FEED THE FUTURE ILSSI – ETHIOPIA

RESEARCH DESIGN

1. General overview

The Feed the Future Innovation lab on Small-scale Irrigation (ILSSI) aims at demonstrating and modelling high potential interventions for small scale irrigation of vegetables and fodder within four woreda's of Ethiopia. Overall, through improved access to small scale irrigation technologies, it aims at improving farmers' livelihood by increasing food production, augmenting nutrition, accelerating economic development within a sustainable environmental context. The project implementation follows a multi-stakeholder engagement approach to ensure its meeting the local demands both from an agro-ecological as well as socio-economic perspective.

The ILSSI project has defined the following interventions at the various sites (Table 1):

- Irrigation technologies:
    - Improved pulley
    - Rope and Washer
    - Petrol/solar pumps
- Groundwater recharge: hard pan treatment (Danghesta only)
- Irrigation scheduling for vegetables and fruit trees
- Irrigation sustainability from a watershed perspective
- Irrigated fodder

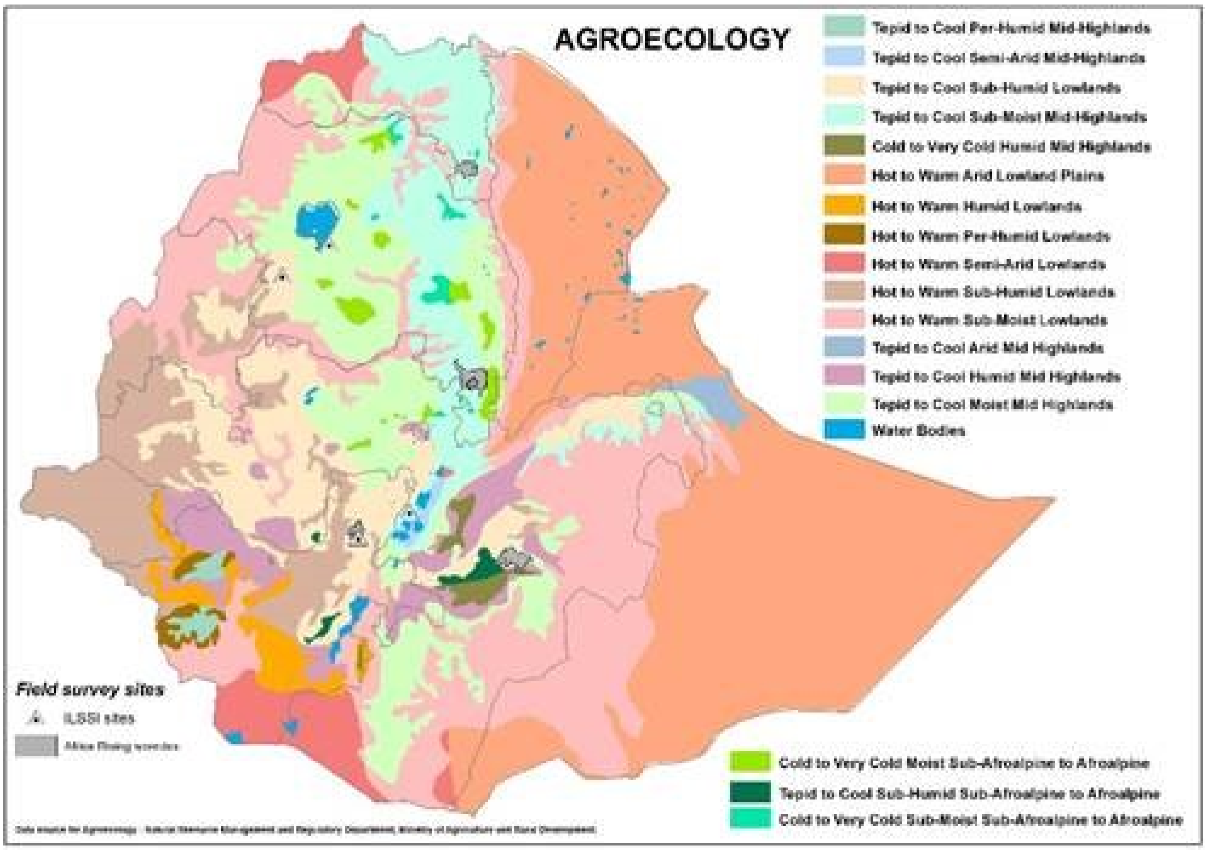
2. Objectives

Through a combination of field experiments the project is aiming to address the following objectives:

1) Assess the feasibility of sustainable groundwater development and sustainable surface water use with the use of improved water lifting technologies for small scale irrigation and develop better insight in irrigation scheduling:
    i) Rope & Washer
    ii) Pulley & Tank
    iii) Motor pumps
    iv) solar system
2) Improve land management on agricultural land to increase subsurface flow recharge through the treatment of the hard pan
3) Demonstrate and field test irrigated fodder for production of livestock feed
4) Assess the overall groundwater potential and sustainability of the technologies at watershed scale

3. Project sites

The project will have field level interventions in multiple sites representing different agroecological zones in Ethiopia.



IWMI will work with national partners, being universities and non-governmental organizations, in the different sites. Bahir Dar University will work on two woredas in Amhara: 1) Dangila, and 2) Bahir Dar Zuria while Arba Minch University will work on 1) Adami Tulu (Oromia woreda) and 2) Angacha/Lemo (Southern Nation Nationalities People Region). In addition, IWMI will partner with organizations and associations to support the provision, training and development of credit arrangements targeting SSI technologies. In particular, Send a Cow Ethiopia will support activities in the southern sites and two local level savings and loans cooperatives will support activities in the Amhara sites.

3.1. Dangila woreda

Dangila is one of Agricultural Growth Program (AGP) and USAID Feed the Future woredas in the Amhara regional state. It is located about 80 kilometers south west of Bahir Dar. In the woreda, there are 27 rural Kebeles among which 16 of them have access to perennial rivers. Average annual rainfall is about 1600 mm, but varies between 1180-2000 mm. The mean annual potential evapotranspiration (PET) is 1250 mm. Monthly PET during November to April exceeds monthly rainfall implying the importance of dry season irrigation. Groundwater mapping by IDE also shows that Dangila woreda is one of the potential areas for manual well drilling and thus suitable for piloting and demonstration of smallholder irrigation technologies for sustainable intensification. We are aware that ATA and Water Aid have work in the Woreda as well, the detail and extent of which we are currently collating to see how much synergy and additional information we may be able to share.

3.2. Robit-Bata Kebele, Bahir-Dar Zuria Woreda

RobitBata is one of the rural kebeles in Bahir-Dar Zuria woreda of Amhara regional state. It is located 10 km north of Bahir Dar. Bahir dar woreda is one of AGP and Feed the Future woredas in the region. It has a sub-tropical ("Woina Dega") climate. The livelihood system is based on cereal and high value irrigated crop production. Groundwater potential and experience in smallholder irrigation is relatively high. Motor pumps together with manual water lifting devices are widely used in the kebele. Shallow groundwater, river diversion and lake pumping are the main sources of irrigation water. In 2014, about 1820 ha of land was irrigated of which 85% used motor pumps. There are about 4000 individual wells in the kebele. According to IDE, Bahir-Dar Zuria is one of the potential areas suitable for manual well drilling. Given its proximity to the regional capital, dairy is one of the emerging businesses implying that demand for improved livestock feed is high and growing. About 53 households are currently producing irrigated fodder which can be developed into business for market.

3.3. Adami Tullu Woreda

Adami Tullu Woreda is located in East Shoa Zone (Ziway area). It is located about 163 kilometers south of Addis Ababa. In the Woreda, there are 43rural Kebeles of which some have access to irrigation water. The altitude of the area is about 600 masl. Average annual rainfall varies between 600-1000 mm. The mean annual potential evapo-transpiration (PET) is 1662 mm. Monthly PET during October to May exceeds monthly rainfall implying the importance of dry season irrigation.

3.4. Lemo Woreda

Lemo Woreda is located between 7°.22"- 7.45" latitude and 37°.40 - 38°.00" longitudinal line which covers an area of 38,140 hectare. 91% of the area covers woina-dega or moderately undulating land and 9% of the area covers dega or high altitude areas. The Woreda is found around the capital of Hadiya zone, Hosanna town, which is located 232 km South of Addis Ababa. The Woredas land mass lies between 1900 – 2700 m above sea level altitude. Annual mean minimum and maximum temperature respectively are 13°C and 23°C. Rainfall distribution is seasonal. The amount of rainfall received ranges from 250 mm to 1200 mm. The rainy seasons are Belg (January to April) and the main rainy season (June to August). The soil textural class encompasses clay, silt, loamy and other mixed textures always exposed to the risk of erosion due to topographic features in some area.

4. Assessing the feasibility and suitability of water lifting technologies for vegetables and fodder

4.1. Hypothesis:

This working package will address the following hypothesis:

1. Design of suitable and sustainable irrigation technologies and practices should take into account the amount of groundwater available and annual amount of recharge.
2. Identifying and use of appropriate technology suitable to the landscape, water resource, agro-ecology and gender needs will improve water use efficiency, labor and land productivity, household income, nutrition, and female participation in small-scale irrigation.
3. Farmers tend to over irrigate when introduced to new water lifting technologies. Hence, a tool is necessary to improve irrigation scheduling to reduce water consumption, increase water productivity and reduce nutrient leaching.
4. The use and sustainability of irrigation pumps for fodder production during the dry season is not well developed; hence, interventions involving irrigated fodder in the dry season linked to improved feeding of dairy animals and marketing of milk will increase livelihood benefits from dairy production.

5. Some types of pumps and incentives may be more suitable, effective or sustainable than others; hence, comparative cost-benefit analysis of water lifting technologies will illustrate recommendations about the appropriateness and economics of water lifting technologies
6. Providing irrigation pumps on credit will enable us to demonstrate the ability of households to pay back loans for this technology. This information along with knowledge on the most cost effective technology will reduce the financial risk to micro-credit institutions and banks for providing loans and will enable them to continue financing and expanding the adoption of such technologies.

4.2. Description of Interventions and experimental layout

In Robit kebele (Bahir Dar-Zuria Woreda), two water lifting technologies (i.e. Rope and Washer (R&W), improved pulley (bucket) system) will be implemented/field tested for dry season irrigation to produce tomato, a high value irrigated crop. In total 23 farmers are selected (11 for R&W and 12 pulley). Additionally 23 farmers were selected to grow irrigated fodder (i.e. 12 R&W and 11 pulley). As well as training in forage and tomato production, farmers will be supported in design of feeding regimes and marketing strategies for increased productivity of forrage. In Danghista kebele (Dangila woreda), the same water lifting technologies will be implemented and field tested, but for the production of onion. For Dangistha a total of 11 R&W and 12 pulley households were selected. In Bochesa kebele (Adami Tulu woreda) 6 households were selected for R&W and 20 households, 5 groups of 4 households for motorized pumps which will irrigated tomato in the dry season. For the Lemo woreda the implementation is done through Africa Rising and where emphasis is given to fruit trees (apple and avocado) and fodder, potentially vegetables. The activities in Lemo are still being designed due to the various actors involved. For ILSSI activities will concentrate in the Upper Ghana kebele whereas Africa Rising will also work in Jewa kebele. Potentially 6 households for R&W and 1 household for solar pump will be selected per kebele. The current design is to monitor up closely the suitability of the technologies in irrigating fruit tree. The project aimed to have a gender balanced experiment, however when female headed households were not available the remaining technologies were given to man headed households. A detailed overview of the amount of farmers per technology and their respective crop is given in Annex I. For a comparative analysis of impact of irrigation on household income, nutrition, gender and wellbeing in general, we will monitor the same number of control households (i.e., households who have no access to irrigation) preferably from the same community/kebele.

Solar pump

Pulley and tank:

Petrol pump

Rope and washer

Figure 1: Overview of the four water lifting technologies used in the experimental design

For the irrigated vegetable experiments farmers will have a land size allocated to the project between 100 and 250 m² while the irrigated fodder farmers have fields between 50 and 1000 m². The land size for the fruit tree experiment is currently unknown. All farmers will receive the technologies on credit and will be asked to pay back their technologies over a 3 year time span with the first payment to be done after the rainy season in 2015.

In each of the sites where the same type of irrigated crop is practiced, homogeneity was obtained through the distribution of one seed variety to the farmers (i.e. for onion, tomato and fodder). For the irrigated fruit trees currently the design is to compare two different apple and avocado varieties (fast and slow growing). Soil samples are being taken for each plot to assess its nutrient content, water holding capacity and other physico-chemical properties in order to calculate the appropriate fertilizer quantities. All farmers will receive the necessary fertilizer and pesticides to avoid potential differences in yield due to insufficient fertilization. Similarly, all farmers will receive the right dosage of pesticides to avoid crop failure. Due to the control of farmers inputs difference obtained in yield and respective water productivity will be allocated to the technologies, labor requirements and irrigation quantities. Farmers are given a field book, monitored by the students hired in the projects, to record time, labor and costs occurred for various land management, agronomic and irrigation practices (i.e. field preparation, fertilizer application, weeding, planting density, irrigation etc.). Throughout each cropping season, BDU and AMU will monitor amount of water withdrawn using a particular technology and at the outlet if applicable (i.e. drainage), amount of inputs (labor, seed, fertilizer, chemicals, water, etc.), amount of crop and fodder produced, amount of crop/fodder consumed, amount of crop/fodder sold, and amount of extra milk production. BDU and AMU will also monitor the duration and frequency of irrigation using a given water lifting technology required to fulfill the crop water demand.

The various sites will be subjected to various irrigation scheduling recommendations. In Robit tomato and fodder farmers will irrigate according to the measured soil moisture content by the students. As the field capacity and wilting point of various fields are known, students will irrigate on a weekly basis after calculating the water requirements of the crop. In Danghista the onion farmers will be split in two groups: one group will receive irrigation scheduling similarly to the Robit farmers while the second group will be asked to irrigate based on the wetting front detector. The 12 farmers in the wetting front detector group will receive training on how the detector works and helps them in signaling when to irrigate and when to stop irrigating. Due to delays in Adami Tulu farmers will potentially not receive irrigation according to the soil moisture as in Robit but will be asked to irrigate according to their preference. The design in Lemo is still in progress but most probably will include two groups of farmers, farmers that took a water lifting technology on credit and use it according to their irrigation knowledge and farmers that did not receive a water lifting technology. For the latter group two group of farmers will be monitored: i) farmers that receive a wetting front detector and irrigate accordingly and ii) farmers that did not receive a water lifting technology nor a wetting front detector.

4.3. Data collection for the water lifting experiments

To assess the water lifting technologies, BDU and AMU will monitor and scale to one hectare: the amount of water withdrawn by the technology, amount of labor inputs, and amount of fodder or vegetable produced in the dry and rainy season. The monitoring results will be documented and reported to project partners. During the first two years, water demand and water productivity will be assessed for the four water lifting technologies while during the third year irrigation optimization strategies as a function of the water lifting technology will be tested and evaluated in terms of crop and water productivity.

For the detail biophysical and agronomic assessment of each water lifting technology, 3 participating households will be selected randomly for each water lifting technology and irrigation scheduling practice. Prior to the start of the experiment, standard soil analysis will be performed in order to obtain the basic soil physio-chemical properties for modeling the soil-plant-water interaction. Basic soil physical (saturated hydraulic conductivity, bulk density, soil texture, field capacity and wilting point) and chemical properties (organic and inorganic carbon, plant available and organic nitrogen, plant available and total phosphorus, CEC and K status) will be determined for each selected plot. Additionally, soil moisture will be monitored throughout the cropping season for those farmers using the wetting front detectors and those following the irrigation scheduling based on soil moisture content.

For each plot (i.e. irrigated fodder or vegetable) the days after planting will be recorded between the various cropping phases to assess potential differences in growing period in function of topographical position and treatment. At the planting phase, planting density will be kept as uniformly as possible and will be measured. During the cropping season standard plant physiological parameters (e.g. plant height, ground coverage or LAI) will be monitored during the various crop development phases (i.e. initial, crop development, maturity, and flowering). At harvest, the total biomass as well as crop yield will be measured in terms of quantity and value. Samples of plant biomass and harvest products will be collected and assessed on plant organic C, N, P and K uptake. The type and amount of fertilizer will be recorded for each plot and a fertilizer sample will be analyzed for its nutrient and carbon content. A detailed overview of the data to be collected during the field interventions for all sites is given in tables 1 and 2 in Annex II.

5. Improve groundwater recharge through the treatment of the hard pan

5.1. Hypothesis:

This working package will address the following hypothesis:

1. Hard pans developed after organic matter losses (forest conversion) were followed by intensive agriculture (e.g. shallow ploughing) resulting in sediment laden water infiltrating and filling macropores with clay particles.
2. Hard pans limit deep percolation of rainfall and produce saturation excess runoff locally.
3. Excess runoff produces sheet & rill erosion resulting in accelerated water movement down the hill causing gully erosion in the saturated valley bottoms.
4. Disrupting plow pans with mechanical means on the hill slopes will increase infiltration, recharge of shallow aquifers, and spring/return flows.
5. Greater availability of water in shallow aquifers and spring/return flows can benefit small-scale irrigation of high value crops during the dry season.

5.2. Description of Interventions and experimental layout

Testing the effect of improving the infiltration through hardpans will take place on experimental household plots in the Robit watershed. The experimental plots will have a combination of different treatment and farming mechanisms to measure their effect on water holding capacity and yield responses of the soil. Three plots at the upper and three at the lower topographic position in the watershed were selected and will be all planted with the same crop during the rainy season. Each plot is divided into three *sub-plots with a dimension of 4*30m, each one treated with no tillage, normal tillage and 30-60 cm deep ripping of the impermeable layer, respectively*. Final plot size will depend on land availability and management conditions. During the selection of the replicates, each replicate at the same topographical position was selected according to similar slope steepness. Because boulders and rocks influence hydrological processes, plot selection took into account the minimum presence of obstructions. This is because soil surface characteristics significantly affect infiltration, especially for rainfall events. During irrigation, the stones slow down the water movement, thus facilitating more infiltration. Additionally, the same inputs (i.e. seeds, fertilizer, pesticides etc.) will be used for each treatment, replication and topographic position. Fertilizer amount will be defined based on soil characterization and fertilizer recommendation in the area. To obtain representative runoff samples of each plot, plots will be delineated according to Wischmeier.

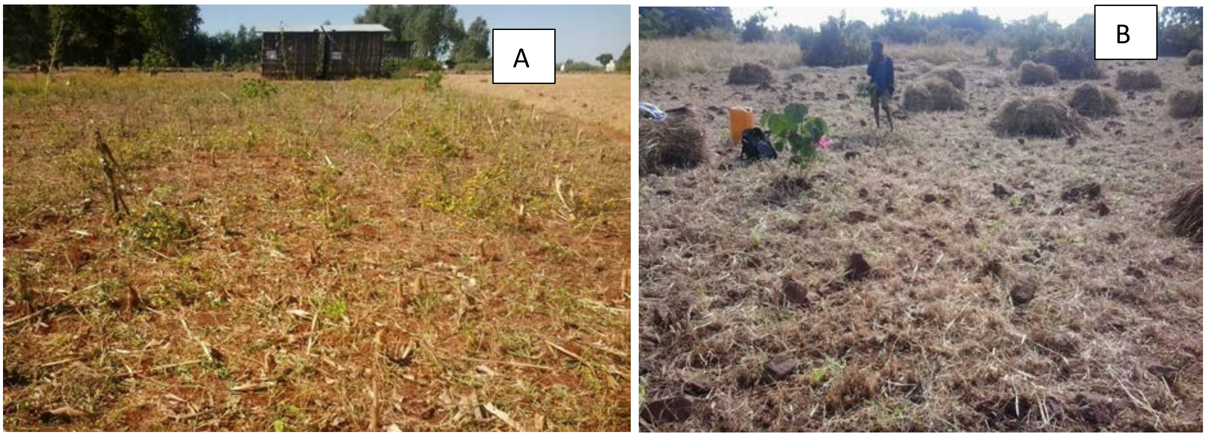


Figure 2: Experimental plots selected at different landscapes for Hardpan (Downslope and Upslope, respectively.)

5.3. Data collection during the hard pan study

Before field preparation and for each cropping season, BDU will determine bulk density based on stratified core sampling and hardpan resistance using a-penetrometer. Basic soil physical (saturated hydraulic conductivity, soil texture, field capacity and wilting point) and chemical properties (organic and inorganic carbon, plant available and organic nitrogen, plant available and total phosphorus, CEC and K status) will be determined on a 1m soil profile adjacent to each selected plot at each topographical landscape position.

Deep infiltration rates will be measured with a hillside infiltrometer, preferably a double ring infiltrometer, prior to planting, as well as during the various phases of crop development (i.e. initial, mid, maturity) and after harvest (5 measurements in total/season). Soil moisture will be continuously monitored throughout the experiment by a soil moisture profiler for all treatments including the replicates in 20 cm intervals. Runoff at the outlet of each plot will be measured by constructing a trench along the lower edge of the plot and capturing runoff in a gauged barrel. Plots will also be instrumented to measure sediment concentration. Monthly, three representative samples will be taken from each plot for sediment analysis. Additional runoff sampling will be done during before and after fertilizer application. Sediment analysis will include standard carbon measurements (total organic and inorganic carbon), total nitrogen, plant available and total phosphorus and potassium as well as particle size.

For each plot, the days after planting will be recorded between the various cropping phases to assess potential differences within the growing period as a function of topographical position and treatment. During the planting phase, planting density will be kept as uniformly as possible and will be measured. During the cropping season, standard plant physiological parameters (e.g. plant height, ground coverage or LAI) will be monitored during the various crop development phases (i.e. initial, crop development, maturity, and flowering). At harvest, total biomass as well as crop yield will be measured in terms of quantity, quality and value. Quality and value assessment of harvested products will be performed using participatory methods. Plant biomass samples and harvest product will be collected and assessed on plant organic C, N, P and K uptake. Fertilizer type and its dosage will be recorded for each plot and a fertilizer sample analyzed for nutrient and carbon content. The results of the treatment practice will be evaluated based on the extent of improvements to the groundwater recharge and productivity by measuring runoff from the plots. The best treatment practice will result in less direct runoff and more infiltration rate that recharges the groundwater.

6. Assessing the overall groundwater potential and sustainability of the technologies at watershed scale

6.1. Hypothesis:

This working package will address the following hypothesis:

1. Although various water lifting technologies are suitable at plot level and improving farmer's livelihood, the up-scaling of the technologies at watershed scale might lead to unstainable extraction of groundwater/surface water
2. The cultivation of irrigated fodder and high value crops is strongly influenced by socio-economic drivers. As water requirements between those crops are significantly different, the expansion of irrigated area and the effect on water resources will be different
3. Successful treatment of the hardpan at watershed scale will significantly contribute to groundwater recharge and hence increase available water resources for irrigation purposes.
4. Expansion of irrigation at watershed scale will effect nutrient redistribution at watershed scale.

6.2. Experimental design and data collection at watershed scale

To assess the feasibility of sustainable groundwater development partly using models, all kebeles are instrumented with a weather station and pressure sensors for flow measurements. Rainfall and other climatic variables (i.e. relative humidity, solar radiation, wind speed, etc.), water level are recorded in 10 min intervals. Pump tests are performed tree times during the year (beginning of dry, end of dry and middle of the wet season) on 10 selected wells in Robit and Danghista. Similar tests are foreseen for Adami Tulu and Lemo. At the start of the project, partners will map the location of each active and abandoned well using GPS. A detailed land use/land cover map of the region will be established with particular emphasis on existing irrigated and rainfed crops and their respective location and area coverage within the watershed. The location of old and big indigenous trees and eucalyptus trees will be marked using GPS because these may indicate the presence of an aquifer. Finally, we will delineate watershed boundaries with respect to the control points using GIS.

Discharge data will be collected both manually and automatically through the establishment of a rating curve for all gauged outlets. To do this, weirs are installed in each of the watersheds. Additionally sediment samples will be collected for selected storm events at the selected outlets in order to assess the erosion vulnerability of the watershed. Storm event samples will be taken from the selected outlets for sediment analysis. Sediment analysis will include standard carbon measurements (Total organic and inorganic carbon), total nitrogen, plant available and total phosphorus and potassium as well as particle size.

In each of the watersheds, at least 30 locations will be selected for groundwater table observations in cross-sections perpendicular to the stream and representative for the various slope gradients and land use types. In areas where existing hand dug wells are not available, piezometers will be installed, such as on hill slope areas. Groundwater levels will be measured using a depth meter. During the normal dry season, groundwater level will be observed once per week, and twice daily during the rainy monsoon phase. The relation between groundwater level and stream flow will also be developed.

Annex I: Detailed overview of the project sites, selected technologies and agronomic activities

Region	Woreda	Kebele	Irrigation technologies introduced	Crop	Number of Households	Irrigation scheduling
Amhara	Dangila	Danghista	Improved Pulley+ tank	Onion	12 (6 man and 5 women headed hhs)	6 using wetting front detectors, 5 using soil moisture readings per technology (gender weighted)
			Rope and Washer	Onion	12 (6 man and 6 women headed hhs)	
Amhara	Bahir Dar Zuria	Robit	Improved Pulley + tank	Tomato	12 (7 man and 5 women headed hhs)	6 using soil moisture readings and 5-6 control farmers per technology and crop type (gender weighted were possible)
			Improved Pulley + tank	Fodder	11 (10 man and 1 women headed hhs)	
			Rope and Washer	Tomato	11 (10 man and 1 women headed hhs)	
			Rope and Washer	Fodder	12 (8 man and 4 women headed hhs)	
Oromia	Adami Tulu	Bochesa	Diesel pump	Tomato	3 mixed groups of 2 man and 2 women headed hhs, 1 group of 3 female and 1 male headed hhs and 1 group of 4 men headed hhs	Irrigation scheduling is not controlled in the project
			Rope and Washer	Tomato	4 men and 2 women headed hhs	
SNNPR	Lemo	Jawe and Upper-Gana	Solar pump	Apple/Avocado or fodder	2 hhs (Not selected)	Irrigation scheduling is not controlled in the project
			Rope and Washer	Apple/Avocado or fodder	12 hhs (Not selected)	Irrigation scheduling is not controlled in the project
			Not identified	Apple/Avocado or fodder (two varieties for each fruit)	12 hhs (6 men and 6 women headed hhs)	Irrigation scheduling according to the wetting front detectors (gender weighted)
			Not identified	Apple/Avocado or fodder (two varieties for each fruit)	12 hhs (6 men and 6 women headed hhs)	Irrigation scheduling is not controlled in the project

Annex II: Detailed collection of data

Table1: Biophysical data

Measurement	Method	Temporal resolution
Climatic data	Weather station	Continuously (Daily)
Potential evapotranspiration and actual crop evapotranspiration	Calculated according to Penman Monteith and FAO drainage paper 56	Continuously (Daily)
DEM, Soil and land use map	Sampling &governmental agencies/university data, GIS, Standard laboratory analysis	Once, start of the project
Discharge	Pressure level sensor	Continuously
Sediment concentration/yield	Sampling	Event based &base flow in dry season
Sediment quality at selected watershed locations	Standard laboratory analysis	Event based &base flow in dry season
Characterization of main irrigated and rainfed crops + crop calendar	Manual observation & GIS	Once, start of the project
Groundwater table	Manual/Floating method	Twice daily in the rainy season and once a week in the dry season
Bulk density	Soil core (plot level)	Before each cropping season
Moisture content	TDR	Twice a week
Crop development stages	Manual observation	At 3 crop development stages
Crop height	Meter	At 3 crop development stages
Planting density	Measurement grid	At planting stage
Crop yield + biomass	Scale (quantification) + economic evaluation	At harvest for the dry season and for the rainy season
Fertilizer application	Type, quantity and quality through manual recording and laboratory analysis	At each application
Soil physiochemical properties of the plots	Standard laboratory methods	Before each cropping season

Table 2: Baseline, socio-economic and crop data

Measurement	Method	Temporal resolution
Location and size of demonstration plots marked with GPS	Baseline survey	At the beginning of the project
Farming system(s) to be simulated for each interventions site	Baseline survey	At the beginning of the project
Type(s) of small-scale irrigation systems (including sources of water, lifting devices, and application methods) to be simulated for each interventions site	Baseline survey	At the beginning of the project
Crop management data (dates/amounts of tillage, planting, harvesting, fertilizer, irrigation, etc.) to be recorded for each interventions site	Follow up survey + household field book	Throughout every crop season
Any livestock data (types, numbers, management, etc.) for the Kebelle or watersheds	Baseline	At the beginning of the project
For the intervention households: farm characteristics, farm family characteristics, including data from previous nearby studies	Follow up	At the beginning of the project
Any cost (labor, input) and price data	Follow up + household field book	Throughout every crop season
Descriptions of "typical" household gardens to be simulated for each intervention site	Baseline	At the beginning of the project
Any available farm survey information relevant to the intervention sites from previous studies	Baseline	At the beginning of the project
Type of crop produced	Follow up + household field book	Throughout every crop season and time of harvest
Cropping period	Follow up + household field book	Throughout every crop season
Irrigation scheduling/frequency/amount	Follow up + household field book	Throughout every crop season
Amount of family labor in man days or hours for crop + irrigation management	Follow up + household field book	Throughout every crop season
Amount of hired labor in man days or hours for crop + irrigation management	Follow up + household field book	Throughout every crop season
Daily wage rate during the same time (Birr)	Follow up + household field book	Throughout every crop season

Measurement	Method	Temporal resolution
Amount of chemical or organic fertilizer in type and amount	Follow up + household field book	Throughout every crop season
Amount of fertilizer in value (Birr)	Follow up + household field book	Throughout every crop season
Amount of seed in quantity	Follow up + household field book	Throughout every crop season
Amount of seed in value (Birr)	Follow up + household field book	Throughout every crop season
Amount of chemicals (i.e. pesticides) in quantity	Follow up + household field book	Throughout every crop season
Amount of chemicals in value (Birr)	Follow up + household field book	Throughout every crop season
Total production/ crop and biomass yield in quantity	Follow up + household field book	Throughout every crop season
Total household food consumption	Follow up + household field book	Throughout every crop season
Total sales	Follow up + household field book	Throughout every crop season
Current market price of each product	Follow up + household field book	Throughout every crop season