Two Small-Scale Irrigation Systems in the Central Rift Valley of Ethiopia: The Way It Is and The Way Forward…

B.Sc. Internship Report by Wim Paas

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Bachelor Internship Irrigation and Water Engineering submitted in partial fulfillment of the degree of Bachelor of Science in International Land and Water Management at Wageningen University, the Netherlands

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Summary

The Central Rift Valley in Ethiopia is a watershed with much irrigation development. The lakes and streams in the watershed form a complex and vulnerable hydrological system. Studies show that changes in land use and the associated increase in water extraction in the Central Rift Valley have resulted in lower lake levels. There is little information about the 'open field smallholder vegetable and fruit production' land use system which is the predominant irrigated system in the area. More information is needed to support stakeholders in de management and sustainable use of water. In this report information is provided on this land use system based on field observations and (in)formal surveys with stakeholders of two irrigation schemes supported by the NGO 'Rift Valley Children and Women Development (RWCD)'.

The two irrigation schemes, Haleku and Golba 1 were established 9 and 7 years ago, respectively. The lay-out of the schemes has similarities, but also some important differences. Both schemes use water from the Bulbula River, but Haleku uses an electric pump, while Golba 1 uses a motor pump. After the water is pumped in a stilling basin it is transported by gravity. Registered cultivated areas by RWCD, farmer's data and measured areas are inconsistent. Therefore, total scheme sizes are uncertain but Haleku is about 35 ha and Golba 1 about 55 ha. Also the information about the number of beneficiaries in each scheme is not consistent among different sources. Haleku has approximately 65 active beneficiaries and Golba 1 approximately 60 active beneficiaries. Haleku is divided into 6 teams, Golba 1 in 7 teams.

Both schemes are registered as legal cooperatives implying that they each have a management team, consisting of chosen beneficiaries. However, both schemes still receive ample supervision and financial support from RWCD, for example through the supply of credit for the purchase of agricultural inputs. RCWD has to develop an exit strategy before March 2011, when support to both cooperatives will stop. The organizational structure of the cooperatives appears mediocre in Haleku and even weak in Golba 1. Beneficiaries seem to lack common responsibility, while enforcement of the bylaw is poor. This results in a low participation of beneficiaries in common activities, for example in the maintenance of canals, especially in Golba 1. Most canals in both irrigation schemes showed signs of poor maintenance during the time of observations.

Onion, tomato, green beans and maize are the major crops in Haleku and Golba 1. Crop choice is mainly influenced by market accessibility. Further the schemes try to rotate crops to avoid the build up of soil borne diseases. The cultivation of green beans is generally from December/January to February/March. Cultivation of onions and tomatoes requires about four months and starts generally in April or October. Maize is mainly cultivated during the rainy season, which starts in July.

Beneficiaries use DAP and urea as fertilizer but they often do not use the recommended amounts and timing. Also the use of agro-chemicals and the agronomical practices differ in most cases from the recommendations provided by RCWD and other extension service suppliers.

In general, one team consisting of 6 beneficiaries gets served for half a day in Haleku. In Golba 1 one team consisting of 2-3 beneficiaries gets served for one day. Water use

is not registered, but the time of application is registered for each team. Each beneficiary in that team has to pay part of the energy costs according to plot size. Tentative calculations suggest rather low water use efficiencies across different crop types in both Haleku and Golba 1.

Economic performance in Haleku and Golba 1 appears to be low. At scheme level, costs outweigh returns in some years resulting in a net loss although there may be large differences in profits at plot level. This and other issues contributed to the rather poor financial balance of both cooperatives. After more than seven years, the amount of savings is very small and insufficient to absorb shocks and to implement necessary maintenance operations of the infrastructure. For example, Golba 1 deals with frequent motor failure hindering irrigation and resulting in dissatisfaction among beneficiaries.

Emphasise in the exit strategy of RCWD should be on strengthening the organization and financial management capacity of both cooperatives. Lack of unity resulting in a low participation in common activities weakens the cooperatives and should therefore be tackled. There are a number of internal and external factors contributing to the sub-optimal performance of both Haleku and Golba1 in terms of water use, agronomy and organization. In the end, both cooperatives should be provided with knowledge and tools to warrant a sustainable development. .

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1. Introduction

1.1 Ethiopia

Ethiopia belongs to one of the poorest countries in the world. It has a population of about 77 million people. The annual population growth rate is 2.5-3%. About 35-40% of the population lives below the poverty line of one USD per day (World Bank, 2005 according to Hengsdijk & Jansen, 2006). Agriculture provides 85% of the employment and 45% of the national income (World Bank, 2005 according to Hengsdijk & Jansen, 2006).

Irrigation development has been identified as an important tool to stimulate economic growth and rural development, and is considered a cornerstone of food security and poverty reduction in Ethiopia. Irrigation generates an average income of approximately US$323/hectare (ha) under smallholder-managed irrigation systems compared to an average income of US$147/ha for rain fed systems (Hagos *et al.*, 2009). Irrigation contributed approximately 5.7 and 2.5% to agricultural Gross Domestic Product (GDP) and the overall GDP, respectively, during the 2005/2006 cropping season. By the year 2009/2010, the contribution of irrigation to agricultural GDP and overall GDP is estimated to be approximately 9 and 3.7%, respectively (Hagos *et al.*, 2009).

1.2 Central Rift Valley (CRV)

The CRV is situated between approximately $7^o15^'$ N and $8^o30^'$ N and $38^o15^'$ E and $39^o25^'$ E. The CRV is bounded to the east and the west by highlands. The climate in the CRV varies with altitude. The area has warm, wet summers and dry, relatively cold and windy winters. The rainy season is from July till September. The distribution of rainfall within the year is highly erratic. The variation in the annual rainfall (1996-2005) varies between 13% and 26% for 20 meteorological stations in and around the CRV. The variations and the relatively short rainy season indicate that rain-fed agriculture is very prone to water shortages (Jansen *et al.*, 2007). Above open water the evaporation rates exceed annual rainfall. Therefore the level of the lakes is maintained by a net inflow of surface water and groundwater from the surrounding catchments (Jansen *et al.*, 2007).

The CRV is a watershed in Ethiopia with much irrigation development. The CRV encompasses a chain of three lakes (Ziway, Abyata and Langano) and streams that are spatially and temporally strongly interlinked (Jansen *et al.*, 2007). The lakes and streams form a complex and vulnerable hydrological system with unique ecological characteristics. Recently, large-scale foreign and national horticulture and floriculture enterprises have been established. These enterprises claim part of the available water resources in the area in addition to (increased) smallholder agriculture, domestic water use, fishery, industrial water use (soda extraction), nature and associated eco-tourism. Hengsdijk & Jansen (2006) show that changes in land use and the associated increase in water extraction in the Ziway/Abyata catchment have resulted in lower lake water levels and increased salinity and alkalinity of Lake Abyata.

The CRV is also a region where poverty and degradation of natural resources are strongly intertwined: On the one hand severe poverty forces people to deplete natural resources to survive, on the other hand degraded natural resources together with unfavorable, highly variable climatic conditions aggravate poverty (Jansen *et al*., 2007). There is an urgent need for improved resource use, with land and water management that takes into account the carrying capacity of the CRV ecosystem (Jansen *et al*., 2007).

In addition to rain-fed production systems there are four types of irrigated production systems in the area: 'Closed vegetable and flower production systems' (planned area of 1000 ha), 'Open field and fruit production systems on state farms' (irrigated area was about 680 ha in mid 2006, in the mean time these state farms have been sold to investors), 'Open field vegetable and fruit production systems on private farms' and the 'Open field smallholder vegetable and fruit production systems'. The latter one predominates in the area in terms of area and number of people involved. In these smallholder systems tomatoes and onions are the main crops. The development of irrigated land in the CRV corresponds with a decreased discharge into the Bulbula River (Jansen *et al*., 2007).

Still little information is available about the 'Open field smallholder vegetable and fruit production systems'. It is necessary to gain more and better understanding of the functioning of these smallholder irrigation systems, to ultimately support policymakers, farmers and other stakeholders in the management and sustainable use of water. In collaboration with the Rift Valley Children and Women Development (RCWD) in Ziway two irrigation schemes have been selected to collect information on the agro systems as a first appraisal.

1.3 Research questions

To better understand the practices and the performance in the smallholder irrigation sector in the CRV, the following questions will be answered in this internship report:

1. ***What are the design principles of the scheme?*** *This question refers both to the physical part and the organizational part of the scheme.*
2. ***When, how and why do farmers cultivate which crops on a certain plot during a year?*** *This question also involves information on the crop rotation.*
3. ***What are the inputs and outputs and what is the distribution of these parameters over head and tail end users?*** *To answer this question data from different years has been collected, e.g. though analysis of logbooks of the irrigation schemes.*

This content report is based on a study carried out as part of the internship of the bachelor program International Land and Water Management of Wageningen University. The study supports the work in two projects, i.e. 'Improving livelihoods and resource management in the Central Rift Valley of Ethiopia (ILCE)' of the partnership program of the Dutch Ministry of Foreign Affairs – Development Cooperation and Wageningen University and Research Centre on Globalization and sustainable rural development; and the project 'Land use planning program for the Central Rift Valley of Ethiopia' of the Dutch Ministry of Agriculture, Nature and Food Quality (LNV). The latter project aims at strengthening the capacity of stakeholders in natural resource management and planning thus contributing to the sustainable development of the Central Rift Valley in Ethiopia (Hengsdijk, 2009). The project focuses at four components for sustainable development, i.e. (1) the development of buffer zones along Lake Ziway; (2) a smallholder horticulture pilot;

(3) the promotion of eco-tourism through development of a map with nature and biodiversity hotspots; and (4) water quality monitoring (Hengsdijk, 2009). The objective of the smallholder horticulture pilot is to improve management in the smallholder horticulture sector to reduce negative environmental impacts, improve resource use efficiency, increase the profitability of smallholder horticulture and stimulate the sustainable development of farm households.

The schemes where the research was carried out are both under supervision of RCWD, which is a secular Ethiopian non-profit NGO, supported by the Spanish development organization Intermon Oxfam. Beside activities on education, health and women empowerment RCWD started to support a small scale irrigation system (Haleku) in 2001. Two years later Golba 1 followed. Currently RCWD Ziway supports six irrigation schemes. RCWD will stop support to Haleku and Golba 1 in March 2011.

1.4 Structure of the report

After this introduction the report proceeds with Chapter 2 describing the methodology of the research. Results of the study are presented in the Chapter 3, which is divided into four parts, i.e. (1) scheme characteristics, (2) agronomy, (3) water use, (4) economics. In Chapter 4 the methodology and the results are discussed. Chapter 5 gives recommendations on the basis of the discussion in Chapter 4.

2. Research methodology

2.1 Data collection

The methodology to work out the research questions is based on surveys (both formal and informal) with stakeholders, observations and measurements in the field and existing data collected by RCWD. Two schemes of RCWD were selected in a rapid appraisal, i.e. Haleku and Golba 1. Some information on water use and economy of production was also collected from nearby Golba 2, which is also supported by RCWD. The selection of Haleku and Golba 1 is based on accessibility and differences in lay-out of both schemes. The characteristics of both irrigation schemes (physical and organizational structure) were analyzed to gain insight in the design principles (research question 1). See Annex A and B for checklists used.

To gain insight in the management of both schemes (research question 2 and 3) formal surveys were carried out among about 15% of the beneficiaries in both schemes, i.e. .13 farmers in Haleku and 16 farmers in Golba 1. See annex C and annex D for the questionnaire that was used in formal surveys. The selection of beneficiaries was made randomly in stratified sub-sections, because of a possible gradient in head and tail end plots. For the formal surveys an enumerator was used. Informal surveys were carried out with RCWD-staff and leaders of the irrigation cooperatives. In addition, some field measurements are done in the fields of surveyed farmers (Annex E). Information about the cropping calendars in previous years is collected from the logbooks of RCWD.

2.2 Data analysis

The data derived from the (in) formal surveys and logbooks have been processed in the forms of Tables. With the aid of CropWat 8.0 the water use efficiency of crops in the schemes have been estimated (FAO, 2008). Also the value of irrigation water has been estimated for different crops.

2.3 Limitations of the study

This study was carried out in two adjacent schemes, both under supervision of RCWD. Therefore it does not pretend to provide an overall assessment of open-field smallholder irrigation systems in the CRV. Calculations on water use efficiency are based on various assumptions and therefore should be interpreted and used with care.

3. Results

3.1 Scheme characteristics

Haleku and Golba 1 are two adjacent schemes along the well maintained gravel road perpendicular to the road from Adami Tulu to Addis Ababa. Both schemes are legally registered irrigation cooperatives. The basic soil characteristics are similar, i.e. sandy loam with a medium fertility. Since the schemes are adjacent to each other also the climate is the same, a warm climate with a dry winter and a wet summer (FAO, 2005).

3.1.1 Haleku

At 2.5 km distance along the gravel road the Haleku scheme is located. Haleku was established in 2001. The total scheme area is 36 ha divided in three blocks. Originally, each of the 75 beneficiaries (60 male and 15 female) cultivated one plot in each block in order to minimize head and tail ender problems. The total area per farmers is supposed not to exceed 0.5 ha; however, there is ambiguity about the exact scheme area, number of beneficiaries and the number of plots per beneficiary:

- According to the chairman of the cooperative, Haleku has three blocks of 14, 8 and 11 ha, totalling only 33 ha.
- In the records of RCWD there are 69 beneficiaries, which cultivate a total area of 32 ha. Because some beneficiaries cultivate more than 0.5 ha, they share land with family members in order to stay below 0.5 ha. For example, almost all female beneficiaries in the scheme are the wives of male beneficiaries. Therefore, the actual number of beneficiaries is less than the original number of beneficiaries.
- Presentation posters of RCWD provide conflicting information.
- Beneficiaries do not have a plot in each block because land rights are transferred to family members. Therefore, the given area in the questionnaires differs from the records in RCWD.
- In addition, field measurements conflict with both the records of RCWD and the declarations of interviewed beneficiaries (Table 1). With two exceptions measured plots are smaller than the records of RCWD.

Table 1: Irrigated plot area of selected farmers in Haleku according to RCWD, beneficiaries and measurements done in this study.

Haleku	area in m2 according to:		
name	*RCWD*	*beneficiary*	*measurement*
Abdela Milkeso	3503	3125	no data
Abo Guye	3750	4350	4397
Abo Marhesa	5750	5000	4553
Dadi Badane	3724	3750	3364
Gamada Herego	10072	5000	5875
Gugsa Lemma	6458	6250	3510
H/Giorgis Galgalu	no data	5000	4779
Leliso Nagawo	5095	5000	2943
Marta Watro	no data	5000	6380
Mohamed Badane	3693	5000	3528
Mohamed Gelato	4650	3750	3415
Safayo Marko	3600	3750	3410
Zebeerga Dila	2500	2500	3024

Currently, the scheme is expanded with 10 ha to serve an additional 21 beneficiaries. At the time of research only 4 ha of this plan had been developed.

Each block of Haleku consists of six teams with a team leader, who is the contact person for the cooperative. Due to land exchange it is possible that one beneficiary is a member of different teams.

All beneficiaries get served by an electric motor pump with a capacity of 100 l/s. Measurements showed that the actual capacity is 98.8 l/s (Beshir, 2008). During power cuts, a diesel motor pump is available with the same capacity (100 l/s). However, this pump is not able to serve all beneficiaries at the right time and with the right amount of water, because the capacity is too low. This motor pump is normally used to convey water to the nursery of Haleku, which measures about 1.5 ha.

Irrigation water is pumped from the Bulbula River to a stilling well on a dike. This stilling well is the beginning of the lined main canal of Haleku scheme. This canal is a bit atypical since its shape is irregular, the bottom width decreases with 20 cm in the first ten meters from 72 to 52 cm while the side slope remains the same. Further the channel bottom slope is irregular (average about 0.016 m/m), causing little ponds at irregular places along the canal. These are potential breeding grounds for water-borne diseases. In addition, there is a lot of leakage causing erosion of the dike and creating ponds along the dike (Fig. 1). In the lined primary canal there are two division boxes which serve only a small part of the first block. In the part after these division boxes sediments are deposited in the main canal that provide a favourable conditions for excessive weed growth (Fig. 1).

Figure 1: Weed growth in the canals (left), pond forming (right top) and erosion (right bottom).

After 500 m of lined main canal, the unlined part of the main canal goes perpendicular to the lined part for about 1000 m. The shape of this part of the main canal is hard to define. The original shape was most likely trapezoidal, but due to erosion and sedimentation the shape is more like in Fig. 2. The width varies within meters length between 90 and 110 cm, while the depth is often not more than 15 cm.

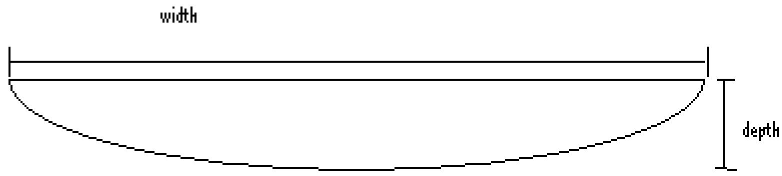

Figure 2: Shape of secondary canals

At the time of research, 10 newly constructed division boxes and two road culverts were constructed. The road culverts were made to facilitate the transport of agricultural products between the blocks. The 10 division boxes were constructed to replace the existing earthen division boxes. The new division boxes are supposed to reduce pond forming near the place of water division. All division boxes will be equipped with two water locks.

The division boxes either convey water to the next division box or to secondary canals perpendicular to the unlined main canal. In general, the secondary canals seem somewhat deeper and less wide than the unlined main canal. There was not a clear gradient in canal size, in the original Haleku area, according to the distance from the main canal. The new irrigation area is supplied by smaller and less or more trapezoidal canals.

From the secondary canals the water is conveyed at right angles to the tertiary canals between the plots. The conveyance to tertiary canal is made possible by temporarily constructed earthen dams. After the tertiary canals, the water is applied to the furrows in the field. Sometimes the furrows are situated diagonal to the edges of the fields in order to make it possible to let the water flow by gravity.

3.1.2 Golba 1

At about 1 km distance from Haleku, the Golba 1 irrigation scheme is located. From the original 129 beneficiaries only 65 are still irrigating. These 65 beneficiaries have in general one plot, but there are exceptions. These plots are scattered throughout the 7 blocks in the scheme without an apparent gradient in head and tail end situation. From the original 55 ha only a small part is under irrigation related to the decreasing number of beneficiaries. Golba 1 has a nursery site of about 1 ha. Also in Golba 1 information on the size of the entire scheme, its plots and beneficiaries are inconsistent:

- According to RWCD records the total cultivated area by 108 (88 male, 20 female) beneficiaries is about 37 ha. The other 21 beneficiaries do not cultivate the miscellaneous 18 ha.
- In 2004, the number of beneficiaries was 183, but other RWCD data is inconsistent.
- Almost all female beneficiaries in the scheme are not head of the household, but the wife of male beneficiaries.
- The total land size of the <u>active</u> beneficiaries according to RCWD is about 18 ha, but some of these farmers rent land from inactive farmers.
- Most estimates of the land area by beneficiaries of Golba 1, RCWD records and field measurements conflict (Table 2).

Table 2: Irrigated plot area of selected farmers in Golba 1 according to RCWD, beneficiaries and measurements done in this study.

Golba 1	area in m2 according to:		
name	*RCWD*	*beneficiary*	*measurement*
Tibeso Bakuye	5308	5000	3348
Cakiso Sinbo	5815	5000	2695
Nura Tika	2500	2500	2156
Baru Hamda	2500	2500	2450
Gabire Amano	2250	2500	2266
Tusu Wariyo	4900	5000	2904
Abo Tusu	8000	5000	5168
Jado Shuro	1900	2500	2254
Kadiro Dube	2110	2500	2323
Amana Tushes	2100	2500	2472
Dakabo Ushexa	2100	2500	2163
Arabi Tibbe	2090	5000	1440
Faxuma Gobe	3300	5000	3388
Lenco Edao	2230	2500	3610
Mudde Bakuye	5500	3750	2673
Thashite Oshee	4350	5000	1968

Each block in Golba 1 has a team with a team leader, like in Haleku. Golba 1 is served by a diesel motor pump with a capacity of 70 l/s. This pump fails frequently due to a lack of maintenance and a lack of spare parts. The available back-up motor has broken down. According to the beneficiaries the motor pump is not sufficient for providing water to the 65 active beneficiaries. In addition to the diesel pump, the government supplied Golba 1 with a small diesel pump to supply water to beneficiaries of one of the teams (team 7) and some other beneficiaries with plots near the road. The capacity of this small pump is not known.

The water conveyance in Golba 1 is similar to that in Haleku: The water is pumped from the water source (Bulbula River) to a higher level, higher than in Haleku, while the lined main canal on the dike is only 360 meters. Also this lined canal has an irregular bottom slope, causing little ponds after irrigation supply, but the bottom width is rather constant over the 360 meters. Considering the excessive weed growth along the canals there is a lot of leakage. Halfway the canal there is also some erosion of the dike due to leakage. After 360 meters the lined main canal stops and flows in a right angle to the left in the unlined part of the main canal. There is a similar turn to the right, to a secondary canal that serves the first block.

The original shape and dimensions of the unlined secondary canal are not clear, but the current width of the canals varies between 90 and 130 cm within a few meters. The shape is like the shape of the unlined main canal in Haleku.

In the main canal there are four places where the water is distributed to the secondary canals between the blocks 2 to 6. Water is divided by temporarily constructed earthen dams, but there are plans to construct four concrete division boxes. The secondary canals were in poor condition with much weed growth. The shape of the secondary canals is more concave than the unlined main canal with an average width of 80 cm. After the secondary canals, the water is conveyed to tertiary canals as in Haleku.

The beneficiaries of team 7 are supplied by the small pump. A tube discharges water in former secondary or tertiary canals. From the tertiary canals, the water is led to the furrows. The fields in Golba 1 are not very levelled, which was a complaint of some beneficiaries and was verified in the field.

3.1.3 Organization of the cooperative

As a legally registered cooperative, Haleku and Golba 1 have a formal organizational structure. The general assembly consists of all the active beneficiaries. The general assembly chooses the executive committee which consists of six beneficiaries. Under the executive committee are four committees: (i) Education committee, (ii) arbitration committee, (iii) water committee and (iv) the credit committee. Because RCWD manages the credit of the schemes, the credit committee is not active. Activities of the committees consist of preparing schedules for water allocation, solving of problems, preparing a production plan, etc.

The general assemblies should be attended by all beneficiaries. However, in Haleku only 73-80% of 75 beneficiaries normally attend such meetings. In general, Haleku beneficiaries are active participants of such meetings. In Golba 1, attendance is lower with 61-69% and beneficiaries participate less in planning and discussions.

Executive committees of both irrigation schemes do not treat beneficiaries equal, according some of the farmers. Sometimes the committees neglect beneficiaries' opinions or they do not supply the required inputs. According to the interviewed farmers, the committee requests inputs like chemicals and fertilizer too late. The production plans should be made by the cooperative committees, but they are often supported by RCWD. The interviewed beneficiaries in Haleku are generally satisfied with the functioning of the cooperative committees. Also RCWD is satisfied with the functioning of the committees in Haleku despite that Haleku depends on RCWD for its financial management.

According to the interviewed farmers in Golba 1 the main problem in their scheme is the water committee, which is responsible for the motor pump. Also there have been disputes between beneficiaries about land, inputs and water supply. For example, between 2006 and 2008 disputes between committee members resulted in missing production records. In general, Golba 1 depends more on RCWD than Haleku and it needs strong organizational support.

The underlying causes of poorly functioning committees according to RCWD are:

1. Being a committee member is not a full time job, so, committee members do not have always the time to solve problems. Also there is no financial reward for being active in a committee.
2. There is a lack of knowledge about how to manage and lead a cooperative.

Participation by beneficiaries in common activities is a sign of well functioning of both the cooperative and committees. Common activities are: Land preparation, sowing, planting, harvesting, watering, weeding, application of chemicals and canal maintenance.

Both, in Haleku and in Golba 1 beneficiaries are not equally participating in such activities. In general, 10 up to 15 of 75 (13-20%) beneficiaries in Haleku are not participating frequently. For Golba 1 this is more, i.e. 20 to 30 of 65 (31-46%) beneficiaries. There are four steps that can be undertaken by the cooperative of a scheme when a beneficiary is not collaborating in common activities:

1. warning (letter)
2. 50 birr fee
3. 100 birr fee
4. exclusion from cooperative

Until now the fourth step has never been carried out in Haleku and Golba 1. Maybe the fourth step will be carried out this year, but for another reason, i.e. not paying back the loan for inputs. RCWD provides the beneficiaries interest-free loans. Because of crop failure due to climatologically circumstances, mismanagement, diseases, etc. not all farmers are able to pay back their loans after each crop cycle. As is written in the bylaws a farmer should be excluded from the scheme after not paying back his/her loans for two sequential cropping cycles. In recent years some beneficiaries did not pay back their loans for two successive cropping cycles, but due to a lack of enforcement of this bylaw, no beneficiary has yet been excluded. About 5-7 beneficiaries in Haleku and 20 beneficiaries in Golba 1 are on the nomination to be excluded from the scheme.

3.1.4 Extension service

Beside credit supply, RCWD provides extension services related to agronomy, environment, management & leadership and irrigation practices. The cooperatives are supposed to get continuous extension service on agronomy by the frontline workers of RCWD. Frontline workers are supposed to give advice during the entire production cycle. They make observations in the field and give beneficiaries information on agronomic practices. Each month, the two frontline workers of RCWD discuss with each other where beneficiaries need extra extension service. The frontline worker for Haleku, Golba 1 and Golba 2 is the same person.

Environmental extension services are given four times a year. Twice a year the best performing farmers are invited for the extension service. After having received the knowledge they are supposed to transfer that knowledge to other beneficiaries. It is not known to what extent this transfer of knowledge happens. Twice a year all beneficiaries are involved. Topics of the environmental extension are:

- How to manage lake Ziway
- Local and global environmental problems

The extension service on management and leadership is given once per month for all the committee members. Specific topics are bylaw enforcement and duties and responsibilities of committees.

For irrigation practices all committee members of all cooperatives of RCWD come together once a year to receive information about:

- Construction and maintenance by beneficiaries
- Water use efficiency (water logging problems, salinity, using compost to increase infiltration)

The intention is that the committee members transfer their knowledge to all beneficiaries.

The majority of the interviewed farmers indicated that the extension service was insufficient in quantity and quality. Also beneficiaries do not like that only a selection of the beneficiaries is invited for some kind of extension service.

Beside extension service from RCWD, beneficiaries of Haleku and Golba 1 receive extension service from the government by development agents (DA's), from the American NGO International Development Enterprise (IDE) on chemical use (Golba 1) and marketing (Haleku), from the Common Fund for Commodities project led by the Ethiopian Producer Exporters Association (CFC-EPHEA) on green beans production and from Meki-Batu (MB-union) on maize production.

3.2 Agronomy

3.2.1 Crop choice and management

The major irrigated crops in Haleku and Golba 1 are onion, green beans and tomato. Major semi-irrigated crops are different maize varieties. Minor (irrigated) crops are potato, cabbage, teff, wheat, barley. The cultivation of potato in Haleku is a pilot project of RCWD and Adami Tulu Agricultural Research Centre to assess its suitability for the Ziway area.

According to the questionnaires most farmers choose a certain crop based on the available market information, which is mainly provided by RCWD staff. Crop choice is further influenced by the availability of credit to purchase inputs like fertilizer, agro-chemicals and fuel. The management of the cooperatives consults the beneficiaries on what they would like to produce after which the management committee is supposed to make a production plan in cooperation with the frontline workers of RCWD. In fact most input for the production plan does not come from the management committee, but from RCWD. The production plan is submitted to the beneficiaries, who – after agreement - have to cultivate according to that plan. To make crop rotation possible crops can be cultivated on a field only after the cultivation of two other crops on that field. In practice there are reasons for cultivation only one crop between two similar crops. In general, the cultivation of green beans starts between November and January, and ends between January and March. Cultivation of onions and tomatoes starts in general in April or October. Maize cultivation mainly takes place during the rainy season and planting is in April and May.

The minimum crop area to produce sufficient amounts that can be marketed is 2.5 ha. Most interviewed beneficiaries in Haleku and Golba 1 are satisfied with the crop choice, although some beneficiaries commented on the restricted crop choice and the need for improved varieties. In Golba 1 regular motor failure limited crop choice.

Only two inorganic fertilizers are used, i.e. DAP and urea. The N-content of urea is 46%. DAP has a grade of 18-46-0. In 2004, RCWD tried to implement an organic fertilizer program, but it failed, because farmers preferred inorganic fertilizer over the time-consuming production and application of organic fertilizer. Nowadays, RCWD frontline workers discourage the use of organic fertilizers, because beneficiaries do not use compost of good quality. Still, RCWD management is aware of the importance of organic fertilizer, but they lack support and implementation capacity while the beneficiaries do not get enough incentives. There are irrigation projects in the area that have changed to organic fertilizer, but details are lacking.

In order to manage their crop, beneficiaries use agro-chemicals to fight diseases/pests, but some beneficiaries do not know their effect. Therefore, IDE provides currently extension services in Golba 1 on the use of agro-chemicals. Measurements of amounts of chemicals are done with an inaccurate (per 100 gram) balance and liquid chemicals are measured with a can with pen stripes in Haleku. Pesticides/fungicides are handled and applied without any protection.

Because onion, green beans, tomato and maize are the major crops in Haleku and Golba 1 more general information is supplied about these crops and the recommended and actual cultivation practices, such as input (i.e. fertilizers, pesticides) use are described. The input of water and fuel will be discussed in section 3.3. Not all crops were cultivated in both schemes at the time of writing this report.

3.2.2 Onions

Onions grow well in the tropics but at elevations above 1000 m (as around Ziway) growth and development proceed relatively slowly and bolting percentages can increase. Most suitable soils are fertile alluvial mineral soils with pH above 5.4. Onions have a low tolerance for salinity and water logging. Crop rotation is important for onions to avoid the build-up of pests and diseases (Schuiling, 2009).

In Haleku and Golba 1 two red cultivars are used, Bombe Red and Adame Red which differ in growing period (135 and 120 days, respectively) and in dry matter content. Both cultivars are produced for the local market. Both varieties are kept at the nursery place for 45 days. Observations on nursery Haleku: some onion beds face many drop outs. Other beds are really crowded because farmers use 12-16 kg/ha instead of the recommended amount of 5.6 kg of seed per hectare. After transplanting it takes 1-2 weeks before the plants are fully developed. In Table 3 the recommended cultivation methods are compared with the actual practices.

Table 3: Cultivation practices in onion.

	According to RCWD	Observations	
		Haleku	Golba 1
Distance between plants (cm)	5-7	5-10	na
Distance between rows (cm)	40-50	20-30	na
Distance between furrows (cm)	40-50	40-50	na
Depth of furrow (cm)	10	5-10	na
*Length of furrow (cm)***	*na*	*1000-1200*	*800-900*

* 'na' means: no data available

** Length of furrows are not measured, the information comes from beneficiaries.

At the time of observations only in Haleku onions were cultivated. No extreme deviations from the recommendations are observed. Remarkably, beneficiaries plant two rows on one ridge, while the recommendation is one row per ridge. The actual use of DAP and urea is usually less than recommended by RCWD (Table 4).

Table 4: Fertilizer use in onion (kg/ha).

	recommendation by RCWD		derived from questionnaires Haleku	
	DAT *	Amount (kg)	DAT *	amount
DAP	**0**	**200**	**0**	**200**
UREA 1	15	75-100	15-60	50
UREA 2	35	75-100	30-90	50
total Urea		**150-200**		**100**

* DAT = Days after transplanting

Both timing and the amount of fertilizer application differ greatly in Haleku. For agro-chemicals beneficiaries seem to stay close to the recommendations, but one farmer applied an extra agro-chemical (Table 5).

Table 5: Agro-chemical use in onion.

Recommended by RCWD			Maximum	Haleku	Remarks
Name	**type**	**disease/pest**	**Amount per hectare**		
Selecrole	pesticide	pests, trips	600g	400g	
Rodimol	fungicide	powder mildew/purper blotch	3kg	400-600g	
Pencozem	fungicide	Mildew	3kg	400g	
				400-600g	Cocide

3.2.3 Tomatoes

Tomato is suitable for tropical highland. Optimal pH ranges from 6.0 to 6.5. Suitable soil types range from sandy loam to clay loams that are rich in organic matter. Tomatoes have a relative low tolerance to water logging and salinity. In the CRV, tomatoes are produced for local and export market.

Tomato variety Sanbarsana grows the first 28 days in a nursery, the growing period is 90-120 days, 90 days for export tomatoes and up to 120 days for locally marketed tomatoes. The recommended amount of seed is 250 gram per ha while the actual amount of seed ranges from 400 to 500 gram per ha (Table 6).

Table 6: Cultivation practices in tomato.

	According to RCWD	Observations Haleku	Golba 1
distance between plants (cm)	60	10-30	20-80
distance between rows (cm)	25	70-80	50-90
distance between furrows (cm)	50	140-160	90-160
depth of furrow (cm)	10-15	10-15	5-10
length of furrow (cm)		*500-600*	*600*

Cultivation practices differ very much from recommendations. Only the actual depth of the furrow is more or less the same as recommended. The amounts and timing of fertilizer applications are shown in Table 7.

Table 7: Fertilizer use in tomatoes (kg/ha).

	recommendation by RCWD		derived from questionnaires Haleku		Golba 1	
	DAT	amount	DAT	amount	days	amount
DAP	**0**	**200**	**0**	**200**	**0**	**100**
UREA 1	20	75-100	15	50-100	15	50
UREA 2	45	75-100	30-45	50-100	30	**50**
total Urea		**150-200**		**100-200**		**50-100**

In Haleku the farmers follow the recommendations, in contrast with Golba 1 farmers. Also pesticides and fungicides use is not according the recommendations in Golba 1 (Table 8).

Table 8: Agro-chemical use in tomatoes.

	recommended by RCWD		Maximum	Haleku	Golba1	
name	**type**	**disease/pest**	**amount per hectare**			
Cocide	fungicide	early blight/late blight	600g	200g	800g	
Pencozem	fungicide	mildew	300g	200g	1000g	
Rodimol	fungicide	mildew	300g	200g	na	
Malatin	pesticide	spider, powder mildew	900mL	na	na	
					800mL	karate
					1200mL	landex

3.2.4 Green beans

Drought or water logging are detrimental for green beans. Also green beans are susceptible to salinity. Suitable soil types are light to moderately heavy and to peaty soils with near-neutral pH and good drainage. Crop rotation is necessary to limit diseases. About 48 kg/ha seed is used. 40 kg is planted immediately, while 8 kg seed is used to replace the drop outs. In Haleku the seed used ranges from 24-72 kg/ha. In Golba it ranges from 36-48 kg/ha. Green beans in RCWD-schemes are in general grown for Ethioflora, an export company for green beans. Ethioflora is supported by CFC-EPHEA. Because of this support, green bean growers in Haleku and Golba 1 get extension service from a fieldworker of the CFC-project. Recommended and observed cultivation practices are shown in the Table 9.

Table 9: Cultivation practices in green beans.

	According to RCWD	EPHEA	Observations Haleku	Golba 1
distance between plants (cm)	5	5	na	5
distance between rows (cm)	50	80	na	50-60
distance between furrows (cm)	50	160	na	50-60
depth of furrow (cm)	10.-15	20-25	na	5.-10
length of furrow (cm)	na	na	*700*	*700*

The recommendations of RCWD and EPHEA differ from each other and the actual practices in Golba 1 differ slightly from those recommended by RCWD. Also the fertilizer application recommendations of RCWD and EPHEA differ (see Table 10).

Table 10: Fertilizer use in green beans (kg/ha).

	recommendation by				derived from questionnaires			
	RCWD		CFC-EPHEA		Haleku		Golba 1	
	DAS *	amount	DAS	amount	DAS	amount	DAS	amount
DAP	**-14**	**200**	**-14**	**100-150**	**0**	**100-200**	**0**	**28-100**
UREA 1	15	75-100	21	37.5	0-30	48-200	15	16-100
UREA 2	45	75-100	35	37.5	21-40	48-50	30-40	25-100
UREA 3	>50	little	na	na	40	28	na	na
total urea		**150-200**		**75**		**50-200**		**16-200**

* DAS= Days after sowing

It did not become clear form the questionnaire how many days before planting farmers applied DAP. In Golba 1 some farmers apply less DAP than recommended. Not all farmers in Haleku seem to apply their urea as recommended. In both schemes, some farmers apply less urea than the recommendations. Only four agro-chemicals are recommended by CFC-EPHEA but farmers use much more (Table 11).

Table 11: Agro-chemical use in green beans.

	recommended by CFC-EPHEA		maximum	Haleku	Golba 1	
name	**type**	**disease/pest**		**amount per hectare**		
Pencozem	fungicide		3 kg	196-800 g	400-2000g	
Cocide	fungicide	Wagi	2.5 kg	60-160 g	500-2000g	
Karate	pesticide	boll worm	1.25 kg	50 g	200-800mL	
Abalon	pesticide	Spider mite	0.25 kg	na	na	
				60-4000 g	400-1200g	rodimol
				300-4000 g	400-1200mL	selecrole
					800mL	metigen
				100-800 g	800mL	indosulfide
				50 g		pampar
				60g		malatin
				200g		cerculin

3.2.5 Maize

Maize is suitable for tropical highland. Relatively maize has a low drought and salinity tolerance. The optimal pH range is from 5.5 till 7.0. The high yield of maize is a heavy drain on soil nutrients. Maize has a high demand for nitrogen. High nitrogen levels should be applied in three doses. It is advisable to apply organic manure to improve soil structure and supply nutrients (Schuiling, 2009).

In the RCWD-schemes different maize varieties are cultivated, BH540 and Zama have a growing period of 100-110 days, while BH 660 needs 147-155 days. The initial and development stage of BH540 and Zama takes 50-55 days, for BH660 this takes 80-85 days. All varieties are dried on stem for one month after the growing period. Most of the seed is grown for Meki-Batu union, a local union for fruits and vegetables. A fieldworker of Meki-Batu union gives extension service on maize cultivation in Haleku and Golba 1. Therefore, the recommendations of MB-union are included in the Tables with inputs and cultivation practices.

RCWD recommends 25 kg seed per ha, while MB-union recommends 45-65 kg seed per ha. Seed use by farmers in Haleku ranges from 16 to 48 kg/ha. Seed use by farmers in Golba 1 ranges from 13 to 40 kg/ha (Table 12).

Table 12: Cultivation practices in maize.

	According to		Observations	
	RCWD	MB-union	Haleku	Golba 1
distance between plants (cm)	15	22-25	15-30	15-25
distance between rows (cm)	80	75	45-75	40-60
distance between furrows (cm)	80	75	45-75	40-60
depth of furrow (cm)	15-20	20-30	10-15	10-15
length of furrow (cm)	*1000-1500*	*1500-2000*	*1500*	*1000*

Recommendations of RCWD and MB-union differ, especially the furrow depth. Considering fertilizer use, farmers in Haleku use the recommended amount, but the timing is not always in line with the guidelines. In Golba 1 farmers use less fertilizer than recommended (Table 13).

Table 13: Fertilizer use in maize (kg/ha).

	recommendation by				questionnaires:			
	RCWD		MB-union		Haleku (only BH660)		Golba 1	
	DAS	amount	DAS	amount	DAS	amount	DAS	amount
DAP	**0**	**200**	**0**	**200**	**0**	**200**	**0**	**0-100**
UREA 1	45	75-100	15	50	0-60	50-100	15-45	25-50
UREA 2	60-70	75-100	30	50	30-35	50-100	60	25
UREA 3	na	na	45-60	50	na	na	na	na
total Urea		**150-200**		**150**		**100-200**		**0-50**

Maize is not very prone to pests and diseases. Therefore it does not need much pesticides and fungicides. The three recommended agro-chemicals by MB-union fight the same pest (Table 14).

Table 14: Agro-chemical use in maize.

Maize	recommended by Meki-Batu union		Maximum	Haleku	Golba 1	
Name	**Type**	**disease**	**amount per hectare**			
Karate	Pesticide	stem borer	300mL	na	na	
Decis	Pesticide	stem borer	250mL	na	na	
Paranix	Pesticide	stem borer	300mL	na	na	
Malatin	*Pesticide*	*stem borer*	*300mL*	*na*	*200mL*	
				1600mL		pentioni

Malatin is recommended by RCWD, but it is not very effective according to MB-union. Interviewed farmers did not use any of the agro-chemicals recommended by MB-union.

3.3. Water use

3.3.1 Supply and scheduling

In Haleku each team receives generally water for half a day, while in Golba 1 water is supplied for the whole day. When there is no electric power cut or motor pump failure, beneficiaries are able to irrigate once every three days in Haleku. When there is no motor failure in Golba 1, beneficiaries can irrigate once every 6 days. However, this is not a rule and depends on the number of beneficiaries under irrigation.

In order to get water, the team leader requests water from the irrigation committee. The irrigation committee prepares a schedule and assigns the pump operator for a certain team. It did not become clear how the water committee establishes the irrigation schedule. When rainfall is low, the pump runs from 8 a.m. till 6 p.m. Because of the extra 4 ha in Haleku, the pump will run longer in future. Beneficiaries request water when they think their crop needs water or when their team is scheduled to receive water. Water requirements are often estimated based on experience taking into account the timing of the last water application and the appearance of the crop.

Only one team gets water at a time. In Haleku six beneficiaries per team are served at the same time. In Golba 1 the number of beneficiaries served simultaneously is 2 and sometimes 3. Sporadically more groups get served at the same time, but only when there are little beneficiaries with irrigated crops. Within a team, the irrigation time per plot depends on the crop and the supply area. Also there are differences between Haleku and Golba 1 as in the latter it depends on the distance of the plot from the main canal. When water availability is low (in the Bulbula) the irrigation period per field is shortened.

3.3.2 Water application

The water is conveyed by canals and ultimately furrows, which are blocked at the end to reduce surface drainage. Farmers switch to the next furrow after a furrow has been filled. Because most cultivated crops have a low tolerance to water logging, farmers use deep furrows. The depth of the furrows might influence the water use efficiency. Team leaders register the amount of applied water through estimating the time of water supply to the whole team. Subsequently, the application time is converted into kW (for electric pump) or liter diesel (for diesel pump) used. Each beneficiary pays according to his/her plot size.

Standard applications in Haleku according to one beneficiary (6 beneficiaries get served at the same time.)

- 0.25 ha of onions (about 180 furrows) 1-2 hours, depends on the uniformity of the furrows
- Bombe Red needs 12 irrigation times, Adame Red needs 14 irrigation times.
- For tomatoes 0.25 ha 1-2 hours, depend on the furrows. Needs 8 irrigation days.
- Green beans 0.25 ha just 1 hour (about 120 furrows) More water gives disease.
- Maize BH660 0.25 ha 2 hours (100 furrows) 16 times

Standard applications in Golba 1 according to one beneficiary differs per team, because of the distance to the main canal in combination with low capacity of the motor pump. Two farmers get served at the same time.)
For team 2:

- Onion 0.25 ha 3 hours (200 furrows)
- Tomato 0.25 ha 3 hours (100 furrows)
- Green Bean 0.25 ha 3 hours (150 furrows)
- Maize 0.25 ha 8 hours (150 furrows)
- For team 6 the application time is about 1 hour more.

3.3.3 Total water use

In order to gain insight in the water use of the RWCD schemes a rough estimation is made for Golba1 and Golba2, Golba 2 is another irrigation scheme under supervision of RCWD adjacent to Haleku. For Haleku a more precise estimate is made.
For the estimations the following information has been used:

- Discharge of the motor pump per second (Q in l/s).
- Consumption of litre diesel per hour or kWh electricity (C in l/h or kWh).
- Price per litre diesel or per kWh electricity (P in Birr/l or kWh).
- Total costs for diesel or electricity (TC in Birr per year).

Based on this information the total water use (in m^3) per year can be estimated by using the following formula taking into account the conversion of litre into m^3, and seconds into hours:

$$\textit{Total water use} = TC*P^{-1}*C^{-1}*Q*3.6$$

The price of diesel varies from week to week, but fuel bills were available of 2007, 2008 and begin 2009. For each year the average fuel price has been defined. The price of electricity has been the same for several years (Table 15). The prices are rounded up to minimize overestimation of water use. Data about the years before 2007 was not available in Ziway.

Table 15: Energy prices for RCWD irrigation schemes, 2007-2009

year	diesel (birr*L^{-1})	electricity (birr*kWh^{-1})
2007	5.5	0.7
2008	6.2 *	0.7
2009	8	0.7

* For 2008 only one fuel receipt was available, since the fuel was paid directly by IntermonOxfam.

The Haleku pump uses 55kW per hour at full capacity. Because the exact price per kW is known, a fair estimation of water use can be made. The pumps of Golba 1 and Golba 2 are the same: they use 3 L of diesel per hour at full capacity (70 L/s). In general, the pump is operating at a capacity of 50 L/s and uses about 2.5 L diesel per hour. With these figures it is possible to estimate the water use per year. The estimations of water use for Golba 1, Golba 2 might be further from reality than in Haleku, because the energy consumption per hour was an assumption of the pump engineer (Table 16).

Table 16 Water use (m3) in three RCWD-irrigation schemes during 2007-2009.

year	Golba 1	Golba 2	Haleku
2007	157133	119204	383566
2008	125762	115687	380833
2009	215543	185752	382267

Water consumption in Golba 1 and Golba 2 increased considerably in 2009 compared to 2007 and 2008. Because of lacking information on the cropping pattern it is not possible to explain these differences. Water use in Haleku has been very constant, while the cropping pattern (onion and green beans) in 2007 and 2009 was quite distinct from 2008. However the irrigated area in 2009 is less than half the size of the irrigated area in 2007, which suggests that water use has increased on the basis of irrigated area.

3.3.4 Water use efficiency

With CropWat (FAO, 2008) it is possible to estimate the irrigation water requirements for various crops taking into account prevailing rainfall. The water requirements divided by the calculated water use per cycle is an indication of the irrigation water use efficiency. Only for Haleku there is information available for more than one crop (Table 17). For Golba 1 only one calculation could be made.

Table 17 Water use efficiency calculations for Haleku in 2007-2009.

Year	period	Crop	Number of Beneficiaries	Area (ha)	Irrigation water applied (mm)	CWR (mm)	efficiency
2007	first cycle*	*Onion*	28	2,5	2033	303	0,15
2007	January-April	Green beans	64	30	1655	158	0,10
2007	third cycle	*Onion*	50	23	751	355	0,47
2007	October-January	Tomato	14	2,3	721	356	0,49
2008	first cycle	*Onion*	62	18	1371	303	0,22
2009	January-March	Green beans	62	14,75	1422	158	0,11
2009	2nd cycle	*Onion*	15	4,5	808	204	0,25

*Exact date is not known

The calculated water use efficiencies of crops ranges from 0.10 to 0.49. The water application for green beans seems to be done in a very inefficient way, but that may be related to the very low CWR estimates. Three water use efficiencies for onions grown in different periods of the year vary between 0.15 and 0.25. Another calculation for onions results in a water use efficiency of nearly 0.50, while these onions were cultivated during another period of the year. There is no clear relationship between water use efficiency and cultivated area.

Table 18 Water use efficiency calculations for Golba 1 in 2009.

crop	Period	area (ha)	mm applied	CWR (mm)	efficiency
Green beans	November-March	7,75	2159	202	0,09

The calculated water use efficiency for green beans in Golba 1 corresponds with those for green beans in Haleku, i.e. a very low water use efficiency.

In the calculations the methods to estimate the effective rainfall for crops differ between the rainy season and the dry season (Annex F). The climate data is derived from the New_LocClim (FAO, 2005), Annex G. For the Kc values of the crops standard values of CropWat have been used. For onion the Kc values are from Beshir (2009).

3.4 Economic performance

3.4.1 Yields and profits

In Table 19 production characteristics of Haleku are presented. What strikes are the low yields for all crops. Most likely, these data are not very accurate and therefore should be used with care.

Table 19: Production characteristics of Haleku 2004-2009

year	*period*	*crop*	*cultivated area (ha)*	*Production (ton)*	*yield (ton/ha)*
2004	2nd cycle	tomato	2.5	5.8	2.3
2006	2nd cycle	maize	17	38.7	2.3
2007	1st cycle	onion	2.5	5.8	2.3
2007	3rd cycle	onion	23	116.4	5.1
2008	1st cycle	green beans	5.75	3.9	0.7
2009	1st cycle	green beans	14	71	5.1

In Table 20 production characteristics of Golba 1 are presented. Yields are different from Haleku, especially tomato. The yield of maize and green beans is comparable with the yield in Haleku. Nowadays, yields in Golba 1 seem to be lower than in Haleku.

Table 20: production characteristics in Golba 1, 2004-2005

year	*period*	*crop*	*cultivated area (ha)*	*Production (ton)*	*yield (ton/ha)*
2004	2nd cycle	tomato	4	16.5	4.1
2004	3rd cycle	maize	20	54.5	2.7
2004	3rd cycle	onion	4.5	15.8	3.5
2005	1st cycle	green beans	17.87	83.5	4.7

In Table 21, the production costs for different crops in Haleku are presented.

Table 21: variable production costs for different crops in Haleku in Ethiopian Birr.

	2008		**2007**	
	10.6 ha maize (Apr.-Nov.)	**30 ha green Beans (Jan.-Apr.)**	**23 ha onion (third cycle)**	**2.3 ha tomato (Oct.-Jan.)**
seed	1711	*92256*	7000	248
DAP	8835	10570	5668	Not used
urea	Not used	11253	6507	243
chemicals	Not used	6986	9371	1050
fuel	Not used	11304	3243	Not used
electricity	1499	25456	10547	1774
*group**	5525	na	na	na
total cost	17570	165136	46672	3314
sale	na	244030	166034	15084
profit	na	78894	119362	11770
cost/ha	na	5505	2029	1441
profit/ha	na	2630	5190	5117

* *Group* covers, for example, the costs for the guards
** *Loss* and *profit* at the same time is possible, because some farmers face crop failure while others do not.

DAP and urea are a major share of the total cultivation costs, from less than 10% for tomato's to 50% for maize. The seed costs differ among crops. For beans the seed costs seem high, but this is because these costs also included other costs that had to be paid to Ethioflora who provided the seed. For Golba 1 the production costs per crop are unknown. The revenue, costs and profit over the last three years are shown in Table 22.

Table 22: Annual crop revenue, costs and profit, Haleku and Golba 1, 2007-2009

	Haleku		
	2009	2008	2007
revenue (birr)	52865	316343	355629
cost (birr)	102384	84139	139367
profit (birr)	-49519	232204	216262

	Golba One		
	2009	2008	2007
Revenue (birr)	22512	27650	*0*
cost (birr)	59527	24953	*139367*
profit (birr)	-37015	2696	*-139367*

Note that for 2009 there is a deficit in both schemes because not all the data has been collected. Asset depreciation of fixed assets of the irrigation beneficiaries is not deducted from the revenue. Also the costs for hiring labour are not included in the total costs, because these are at the expense of individual farmers. The production costs in Table 22 also do not include construction and maintenance costs, which are covered by RCWD (Table 23).

Table 23: Construction and maintenance costs, Haleku and Golba 1, 2007-2008

	construction and maintenance (birr)		
	Haleku	Golba One	Golba Two
2007	30421	17318	10088
2008	88886	48162	54805

The construction and maintenance costs are the costs for upgrading of irrigation scheme infrastructure. The costs for 2008 are higher because of an unexpected budget surplus.

3.4.2 Credit supply

Most of the beneficiaries in both schemes are dependent on credit supply to purchase inputs (i.e. seed, fertilizer, agro-chemicals, fuel/electricity and group expenses.) In Haleku 80-90% is dependent on credit. For Golba 1 this is 100%. The credit supply for production costs is provided by a revolving credit fund. In theory, the same amount of credit is used each year. However, the credit is supplied against 0% interest, which results in monetary losses. RCWD supplies each year new funds to fill up this gap; therefore the principle of the revolving credit fund is not really achieved by RCWD.

The losses are registered per beneficiary. After nine years the result for Haleku is 70,000 birr suspended expenses (non-paid credit loans) to recover input costs. Data about results of suspended expenses of Golba 1 are only available till begin 2006. This is an amount of about 135,000 birr. Note that these amounts are for the entire scheme, there are individually farmers who don't have any suspended expenses.

Suspended expenses are created when farmers have a net negative result after a cultivation cycle. It also occurs that suspended expenses of former cycles are suspended as well in the latest cycle. Therefore it is possible that individual farmers have saved some money and at the same time have some suspended expenses. Sometimes RCWD uses alternative sources to fill up the credit deficit for a while. In both schemes, beneficiaries complain that the credit is not enough. Some interviewed farmers said they need cash to cover costs for hiring labour.

3.4.3 Saving

Each cooperation has a bank account for administrative costs. This bank account is obligatory in order to receive the official status of irrigation cooperation. There is also a community account for all schemes. RCWD controls the community account of the beneficiaries. In this account all the net profits are saved. Haleku has saved 50,000 birr and Golba 1 has saved 20,000 birr. These savings are supposed to be used to buy new productive assets for the next generation or expansion of irrigation activities. When there is not enough budget for the purchase of inputs, RCWD takes money from this account or other resources to fill the gap. The balance at the start of 2007, 2008 and 2009 for all beneficiaries in all schemes was respectively 24,711, 38,049 and 424 Birr. If the account continues to decrease, less funds will be available for productive assets.

4 Discussion

RCWD will have to develop an exit strategy for their irrigation schemes before March 2011 when donor funding stops. Currently, the studied irrigation schemes heavily depend on support from RCWD. After 9 and 7 years of support for Haleku and Golba 1, respectively, there is an urgent need for strengthening the capacity of farmers to secure a sustainable future for both schemes. Two main, interrelated topics for the cooperatives are the organizational sustainability and financial management. Lack of responsibility and low participation of farmers weakens the cooperatives and endangers the sustainability of both irrigation schemes. Extension services on agronomy, organization/management, irrigation and environment somehow do not seem very successful. Water use efficiency is rather low, though calculations on efficiency are tentative only. (Economic) performance differs from beneficiary to beneficiary, but the overall view shows that the performance of cooperatives is low. The performance of Haleku is better than Golba 1 because the latter seems less organized and it faces frequent pump failures increasing the stress on the system. Since water losses during conveyance are higher for tail-end water users, pumping costs of tail-end users in Golba 1 are higher. Other differences between head and tail-end farmers were not found in both schemes.

Without improvement in organization and financial management of the cooperatives, the sustainability of the RWCD schemes is at stake. Therefore, any exit strategy should address these topics explicitly. In this respect, it is necessary to investigate the factors that contributed to the current situation. Internal and external factors are distinguished and options identified for the way forward.

4.1 Internal factors

The revolving credit fund against 0% interest is one of the major factors that contributed to the financial dependency of beneficiaries. Which beneficiary would not like 1000 birr now instead of four months later? Such non-market-based interest rates are unsound and deplete the available revolving credit fund. By introducing more market-based interest rates, the fund will become less attractive, but will be able to fill up the gap in the revolving credit fund when some beneficiaries are not able to pay back loans. When both cooperatives are no longer supported by RWCD beneficiaries have to lend money from other sources applying market-based interest rates.

Frequently, beneficiaries are not able to pay back their loans. Crop failure due to adverse weather conditions and/or malpractices is/are major causes. Because RCWD supplies the loans, they decide whether they will suspend the expenses for a beneficiary that can not pay back his/her loan. Until now RCWD has been very generous towards the beneficiaries by suspending the expenses. However this creates dependencies on RCWD for beneficiaries and lessens their own initiative. Also the financial balance seems not good as the suspended expenses exceed the savings. Major concern is that RCWD uses the savings of beneficiaries to fill the gaps of the revolving credit funds.

The savings are collected by RCWD as a fixed percentage of the returns of individual farmers. The percentage is now 5%, but RCWD tries to increase this percentage as it does not cover the costs for new investments. Therefore, raising this percentage by RWCD is recommended but it should be done by the cooperatives themselves so that they gain financial management skills.

Low participation is a problem in both schemes that influences the trust among farmers. How to strengthen collaboration of beneficiaries is a big challenge. Extension service should not be focussed only on the theory of management, but more on interactions between farmers and how they can be influenced to collaborate within the cooperative. Another point is the enforcement of the management committee to enhance participation, an issue also recognised by RCWD. Enforcement of the bylaw is threatened by one measure, i.e. the fine system. Within four steps a beneficiary can be excluded from the scheme (section 3.1.2). The first three steps are very light penalties which do not really affect farmers, while the fourth step is the exclusion of a beneficiary. The difference between the third and the fourth step seems too large for a committee to enforce. Therefore, the first three penalties should be modified in such a way that offences of the bylaw are reduced and enforcement of the fourth step becomes easier.

4.2 External factors

Accessibility to the market is a big problem in the CRV. The schemes have a good outlet to Meki-Batu union for maize and Ethioflora for green beans. Selling tomatoes and onions is more difficult. Currently, RCWD provides information to the cooperatives concerning market prices, but beneficiaries still complain about low prices at the time of selling their products.

Availability of qualitative good tomato and onion seed is low. Supply of seed for beans and maize is good. Accessibility to the input market for seed and output market may be improved through collaboration with the Meki-Batu union. Up to now collaboration with Meki-Batu union is limited to green beans and maize but results have been positive. Therefore, Meki-Batu union should be considered as an option for the cooperatives to improve access to input and output markets.

4.3 Repercussions for the agronomy

The combination of poor crop management and low quality seed causes high drop out ratios and associated low crop yields. Probably, the estimated water use efficiencies are lower than calculated because of the low planting density. By using seed of higher quality drop outs can be reduced. Another option is re-seeding of the crop, i.e. after seed germination, new seeds are sown in those places where seeds did not germinate. For tomato and onion this means that extra seedlings need to produced in the nursery.

Poor crop management is a result of inadequate knowledge and skills of beneficiaries. Though farmers receive extension it seems that many are not very responsive. Extension should not be the literal translations of handbooks and blueprints, but need to enhance the capacity of farmers to act properly under various conditions. At this moment each beneficiary seems to have his or her own opinion on what is good and bad. Some beneficiaries with good agronomy skills realize high yields, but less performing farmers do not follow. Therefore, a pilot farm may enhance the capacity of farmers but is not a guarantee for success.

Crop rotations are important to reduce soil-borne and other diseases. Regularly, farmers opt for short-term economic benefits and neglect soil quality aspects resulting in very tight crop rotations. This will certainly result in problems in the mid or long-term. In this respect the choice for potato to diversify the existing production portfolio is not recommended because it is family of the tomato and prone to the same diseases.

Because of the low soil fertility and the lack of organic matter in the surrounding area, all beneficiaries who can afford it, purchase inorganic fertilizers DAP and urea. The timing of application is often not according to the recommendations resulting in poor crop appearance in the field. If that happens, the crop is already stressed and fertilizer applications are often too late to avoid yield reductions. In recent years the price of DAP and urea has increased considerably, which has put an increased claim on the revolving credit fund. Organic fertilizers may provide a cheap alternative to farmers, but organic matter is scarce. Possible external sources of organic matter are Sher Ethiopia and buffer zones but their suitability and feasibility needs to be assessed. At scheme level, alfalfa or other legumes may be planted along ditches and canals. Such crops can provide high quality biomass for different purposes including the enrichment of soil organic matter. An additional benefit of such crops may be an increase in water holding capacity of the soil. An incentive to stimulate the use of organic fertilizer is to decrease the available credit fund for inorganic fertilizer.

4.4 Repercussions for irrigation

Improving the soil organic matter content through the use of organic fertilizers may decrease the demand for irrigation water. However, without changing the water scheduling in Haleku, this will probably not contribute much to increased profits. For Golba 1, a higher water holding capacity of the soil could release the pressure on water scheduling. In both schemes the crop irrigation water requirements are established on experience (rules of thumb) and observations. These may work well in view of the crop needs but seem to result in the over supply of water as indicated by the low to very low water use efficiencies.

Another point is the poor state of the irrigation canals. The concrete main canals in both schemes were in poor condition resulting in leakages. Maintenance of the earthen canals was low during the time of research. The irregular shape of the canals and the weed growth in the canals slows down the water flow and is a cause of water loss that can be easily prevented. But this will require commitment and participation of beneficiaries in canal maintenance and other common activities. How to improve participation is discussed in section 4.1.

4.5 Repercussions for organization

Lack of information and data is a major bottleneck in the identification of problems and options in both RCWD schemes. It all starts with registration of beneficiaries and their actual land size. Currently no reliable information is available on beneficiaries and irrigated land holding. But also a better monitoring of the performance of individual farmers would be helpful to identify poor performers in an early stage and enable early and targeted interventions at the individual level.

5 Recommendations

The following recommendations are proposed contributing to the sustainable development of both cooperatives:

- Review the current information on the irrigation schemes, i.e. land size, number of beneficiaries, cultivation records etc.

- Improve the monitoring of the scheme, e.g. cultivation per plot per year in stead of per scheme, but also better monitoring of the scheme infrastructure and water use.

- Review the current way of water supply and avoid irrigation during hot periods of the day.

- Maintain and improve canal structures.

- Use more market-based interest rates in the supply of credit.

- Promote the use of organic fertilizer, for example through creating linkages between cooperatives and potential organic matter suppliers like the nearby greenhouses.

- Review the bylaw and change it in a way that it is better equipped to deal with the low participation in communal activities and the low repayment of credit of beneficiaries.

- Create ownership among the beneficiaries for their crops and scheme. The development of a learning platform for <u>all</u> beneficiaries, for example, through pilot plots in the scheme could be instrumental to realize that goal.

6 Literature

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7 Annexes

Annex A: Query sheet for WUA/frontline worker

Organization structure (schematic):

Facilities (which, when and in what magnitude) for irrigation scheme created by WUA:

- Maintenance: How is it organized? Are farmers willing to help?
- Extension provision: How is it organized? Do farmers attend the extension sessions
- Operation: How is it organized? Enough water at the right time?
- Credit: How is credit supply organized?
- Pesticides supply: Which pesticides? Enough at the right time?
- Fertilizer supply: Only DAP and UREA? Enough at the right time?
- Seeds/plants supply: which varieties? Enough at the right time?

Income generation of WUA:

Fees paid by farmers: For what exactly and how much and how often? Discipline in payments?

Is WUA supported by other external organizations/institutions than RWCD: For what, in which way, how much and how often?

Is there interest from own capital?

What is the influence of the WUA on a farmers (individual) crop choice?

What is the influence of the WUA on farmers (individual) inputs/outputs:

What is financial contribution (or in kind through support in financial administration, extension, maintenance pump, etc.) of RWCD?

Annex B: Query sheet for irrigation scheme properties

Name:
Location:
Active since:

Pump	1	2	3
Type			
Capacity			
Energy source			

Sub-section*	1	2	3	4	All sub-sections
area (ha)					
number of beneficiaries					
average area per beneficiary (ha)					
number of plots					
average area per plot (ha)					
average number of plots per beneficiary					
ratio female/male of beneficiaries					

**Sub-sections are made on base of head/tail end situation of the section. A maximum of four sub-sections is preferred.*

Estimated average discharge per year/month/event per sub-section:

Estimated overall water use:

Type of deliverance:
    On demand/Supply driven:
    How often:

Design information (including a map):

Additional information:

Annex C: Survey sheet for farmers

Date: Time: Location

Head of household:

- Name:
- Age:
- Gender:
- Position(s) in cooperation:
- Family in cooperation:
- Family in team:

Family size of household:
Distance from home to field:
Way of transportation:
Number of plots in irrigation scheme:

plot nr.	sub-section
1	
2	
3	
4	

Total area in irrigation scheme:
Total (rain-fed) area outside irrigation scheme:

Crop rotation current year*:

Plot nr.	Dec.	Jan.	Feb.	March	April	May	June	July	Aug.	Sept.	Okt.	Nov.	Dec.	Jan.
1														
2														
3														
4														

**Probably this crop rotation table has to be made suitable for the Ethiopian calendar.*

Estimated yield (kg):

plot nr.	Crop 1	Crop 2	crop 3
1			
2			
3			
4			

Estimated revenue (birr):

plot nr.	Crop 1	Crop 2	crop 3
1			
2			
3			
4			

Are you satisfied with:

- **The roads**
- **The canals**
- **The fields**
- **The organization**
- **Water supply**
- **Crop choice**
- **Extension service**

How do you choose your crop? What is most important?
(Economical factors, convenience, market accessibility, input from cooperation)
Additional information:
What is the number and the kind of livestock you have? For what purpose?

Annex D: Input table

Assessment inputs per plot in first cycle 2009

plot number …	Name	amount	when applied	where purchased	remarks
pesticide 1					
pesticide 2					
pesticide 3					
pesticide 4					
pesticide 5					
pesticide 6					
fertilizer 1					
fertilizer 2					
manure 1					
manure 2					
crop residues					
seed/seedlings					

plot number …	Name	Amount	when applied	where purchased	remarks
pesticide 1					
pesticide 2					
pesticide 3					
pesticide 4					
pesticide 5					
pesticide 6					
fertilizer 1					
fertilizer 2					
manure 1					
manure 2					
crop residues					
seed/seedlings					

plot number …	name	Amount	when applied	where purchased	remarks
pesticide 1					
pesticide 2					
pesticide 3					
pesticide 4					
pesticide 5					
pesticide 6					
fertilizer 1					
fertilizer 2					
manure 1					
manure 2					
crop residues					
seed/seedlings					

Annex E: Observation sheet for plots

Date:
Time:
Plot owner:

Plot number …	1	2	3	4
crop grower				
plot length				
plot width				
plot area				
Actual crop				
Distance between plants (cm)				
Distance between rows (cm)				
Distance between furrows (cm)				
Depth of furrows (cm)				
appearance of crop (scale 1-10, 1 = worst , 10 = best)				
uniformity of crop (scale 1-10)				
ratio of drop outs				

Annex F: Rainfall and effective rainfall

Monthly rain - C:\Documents and Settings\All Users\Application Data\CROPWAT\data\r...

Station: Adami Tulu   Eff. rain method: Fixed percentage

	Rain	Eff rain
	mm	mm
January	30.0	24.0
February	52.0	41.6
March	95.0	76.0
April	128.0	102.4
May	166.0	132.8
June	209.0	167.2
July	213.0	170.4
August	210.0	168.0
September	183.0	146.4
October	93.0	74.4
November	66.0	52.8
December	32.0	25.6
Total	**1477.0**	**1181.6**

Monthly rain - C:\Documents and Settings\All Users\Application Data\CROPWAT\data\r...

Station: Adami Tulu   Eff. rain method: USDA S.C. Method

	Rain	Eff rain
	mm	mm
January	30.0	28.6
February	52.0	47.7
March	95.0	80.6
April	128.0	101.8
May	166.0	121.9
June	209.0	139.1
July	213.0	140.4
August	210.0	139.4
September	183.0	129.4
October	93.0	79.2
November	66.0	59.0
December	32.0	30.4
Total	**1477.0**	**1097.4**

Annex G: Climate data

Monthly ETo Penman-Monteith - E:\Haleku.pen

Country: LocClim_Single_Point   Station: Adami Tulu

Altitude: 1760 m.   Latitude: 7.00 °N   Longitude: 37.00 °E

Month	Min Temp	Max Temp	Humidity	Wind	Sun	Rad	ETo
	°C	°C	%	km/day	hours	MJ/m?/day	mm/day
January	7.5	28.1	62	95	7.2	18.7	3.75
February	9.3	28.3	63	104	6.5	18.6	3.90
March	11.3	29.0	68	173	6.4	19.3	4.41
April	12.6	28.2	71	130	6.5	19.5	4.17
May	13.1	27.2	77	104	6.1	18.3	3.75
June	13.1	25.5	83	104	5.2	16.6	3.28
July	13.1	24.3	89	95	3.6	14.3	2.79
August	13.1	24.7	86	104	4.1	15.5	3.03
September	12.8	25.5	82	86	5.1	17.2	3.36
October	11.0	26.3	74	95	6.8	19.2	3.75
November	8.6	27.2	72	69	7.2	18.8	3.56
December	7.6	27.2	70	69	7.6	18.8	3.48
Average	**11.1**	**26.8**	**75**	**102**	**6.0**	**17.9**	**3.60**