Enhancing communities' adaptive capacity to climate change in drought-prone hotspots of the Blue Nile Basin in Ethiopia

Final Project Report

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Partial view of Kabe watershed with Yewol Mountain at the peak of the upstream (photo credit: Derbew Kefyalew, ILRI)

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Executive summary

The Nile basin region is vulnerable to climatic variability as its economies are largely based on weather-sensitive crop and livestock production systems. A pilot project on ôEnhancing communitiesô adaptive capacity to climate change in drought-prone hotspots of the Blue Nile Basin in Ethiopiaö was implemented in Woreilu Wereda, South Wollo of Ethiopia from Oct 2011 to Feb 2013. The objectives of the project were (1) to understand key socio-economic factors of dry land communities affecting adoption, collective action and effective utilization of land and water management (LWM) interventions; (2) create a knowledge base forum at local level to share best practices; (3) assemble knowledge base to integrate LWM interventions and approaches, and improve local climate adaptation capacity; and (4) generate local scientific evidence that may contribute to the regional and global policy debate on climate change issues. The pilot project had seven major activities to fulfill the project objectives. The activities included stakeholder workshops to initially introduce the project ideas and at the end of the project share key insights and to effect policy influence. Furthermore surveys were undertaken to assemble knowledge on factors influencing adoption of climate adaptation strategies. Capacity building activities were undertaken for local partners. Mapping and targeting LWM related interventions in the landscape was carried out. Action research was undertaken on climate change adaptation interventions. Finally, information materials were developed and disseminated to upscale lessons learnt from the project interventions.

The project operated in Kabe watershed (Worreilu district), which is part of the Jemma sub-basin of the Blue Nile, Amhara Region, Ethiopia. Upstream to downstream interactions at Kabe watershed are very strong. Altitude range is 2822-3837 m.a.s.l. The mean annual rainfall is 840 mm per annum. Main and short rainy seasons are the two crop growing seasons in the watershed. Climate variability in the area has pushed farmers to abandon the small rainy season for cropping. The watershed is characterized by a mixed crop-livestock system. A total of seven land use systems can be identified in the watershed. The dominant land use is agricultural land that covers 71 % of the watershed area. Major crops grown in the watershed include cereals (barley, wheat), pulses (faba bean and field pea) and horticultural crops (cabbage and potato). Small ruminants such as sheep, and cattle and equines are abundant in the watershed and also play significant economic and cultural roles for the communities. Natural vegetation is declining from time to time. The soil classes in the watershed are Glyic Cambisols, Vertic Cambsols, Eutric Regosols and Eutric Nitisols. The upstream part of the watershed is less fertile due to nutrient depletion. Generally, land degradation is apparent because of soil erosion and extractive farming system. Over all, the watershed has more than 18 watering points or stream heads that could be developed and potentially used for drinking as well as supplemental irrigation and dry season high value crops production.

The partners for the project were composed of ILRI, UNEP, Wollo University, ARARI (Sirinka Agricultural Research Centre), Woreilu Wereda Office of Agriculture, Woreilu Wereda Administration and Kabi Kebele Administration. These institutions collaborated and implemented the project interventions. The project also employed a local community facilitator to promote collective action, integrate new interventions, upgrade the existing ones and enable regular learning and sharing among farmers through cross-farm visits, community meetings, demonstration fields and collective action engagements. Surveys were conducted to characterize the watershed constraints, opportunities and communitiesô climate change adaption strategies. Watershed resources mapping and a training program on making digital stories were sub-contracted to consultants.

ILRI and Wollo University organized a launching **stakeholder workshop** in Dessie, Northern Ethiopia from 24-25 Nov 2011. A wide range of partners participated in the workshop to share their experiences and to engage in this project. Key challenges encountered by most watershed management initiatives include: negotiations and convincing farmers are time-consuming and sometimes challenging; some initiatives do not sustain after the completion of projects due to lack of ownership; poor exit strategy by donor-supported projects; duplication of initiatives and institutions; and lack of landscape scale planning - delineation commonly based on project objectives and available budgets.

The survey on **assemblage of communities' knowledge** in relation to the factors affecting adoption of climate adaptation strategies demonstrated that erratic and insufficient rainfall particularly during the short rainy season, lack of improved crop varieties, poor farming practices, land degradation and crop diseases (yellow rust on wheat, root rot on garlic) as major challenges of crop production. Poor performance of local breeds, lack of animal fodder and prevalence of animal diseases constrained livestock productivity. As a result of challenges related to biophysical and socio-economic issues, farmers are not able to produce enough to satisfy their annual food requirement. The national Safety Net Programme supported the majority of the community to complement their livelihoods.

As part of the **capacity building scheme** undertaken by the project, the project trained 160 farmers and 120 extension workers. Farmers and extension workers training focused on physical and biological soil and water conservation (SWC), crop and livestock production, water, forestry/agroforestry, livestock management, horticulture technologies and community mobilization, and supported by training manuals. The importance of needs assessment to identify training topics, the comprehensive nature of the training to address different topics, the participatory nature of the training program, and the involvement of experts from different fields for enhancing cross learning are important lessons from the capacity building schemes.

A significant number of **interventions** were considered to address the constraints related to water, crop, livestock and feed, forestry/agroforestry, home-garden development and collective action. The project team in collaboration with the communities of the watershed improved two springs, and used them as source of drinking water for more than 60 beneficiaries. Similarly, three hands dug wells, and one water harvesting dam were constructed at a household level. The water stored during the rainy season served as a source of supplementary irrigation for the home-garden grown vegetables. Utilization of clean water for drinking contributed to the communitiesôhealth and to the productivity of their farming activities.

Crop related activities focused on selection/evaluation of already released crop varieties and demonstration of varieties with recommended fertilizer rates for scaling up purposes. The wheat variety (Dinkinesh), barley variety (Estayish) and field pea variety (Adi) performed better in terms of grain and biomass yield as well as preference by the local farmers. Grain and straw/biomass yield of the improved barely and field pea varieties was 3 and 3.8 t ha^{-1} and 2.8 and 1.3 t ha^{-1} over the grain and biomass yield of the respective local varieties. About 80 farmers participated in crop varietal evaluation and scaling up activities. It was expected that farmers can easily get these improved seeds of the varieties either through exchange in kind or in cash for wider utilization.

The project introduced 13 improved Awassi breed rams to 13 groups of farmers in cluster/village based approach within the watershed to improve the potential productivity of local sheep breed. So far, local ewes mated with the improved rams have produced more than 80 lambs. The quality of the improved sheep in terms of selling price and increased birth weight attracted farmers as these benefits help them generate more income and enable them cope with the effect of rainfall variability. In line with the introduction of improved sheep breed, the project introduced forage plants at the watershed. The forage plants and grass species were planted on SWC structures and around the homesteads (backyards). Survival after 3 month of planting was 70% for Desho grass and less than 50 % for Phalaris, Sesbania and Tree Lucerne.

Different species of tree seedlings were raised and planted on bench terraces with integration of moisture conservation practices around Mount Yewol through the project support. The planted species include *Erica arborea*, *Arundinaria alpine, Acacia decurrens*, *Acacia saligna*, *Acacia abyssinica*, *Cuppresus lusitanica*, *Sesbania sesban* and *Chameacytisus palmensis*. Survival after 3 months of planting was more than 65% for *Erica arborea* and *Acacia saligna*. In addition to Mount Yewel, a hilly landscape was identified and used to plant *A. decurrens*, *A. saligna*, *C. lusitanica, Shinus mollie* and *C. palmensis.* Mean *s*urvival rate of seedlings 3 months after planting was above 87% with Ibro water conservation basin and 76 % with normal pit. This was achieved due to the implementation of appropriate physical SWC conservation measures, introduction of niche compatible tree species, improved tree plantation and seedling management practices and controlled free grazing systems.

The home-garden initiative has been found attractive to farmers as it helps them produce and consume vegetables and root crops, and generate income within a short period of time. Most of the participating farmers planted cabbage, swiss chard, lettuce, carrot, shallot, garlic and potato and high land fruits such as apple and plum in their respective home-gardens. However, the performance of potato and garlic was poor due to the incidence of diseases like late blight and root rot. Problems in relation to lack of application of proper cultural practice (spacing, watering, weeding and cultivation) were apparent in some of the home-garden development efforts.

The Wereilu Wereda facilitated the implementation of different physical and biological SWC practices, plantation of tree and forage seedlings on hillsides and farmlands and around the homesteads. The local communities voluntarily participated in the watershed management activities for 60 days to support the recent government NRM initiatives. Stone faced soil bunds and stone terraces covered 33.6 and 37.7% of the physical SWC measures. Survival of the indigenous plant species such as *Erica arborea, Juniperus procera and* Festuca species was promising under the extreme high altitude (upstream watershed) conditions. The physical and biological SWC measures are expected to contribute to the maintenance of soil fertility and halt soil and water erosion, and finally improve water infiltration and ground water recharging. In addition to the soil improving and protection role, the grasses and shrub species provided forage to animals.

Privately owned but collectively managed grazing lands cover 82 ha of land in the watershed. In addition to crop residues and other locally available feeds, grazing lands served the community as important sources of feed for different livestock species both during the dry and rainy seasons. Farming communities in the watershed closed grazing lands, harvested the biomass and fed to their animals. Farmers believed that the current arrangement and management of grazing lands enhanced productivity of grazing lands in terms of quantity and frequency of biomass production. The cut and carry system also improved livestock productivity as a result of controlled feeding and avoidance of long distance movement of animals.

The project used **field-day** and **digital photo stories** as important tools to advocate and up scale the lessons from the project implementation activities. Project personnel also produced and released online three digital stories focusing on grazing land management, improved crop varieties and water harvesting. A field-day was organized at Kabe watershed and involved 96 participants from various institutions. Implementers of the project demonstrated selected climate change adaption interventions to the field day participants. Identified strengths of the project included the ability of the project to enhance partnerships at local level, the integrated approach of the project and the focus of the project in alignment with the government development agenda. On the other hand, low effort to prevent disease and provide technical support on home garden crops, low effort to use local materials for gully rehabilitation and weak exit strategy to ensure sustainability were identified as limitations of the project. The participants also recommended that a sense of ownership has to be ensured for the developed springs, the Woreda has to take over the project activities to ensure their sustainability, and the project has to scale up its success stories to a wider scale.

ILRI in collaboration with UNEP, Wollo University, ARARI and Woreilu Office of Agriculture organized a two day **workshop** on ñ*Lessons and success stories from a pilot project on climate change adaptation interventions in Kabe watershed, south Wollo, Ethiopia*ò The workshop took place from 11-12 February 2013 at ILRI campus. The total number of participants was 49. Presentations, demonstration of digital stories, and group discussions on possible strategies of scale out/up of success stories/lessons and possibilities for the second phase of the project were part of the workshop sessions. Establishment of strong partnership among partners, creation of demand for research and development, production of baseline information, building of capacity of some farmers and extension workers through training and site visits, and identification and introduction of some potential technologies and practices that can enable communitiesôcapacity to adapt climate change/ variability impacts were some of the project successes. Technologies, practices and approaches accepted by the watershed communities were suggested to be scaled out and up through organizing experience sharing visits, facilitation of farmer-to-farmer experience exchange, application of participatory extension, improving access to information (credit, market, climate, inputs, best practices) and establishment of partnerships with NGO's and private organizations. A second phase of a project was proposed by the workshop participants. This phase will consider water as a central issue, and it will be livestock-led and include diversified technological options. Capacity building will be a big component of the project, and the project will include off-farm and on-farm activities to address the concerns of low income, landless and poor women households. Value chain approach will receive much attention to address gaps both at supply and demand side. The project is also assumed to have stakeholdersô forum, and strengthen partnership among government development institutions, universities and research organizations.

In conclusion, partnership among farmers and partner institutions were strengthened because of the operationalization of the project at Kabe watershed. Meetings, trainings, workshops and field evaluation forums enhanced the knowledge of farmers and other local extension workers on climate change effects and possible adaptation intervention measures. A number of climate change adaptation interventions were implemented at the watershed and sub-watershed level, and benefited the communities. Although the life span of the project was very short, the interventions on spring water development, shallow wells, drought resistant and early maturing crop varieties, improved sheep breeds and home-garden high value fruit and vegetable plants and the NRM activities are evidence of the possible avenues for communities to adapt the effects of climate change.

Some of the issues and the R&D gaps that need a follow up action at the watershed include: more area coverage and involvement of more farmers, technologies coverage beyond entry points, backyard forage development, use of locally available feed resources, R&D on income generating activities, off-farm income, capacity building on researchers, market linkage activities, detailed studies on collective actions for grazing land management, gully rehabilitation and landscape/ watershed based SWC, studies on technological options/ agronomic practices that improve the productivity of collectively managed grazing lands, the potential contribution of watering points and the positive and negative impact of Eucalyptus species for adapting effects of climate change/ variability.

A number of lessons emerged from project implementation and these are listed in the main report. In summary, the project demonstrated the possibility of achieving practical climate change adaptation measures quickly through strong engagement with existing local institutions. Practical field demonstrations were effective in stimulating local demand for innovations. When involving local institutions in a research for development project it is important to provide strong orientation on M&E protocols. The project was short and the early success stories of the project should be scaled out/up within and beyond the watershed through new initiatives.

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Abbreviations

ARARI	Amhara Region Agricultural Research Institute
CCF-E	Climate Change Forum ï Ethiopia
CIMMYT	International Maize and Wheat Improvement Center
CSD	Commission on Sustainable Development
DAP	Diammonium Phosphate
GDP	Growth Domestic Product
ICRAF	International Center for Research in Agroforestry
ILRI	International Livestock Research Institute
IWMI	International Water Management Institute
LOSOFT	Location Specific On-farm Fertilizer Trial
LWM	Land and Water Management
m.a.s.l	Meter Above Sea Level
MoA	Ministry of Agriculture
NBDC	Nile Basin Development Challenge
NGO	Non-Governmental Organization
N	Nitrogen
P	Phosphorus
R&D	Research and Development
RCD	Root Collar Diameter
SARC	Sirinka Agricultural Research Center
SWC	Soil and Water Conservation
SWM	Soil and Water Management
UNCCD	United Nations Convention to Combat Desertification
UNEP	United Nations Environmental Program
UNFCCC	United Nations Framework Convention on Climate Change
WU	Wollo University

1.0. Background

The Nile basin is one of the most poverty stricken regions of the world, where the economic performance and income per capita has been declining while population has been increasing by about 2.5% per annum (Marenya et al. 2003). The region is particularly vulnerable to climatic variability as its economies are largely based on weather-sensitive crop and livestock production systems (Stige, et al. 2006). This vulnerability has been demonstrated by the devastating effects of the various droughts in the last two decades.

Rain-fed agriculture is the backbone of the economies, whereby rainfall patterns dictate food security and annual GDP of member states (Grey and Sadoff, 2002). In Ethiopia, the national economy and the contribution of agriculture to the national economy is strongly linked to rainfall patterns (Grey and Sadoff, 2002), and this is reflected particularly in the Blue Nile Basin of Ethiopia where agriculture is practiced in sloping landscapes, land degradation is apparent and water conservation practices are rarely applied. Even in landscapes where there are ongoing land and water management (LWM) initiatives, investment is targeted mainly on crop-dominated and high rainfall areas. There is lack of due consideration of the dry-land drought-prone crop-livestock systems, which is the focus of this project. Climate change directly affects the natural resource base thereby it impacts livelihoods and ecosystem services. In general, LWM related investments in the region need to be revitalized to improve food security and minimize the effects of climate change. Climate change effects can be lessened through building local capacity, including strengthening local governance structures, and introducing cross-sectoral and integrated incentive mechanisms that would enable short term economic benefits and long term sustainable resource management.

There have been positive experiences in developing LWM strategies such as rehabilitating degraded lands and improving water budgets of landscapes in Northern Ethiopia, particularly in Tigrai region. In this region it was possible to reverse water scarcity and enhance the adaptive capacity of communities through integrated LWM of upper watersheds using collective action and area enclosures. Research work from ILRI and IWMI showed an improvement of water flows and livestock feed availability through rehabilitation of watershed within 5 years (Descheemaeker et al., 2011). However, most of these projects are either government-led, or opertionalized with top-down approaches or with strong involvement of external actors (e.g. NGOs). Experiences have shown that top-down implemented projects have mostly failed as these investments either did not integrate the views and the priorities of the local communities, did not use an integrated cross-sectoral and ecosystem services or did not bring immediate benefits / incentives to engage communities in long term investments. For instance in Ethiopia, only about 35% of the water harvesting ponds constructed through national campaign over the years of 2003 and 2004 are currently operational (Merry and Gebre Selassie, 2010). Moreover, project-based attempts to disseminate technologies in the region have failed in the absence of institutional capacity building (including farmers and local institutions). On the other hand, there are a few farmers in these watersheds, who have managed to make a fortune out these investments.

Integrated LWM embraces a whole range of practices; from *in situ* moisture conservation and water harvesting, various forms of irrigation to SWC and livestock management. The most important are those strategies that foster maximum economic use of rainwater that falls onto an agricultural field (Rockström, 2000). Improved LWM is an important adaptation strategy to help combat the negative effects of drought and seasonal rainfall variability, thereby improving food security and overall livelihoods of the people. With climate change such variability is likely to become more frequent, and hence water stress more pressing. Applying the lessons learned in integrated LWM to new initiatives to climate proof land use and agriculture in water-stressed dry environments is a promising approach for building community adaptive capacity in the face of climate change. Earlier research suggests that five fundamental barriers could be responsible for poor management of water resources in drought-prone dry-land regions of Ethiopia (Amede et al. 2011):

- Top-down and poorly implemented water management interventions. In most cases, farmers have been forced to construct trenches and develop water reservoirs regardless of their perceived priorities, market opportunities, access to resources and enterprises choices;
- Physical investment on LWM interventions (e.g. water harvesting structures, conservation trenches) was not accompanied by short-term incentives for farmers. It was commonly a policy decision without linking it to the local socio-economic contexts. Moreover, most of the water harvesting structures dried up even before the drought incidence happens partly due to technical failure (leakages and evaporation). Hence farmers rarely have incentives to invest in these facilities;
- The tendency of local knowledge is questioned in the face of more dominant external knowledge systems, undermining consensus on ŏbest practiceò and eroding traditional forms of institutions. There are different types of institutions in these dry-land drought-prone regions (e.g. traditional user groups, local chiefs and cooperatives) in some cases with conflicting interest. It is critical to identify the key institutions and their roles and strengthen their byelaws or their capacity to develop byelaws in moving from social support to collective action in resources and ecosystem services management and in responding to the increasing demand for water management;
- Dry-land farmers had limited access to knowledge, inputs and services related to improved technologies, farm inputs and extension services, which would hinder small scale farmers and other development actors to improve food security and ecosystem services at farm and landscape scales.
- Weak institutional arrangements and sectoral policies have affected cross-institutional learning, local action and policy implementation in managing natural resources at various scales.

2.0. Objectives

The pilot project is under the umbrella of UNEP Nile River Basin bigger project (Work Programme 3: Demonstration/Piloting at country level). It operates in Ethiopia and Uganda. The objectives of the pilot project in Ethiopia were:

i. To understand key socio-economic factors (barriers and opportunities) of dry land communities affecting adoption, collective action and effective utilization of LWM interventions (e.g. watershed management, water harvesting, watering points for livestock).
ii. In alignment with NBDC (Nile Basin Development Challenge), create a knowledge-based forum at local level that would enable communities, policy makers and development actors to share best practices and improve their collective action schemes and assess functional innovations for improved water management.
iii. To assemble a relevant knowledge base (including extension guides) appropriate for the local extension system to integrate LWM interventions and approaches, minimize effects of recurrent drought on crop and livestock systems and improve local climate adaptation capacity.
iv. To generate local scientific evidence that may contribute to the regional and global policy debate on climate change issues, related to United Nations Framework Convention on Climate Change (UNFCCC), United Nations Convention to Combat Desertification (UNCCD), Commission on Sustainable Development (CSD) and the Nile Basin Development Challenge (NBDC).

3.0. Activities/interventions

The activities/interventions that the partners implemented to generate evidence on promising climate change adaptation practices included:

i. Stakeholder workshops to introduce the project, receive feedback from local actors and share lessons

ii. Assembly of knowledge on perceptions, incentives, constraints and collective action schemes affecting adoption of climate adaptation strategies
iii. Training of local extension agents, communities and other development actors in the area
iv. Action research with communities on climate change adaptation interventions
v. Mapping and targeting LWM related interventions in the landscape
vi. Development and dissemination of materials to upscale lessons learnt to influence national policy
vii. Final end of project workshop, for sharing key insights, and policy influence

4.0. Methods/approaches

4.1. Project site description

The project operated in Kabe watershed (Worreilu district), which is part of the Jemma sub-basin of the Blue Nile, Amhara Region, Ethiopia, about 450 kms north of Addis Ababa, where recurrent drought has become part of the daily life of the rural community. The watershed is geographically located (39° 26' 10.713" E, 10° 53' 14.098"N and 39° 28' 8.6279" E, 10° 49' 35.788" N) (**Figure 1**). There is a large elevation gradient in the watershed encompassing plains, midland areas and mountains. Upstream to downstream interactions at Kabe watershed are very strong. The watershed lies to the south of Yewel Mountain. Streams originate from Yewel and flow to the Selgi River which joins the Betho River (tributary of Blue Nile). The altitude range is 2822-3837 m.a.s.l. The mean annual rainfall is 840 mm per annum. There are two crop growing seasons in the watershed: main and short rainy seasons. The main rainy season occurs from July to September and the short rainy season from March to April. Climate variability in the area has pushed farmers to abandon the small rainy seasons. Traditional irrigation system is practiced in the downstream part of the watershed. The watershed is characterized by a mixed crop-livestock system. Major crops grown in the watershed include cereals (barley, wheat), pulses (faba bean and field pea) and horticultural crops (cabbage and potato). Small ruminants such as sheep, and cattle and equines are abundant in the watershed and also play significant economic and cultural roles for the communities. Natural vegetation is declining from over time and Eucalyptus species are becoming dominant in the watershed. The soil in the upstream part of the watershed is the least fertile due to nutrient depletion. Generally, land degradation is apparent because of soil erosion and the extractive nature of the farming system. Kabe and the surrounding areas are places where access to markets is moderate and various NGOs are keen to work with the local communities in improving water and land management.

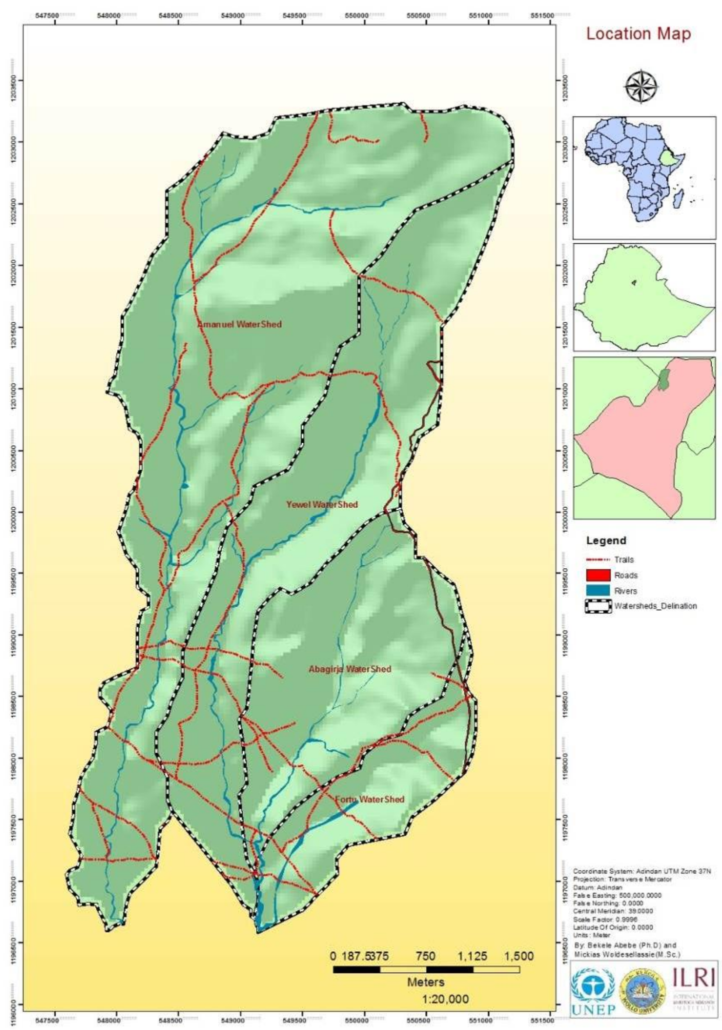

Figure 1. Map of Kabe Watershed (image credit: Bekele Abebe and Mickias W.Sellassi. Addis Ababa University)

4.2. Partnership and facilitation

The partners for the project were ILRI, Wollo University, ARARI (SARC), Woreilu Wereda Office of Agriculture, Woreilu Wereda Administration and Kabi Kebele Administration. These institutions collaborated and implemented the project interventions. UNEP was the project funding institution. The project also employed local community facilitators who understand the language and the culture of the community to promote collective action, integrate new interventions, upgrade the existing ones and to enable regular learning and sharing among farmers through cross-farm visits, community meetings, demonstration fields and collective action engagements. Training workshops and technical extension materials were made available for farmers, extension practitioners and development organizations to support the project agenda.

4.3. Identification of institutions and constraints

Various consultation meetings, workshops and surveys were held to identify the project site, partners from local, regional and national institutions, constraints/challenges and potential climate change adaption interventions, and develop project documents, and finally review progress and lessons. Kabe watershed was selected as the project site because water scarcity is apparent, climate variability is evident and upstream-downstream relationships are strong. Consultation meetings, workshops and surveys also helped to provide a base for understanding opportunities and barriers of adoption of water management, as well as indications of the type of incentive mechanisms required to facilitate collective action.

4.4. Implementation of interventions

ILRI and other project partners (Wollo University, Sirinka Agricultural Research Center, Wereilu Wereda Office of Agriculture) shared responsibilities to implement the climate change adaptation interventions. ILRI was responsible to backstop the implementation of interventions and facilitate financial allocations. Wollo University and SARC implemented demonstration and evaluation of various crop, livestock, horticultural, water and tree related interventions. They also provided training to the farmers and extension workers. Wereilu Wereda Administration and Office of Agriculture, and Kabe Kebele Administration mobilized the watershed communities on activities that required collective action (SWM, grazing land management and spring development). Watershed resources mapping was done through contracting consultants from Addis Ababa University. A similar procedure was followed to conduct a training program on making Digital Stories.

5.0. Results/outputs

5.1. Stakeholder workshop to introduce the project, receive feedback and share lessons

ILRI and Wollo University organized a launching stakeholder workshop in Dessie, Northern Ethiopia from 24-25 Nov 2011 with the objectives of introducing the project to various governmental and non-governmental institutions operating in the Amhara regional state, particularly in South Wollo zone and seek for broader collaboration among actors; share experiences and insights from various watershed management projects in the Amhara region in general and in South Wollo Zone in particular with the project members and the wider participants; seek for inputs and good practices in the planning and implementation of the project; and create a forum for broader discussion on climate change effects on livelihood and ecosystem services and discuss and discuss about possible adaptation strategies at farm, landscape and higher scales (first stakeholders workshop-http://nilebdc.wikispaces.com/nile+6).

A wide range of partners participated in the workshop to share their experiences learn about the project and their prospective roles in implementation. The partners were from Amhara National Regional State including heads of the Land Administration and Environmental Protection Bureau, Bureau of Agriculture, the Director General of the Amhara Regional

Research Institute (ARARI), President and Vice Presidents of Wollo University, South Wollo Agricultural Zonal Administration and Agriculture Bureau, Woreilu Woreda Administration and Agriculture Office, Kabe Kebele Administration and Development Agents (**Figure 2**). Generally, 49 participants attended the workshop for two days.

The partners from different institutions presented papers to share their experience on the various topics such as enabling communities to regenerate Mountain Landscapes in African Highlands; climate change adaptation in Northern Ethiopia; watershed management experience in Amhara Region; and community watershed management for improved livelihoods and systems in Wollo.

Presentation of papers and group discussion were part of the workshop session. The group discussions focused on strategies to enhance community capacity in adapting climate change, how to organize communities and create collective action to respond to climate change and what kind of local/regional level policy environment for enabling communities adaptive to climate change. **Table 1** indicates the outcomes from the three groups.

Table 1. Summarized information from the three groups.

Local/regional level policy environment for enabling communities adaptive to climate change	**How to organize communities and create collective action to respond to climate change**	**Strategies to enhance community capacity in adapting climate change**
Availability of international level-convention on combating desertification, convention on climate change	Awareness creation	Physical technologies like zai pits, percolation thanks
	Problem identification (action oriented)	In situ water harvesting technologies to restore water

and wetland management convention.	Prioritizing problems	Gully rehabilitation to change landscape
Availability of national level- Article 41 on environmental rights, Article 43 on development right, proclamation on basic forest management (proc number 49).	Cause-effect relationship	Improved crop varieties to maximize yield
	Drawing possible solutions	Soil management technologies to avoid risk
	Identifying solutions for collective action	Collective action for improved planning of watersheds management
Availability of regional level- Amhara forest management and food security strategies.	Setting rules and regulation	Increased organic matter for more C-sequestration

Participants held group work on the ILIRI-UNEP-WU project and another two projects within Amhara region to draw lessons. The discussion points were: what has been tried, failed and best practices, potential reasons and suggested solutions in Kabe, Lenche Dima and Harbu watersheds. Key challenges that encountered most watershed management initiatives include:

- Negotiations and convincing farmers could be time taking and sometimes painful
- Some initiatives died after the completions of projects; question of sustainability and ownerships were the most important concern
- Poor exit strategy by donor-supported projects
- Duplication of initiatives and institutions (e.g. local watershed development committee vs. government committee)
- The potential conflict between social planning units of the government vs. watershed planning unit

- Lack of landscape scale planning; delineation commonly based on project objectives and available budgets

5.2. Assemble knowledge on perceptions, incentives, constraints and collective action schemes affecting adoption of climate adaptation strategies

Communities in Kabe watershed live in precarious ecological conditions where recurrent drought threatens their socio-economic well-being. The objectives of this component of the project was to identify farmersô knowledge on livelihood bases/incentives, constraints and collective action schemes affecting climate change adaptation strategies; devise options and appropriate incentive mechanisms to adapt climate change and variability; and enhance local partnership and collective action measures. A total of 653 (215 female and 438 male) community representatives participated during the study. In addition, local development agents, researchers, extension experts from South Wollo zone and Woreilu Wereda facilitated the study.

Crop and livestock are important sources of livelihoods for the local communities in Kabe watershed. Land holdings are small (< 0.9 ha on average) and there is very little source of income from off-farm activities (Socioeconomics survey- http://nilebdc.wikispaces.com/nile+6). Rainfall is unreliable, erratic and insufficient particularly during the short rainy season for the last 10 years. Farmers in Kabe perceived that there is an increasing trend of temperature and a decreasing trend of rainfall over time. They also mentioned that lack of improved crop varieties, poor farming practices and crop diseases like yellow rust on wheat, root rot on garlic and water logging on faba bean as major challenges of crop production (assemble knowledge: http://nilebdc.wikispaces.com/nile+6). Although livestock in Kabe watershed plays an important role in filling food gaps resulting from crop failure, the poor performance of local breeds, lack of animal fodder and prevalence of animal diseases constrains their productivity. As a result of challenges related to biophysical and socio-economic issues, farmers are not able to produce enough to satisfy their annual food requirements. The national Safety Net Programme supports majority of the community to supplement their livelihoods.

Kabe watershed has water potential of both surface and ground water sources as the area previously called *Legegpra* in Oromifa, means ‶water tower‷. However, according to the farmersô views, availability and amount of water has decreased over time due to the occurrence of frequent drought and deforestation. Springs, shallow wells and rivers are the main sources of water for both irrigation and drinking purposes. Since the communities fetch water from unprotected water sources together with animals water borne diseases are very common in the area. The watershed communities practice traditional irrigation at a small scale. Any attempt to introduce irrigation technologies and develop or upgrade irrigation canals has been very minimal. The community has limited knowledge on irrigation management.

The communities in Kabe watershed discuss in groups on matters that need collective action or common consensus and understanding. Particularly, elders and religious leaders (Sheik) are influential in conflict resolution and management. When there is conflict on the use of common resources like grazing land and irrigation water, the elders and religious leaders resolve it quickly to avoid subsequent crises. Idir (local community organization) is the main local institution that the community uses to resolve conflicts.

Kabe watershed communities have their own knowledge and practices to adapt the impacts of climate change. They also seek additional climate adaptation interventions that fit to their socio-economic and ecological circumstances. Some of suggested interventions by the watershed communities during the focus group discussions include:

- Improve availability and accessibility of improved seed

- Improve soil fertility through composting, physical, and biological SWC measures
- Introduction of home garden crops like high land fruits and vegetables
- Crop diversification and intensification
- Introduction of improved breeds of cattle, small ruminants and chicken
- Introduction of adaptable and improved forage crops
- Improve market linkages and information
- Improve and upgrade streams, springs and ground water for irrigation
- Availing inorganic fertilizer with subsidized cost or loan
- Engaging in livestock fattening and dairy production
- Improve or facilitate the capacity of existing veterinary services
- Build the capacity of the community, local actors and farmersôcooperatives

5.3. Training of local extension agents, communities and other development actors in the area

Education plays an essential role for increasing the climate change adaptive capacity of individuals, communities and nations by enabling them to make informed decisions. Adaptation to climate change requires individuals/groups to be aware of potential changes in the climate and to understand the implications of changes for their lives. The objectives of the capacity building scheme particularly the training components were to enhance the capacity of extension workers, communities; convene a watershed level community workshop on collective action and community organizations; and equip the trainees with concepts, principles and practical application of watershed management for climate change adaptation (**Figure 3**). Initially, the project team assessed training needs, and subsequently prepared materials (manuals) for the selected 160 farmers and 120 extension workers. The training for farmers and extension workers focused on physical and biological SWC, crop and livestock production, water, forestry/agroforestry, livestock management, horticulture technologies and community mobilization, and was supported by training manuals (manuals-http://nilebdc.wikispaces.com/nile+6). Among important lessons learned from the capacity building work were (1) importance of a needs assessment to identify training topics, (2) the need for comprehensive training to address different topics, (3) the importance of participatory approaches for the training program, (4) the involvement of experts from different fields enhancing cross learning, (5) the importance of organizing hard and soft copies of all training materials and (6) the role of keeping all the documents in a systematic manner for future reference.

5.4. Action research with communities on climate change adaptation interventions

The most important climate variability/change induced constraints identified in the watershed include: soil erosion, animal feed shortage, poor productivity of crops and small ruminants and poor water quality and quantity (Socioeconomics survey- http://nilebdc.wikispaces.com/nile+6). The project partners also identified weak collective actions, lack of income sources and poor access to technologies to adapt climate change as most important constraints. The interventions considered to address the constraints are now considered.

5.4.1. Water related interventions

The project team in collaboration with the communities at the watershed improved two springs, and used them as sources of drinking water for more than 60 beneficiaries. Similarly, three hands dug wells, and one water harvesting dam were constructed at a household level (**Table 2**) and (**Figures 4 and 5**). The beneficiaries dug the water harvesting structures. The project provided technical support, cement, geo-membrane and hired a mason for the dam, and rope and washer pumps for the hand dug wells. The water stored during the rainy season served as a source of supplementary irrigation for the home-garden grown vegetables (**Figure 6**). Communities in the area used to have problems of water borne diseases before developing/improving the two springs. The watershed communities had access to pure drinking water after the project (**Figure 7**). The utilization of clean water contributed to their health and the productivity of their farming activities.

Table 2. Water related activities and benefits at Kabe watershed.

Scheme type	Water depth (m)	Water volume (l)	Discharge rate (l/min)	No of users			Possible irrigable land (ha)	Benefits
				M	F	Total		
Hand Dug Well-1	3	54.9	2.75	2		2	0.5	Not yet used for irrigation
Hand Dug Well-2	6	23.5	0.35		1	1	0.25	Grown vegetables and sold USD 122
Hand Dug Well-3	3	39.2	0.49	1		1	0.13	Not yet used for irrigation
Spring Dev -1	-	-	3.67	72	71	143	0	Clean drinking water
Spring Dev -2	-	-	0.23	1		1	0.03	Not yet
Spring Dev -3	-	-	9.63	33	37	70	0	Clean drinking water
Night storage	-	-	14.78	10	9	19	1.09	Not yet used for irrigation
Water harvesting Dam	2	64000	-	1		1	0.03	Vegetable sale

5.4.2. Crops related interventions

Crop related activities focused on selection/evaluation of already released crop varieties and demonstration of varieties with recommended fertilizer rates for scaling up purposes. The project distributed food barley (6 varieties), and wheat (8 varieties) to demonstrate and later on select the varieties that fit the ecology and interest of the communities. Additionally, high-yielding, pest-resistant and high-market value varieties of field pea (Addi) and wheat (Dinkinesh) were demonstrated to the farmers to scale up in the watershed and the surrounding areas (**Figures 8, 9, 10 and 11**). Some selected farmers in the watershed received 15-30 kg of seeds of the improved varieties. The wheat variety (Dinkinesh) was high yielding, early maturing and yellow rust resistant in other similar agro-ecologies of the north-eastern parts of the country. This variety also provided a better yield at Kabe watershed compared to other wheat varieties. Dinkinesh was equally good and better performing at the watershed compared with the majority of the improved wheat varieties.

From the barley varieties, Estayish (218963-4) performed better than existing varieties in terms of grain and biomass yield as well as preference by the local farmers. This variety had a grain and biomass yield gain of 3 and 3.8 t ha^{-1} over the grain and biomass yield of the local barley variety (**Table 3**). Generally, the local barley variety was very poor in terms of grain and biomass yield compared to the introduced barley varieties. Farmers considered yield, seed color and freedom from diseases as criteria to select the field pea varieties. Based on these criteria, farmers ranked Addi as the most preferred introduced field pea variety. Addi had a grain and biomass yield gain of 2.8 and 1.3 t ha^{-1} over the grain and biomass yield of the local field pea variety (**Table 4**). About 80 farmers participated in crop varietal evaluation and scaling up activities. It was expected that farmers can easily get these improved seeds of the varieties either through exchange in kind or in cash for wider utilization.

Table 3. Performance of improved and local varieties of wheat and barley.

Crop type	Duration from sowing to harvesting (months)	Grain yield (t/ha)	biomass yield (t/ha)	Rank according to farmers preference
Wheat improved varieties				
Bolo	4.4	1.3	2.8	5
Digalo	4.6	1.5	3.0	3
Gassy	4.5	2.0	4.5	2
kakaba (picaflor)	4.7	1.8	4.0	2
Menze	4.6	1.5	3.0	2
Sinkenga	4.7	1.5	3.8	4
Tay	4.6	1.0	2.5	1
Dinknesh (HAR3919)	4.3	3.7	8.1	1
Wheat local variety	4.8	1.8	4.0	2

Barley improved varieties				
Agegnehu (218950-18)	4	4.3	11.3	3
Shedho (3381-01)	3.9	4.5	10.8	2
Estaysh (218963-4)	4	4.8	11.4	1
Yedogit (BI95IN198)	4.1	3.8	10	3
Trit (215235-2)	4.1	3.6	9.5	4
Bentu (EMBSN 5th 2/95-3-3-3)	4.1	2.3	7.8	6
Barley local variety	4.1	1.8	7.8	5

nd - no data; Farmers used general performance of crops (spike size, grain yield, maturity date, disease free, seed color) as criteria to select varieties

Table 4. Performance of improved and local varieties of field pea and faba bean.

Improved varieties	Duration from sowing to harvesting (months)	Grain yield (t/ha)	Straw yield (t/ha)	Rank according to farmers preference
Improved field pea varieties				
Addi	3.4	3.5	7.6	1
Tegegnech	3.5	2.8	6.2	2
Local field pea variety	3.2	1.2	5.8	
Improved faba bean varieties				
Dagim	4.6	2.5	5.2	nd
Lalo	4.5	3.2	6	nd
Local variety	4.8	0.9	5	

nd - no data; Criteria of farmers for improved field pea varieties include yield, seed color/white/, free from diseases.

Crop production at Kabe watershed and the surrounding areas required a supply of essential mineral nutrients to provide adequate grain and biomass yield. When the soil does not supply sufficient nutrients for normal plant development and optimum productivity, application of supplemental nutrient is essential. Most soils in the semi-arid areas of northeastern Ethiopia including Kabe watershed tend to exhibit low total N, available P and organic C (Asnakew, 1994; Kidane and Getachew, 1994). In a cropping system where large quantities of nutrients are exhausted by erosion and exported in harvested products, it is unlikely that sustainable high yield will be obtained without nutrient replenishment. The research findings from one season location specific on farm fertilizer trial (LOSOFT) at Kabe watershed demonstrated an increased grain yield of wheat (Dinkinesh) and barley (Agegnehu) over that of the farmers traditional practice (**Table 5**).

Table 5. Comparison of grain and biomass production from wheat (Dinkinesh) and barley (Agegnehu) with and without fertilizer applications.

Treatments	Grain Yield (t ha^{-1})	Air dried biomass weight (t ha^{-1})
Wheat		
No fertilizer application (farmers practice)	0.62	3.3
46 kg ha^{-1} P_2O_5, 46 kg ha^{-1} N	3.04	11.7
23 kg ha^{-1} P_2O_5, 46 kg ha^{-1} N	2.99	10.8
Barley		
No fertilizer application (farmers practice)	1.5	4.6
46 kg ha^{-1} P_2O_5, 69 kg ha^{-1} N	2.3	6.8
69 kg ha^{-1} P_2O_5, 46 kg ha^{-1} N	1.7	5.7

Note: Fertilizer sources for P and N are DAP and Urea.

5.4.3. Livestock and feed interventions

The project introduced 13 improved Awassi breed rams to 13 groups of farmers in a cluster/village based approach within the watershed to improve the potential productivity of local sheep breed (**Figure 12**). So far, local ewes mate with the improved rams and have produced more than 80 lambs. Comparison of the improved sheep with that of the local sheep breed in terms of birth weight, selling price at different ages and other characteristics is shown in **Table 6**. The quality of the improved sheep in terms of selling price and increased birth weight attracted farmers as these benefits help them generate more income and enable them cope with the effect of rainfall variability. Income diversification through improved animal husbandry is one of the pathways to enable vulnerable communities to adapt climate change impacts. In line with the introduction of improved sheep breed, the project introduced forage plants at the watershed (**Table 7**) and (**Figure 13**). The forage plants and grass species were planted on SWC structures and around the homesteads (backyards).

Table 6. Comparison of the improved (Awassi crossbred) and local (Wollo) sheep at Kabe

	Improved sheep (Hawassi)	Local sheep
Blood level		
ram	65	-
ewe	0 (local 100%)	-
lambs	32	-
Age at first Lambing (month)	12.8 (4.5)	14.5 (5.15)
Lambing interval (month)	7.8 (1.9)	8.4 (2.8)
Litter size	1.1 (0.2)	1.2 (0.04)
Male sexual maturity (month)	9.8 (5.0)	13.5 (5.4)
Birth weight (kg)	3.8 (0.2)	1.9 (0.4)

Selling price at the age of 3 months	21.2 (6.7)	11.5 (3.2)
Selling price at the age of 6 months	30.2 (10.7)	17.1 (5.8)
Selling price at the age of 9 months	39.8(12.6)	23.6 (8.4)
Selling price at the age of 12 months	57.2 (7.9)	29.3 (12.0)
Selling price at the age of > 12 months	60.1 (22.7)	38.1(15.4)

Note: Selling prices are in USD. The exchange rate during data collection was 1 USD= 18 Eth Birr. Figures in parentheses are standard deviations.

A total of 106,386 tree lucerne, 100,001 *Sesbania* seedlings, and 15,000 Phalaris and 354,500 D*esho* splits were planted on soil bunds of the farmlands. The area coverage for tree/shrub plantation is 190.4 ha whereas 17.5 ha for Desho grass plantation. A total of 4125 beneficiaries (2759 male and 1366 female) participated during plantation of the tree/shrub seedlings. The beneficiaries from the plantation of Phalaris were 375 male and 296 female farmers. A total of 63 households planted 2,205 tree lucerne and 2,205 *Sesbania* seedlings around the homestead/backyards. Of the 63 households, four of them were female-headed. Survival after 3 months of planting was 70% for Dinsho grass and less than 50 % for Phalaris, sesbania and tree lucerne (**Table 7**). Low survival for Phalaris, sesbania and tree lucerne could be associated with late planting.

Table 7. Mean survival and growth of fodder plants planted on soil bunds and backyards at Kabe watershed (3 months).

Species	Survival (%)		Average RCD (cm)		Average height (cm)	
	SWC structures	Backyard	SWC structures	Backyard	SWC structures	Backyard
Grasses						
Phalaris	30	-	-	-	30	-
Desho	70	-	-	-	40	-
Fodder trees						
Sesbania	50	40	?	?	35	40

Tree lucerne	30	45	?	?	25	30

RCD ï Root Collar Diameter

5.4.4. Forestry/agroforestry interventions

Plantation of tree seedlings used to be practiced in the watershed for many years. However, survival rates of tree seedlings were very low. More than 40,000 different tree seedlings were raised and planted on bench terraces with integration of moisture conservation practices around mount Yewol through the project support. The planted species include Asta (*Erica arborea)*, highland bamboo (*Arundinaria alpine, Acacia decurrens*, *Acacia saligna*, local Acacia spp (*Acacia abyssinica*), *Cuppresus lusitanica*, *Sesbania sesban*, tree lucerne (*Chameacytisus palmensis)*, guassa grass (Festuca spp) split (detached- 7000). Survival after 3 months of planting was more than 65% for *Erica arborea* and *Acacia saligna* (**Table 8**). A total of 1690 (606 female and 1084 male) farmers participated during plantation of these seedlings (free labor contribution). In addition to mount Yewel, a hilly landscape was identified and used to plant *A. decurrens*, *A. saligna*, *C. lusitanica, Shinus mollie* and *C. palmensis* (**Figure 14**). Mean survival rate of seedlings 3 months after planting was above 87% with Ibro water conservation basin and 76 % with normal pit (**Table 9**). This was achieved due to the implementation of appropriate physical SWC conservation measures (Ibro basin and normal pits), introduction of niche compatible tree species, improved tree plantation and seedling management practices and controlled free grazing systems.

Table 8. Mean survival and growth of tree species planted on normal pit moisture conservation structure at Mount Yewel (3 months).

Tree species	Number of trees planted	Survival (%)	RCD (cm)	Height (cm)
E. arborea	2000	65.2	0.4	20.5
A. alpine	1058	44.4	0.3	21.2

A. abyssinica	2800	23.6	0.5	19.2
A. decurrens	4000	34.9	0.3	17.7
A. saligna	17500	65.2	0.4	21.3
C. lusitanica	3665	34.3	0.2	17.4
C. palmensis	1000	40.6	0.3	21.9
S. sesban	1500	45.1	0.2	20.0

RCD - Root Collar Diameter

Table 9. Mean survival and growth of tree species on different moisture conservation structures.

Tree species	Survival (%)		RCD (cm)		Height (cm)	
	Ibro basin	Normal pit	Ibro basin	Normal pit	Ibro basin	Normal pit
A. saligna	100.0	81.4	0.58	0.52	32.25	32.05
A. decurrens	100.0	73.6	0.45	0.35	20.25	18.10
C. lusitanica	75.0	np	0.25	np	6.67	np
S. mollie	72.5	np	0.23	np	19.50	np
C. palmensis	90.0	np	0.27	np	29.33	np

np - not planted using normal pit; RCD - Root Collar Diameter

5.4.5. Home-garden development

The home-garden initiative was attractive to farmers as it helped them produce and consume vegetables and root crops, and generate income with short period of time. The home-garden activities need an integrated approach and market linkage.

The project team accessed Plum (one variety) and apple (six grafted varieties) seedlings from Chencha (southern parts of Ethiopia) and distributed to 18 and 50 selected beneficiary farmers, respectively. The total number of seedlings was 618 although apple seedlings took more than 97% of the share (**Table 10**).

Most of the participating farmers planted cabbage, Swiss chard, lettuce, carrot, shallot, garlic and potato and highland fruits such as apple and plum in their home-gardens (**Figure 15**). However, the status of potato and garlic was poor due to the incidence of diseases like late blight and root rot, respectively. Problems in relation to lack of application of proper cultural practices (spacing, watering, weeding and cultivation) were apparent in some of the home-garden development efforts.

Table 10. Home-garden related activities and benefits at Kabe watershed.

List of home-garden crops introduced to the watershed	Number of beneficiaries		Yield obtained (t ha^{-1})	Most important benefits of the home-garden initiative	Challenges faced to achieve the home-garden initiative
	Male	Female			
Cabbage	46	4	24.69	Cash crop (income source) and home consumption	Late blight on potato and root rot of garlic
Shallot	46	4	16.63		
Garlic	46	4	10.15		
Carrot	46	4	35.25		
Potato	46	4	22.64		
Swiss chard	46	4	15.05		
Apple	46	4	Vegetative stage		
Plum	18	0	Vegetative stage		

5.4.6. Collective action interventions

5.4.6.1. Soil and water conservation measures

Awareness creation, community consensus meetings on collective action and formation of a watershed committee were some of the initial responsibilities of Wereilu Woreda Agriculture Office. The Wereda facilitated the implementation of different physical and biological SWC practices, plantation of tree and forage seedlings on hillsides and farmlands and around the homesteads. The local communities voluntarily participated in the watershed management activities for 60 days to support the recent government NRM initiatives. Stone faced soil bunds and stone terraces covered 33.6 and 37.7% of the physical SWC measures (**Table 11**) and (**Figure 16**). Survival of the indigenous plant species such as *Erica arborea, Juniperus procera and Festuca* species was promising under the extreme high altitude (watershed upstream) conditions (**Table 12**). The physical and biological SWC measures contribute to maintain soil fertility and halt soil and water erosion, and finally improve water infiltration and ground water recharging. In addition to the soil improving and protection role, the grasses and shrub species were intended to provide forage to animals.

Table 11. SWC physical structures implemented at Kabe watershed.

Description	Unit	Plan	Achiev-ement	Participants			Contribution (Birr)
				Male	Female	Total*	
Stone terrace	ha	78.3	83.4	12178	9247	21425	214250
Cut off drain	ha	0.5	0.7	120	65	185	1850
Stone faced soil bund	ha	89.6	93.2	16150	7868	24018	240180
Hill side terrace	ha	42.5	42.5	7314	3558	10872	108720
Trench	ha	0.9	0.9	86	98	184	1840
Water percolation trench	ha	4.5	4.5	2256	1964	4220	42200

Stone check dam	ha	9.0	9.0	2149	715	2864	28640
Planting pits	ha	16.0	12.9	967	650	1617	16170
Total		241.3	247.0	41220	24165	65385	653850

* Estimated cost for free labour contribution of the watershed communities

Table 12. Biological measures and afforestation at the top of the watershed.

Type of tree seedlings	Planted (number)	Planted (ha)	Survival (number)	Survival (%)
Sesbania sesban	10001	84.01	2483	24.83
Chamaecytisus palmensis	106386	103.42	986	0.93
Acacia decurrens	38025	3.80	3145	8.27
Acacia saligna	30508	3.05	16779	55.00
Juniperus procera	3665	0.36	896	24.45
Erica arborea	600	0.06	594	99.00
Arundinaria alpine	1058	0.11	841	79.49
Guassa (grass) splits	7000	0.70	6965	99.50
Desho grass splits	354500	17.50	230425	55.00
Phalaris grass splits	14290	1.42	6488	45.40
Acacia abyssinica	2800	0.28	663	23.68
Total	573833	215.21	272910	47.56

5.4.6.2. Grazing land management

Privately owned but collectively managed grazing lands cover 82 ha of land in the watershed (**Table 13**). Collectively managed grazing lands were located in the four sub-watersheds. In addition to crop residues and other locally available feeds, grazing lands served the community as important sources of feed for different livestock species both during the dry and rainy seasons. Farming communities in the watershed closed grazing lands, harvested the biomass and fed to their animals (**Figure 17**). Farmers believed that the current arrangement and management of grazing lands enhanced productivity of grazing lands in terms of quantity and frequency of biomass production. The cut and carry system also improved livestock productivity as a result of controlled feeding and avoidance of long distance movement of animals. According to the local communitiesô perception and observation, free grazing caused considerable damage to young grasses and other plants, and aggravated the degradation of natural resources. It also caused disappearance of palatable species and the subsequent dominance by other, less palatable, herbaceous plants or bushes. Excessive livestock grazing activated soil compaction and erosion, decreased water infiltration and soil fertility, and led to a loss of organic matter content and water storage capacity. Mphinyane (2001) and Borman (2004) also reported a similar impact of free livestock grazing on different natural resources.

Table 13. Grazing land arrangement and management

Baseline information	Sub-watersheds				
	Abagirga	Yewol	Amanuael	Fortu	Total
Area collectively managed (ha)	30	21	17	14	82
Number of household members					
Male households with livestock	66	51	41	33	191
Male households without livestock	11	7	5	4	27
Female households with livestock	15	9	8	12	44
Female households without livestock	8	6	3	3	20
Estimated biomass harvested after closure (dry weight t ha^{-1})	2.83				

Facilitation made from the project	Organization of community level workshops on improved forage production and utilization, assistance in formulating community based bye laws for a cut-andï carry system, supply forage seeds, and grass splits, and encourage farmers to irrigate and increase harvesting frequency.
Challenges	Initial resistance to implement the bye law and stop free grazing due to lack of immediate feeding options, low level of understanding about the multiple advantages of zero grazing, competing use of crop residues, and limited intervention on fuel sources and energy saving practices.
Lessons	There is a need to search niche compatible and demand driven forage species that meet the need of different community groups, and identify and characterize locally available feed resources.

5.5. Mapping and targeting land and water related interventions in the landscape

Mapping resources at the watershed was carried out to support watershed management planning processes. The most important components considered for the watershed resource mapping activities were watershed/catchment delineation, land use types/land cover, hydrology/water resources, soil types, vegetation types/biomass production, human and livestock population density, agro-climatic zones/altitude, climate change (rainfall and temperature trends/projections) and future projections on water and land use (http://nilebdc.wikispaces.com/nile+6). The watershed had four sub-watersheds (Amanuel, Aba Girja, Yewel and Fortu) with various characteristics.

The soil classes in the watershed were Glyic Cambisols, Vertic Cambsols, Eutric Regosols and Eutric Nitisols although they originated more or less from the same parent rock-basalt. A total of seven land use systems identified in the watershed. The dominant land use was agricultural land that covers 71 % of the watershed area. Some of the agricultural lands particularly in the upstream part of the watershed were with shallow soil, and they were less compatible for crop production.

The downstream part of the watershed had relatively deep soil and water resources that led to intensification. Over all, the watershed had more than 18 watering points or stream heads that could be developed and potentially used for drinking as well as supplemental irrigation and dry season high value crops production. Nearly 15 % of the land was bare land resulting from continuous cultivation, deforestation and land degradation. Grasses, shrubs, sparse forests and plantations with Eucalyptus were the dominant vegetation types in the watershed. Biomass in the watershed was scarce to satisfy the human and livestock demand because of low coverage of vegetation. Significant land use change within a short period of time did not seem apparent as the agricultural lands already covered more than two-third of the watershed for long periods of time.

5.6. Development and dissemination of materials to upscale lessons learnt to influence national policy

The project used field-day and digital photo stories as important tools to advocate and up scale the lessons from the project implementation activities. The project also produced and released online three digital stories focusing on grazing land management (http://cgspace.cgiar.org/handle/10568/25168), improved crop varieties (http://cgspace.cgiar.org/handle/10568/25173) and water harvesting (http://cgspace.cgiar.org/handle/10568/25175). At the ILRI-UNEP-WU project ending workshop from 11-12 February 2013, 50 participants were exposed to the digital stories information and demonstration.

A field-day was organized at Kabe watershed and involved 61 (13 women, 48 men) farming communities and 35 (3 women and 32 men) participants from NGOs, policy makers from the district to the regional level, radio and television news broadcasting agencies, CGIAR, research and University professionals (field day- http://nilebdc.wikispaces.com/nile+6). Selected climate change adaption interventions related to water harvesting, spring development, improved crop varieties, improved village based sheep breeding program, home-garden intervention on high value fruit trees and vegetable crops, forestry/agroforestry and SWC activities, and collective management of privately owned grazing lands were demonstrated to the field day participants. At the end of the field visit, participants of the field-day gathered and provided feedback on the strengths and limitations, and risks associated with the project activities. The ability of the project to enhance partnerships at local level (work together different partners (WU, SARC, Woreda and the community), the integrated approach of the project (research and development) and the focus of the project (all the project activities are in line with the government policy) were highlighted as strengths of the project. On the other hand, low effort to prevent disease and provide technical support on home garden crops, low effort to use local materials for gully rehabilitation and a weak exit strategy to ensure sustainability were identified as limitations of the project. The issue of free grazing on collectively managed farmlands and grazing lands was raised as a risk unless close supervision and alternative animal feed sources strategies are properly planned and implemented. The participants also recommended that a sense of ownership has to be ensured for the developed springs (beneficiary contribution for maintenance has to be done), the Woreda has to take over the project activities to ensure sustainability, and the project has to scale up its intervention to a wider scale in terms of scope (area and time) and intervention area.

5.7. Final end of project workshop, for sharing key insights, and policy influence

ILRI in collaboration with UNEP, Wollo University, ARARI and Woreilu Office of Agriculture organized a two day workshop on "*Lessons and success stories from a pilot project on* *climate change adaptation interventions in Kabe watershed, south Wollo, Ethiopia*". The objectives of the workshop were to share research and development achievements of the project, synthesize lessons and identify success stories that can be scaled up, and discuss a potential second phase of the project. The workshop took place from 11-12 February 2013 at ILRI campus. The total number of participants was 49. Participants represented different Amhara Regional Bureaus, Amhara Regional Agricultural Research Institute (ARARI) headquarters, Sirinka Agricultural Research Center (SARC), Wollo University, South Wollo Zonal Offices, Wereilu Wereda Administration and Agricultural Offices, EIAR, Addis Ababa University, ILRI, IWMI, CIMMYT, ICRAF, CCF-E, MoA, UNEP and NGOs (Menschen für Menschen and Mekane Yesus) (**Figure 18**).

The workshop had three major thematic groups, namely: watershed exploration, climate change adaptation interventions and cross cutting issues (watershed resources mapping, capacity building and collective action issues). Group discussions and presentations, demonstration of digital stories (water, grazing land management and field pea crop variety), possible strategies to scale out/up lessons learnt from the watershed interventions and identification of gaps and potentials for the second phase of the project were also part of the discussion sessions (final workshop- http://nilebdc.wikispaces.com/n6finalworkshop). Establishment of strong partnership among partners, creation of demand for research and development, production of baseline information (socio-economic, resource maps), building of capacity of some farmers and extension workers through training and site visit, and identification and introduction of some potential technologies and practices that can enable communities capacity to adapt climate change/ variability impacts were some of the project successes. Technologies, practices and approaches were accepted by the watershed communities and there were suggestions to scale these out and up through organizing experience sharing visits, facilitation of farmer-to-farmer experience exchange, application of participatory extension, facilitation of timely and adequate supply of inputs, facilitation of access to credit, improving access to information (market, climate, inputs, best practices), establishment of partnerships with NGO's and private organizations, capacity building (training, audiovisual skill development), creation of innovation platforms (University, research, development) and community mobilization.

The project produced information and knowledge, and built capacities that will contribute to the effort on climate change adaption. However, the duration of the pilot project was one year and it was suggested to develop a project concept note for the second phase. Justifications for the idea of initiating a second project phase included: one year is too short to see visible impacts from the pilot phase, problems at the watershed are severe, farmers are still interested to work with researchers and other experts and they expect project continuation, not all the sub-watersheds and technological options explored, policy makers expect lessons from the pilot project for in-depth analysis, and more strategic research are needed. The second phase of the project will consider water as a central issue, and it will be livestock-led and include diversified options (apple, agro-forestry). Capacity building will be a big component of the project, and the project will include off-farm and on-farm activities to address the concerns of low income, landless and poor women households. The value chain approach will receive much attention to address gaps both at supply and demand side. The project is also assumed to have stakeholdersô forum, and strengthen partnership among government development institutions, universities and research organizations.

5. Conclusions and recommendations

Partnership among farmers and partner institutions were strengthened as a result of the operationalization of the project at Kabe watershed. Meetings, trainings, workshops and field evaluation forums enhanced the knowledge of farmers and other local extension workers on climate change effects and possible adaptation intervention measures. A number of climate change adaptation interventions were implemented at the watershed and sub-watershed level and benefited the communities. Although the life span of the project was very short, the interventions on spring water development, shallow wells, drought resistant and early maturing crop varieties, improved sheep breeds and home-garden high value fruit and vegetable plants and the NRM activities are evidence that it is possible to capacitate communities to adapt the effects of climate change.

The barley variety named as Estaysh, the wheat variety Dinknesh and the field pea variety Addi received the highest score by farmers mainly in relation to their yield advantage and disease resistance. Therefore, there is a need to multiply and scale up these varieties. This approach can help to reach more farmers and capacitate communities to improve food security and adapt the effect of climate change.

The soil in the upstream part of the watershed is highly depleted and requires nutrient addition from organic and inorganic fertilizer sources. It was evidenced from a location specific on-farm fertilizer trial (LOSOFT) at the watershed that the soil was responsive to DAP and urea fertilizer application. The plots provided with DAP and urea fertilizers provided more wheat and barley grain and biomass yield than the traditional (without fertilizer application) farmersô crop production system. However, farmers strictly questioned the escalating price of fertilizer for its wider utilization. Therefore, continuous awareness creation on the use of recommended fertilizer rates and creating various income generating options are very critical.

The crop yield from the fertilizer trial and varietal evaluation varied tremendously. The crop yield in the varietal evaluation was relatively high as compared to the fertilizer trial as the sources of seeds for the former is breeder seed while the later was from the farm management seed. The site variability in the watershed also contributed to yield differences between the two research and demonstration activities.

The local sheep at the watershed are characterized by their low reproduction performance and low body condition although they have their own important qualities. On the other hand, the introduced Awassi crossbred showed reasonable birth weight as compared to the local sheep. Farmers can achieve earlier weaning weight and benefit more from the Awassi cross bred sheep if they able to feed the locally available fodder trees as well as improved forages. Appropriate feeding regime especially for pregnant ewes should be also promoted in order to achieve better pre- and post-weaning weights.

Tree planting with water harvesting structure such as eyebrow basins could increase the survival rate and growth performance of tree species. Tree planting should be also combined with stone fenced structures in high altitude and wind prone areas to protect the seedlings from frost and wilting and enhance growth performance. Based on three month data, *Acacia saligna* and *Acacia decurrens* demonstrated the best survival and growth performance.

R&D issues/gaps that need follow-up action:

- Project implementation in terms of area coverage and involvement of farmers was limited in scope (focused mainly in one sub-watershed, and involved and benefited relatively few farmers).
- Technology coverage was limited to entry points (water harvesting techniques, crop varieties, livestock breed and SWC).
- The potential of backyards for forage development (fodder trees) was not adequately exploited.
- Locally available feed resources received little research attention (indigenous fodder trees and crop residues).
- Generating evidence for some activities requires more time (fertilizer trials, performance evaluation of introduced sheep breed, fruit trees, impact of SWC activities).

- R&D on income generating activities (poultry, beekeeping, livestock fattening) and irrigated agriculture was minimal.
- Off-farm income, capacity building on researchers and market linkage activities received little attention.
- Detailed studies on collective actions for grazing land management, gully rehabilitation and landscape/ watershed based SWC were lacking.
- Studies on technological options/agronomic practices that improve the productivity of collectively managed grazing lands were minimal.
- There are more than 18 watering points in the watershed. However, the potential contribution of these watering points to adapt impacts of climate change/ variability has not been well studied.
- Eucalyptus is replacing native woody species in the watershed. However, the positive and negative impact of the species for adapting effects of climate change/ variability has not been investigated.

Lessons:

- The experience from the pilot project demonstrated the possibility to bring change in terms of land and water management, capacity building, crop production and income diversification within short periods of time through mobilizing locally available institutions such as research institutions, Universities, development partners and communities.
- The pilot project demonstrated the way in which communities develop confidence, and then demand and adopt water, crop, livestock and natural resources management related technologies and practices when there are practical field demonstrations and periodical M&E activities.

- The experience from the pilot project demonstrated how provision of orientation on data/information collection to researchers and development partners is critically important before implementing project interventions.

Recommendations:

- Additional research is needed to more fully understand the long-term impact of various interventions. For example, there is a need to understand the impact of SWC interventions on hydrological processes (discharge rate of water before and after interventions); effect of sheep crossbreeding and improved crop varieties on erosion of locally available genetic resources; and effect of eucalyptus species on local water resources.
- Success stories of the project should be scaled out/up within and beyond the watershed.
- The pilot project should be either extended or a new project developed to generate more robust evidence for the benefits of some climate change adaption interventions that require more time and follow up such as evaluation of the performance of improved sheep (ram) and crop varieties, NPK fertilizer, fruit trees, SWC measures and afforestation programmes.

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Figure 2. Workshop participants from the inception workshop in 2011 (photo credit: Derbew Kefyalew, ILRI)

Figure 3. Awareness creation training workshop on NRM at Kabe (photo credit: Derbew Kefyalew, ILRI)

Figure 4. A rope and washer pump installed at a shallow well for irrigation (photo credit: Zerihun Sewnet, ILRI)

Figure 5. Water harvesting dam to irrigate and grow high value crops (photo credit: Kindu Mekonnen, ILRI)

Figure 6. High value vegetable crops grown using the harvested water (photo credit: Zerihun Sewnet, ILRI)

Figure 7. Improved spring for use by the watershed communities (photo credit: Zerihun Sewnet, ILRI)

Figure 8. Improved disease resistant and early maturing wheat variety (photo credit: Zerihun Sewnet, ILRI)

Figure 9. Improved disease resistant and high yielding field pea variety (photo credit: Kindu Mekonnen, ILRI)

Figure 10. Faba bean variety introduced in the watershed (photo credit: Kindu Mekonnen, ILRI)

Figure 11. Locally identified high yielding barley variety (photo credit: Zerihun Sewnet, ILRI)

Figure 12. Cross-bred sheep for community based breeding program (photo credit: Zerihun Sewnet, ILRI)

Figure 13. Forage species integrated on SWC structures (photo credit: Kindu Mekonnen, ILRI)

Figure 14. Tree species plantation with SWC techniques (photo credit: Zerihun Sewnet, ILRI)

Figure 15. Home garden vegetable activities at the watershed (photo credit: Kindu Mekonnen, ILRI)

Figure 16. Watershed based SWC with community participation (photo credit: Derbew Kefyalew, ILRI)

Figure 17. Privately owned but collectively managed grazing land (photo credit: Zerihun Sewnet, ILRI)

Figure 18. Project ending workshop participants in Feb 2013 (photo credit: Zerihun Sewnet, ILRI)