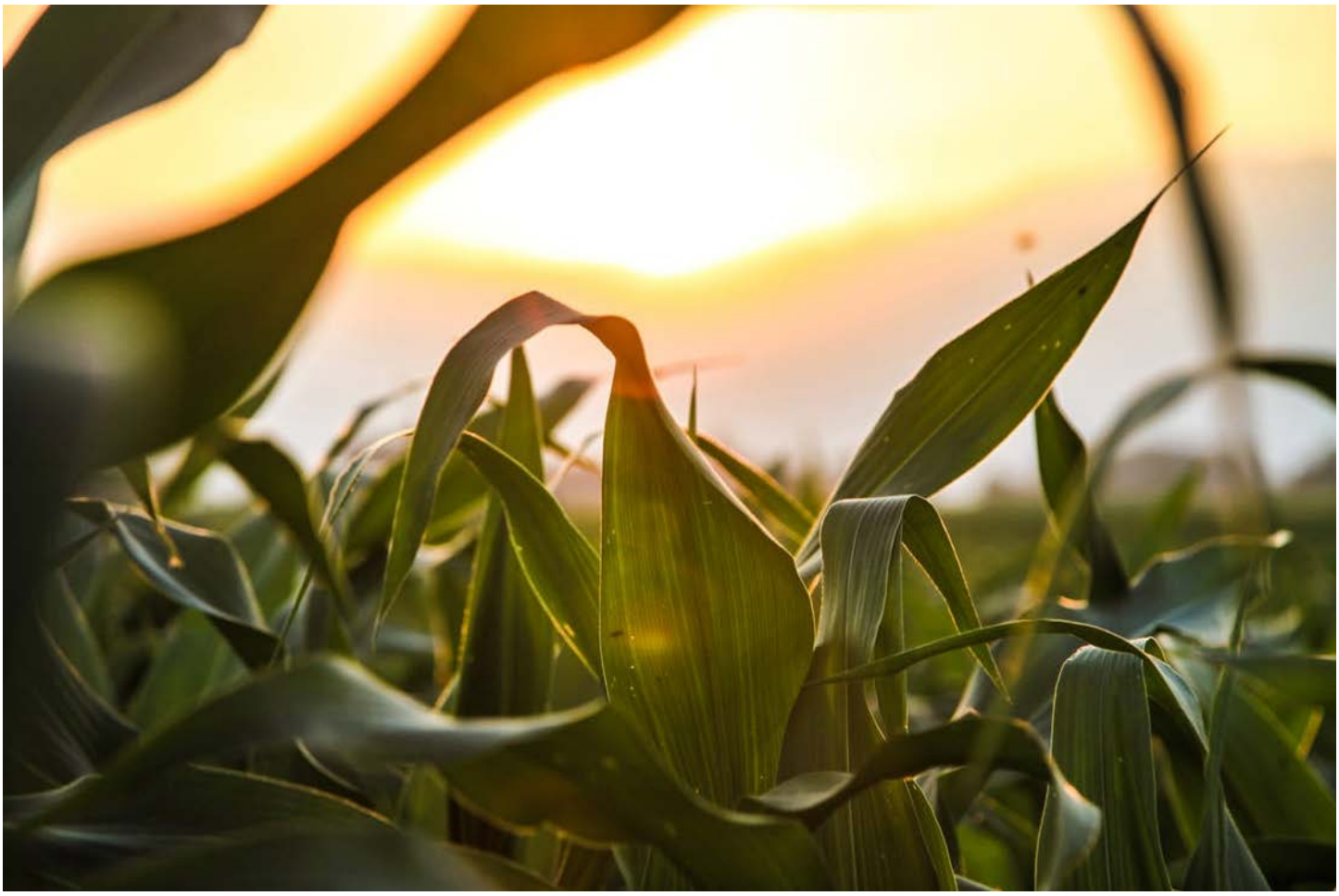

Introducing the Treadle Pump: A Preliminary Impact Assessment of Household-based Irrigation Schemes in Ethiopia

Fieldwork Report
July 2015

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Executive Summary

The purpose of this fieldwork was to conduct a preliminary impact assessment of treadle pump irrigation schemes installed in 2013 through a Daugherty Water for Food Global Institute (DWFI) and iDE supported project in eastern Ethiopia. In 2015, two years after the treadle pump installation, the research team of Dr Beyene and Dr Regassa visited several farms with varying levels of irrigation. The team spoke with farmers, development agents, non-governmental organizations (NGOs), academic and research institutions, and local experts in four woredas (districts) in South Wollo Zone of the Amhara Region, one woreda in North Wollo Zone of the Amhara Region, and one woreda in East Hararghe Zone of the Oromia Region. Almost all discussions with farmers were conducted at or near their farms.

The team also visited the Kobo-Girana Irrigation Project and the Sirinka and Melkasa Agriculture Research Centres and spoke with farmers, experts and the two centres' directors regarding on-going irrigation efforts and potential areas for future collaboration.

The fieldwork destination in East Hararghe Zone, Haromaya Woreda is where the 38 treadle pumps were installed with the support of DWFI and iDE, as part of a project entitled, "*A Holistic Approach to Sustainable Food Security through Adaptive Eco-region Based Watershed Management in Ethiopia.*" Here the team visited sites where nine of the 38 treadle pumps were installed. Of these nine original treadle pumps, only two were in the original form and still functioning. The rest had been replaced by locally modified technology (please see below for details).

The significant impact of the treadle pump technology was the introduction of a special excavating technique that has now become wide spread, with innovative modifications of the initial treadle pump excavation technique by the communities themselves. This new technology not only made irrigation accessible to a higher number of households than the project anticipated, but also many have helped farmers accumulate enough resources to diversify their off-farm economic activities.

Introduction

This preliminary assessment was conducted as a follow up to the DWFI and iDE funded project, "*A Holistic Approach to Sustainable Food Security through Adaptive Eco-region Based Watershed Management in Ethiopia,*" that installed treadle pumps (TPs) as a pilot, low-cost technology for small-scale irrigation in the East Hararghe Zone, Oromia Region, Ethiopia. Although DWFI/iDE supported TPs were installed only in East Hararghe, the research team also conducted assessments on various irrigation practices in Wollo, the second site where the University of Nebraska at Lincoln (UNL) has long-term research projects, for comparative purposes. It is to be noted that both Hararghe and Wollo (Figure 1) include the most drought prone and food insecure areas in Ethiopia.

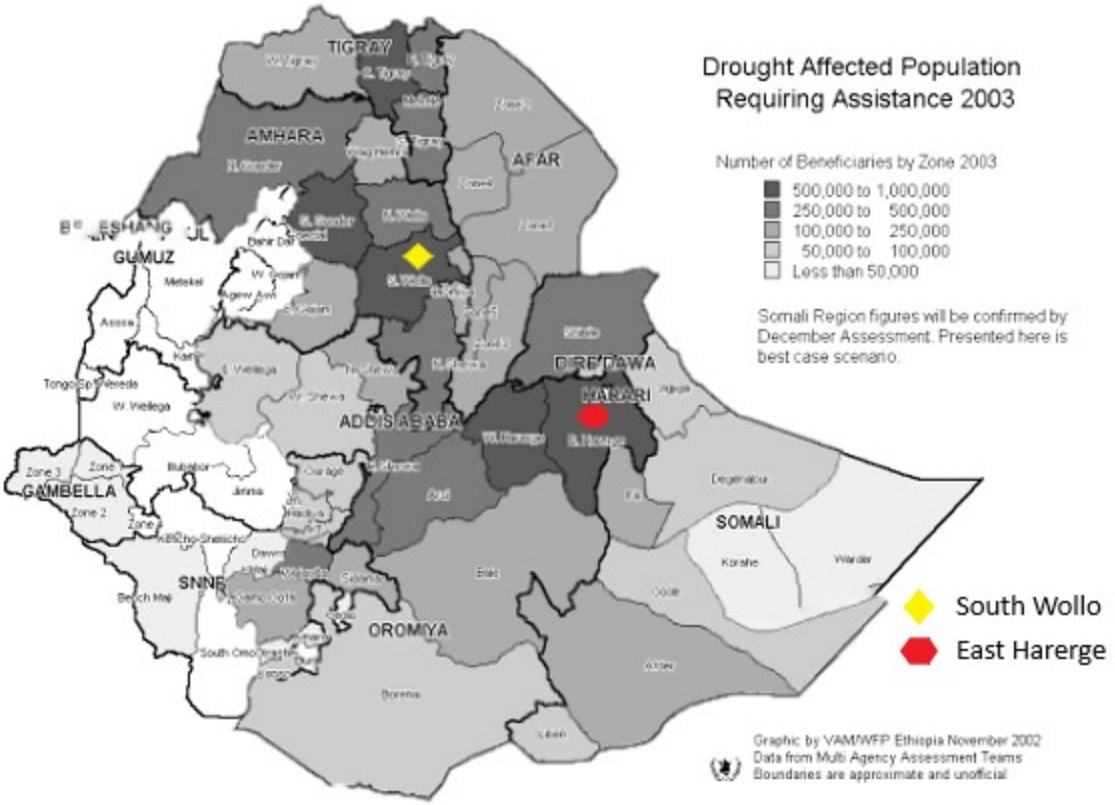

Figure 1. Fieldwork areas

The fieldwork areas, South Wollo and East Harerge, are two of the most drought-prone regions of Ethiopia. This map shows that in a 2003 drought, over half a million people in both regions required food assistance to meet their minimum daily requirements. (Source: FAO 2002)

The team visited several irrigated farms and spoke with farmers, development agents, NGOs, academic and research institutions, and local experts in four woredas (districts) in South Wollo Zone of the Amhara Region, one woreda in North Wollo Zone of the Amhara Region, and one woreda in East Hararghe Zone of the Oromia Region. Almost all discussions with farmers were conducted at or near their farms.

The team came across a wide range of irrigation practices in terms of technology, management arrangements, crop types, and scales of operation (summarized in Appendix A). Observations from each area visited are briefly described below.

Fieldwork

The fieldwork component of this assessment was coordinated with Dr Teshome Regassa's visit to Ethiopia. The objectives of his visit included:

1) Signing of memorandum of understanding (MOU) between Haramaya University and UNL, and between Wollo University and UNL;
2) Making arrangements for the upcoming, education abroad in Ethiopia, fieldwork in December 2015;
3) Discussing with management of both Ethiopian universities possible collaboration on the "Doctor of Plant Health" program at UNL;
4) Discussing possibility of future collaboration with three other universities (Ambo University, Dire Dawa University, Meda Walabu University) and two research centres (Melkasa and Sirinka Agriculture Research Centres).

His visit provided the opportunity to leverage resources, such as transportation and multiple perspectives, for the preliminary impact assessment.

South Wollo

Fieldwork started in Dessie town, the capital of South Wollo Zone, on June 6, 2015. The team made a brief visit to Wollo University (WU) to discuss the purposes of the visit with the WU President and Acting Vice President. Both provided the necessary management support to accomplish planned activities, including signing the MOU. The team also met with the Dean of the College of Agriculture, Ato Solomon Abreha, who served as their point person and accompanied them in their research activities.

Later that morning, the team visited the South Wollo Zonal Agriculture and Rural Development Office. They also met the Zonal Irrigation Development Office Head. The Office Head briefed the team about the irrigation activities going on in South Wollo Zone and suggested areas they could visit for their comparative purposes. These areas were spread over five different woredas (districts), three of which are also UNL's long-term research sites.

Between June 2 and 6, 2015, the team conducted field observations and interviewed farmers and other stakeholders in four woredas. Major findings from these observations are listed in Appendix A. In all areas the team visited, irrigation was used primarily to produce vegetables for market. The most common vegetable crop was onion, although potato became dominant in the highlands. Various species of greens, carrot, tomato, pepper, garlic and beetroot made up the reminder of vegetable crops. Perennial crops included orange, papaya, mango, banana, sugar cane and Khat. Apple was being introduced in the highlands. It appeared that the focus of small-scale irrigation in South Wollo was primarily to produce cash crops.

In South Wollo, the team observed a variety of irrigation types in terms of water sources for irrigation, mechanisms of accessing water, and management practices. The major water sources included: river diversion, spring development, underground wells, open pits, ponds,

and lakes. Water was accessed through gravity, motorized pumps, treadle pumps, and manually by carrying water with buckets. The management arrangements of these small-scale irrigation schemes also varied. Small wells and open pits could be individually owned by a household or a group of related households. Spring diversions, ponds and some wells could be managed at a community level, where several households were involved. Dip wells (often with high capacity pumps), river diversions, and lake-based irrigation tended to be managed by formal water users associations (WUAs), often with the support of the government line departments and/or NGOs.

Major agricultural and irrigation issues raised in South Wollo included:

1) Shortage and management of water – Even where there was underground potential, extraction was an issue. Experts believe that current irrigation practices use water inefficiently, perhaps related to limited irrigation experience. The methods the team observed were furrow and flood irrigation.
2) Seeds – Shortage of vegetable seeds, especially those adapted and high yielding varieties. In all area visited, farmers complained about the shortage, high price, and/or poor quality of vegetable seeds.
3) Market – Price fluctuations sometimes lead to loss for farmers. One example was recent experiences with carrot. Farmer cooperatives used to produce carrots for businesses in Addis Ababa directly. The benefit from this arrangement increased carrot production. However, demand declined, price went down, and the exchange broke down, leading to weakening of the cooperatives.
4) Pests – Various pests, some encouraged by inefficient use of irrigation, caused significant damage to crops, discouraging farmers from trying new practices.
5) Weeds – Weeds, especially grassy weeds, are common in South Wollo demanding high labour to manually remove them (Figure 2).
6) Frost – Frost is a problem from October to January in the high highlands, so timing is critical in this area, which makes irrigation all the more important.
7) Cultural inertia – In many areas, it is culturally unacceptable to buy grain for household consumption. Farmers were, therefore, encouraged to use part of their plots, or one of the irrigation cycles, for subsistence crops, such as barely, sorghum, corn, etc.
8) Grazing and communal area – Conflicts between irrigators, herders, and other water users often include water sources and access the water. While WUAs deal with internal issues, government often handles conflicts between associations, which may not be efficient.

Figure 2. Weeding in an onion farm, South Wollo

North Wollo

Next, the team visited Kobo Girana Irrigation Project, which was implemented by the Kobo-Girana Valley Development Program Office (KGVDPO). This project is the Amhara Regional Government's pilot project in the "buckle of the famine belt of Ethiopia." It has well-developed irrigation infrastructure and well-managed irrigation schemes. Farmers with adjacent plots were organized into cooperatives to access irrigation and to deal with market issues.

In Kobo, the three irrigation methods practiced, in order of area covered, were furrow, drip, and sprinkler irrigation. Some features of these schemes included:

- Large and sophisticated pump system installed by the government (Figure 3).
- High underground water potential. On the farm the team visited, the well potential was 70 hectares, although the pump capacity was 52 hectares.
- The KGVDPO provided extension services and some technical support.
- Cooperatives were responsible for minor repairs, accessories and management, such as water allocation, collecting user fees, and conflict resolution.

The primary crop grown was onion in direct response to market demand. Teff and chickpea were the other crops in the rotation. Because farmers in the cooperatives directly dealt with selling the crops, facilitated with local government support, the 'middle man' was eliminated.

Major agricultural and irrigation issues raised in Kobo included:

1) Salinity – Salinity was problematic, perhaps related to inefficient use of water. KGVDPO was trying to introduce perennial crops, such as mango, to mitigate salinization.
2) Electricity – Lack of reliable electric power to run pumps at critical plant growth stages. It is not unusual to see power down frequently across the country.
3) Market – A market for tomato was lacking, but a tomato canning factory was under construction in the town of Woldia, about 15 kilometres away.
4) Seeds – Shortage of seeds and problem with varieties. For example, onion seeds purchased as the three-month variety took more than four months to mature, affecting farmers' schedules for different crops. This variety also has low productivity. Farmers had to go as far as Addis Ababa, 535 kilometers away, to purchase onion seeds.
5) Drip irrigation issues –
    a. Farmers stated that compared to furrow irrigation, drip irrigation (Figure 4) is better for; (a) reducing weeds (hence reducing labor demand) , and (b) making the land more fertile, "*Meret yawofral*".
    b. One problem with drip irrigation is clogging of the tubes, perhaps related to using underground water (experts' view), and/or using dissolved fertilizers through the drip tubes (farmers' view).
    c. Farmers puncture holes on the clogged tubes that affects pressure, and replacing old drip tube is an issue.

Figure 3. Large electric pump in Kobo-Girana, North Wollo

Figure 4. Drip irrigation in Kobo, North Wollo

The team also visited the Sirinka Agricultural Research Center, one of the strongest research centres in the region. They spoke with a group of researchers at the Center about (a) their on-going research programs and (b) avenues for potential collaboration in the future.

East Hararghe

Next, the team started their visit to East Hararghe by meeting with the Haramaya University President to discuss the purposes of their fieldwork and updated him on on-going collaborative efforts. Upon his recommendation, the team met with several university authorities at different dates to discuss potential areas of collaboration. The president also suggested the team meet with members of a committee established to rehabilitate the Haramaya watershed and resuscitate Lake Haramya. The committee is a national body encompassing federal, regional and local governments, regional and local businesses and municipalities and NGOs. Haramaya University spearheaded the effort and the President encouraged UNL (and DWFI) to help in this effort, where the potential for basic and applied research is very high for UNL graduate students and faculty.

The team visited various university offices (Vice President for Academic Affairs, Vice President of Institutional Development and Community Service, and Directorate for University Enterprise Development), the Haromaya Woreda office, and the farming community in the woreda. The team's long-term collaborator, Dr. Belaineh Legesse, who served as the point person to accompany the team in their fieldwork activities, facilitated the visits.

The story of the treadle pump

The team visited three of the four kebeles (sub-districts) in which treadle pumps (TPs) were installed through a DWFI/iDE supported project, "*Holistic Approach to Sustainable Food Security through Adaptive Eco-Region Based Watershed Management in Ethiopia*." At every site visited, Dr. Belaineh Legesse, who facilitated the instalment of the TPs, reminded the farmer groups of DWFI/iDE project, the set of TPs the project was instrumental in installing, and the purpose of the current visit. The team had the opportunity to visit six different villages in Tinike, Tuji Gabissa, and Damota woredas. The team then ask questions regarding the status of the TPs as well as what changes occurred since the introduction of the TPs in terms of irrigation practices, water use and management, challenges in agronomy and marketing, and any other issue they wanted to raise.

Like Wollo, irrigation in East Hararghe was primarily used for vegetable crops. Similarly, the major vegetation crops included onion, potato, various greens, and carrots. The dominant perennial plant was Khat, which is also economically and culturally important. The sites visited as representative irrigation schemes in the region used furrow and flood irrigation with motorized pumps. Typically, farmers pump the water to a reservoir and from the reservoir to the fields using large hoses (Figure 5). They often have a relay of reservoirs and pumps that can take the water more than five hundred meters away from the original source. Major issues raised about this typical system were cost of fuel for pumps, lack of storage after crops are harvested, weeds and crop diseases. Farmers also expressed fear of underground depletion due to excess extraction. The unsustainable use of water was a concern of all stakeholders in the area, due to the drying up of Lake Haramaya.

Figure 5. Hoses used to carry water to farms

Farmers in the project area, where treadle pump installation occurred, stated that the treadle pumps had several limitations:

(a) Very limited capacity – farmers mentioned that the area that could be irrigated with TPs was at most 50 by 50 meters, which is too small for most farmers.

(b) High labor demand – the manual operation of the TP was too demanding for such limited output. Although this could be overcome by using diesel pumps, the narrow tube constrains the amount of water for irrigation.

For these two reasons, among the nine TP sites the team visited, only two were still functional (Figure 6). The rest had been replaced by locally modified technology. Of the two that were functional, one was used as a supplement to a new system installed about five meters away. The other functional TP was owned by in an elderly person who was planning to go with the new technology. He was negotiating with one of the local drillers (through cell phone) while the team was visiting another TP site owned by a female household head. She had already replaced the original TP with a new system. Although she had moved to an updated technology, she claimed that "the treadle pump has enabled me to compete with male farmers."

Figure 6. A functional treadle pump

The new technology

During the implementation phase of the DWFI/iDE project, one of the interventions included training selected community members on construction and maintenance of TP systems. Thus, the area irrigation branch of the ministry of agriculture, in collaboration with Haramaya University and coordinated by Dr. Belaineh Legesse, trained five individuals in constructing boreholes and installing casings and hoses, and organized these individuals as a cooperative.

In the two years from 2013 - 2015, more than 100 new systems have been constructed by DWFI/iDE trained community members. The key difference of the new excavation system included (a) wider diameter of the borehole (five instead of 1.5 inches), (b) more efficient, locally constructed, excavating tools with serrated edges, and (c) cost effective casing. Furthermore:

- The new system costs 5,000 to 8,000 birr. Farmers had paid up to 36,000 birr for excavation of traditional water pits. One particularly large water pit, shared by 21 individuals, cost nearly 60,000 birr (Figure 7). Traditional water pits were not only expensive to maintain, as they could cave in, but also took more land that could have been used for cultivation.
- Since the introduction of the TP system, farmers reported doubling of crop production and increased income from an estimated 40,000 birr to 90,000 birr annually.
- The new system supported up to 10 households, with an average of seven household members each. This is ten times more than the old system.
- The new system excavates deeper, up to 30 meters, while the initial treadle pump excavation could go only down to 20 meters maximum (Figure 8 and 9).

It is no wonder, therefore, that almost all farmers with treadle pump system have invested in the new system. However, this new irrigation system could not have been possible without the introduction the treadle pump system by DWFI/iDE project.

Figure 7. Traditional water well/pit

Figure 8. Well drilled with controlled excavation method

Local entrepreneurs, assisted by Ethiopian tool makers, continued to drill and make improvements to the shallow irrigation wells installed initially through the project. In two years, over 100 such wells were in operation in the project community, a 250% increase from the original 38 wells.

(a) (b)

Figure 9. Wells drilled by project-trained community members

Young entrepreneurs install new well casings (9a) and pumps (9b) within the project community.

Conclusion

The BREAKTHOUGH OF THE PROJECT was the introduction of CONTROLLED EXCAVATION technique that has now become wide spread, with innovative modifications of the initial treadle pump excavation technique by the communities themselves, to fit their needs. The major impact of the new technology was that it not only made irrigation accessible to a higher number of households than the project anticipated, but also it enabled many farmers to accumulate enough resources to diversify their livelihoods into off-farm activities, including the purchase of trucks.

The short duration of this preliminary assessment did not allow detailed study, and a goal of future work is to systematically document the process of this transformation and its social, economic, agronomic and environmental impacts.

Appendix A. Woredas and Sites Visited and Major Observations

South Wollo				
Woreda – Sites	**Major Crops**	**Irrigation Sources**	**Irrigation Scales**	**Major Issues**
Albiko – Tossa Felana	Veg. – Potato, onion, tomato, carrot, cabbage & various greens	River diversions & spring development using gravity	Small-scale but adjacent plots form extensive irrigated farms of several thousand hectares forming cooperatives	-Market -Vegetable seeds -Dirt road difficult for trucks during rainy season -Farmers at higher ground lack access to irrigation
Kalu – Harbu	Veg. – Onion, potato, pepper, carrot Perr – mango, citrus, papaya, banana	-Pumping water from Borkena River. -Big pump by gov for cooperative. -Small pumps (3 to 4 hectares) by individuals	Small-scale by households (HHs), medium by cooperatives, and large-scale by 'investors'	-Market -Algal bloom in reservoirs -Pests -Crop varieties -High number of women headed HHs
Legambo - Gimba	Veg. – Potato, garlic, and some mustard spp. Perr. - apple	-Shallow-well individually owned -Community dug pond	Small-scale individually owned	-Frost -Pests -Horticultural diseases like mildew
Tehuledere – Hayk	Veg. – onions, cabbage, potato, tomato, pepper, and carrot Perr. – orange, banana, mango, papaya, sugar cane and guava, coffee and Khat	Traditional & modern river diversion & spring development, treadle pump, motorized pump, pond, drip irrigation	Small-scale and medium-scale by cooperatives	-Shortage of vegetable seeds -Pests -Planting practices less than optimal to minimize risk
North Wollo				
Kobo – Kobo, Sirinka	Veg. – Onion, tomato	Sophisticated pump (52 hectares) by government. Furrow, drip and sprinkler	Small-scale and medium-scale by cooperatives	-Market -Salinity -Seed shortage -Weeds -Unreliable power for the pump
East Hararghe				
Haromaya – Tinike, Tuji Gebisa, Damota	Veg. – Onion, potato, beetroot, cabbage, spinach, carrot, sweet potato Perr. - Khat	Shallow-well with motorized pump, treadle pump, traditional water pit with motorized pump	Small-scale	-Market -Crop diseases -Lack of storage -Underground water depletion

Appendix B. Beyene's Itinerary

Date	Activities
June 01, Monday	Travel to Dessie (400 km)
June 02, Tuesday	Meeting with WU President and Acting V/President Meeting with South Wollo Zone Irrigation Development Office Meeting at Tehuledere Woreda Irrigation Development Office
June 03, Wednesday	Meeting at Legambo Woreda Agriculture Office Site Visit Gimba, Segno Gebeya Site visit Tossa Felana in Albko Woreda
June 04, Thursday	Meeting at Kalu Woreda Agriculture Office in Kombolcha Meeting with Concern Ethiopia S. Wollo Office Head Site visit Harbu and Chefe
June 05, Friday	Meeting with Kobo Girana Agricultural Research Center Head Visit two farmer cooperatives involved in irrigation Meeting with Sirinka Agriculture Research Center
June 06, Saturday	Travel back to Addis Ababa (400 km)
June 09	Visits Melkasa Agriculture Research Center
June 10, Wednesday	Travel to Haramaya/Dire Dawa (500 km)
June 11, Thursday	Meet with HU President, Dr. Girma Amente Meet with HU Academic V/President, Dr. Chemeda
June 12, Friday	Site visit and discussion with farmers – Tinike Meeting at Prof. Kebede office
June 13, Saturday	Site visit – Tuji Gebissa
June 14, Sunday	Site visit – Laga Oda
June 15, Monday	Meeting at Haromaya Woreda Agriculture Office Site visit – Dammota Meeting at Prof. Kebede W/Tsadik Office
June 16, Tuesday	Travel back to Addis Ababa (500 km)
June 17, Wednesday	Visit Ambo University and meeting with the President.
June 25,	Type field notes, seek additional information from HU and WU
July 7	Draft report, seek feedback from partners
July 20	Finalize draft based on feedback from partners