beans with weeds growing in between fallows

Appendix 8: Fodder storage to minimise wastage

Appendix 9: Automated weather station with a data logger



Appendix 10: Diffused light store for potato

Appendix 11: Trenching

Appendix 12: A protected well in Jawe