Water availability at farm household level

– a case study in the Nyando district in South-Western Kenya

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Front-page picture: Women collecting water in a well, Onjiko, Kenya. Photo: Erika Näslund

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Preface

This Bachelor project, worth 15 credits, was performed as a Minor Field Study funded by a scholarship from the Swedish International Development Cooperation Agency (SIDA). The project was carried out in collaboration between Vi Agroforestry in Kisumu, Western Kenya and the Department of Crop Production Ecology, Swedish University of Agricultural Science (SLU) and I greatly appreciate the opportunity given to me.

I would like to give my thanks to my supervisors, Ingrid Öborn for her assistance during the preparations and finish of the work and Ylva Nyberg, for her great help and tutorial, especially during the field work in Kisumu. I would also like to thank all the staff working at the Vi agroforestry office in Kisumu for their help and their warm welcome. Further I would like to thank all the field officers assisting us during the farm visit. A special thanks to all the farmers and their families who let us visit their homes and shared their knowledge that made it possible for me to finish this report. I greatly appreciate the help we got from ICRAF and from the other people we met who shared important information with us.

Abstract

Water is an essence of life, both for animals and plants. Still we are unable of supporting the world's human population with water. The amount of water on earth is unevenly distributed. Some areas suffer more from dry periods than others and according to FAO (2010) people that live in poor, developing countries suffer the most from these problems. Kenya has a bi-modal rain distribution, meaning two rainy seasons and two dry seasons and suffers from both draughts and floods. In Kenya 80 percent of the population practise agriculture as a livelihood and many of them are small-scale farmers with an average farm size of less than two hectare. The aim of this project was to survey the water sources and water management strategies at farm household level in the Nyando district, Nyanza Province, in Western Kenya, and estimate the volumes used per day for the farm. 19 farms were selected and visited and interviews regarding water were held with the owner or the supervisor of the farm. At the same time a visual analysis was made on the farm and the distance to the water source was measured. Interviews with local experts with knowledge in the field, water management, were also performed. The water sources used for each farm varied a lot. Sources used were rivers, water taps, shallow wells, ponds, mountain wells and rainwater tanks. Some of the sources were located close to the farm and others could be placed two kilometres from the farm. This led to different workload for the people on the farms. Women were most often the ones responsible for collecting water but some farms had donkeys as a help and one farm had a bike. The furthest distance to walk for one person to collect water was almost 13 kilometres per day. The farmers had different problem regarding the water. Dirty water and salty water was common. Other problems the farmers had to deal with were long distances and problem with money when you had to pay for water. Even though the water availability varied with the season 13 out of 19 farmers had experienced an improvement in the water availability over the past ten years. Water availability is a problem in the area and to be able to improve the living conditions people have to think ahead, save for poorer periods, learn from each other and cooperate.

Sammanfattning

Vatten är en livsnödvändighet för både djur och växter. Trots det kan vi inte försörja hela världens befolkning med vatten. Vattnet på jorden är ojämnt fördelat, en del områden lider mer av torka än andra och enligt FAO (2010) lider människor som bor i fattiga utvecklingsländer mest utav de här problemen. Kenya har två regnperioder om året och drabbas av både torka och översvämningar. 80 procent av populationen lever av jordbruket och många är småskaliga jordbrukare med en gårdsstorlek på mindre än 2 hektar. Målet med det här projektet var att kartlägga vattenresurserna och vattenhanteringsstrategierna för familjer i Nyando distrikt, Nyanza province i västra Kenya och estimera volymen som används varje dag på gården. 19 gårdar valdes ut och besöktes och intervjuer som handlade om vatten hölls med ägaren eller handledaren av gården. Under tiden gjordes en visuell analys av gården och utrustningen, och avståndet till vattenkällan mättes. Intervjuer med lokala experter i området vatten gjordes också. På de olika gårdarna fanns många olika vattenkällor. De använde floder, kranvatten, grunda brunnar, dammar, bergskällor och regnvattentankar. Några av de här källorna fanns på gården medan andra låg två kilometer därifrån. Det här ledde till att olika gårdar behövde arbeta olika mycket för att skaffa vatten. Kvinnorna var ansvariga för att hämta vatten men en del gårdar hade hjälp av åsnor och en gård hade en cykel. Det längsta avståndet att gå för en person för att hämta vatten var nästan 13 kilometer per dag. Gårdarna hade olika problem vad gällde vatten. Smutsigt och salt vatten var vanligt. Långa avstånd och problem med att få ihop tillräckligt med pengar för att köpa kranvatten var andra problem bönderna var tvungna att lösa. Vattentillgången varierade över året och det har skett en förbättring de sista tio åren. Vattentillgången är ett problem i området och för att förbättra levnadsstandarden måste människor ligga ett steg före, spara för sämre tider, lära av varandra och se till att samarbeta.

Contents

1 Introduction

Today, mankind has in general a lot of knowledge and skills that goes way beyond that of their ancestors. However, we are unable of supporting the world's human population with what is essential; water, food and shelter. According to FAO (2010) people that live in poor, developing countries suffer the most from these problems.

Kenya has a population of around 38 million people (NE, 2010). It is a country with a varying landscape consisting of savannah, tropical rain forest and semi arid areas. In the country over 80 per cent of the population work within the agriculture sector (Vi Agroforestry, 2010), which is the base of the country's economy (SIDA, 2010). Kenya as many other countries lack food and water (SIDA, 2010). Almost half of the population is poor and they are unable to support themselves with their every day nutritional needs (IFAD, 2011a). The lack of water is mainly due to the waves of drought but there are also other reasons for the water crises (SIDA, 2010). Uneven share of the water, major deforestation, an enormous increase of the population, tripled over the last 30 years (IFAD, 2011a), and trouble with good management of the water supply are other factors making it harder for the population. Water availability is crucial for food production, both for crops and livestock (NE, 2010). Some areas suffer more from dry periods than others and these areas require livestock specially adapted to that harsh environment and a lot of work from the farmers.

Western Kenya has bimodal rain distribution, which means two rainy seasons, one shorter rain period in September-November and one longer in March to May (NE, 2010). Close to Lake Victoria, lies the Nyando district in the Nyanza province. The capital city in the province is Kisumu, a large urban centre connecting most of Western Kenya with the lake. The vegetation surrounding the city is mainly shrub and grassland that dries up a lot at the end of the dry periods. This area, as many others in Kenya, is dominated by farming (SCC, 2006). The ability to have livestock, above all cows, is important for the households, but they also consume a lot of water (Ong'or *et al.,* 2007). The local animals are well adapted to the environment, coping with the heat and the African conditions but they give a low milk yield (Millogo *et al.,* 2008). Farmers have therefore started to buy western *Bos taurus* breeds such as Holstein and they cross the local *Bos indicus* (Zebu) with those western breeds. The crosses and pure-bred (upgraded cows) often struggle in the African conditions and they need a lot of water and high quality feed to be able to produce a reasonable amount of milk. This adds to the problem of providing water for the household, when the family already has trouble finding water for themselves. Many families travel three to four hours per day to collect water from shallow wells (reviewed by Hansen, 2004). This stops women from having an alternative income and girls from attending school (SIDA, 2009).

1.1 Objectives and hypotheses

The overall goal of this thesis was to study water access (how to reach the water) and water availability (amount of water you can use when you reach it) at farm household level in the Nyando district, Nyanza Province, in Western Kenya. The aim of this project was to survey the water sources and water management strategies at farm household level and estimate the

volumes used per day for the farm. Water sources were divided into the following parts; household consumption, irrigation and livestock.

Hypotheses of this study were that:

1. The water source is often located far away from the farm (>500 m) and the collecting of water is mainly performed by women.
2. A household uses less water if the water source is further away, or difficult to access.
3. Water is a limiting factor considering how many animals to keep.
4. Water availability has become a bigger problem over the past 10 years.

The study was divided into two parts (two BSc theses projects), tightly linked and the field work carried out at the same time, but with different aims. The aim of the other project, done by Lina Wallberg in the subject area of animal science, was to understand the relationship between the milk production and water consumption in local and upgraded (cross- and pure-bred) dairy cows and goats.

2 Literature review

2.1 Water access

Over 70 percent of the human body consists of water and three days without water often results in death. These things considered it is not hard to understand that water is the most important essence for health, success and wealth in the world (reviewed by Zeman *et al.,* 2006). The earth is made up to two thirds of water but over 97 percent of that water is salty and present in the oceans (Zeman *et al.,* 2006). Water is also stuck in glacial and polar ice and as a permanent snow cover. The water available for human use is only 0.01 percent of the total water amount on earth. The water is also very uneven distributed. When Surinam has 289848 m^3 available freshwater/person/year, Kenya has only 947 (Zeman *et al.,* 2006).

There are several health problems related to water in the world, involving both lack of water and the quality of water (Zeman *et al.,* 2006*).* The developing world still has the furthest way to proceed before solving many of these problems. A big challenge is to provide people with water of drinking quality, for example not infected by sewage or industrial pollutants. Today around one billion people in the world, one out of six, have hardly any choice but using an unwholesome water resource and around two billon people has no access to a basic improved latrine (WHO and UNICEF, 2004). The world, being unable to solve these problems leads to millions of people living with poverty and diseases. Contaminated water is the cause to around 4.37 billion diseases yearly and most of the victims are children (Zeman *et al.,* 2006). Malaria is one water-related diseases and it causes millions of death each year.

Sub-Saharan Africa is still considered to be one of the areas with the least developed water system, with 42 percent of the population using unimproved water resources (WHO and UNICEF, 2004). Kenya is according to FAO (2011a) to be considered as a water scare country. Many people depend on basins and rivers and the water is unevenly distributed. The agriculture uses most of the water, up to 80 percent, and the rest is shared between commercial and domestic use (FAO, 2011a). The unequal share of the water creates a lot of conflicts between water users especially in the northern part of the country.

2.2 Environmental aspects

Today it is accepted that the world is affected by climate changes and it is also accepted that the ongoing changes are not going to stop (Verchot *et al.,* 2007). It is furthermore concluded that the people suffering the most are the ones living in developing countries. In developing countries, like Kenya, a big share of the population depends on agriculture as their livelihood. Agriculture has already been affected negatively by the changes but the conditions will probably get worse (Verchot *et al.,* 2007). Small-holder farmers in developing countries do not have the resources to adapt to the changes. The climate changes have already affected Kenya through more frequent droughts and floods and thereby declining yields over the past decades (IFAD, 2011a). Environmental degradation is another factor having a big influence on Kenya. Incidents like soil erosion, poor water management, land degradation and declining soil fertility are commonly experienced in the country (IFAD, 2011a).

A big part of the domestic livestock in Kenya today is kept in a traditional way, free-grazing. Free-grazing means that the animals are herded around grazing everywhere during the day and taken back to the farm during the night (Bebe *et al.,* 2003). The increase in the population has led to an increase in the amount of animals; the pressure of the land has exceeding its carrying capacity (Review by Sindiga, 1984). Bad grazing routines lead to overgrazing and further to erosion when nothing holds the particles in the soil together. When the drought is taking place nothing will grow and the ground is left bare. Streams and dams are drying up and farmers are cultivating the soil without preparation and that does further contribute to the erosion (Sindiga, 1984).

Water, is as seen, a connecting factor in many of the above-mentioned issues. The climate changes have an influence on water in many ways. The changes create irregular rainfalls, raised see levels, runoffs, problems with erosion and transformed soil water content. The erosion is further heavily affected by the rainfalls (Verchot *et al.,* 2007). Irregularity and scarcity of something as essential as water has a big influence on the people (Verchot *et al.,* 2007) and in times with scarcity of water the people put a high pressure on the resources in the country. Thereby the education as wells as income, employment, food security and health become affected (IFAD, 2011a). The lack of water during some periods and the abundance during others, together with poverty and population growth is causing many problems in Kenya today (IFAD, 2011a).

2.3 Water problems in Kenya

Kenya is a country were many of the water sources, lakes, rivers and ponds, are not suitable for drinking (Lalah *et al.,* 2008). Many of these sources provide nevertheless the inhabitants with their daily water use. Point source pollutants are, among others, the remains from industries, dairy factories, sugar processing, paper mills, distilleries, breweries and the fish industry (Scheren *et al.,* 2000). The wastewater from the cities is another big source of pollutants. A lot of the water is not being processed before let out in the nature again.

Rivers around Kisumu city show high levels of electrical conductivity (Lalah *et al*., 2008). This is an indicator of high salt contents in the water, contaminated by among others industrial effluents. Many watercourses have also higher turbidity (particles in the water) than the international recommendations (Lalah *et al.,* 2008). High levels of heavy metals are another problem regarding drinking water in the region (Oyoo-Okoth *et al.,* 2010). Big shares of these disposals are linked to the effluent from large cities. People wash their cars in the lake and rivers and that is another source of pollutants in the water (Ongeri *et al.,* 2010).

Kenya, as many other developing countries in the world is going through a rapid urbanisation (Otisu & Owusu, 2008). People move to the cities and this is creating overcrowded slums and shantytowns. These areas are unplanned and the houses are built extremely close to each other (Wambui *et al.,* 2007). All these households are in need of water and sanitation facilities. In many areas the water is collected from shallow wells dug by the family. Pit-latrines are the most common used for defecation even though many children use the open field (Wambui *et al.,* 2007). Latrines and shallow wells need to be kept apart to avoid the water being infected from microorganisms from the faeces. The minimum distance separating the latrine and the

well should be 30 metres, but in the slum areas they can be seen at a distance of only two metres. In a study proceeded in a slum area in Eldoret by Wambui *et al.* (2007) coliforms were found in all samples taken from shallow wells. Coli forms are an indicator of contamination to faecal matter and water containing coli forms is not suitable as drinking water (WHO, 2008).

2.4 Lake Victoria

The second largest freshwater lake in the world is the 68 800 km^2 big Lake Victoria (LVFO, 2011a). The fishery in the lake is large and considered as one of the largest fisheries in the world, yielding around 800 000- 1 million tons per year (LVFO, 2011b). The lake has attracted a lot of attention over the past decades because of drastic ecological changes. In the mid 80's a new fish, the Nile perch, was introduced in Lake Victoria with the intention of reaching a more profitable fishing industry. Instead of having many small fishes one big would be better for the industry and the money making (Andersson *et al.,* 1961). The goal was almost fulfilled too well with the Nile Perch taking over the whole lake leading to other fish's extinction. This lead to food webs in the lake being simplified and as a result the lake became eutrophic (Witte *et al.,* 1992). As a consequence of the dramatic change in nutrients an enormous increase of water hyacinths took place in the lake. By 1998 it covered around 200 km^2 of the lake (Sitoki *et al.,* 2010). Since the worst condition in the lake during the 1980s the Nile perch has been reduced (LVFO, 2011b) and the conditions of Lake Victoria have improved (Sitoki *et al.,* 2010). It looks like the super saturation of oxygen in the top layer (caused by the algal blooms) has declined and there is hardly any evidence of lasting deoxygenation at deeper levels anymore.

Lake Victoria is today a vital ecosystem for around 30 million people in the countries surrounding the lake (Swallow *et al.,* 2009). The lake has high levels of nitrogen and phosphorus due to deposition from the atmosphere and municipal centres as well as high amounts of land runoffs (Scheren *et al.,* 2000). The soil from the run offs also creates a high turbidity (particles in the water) in the lake. Drinking water should have a turbidity of less than five NTU (Nephelometric Turbidity Unit) and Lake Victoria has sometimes values as high as 130 NTU (Agwanda, 2011 personal message). The water is considered not to be suitable for drinking but despite that many poor people depend upon the water from the lake for their daily use (Agwanda, 2011; Obango, 2011 personal message).

2.5 Small-scale farming

In Kenya people mainly practise agriculture for a living and approximately 70 percent depend upon it (FAO, 2011b). Small-scale farmers have an average farm size of two hectare or less (Livingstone *et al.,* 2011). They often integrate crop production (food and cash crops) with dairy production (Bebe *et al.,* 2003). The reason for that is to decrease the risk of depending on one single crop or one single livestock unit. Small-scale farmers often keep their animals for family use and not as economically beneficial business (Kosgey *et al.,* 2008). They use output from the animals such as milk, manure and meat for the household and utilize non-arable land as feed source. The livestock are mainly used as a supply of money, a bank. They can be sold in case of emergency or if extra money is needed.

Crops produced for own use in Western Kenya is maize, cassava, sorghum and sweet potato (SCC, 2006). Crops produced for commercial use, yielding money, are sugar cane, rice, cotton and coffee. The dominant milking animals used are different breeds of Zebu cattle, but also small stock of goats and sheep are kept (Kenya Food Security Meeting, 2010). Other animals used are chickens and sometimes pigs, and donkeys as working animal. The local Zebu cattle are adapted to the climate and have higher tolerance level against drought and diseases than non-domestic breeds (Hansen, 2004; Ruto *et. al.*, 2008). Factors such as low productivity, breeds that do not produce well, bad control of diseases and lack of water are reasons that restrict the development (Kenya Food Security Meeting, 2010).

Small-scale farmers depend upon rivers and streams, but pipes and boreholes are also built at some places in the area to make it easier for the population (SCC, 2006). The water many people use is insufficient and unsafe to drink and many of the sources varies with the season, creating rough times during drought. The people often have to walk long distances to reach water.

2.7 Women farmers

In rural areas in developing countries live the women farmers whose lives are characterized by extreme poverty (SCC, 2010). Kenya is a country where the heavy work on the farm is mainly carried out of by women (IFAD, 2011b). Gender roles follow even today traditions and cultural roles in rural parts of Kenya. Women are taking care of the animals, the crops, the children, the fetching of water and firewood and most of the other farm duties. The women are accordingly the people making sure that the children and household get sufficient nutrient and that their health and development are increasing (Wallingo, 2009). More and more men are moving to the cities where the chances of getting a better-paid job are higher (IFAD, 2011b). Women are left alone to run the farm and the duties earlier made by men are more and more transferred to the women. Their already heavy workload is getting even bigger since none of their normal responsibilities are taken over by the men.

Fetching water is an everyday business for these women. In a study by Lasage *et al.* (2008) dams had been constructed in Kitui district located 150 kilometres east of Nairobi. These dams could hold water as a reserve for drier periods. Before the dams were built, the average distance to the water source varied markedly between the wet season (1 km) and the dry season (4 km). After the dams were constructed the average distance to the water was one kilometre in the wet season and one kilometre in the dry season. This led to increased in water availability and the domestic water use rose with around 50 percent and the agricultural use with 100 percent. This led to larger farm yields and the farmers also started to grow crops with higher demand of water such as, tomatoes, fruit trees and onions. The average increase of the income, for farmers living close to the dams, was 60 percent. Changing the access of water can change women's lives (IFAD, 2011b). When the local access to water is improved a lot of time is saved for these women.

3 Materials and Methods

3.1 Study site

This project was performed as a Minor field study funded by SIDA. It was carried out in collaboration with Vi Agroforestry in Kisumu between January and March 2011. The field work was performed in Nyando district in the Nyanza province in Western Kenya (Figure 1). The area is located around 40 kilometres southeast of Kisumu (latitude 0.11-0.35° S, longitude 34.75-35.05° E) with an altitude ranging from 1123 to 1473 metres above sea level.

Figure 1: Map of Kenya (left) and the study area southeast of Kisumu (right) (Nationalencyklopedin, 2011; Google maps, 2011).

The area has two rainy periods, the long rains between March and May having its peak in April, and the short between September and November (SCC, 2006). Kisumu receives an average rainfall of 1141 millimetres per year (BBC, 2011; Fig. 2). The average monthly temperature ranges between 17-29° C but the minimum and maximum temperatures can vary between 12-37° C.

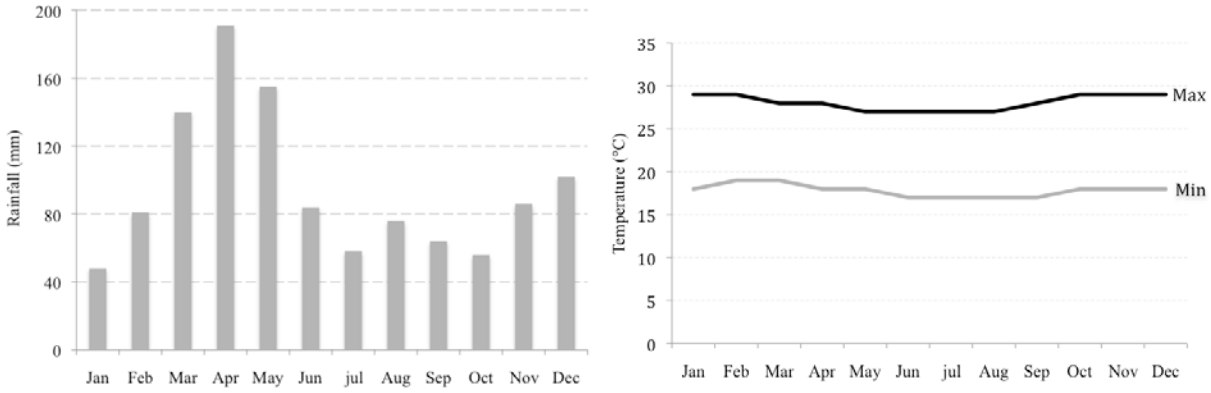

Figure 2. Precipitation (left) and average monthly temperature (right, max and min) in Kisumu, the climate station closest to the study site (BBC, 2011).

The area is divided into five divisions and the divisions into locations and sub locations. Two main rivers flow through the area, Sondu Miriu and River Nyando, both are draining into

Lake Victoria (Kenya Food Security Meeting, 2010). These rivers are two major sources of drinking water for the people living in the area. Apart from these two rivers the area depends upon other rivers and streams, earth dams and sometimes roof catchment for their water use (SCC, 2006). Pipes and boreholes are also built in some areas.

Grassland and scattered trees/woodland and shrubs mainly cover the area visited. Most of the people are small-scale farmers and the dominant animals used are different breeds of Zebu cattle, but also small stocks of, for example, goats and sheep are kept (Kenya Food Security Meeting, 2010). The people also use land for crop production (SCC, 2006). The area is poor; around 60 percent of the people live below poverty line (1.25 USD/person/day) (SCC, 2006).

3.2 Vi Agroforestry

Vi Agroforestry is a non-governmental organisation (NGO) funded in Sweden in 1983 (V Agroforestry, 2011). Their aim is to improve the living conditions among small-scale farmers in the Lake Victoria basin in East Africa. Supporting farmer groups with field advisors they are promoting agroforestry, planting a mix of trees and crops, and thereby they contribute to decrease the poverty among farmers. Trees are essential since they create new possibilities. Threes contribute with firewood, feed, shade, decrease of erosion, etc. It also has an economic value, a help to finance unpredictable costs.

Vi Agroforestry work with education (Vi Agroforestry, 2011). They spread their knowledge about farming techniques and agroforestry to small-scale farmers helping them to help them selves. Women are important in Vi Agroforestry's work and that leads to improved living conditions for the family and strengthening of the woman's role in the society.

Vi Agroforestry works in the countries surrounding Lake Victoria basin, Kenya, Uganda, Rwanda and Tanzania. In Kenya they have an office in Kisumu and it was there this study had its base.

3.3 Field work

The fieldwork was divided into four parts 1) semi-structured questionnaires 2) visual analysis 3) weighing and measuring and 4) interviews with local experts. The questionnaires were the basic and largest part of the farm study and information about water management and live-stock on the farm was gathered. During the visit a visual analysis were made to get the overall picture about the farm and measurements were made to confirm the information gathered from the farmer.

3.3.1 Questionnaire

Staff at the Vi Agroforestry's office in Kisumu contacted their local field officers in the area. Four different field officers at four different locations in Nyando were contacted. They were to select farmers that could be interviewed, in their working area. A total of 19 farms were selected. The criteria the field officers were given were farms with milking animals, either cows or goats. Both local breeds and pure/cross breeds were needed to be able to notice a difference in the milk amount and water demand between the breeds (mainly important for the second project performed by Lina Wallberg). When the farms were selected all farms were

visited for approximately 2 hours each. During the visit at the farms questions were asked based on a questionnaire with three parts, general information, questions regarding water and questions regarding animals (Appendix 1). This project is focusing on the two first parts. The interviews were held with the owner or the supervisor of each farm and the questions were asked varying by two persons and both were taking notes. An interpreter was used during the conversation with the farmers.

3.3.2 Visual analysis

On each farm a visual analysis was made and pictures were taken to document what was seen. Special attention was put on water tray, water storage, water buckets and feed storage. Details noted were whether the things were clean and whole, and what material that was used. Whether the water was clean and fresh was also noted. The water source was visited. Notes were taken regarding what kind of water source it was and if the water looked clean. The way to the water source was walked to see the quality of the road. Pictures were taken.

3.3.3 Weighing and measuring

Weighing and measurements were also made on each farm. If possible the filled water buckets and the amount of water given to the animals were weighed. GPS positions were taken on each farm so as at the water source. The distance between the house and the water source were measured using GPS.

3.3.4 Interviews

Two local experts with knowledge in the field water quality and water management were contacted, Peterlis Obango and Paul Agwanda. Interviews were held with the two, no questionnaire was used and general information about water availability, water management and water quality etc. in the area was gathered. That information was later used as a reference in the discussion part of the report.

3.3 Data evaluation

Excel was used to calculate correlations between parameters. The statistical formula (Olsson *et al.,* 2005) below was used to estimate correlation between distance to water source and amount of domestic water used per person and day. It was also used to estimate the correlation between total amount of water used per day on each farm and number of people in the household as well as the correlation between water used per household per day on each farm and number of people in the household.

$\bar{x}$ = mean value for the first parameter x_i = all values for the first parameter

$\bar{y}$ = mean value for the second parameter y_i = all values for the second parameter

$$r = \frac{\sum_{i=1}^{n}(x_i - \bar{x})(y_i - \bar{y})}{\sqrt{\sum_{i=1}^{n}(x_i - \bar{x})^2}\sqrt{\sum_{i=1}^{n}(y_i - \bar{y})^2}}$$

4 Results

4.1 Farm and household characteristics

The 19 interviews included some general information about the farm (Table 1). All farms visited were small in size with a mean value of 0.93 ha, ranging from 0.1 – 1.4 ha. The majority of the farmers visited were women (13) compared to men (6). The number of people living on the farms was varying, with a lowest value of three and a highest value of twelve persons per household. The level of education for the owners of the farms were also very diverse and was categorized as follows; no school (16%), primary school (26%), secondary school (53%) and collage (5%). Some farms had full time employees and some farms had seasonal employees, hired during shorter periods, harvest for example.

Table 1: General information about the farmers visited.

Farm no	Farm size/ha	Owner/worker	School background	People in household	Children in household	Employee
1	0,2	W/W	No school	7	6	none
2	0,6	W/W	Primary	6	5	1 full time
3	0,8	M/W	Secondary	7	4	6 seasonal
4	0,6	W/W	No school	12	7	none
5	0,6	W/E	Collage	3	2	1 seasonal
6	0,8	W/W	Secondary	12	10	2 full time
7	0,3	M/M	No school	5	3	none
8	1,4	W/E	Secondary	3	2	1 full time
9	0,3	M/W	Secondary	7	5	none
10	1,4	M/W	Secondary	11	9	none
11	1,0	M/W	Secondary	12	10	none
12	0,1	W/W	Secondary	9	7	none
13	1,2	W/E	Primary	5	4	2 full time
14	1,4	M/W	Secondary	4	2	none
15	1,4	W/W	Secondary	3	1	none
16	2,0	W/W	Secondary	8	6	none
17	0,8	W/W	Primary	3	2	none
18	1,2	W/W	Primary	9	8	none
19	1,2	W/W	Primary	7	6	1 seasonal

W = woman; M = man; E=employee (young man) No = not finished primary school; Primary = finished primary school (year1-8); Secondary = finished secondary school (year 9-12); Collage = finished collage

The farmers had a varying amount of livestock (Appendix 2). Some of the farmers had upgraded animals and some had local breed. The most common to own was local cows (74% of the farmers), local goats (58%), sheep (63%), upgraded cows (42%) and upgraded goats (42%) (Figure 3). The farmers also had smaller animals as chickens, cats and dogs and some owned donkeys.

Figure 3. Pure-bred goat in shed (left) and local cows grazing (right). Photo: Lina Wallberg

4.2 Water sources and water use

The farmers visited did not use the same kind of water sources and some of them also had different water sources for domestic use and animal use. This visit was made during the dry period and the results are based on that. All farmers got more alternatives as soon as the rain started. The sources used were tap water, rivers, ponds, shallow wells (defined as a borehole less then 30 feet deep), rainwater tanks and mountain wells (water from up the hill/mountain led through a pipe to a place where the people are able to collect it) (Figure 3).

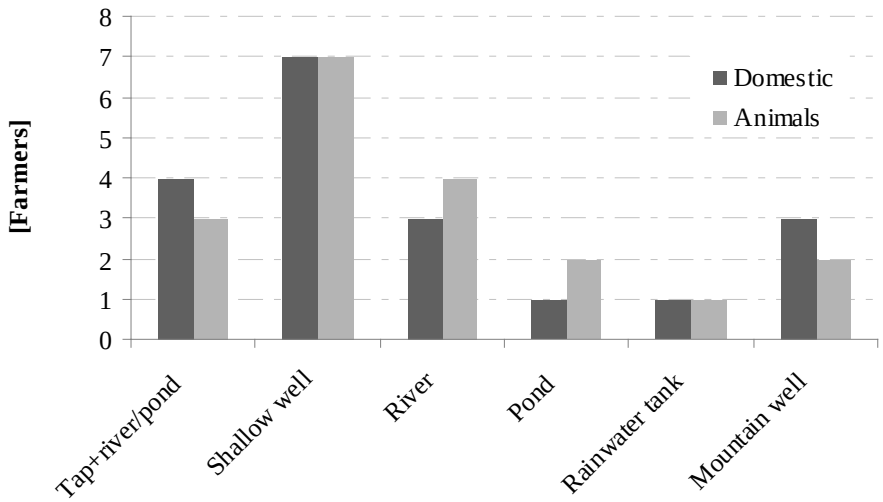

Figure 4: Water sources for the farmers visited; the domestic use and the water used for animals (n=19 domestic; n=19 for animals). Shallow well is classified as a hole in the ground, less than 30 feet. Mountain well is water from up the hill led through a pipe to a place where the people are able to collect it. If the animals got water only when grazing is defined as river.

The farmers collected different amounts of water for their farms each day varying from 60 L/day to 600 L/day (Table 2). The water was used for different purposes, household, watering the plants or watering the animals. All people had to collect water for the house hold, the most

essential thing. Since it was dry period during the time of the study many of the farmers had to collect water for their animals. The ponds and rivers they used to bring them to had dried out. Other farmers visited still had the possibility to take their animals to the water source even if it was further away in some cases. Some farmers both brought the animals to the water source and gave them water by the house. Bringing animals back and forth was only done with local breeds. Only 4 farmers had water enough to water their plants.

No correlation could be seen between number of people in the household and total amount of water brought back using statistical tools. Number of people in the household and water for domestic use did not correlate either.

Table 2: Water information; total amount of water brought back to the farm, and the use of it (L/day).

Farm number	Water for house hold	Water for plants	Water for animals	Total amount collected
1	-	-	-	600
2	140	0	60	200
3	200	0	0	200
4	140	0	60	200
5	40	0	40	80
6	200	0	200	400
7	60	0	0	60
8	160	0	80	240
9	100	0	80	180
10	80	0	240	320
11	20	0	60	80
12	100	100	40	240
13	250	20	50	320
14	100	140	80	320
15	-	-	-	*Did not know
16	40	20	60	120
17	80	0	20	100
18	80	0	80	160
19	80	0	60	140

**Had well on farm but did not count the amount used.*

4:3 Distance to water source

The distance to the water source varied markedly (Table 3). Some farms had a shallow well on the farm and some had a one-way distance of around 2 kilometres. The average distance to the water sources was 575 m. The distance to the water source and the amount of water collected per person for domestic use is shown in figure 5. No correlation between the amount of water per person and the distance could be shown using statistical tools.

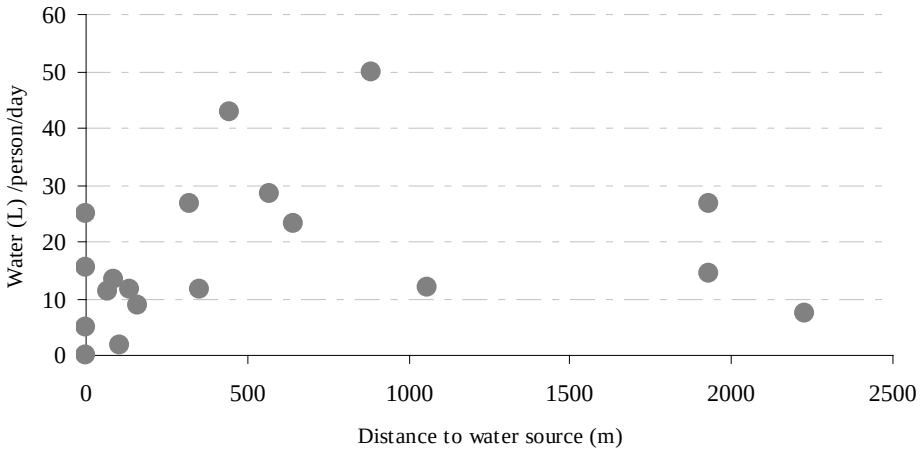

Figure 5: The distance to the water source compared with amount of water per person per day, domestic use, on each farm (n=18).

4.4 Workload

Since different farms had different distances to the water source and collected different amount of water the workload for the people collecting the water on the farms varied a lot. The workload depended on the distance to the water and the number of people participating in the work. One person could walk a distance of 21 km every day to collect water, or the water source was located on the farm. The people collecting used 20 litres (L) jerry cans (Figure 6). They carried one jerry can at the time. The amount collected varied from 0-200 litres per person per day. Some farms used donkeys (60 L at the time; Figure 6) and one farm had a bike (40 L at the time).

Figure 6: Donkey carrying water for the household (left) and a woman carrying water and dishes (right). Photo: Lina Wallberg

Table 3: Distance to water source and persons collecting the water. Workload for the people on the farms; amount collected per day and distance walked per day.

Farm-number	One way distance to water source (m)	No of persons collecting	No times walking /day/person	Total distance (m) /person	Amount carried (L) /person each time	Amount of water collected (L) /person/day
1	446	1W 2G	10	8920	20	200
2	645	1W	10	12900	20	200
3	570	2W	5	5700	20	100
4	353	2W	5	3530	20	100
5	89	1W	4	712	20	80
6	On farm	anyone	-	-	-	-
7	1060	1M+bike	1	2120	60 /bike	60
8	1930	1E+ 2 donkeys	2	7720	60 /donkey	240*
9	1930+228**	1W	5+4	21124	20	180
10	2230	1W 1M+donkeys	4	17840	W-20, donkey-60	320*
11	104	anyone	4	832	20	-
12	71	anyone	12	1704	20	-
13	883	1E+ 2 donkeys	2	1766	80 /donkey	320*
14	On farm	anyone	-	-	-	-
15	On farm	anyone	-	-	-	-
16	On farm	anyone	-	-	-	-
17	321	1W	5	3210	20	100
18	161	2W	4	1288	20	80
19	136	anyone	7	1904	-	-

W=woman, G = girl and M = man, all from household; E = employee (young man)
** donkeys carried the water*
*** different water source for domestic use and animals*

4.5 Person responsible for collecting the water

The women were in most cases responsible for collecting water on the farm (8 of 19), even though the whole family helped out in some cases (Table 3). As seen in figure 7 there is a relation between the distances to the water source and who is collecting the water. When the distance to the farm was less than 200 m anyone collected water in 8 out of 10 cases. When the distance was 200-700 m it was only women who did the collecting. At an even longer distance four out of five farms used some sort of help (donkeys or bike). Interesting is to further look at the short distance (<200m) to distinguish who collects the water. The person responsible for collecting water is often the one taking care of the farm and in 15 of the 19 cases a woman is doing the work on the farm (Table 1).

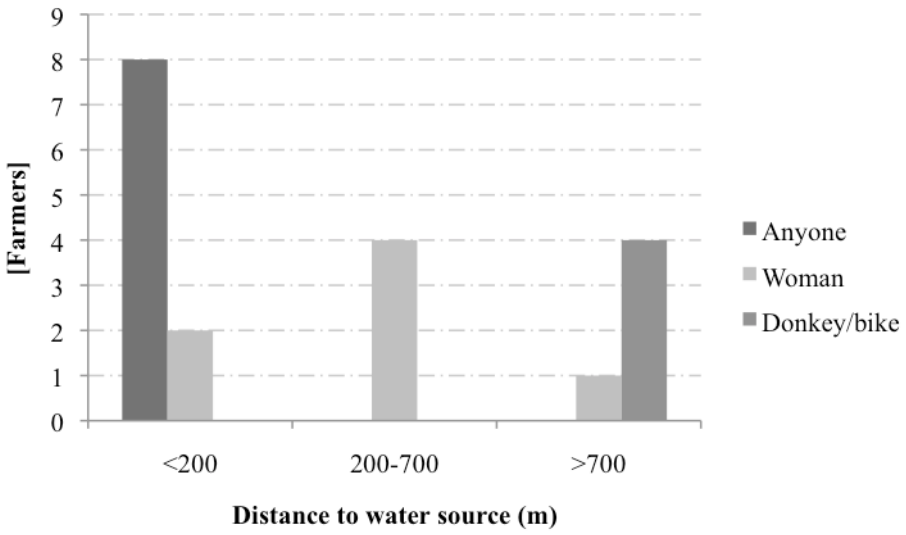

Figure 7: One way distance to water source related to the person collecting.

4.6 Effects of water shortage

The area was very dry during the study period and 5 out of 19 farmers mentioned water as a reason for not having more animals. Of the 14 people answering that water was not limiting, 8 said that water was an indirect factor for not having more animals. No water means shortage of feed and for those farmers feed was the main reason for not having more animals. 11 out of 19 farmers reuse water in some way, (ex. wash the dishes and water plants, give the water to animals thereafter) and 4 out of 19 farmers store water for longer periods than on daily basis (Appendix 3).

Asking the farmers about their biggest problem with the water following categories came up; cost of water (money), scarcity of water, water being dirty, water being salty and collecting of water being time-consuming (Figure 8). There was just one farm that did not have any problem with the water. That farm had a shallow well located directly on the farm. All farmers having access to tap water faced the problem of not being able to buy enough water because the expense of it (5 shilling=0.33 SEK /20 L). The farmers having problems with water being salty had water in a shallow well. They had enough water but no good quality. Farmers with rivers or ponds had to deal with dirty water or long distance (time consuming) (Figure 9). The farmer having a rain water tank did during dry periods not know how much water to use since she did not know when the rain was to start again. She did only have that tank to rely on and had to be very frugal if she was to have water all year through. Time consumption included both to have long distances and that it took time to collect the water. Some had to dig to find water and others had to wait in line to get water (Figure 9).

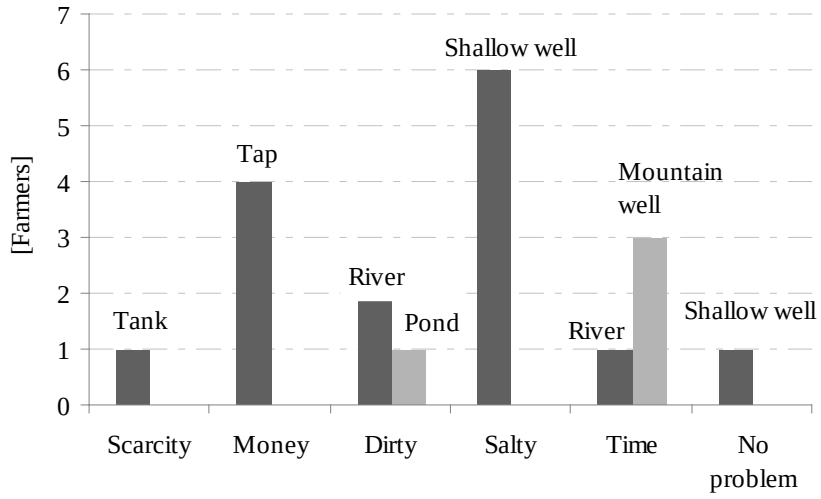

Figure 8: The biggest problem with the water for the farmers visited. Written above the bars is the water source used for domestic use on the farm for the farmers facing those problems.

Figure 9: Dirty water taken from a pond, used both for animals and the household (left). Women digging for water in an almost dry river (right). Photo: Lina Wallberg

4.7 New events

Out of 19 farms six had seen no change in the access of water within the past 10 years (Figure 10). The other farmers had had an improvement in the water access, including getting tap water, shallow wells, pipe water and tank for storing rainwater. Only one mentioned that it was currently worse than earlier, with the river now drying out during the dry season.

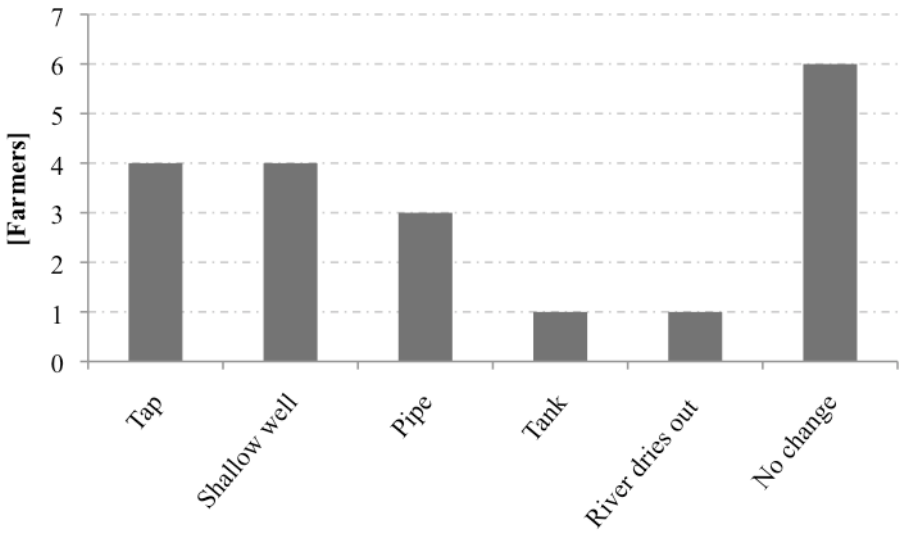

Figure 10: New events the last 10 years leading to a change in water access.

5 Discussion

5.1 Water use

The aim of this study was to get the overall picture of the water access and the water availability for farmers in the Nyando district in Kenya. During the interviews questions about amount of water collected, amount of water given to the animals and amount used for other purposes was asked and all questions regarding quantity were very uncertain. This is a major source of error in the project. It was hard for the people to estimate amount, weight, length etc. It did not always match with our own measurements. To get more reliable results more own measurements and monitoring would have had to be done, but there were a limited amount of time to spend on each farmer.

This project was performed during the dry period so the vegetation was poor and many farmers had problems finding enough water. Farmers fetched water both for the household, the crops and the animals. Every farm had to fetch water for the household for drinking, cooking and cleaning, since that is an essential need. This could not be put on hold and everyday women and children fetching water could be seen in the area visited. Watering the plants was put second, (4 out of 19) the farmers did not have enough water for that procedure. Many plants also looked very dry and the feed planted for the animals was growing limiting. Further 11 out of 19 of the famers visited reused water in some way, the water first used for cooking and then for watering plants or livestock for example. This is an indicator of that the people are aware of the situation and try to improve there living conditions. 4 out of 19 stored water for longer periods. The storing requires big tanks and few people were able to have that because the expense of it. The storing of water for longer periods leads to bigger opportunities for the farmers since they are not so vulnerable during the dry periods (Lasage *et al.* 2008). All of the people stored however water in jerry cans or barrels during the day or the following days.

Water for animals are also essential during the dry periods and 17 out of 19 farmers collect part of the daily water for the animals. Many of the farmers mentioned that they both took the animals to the water source and gave them water in buckets at the farm. Taking the animals to the water was only done with local breeds and the pure breeds were always kept at home (Appendix 4). The local breeds were kept free-grazing as is common in Kenya (Bebe *et al.*, 2003). Upgraded breeds however were mainly kept zero-grazing. This creates different routines for the farmers. If the animals were only on the farm, the farmers had to collect a lot of water and feed. If the animals instead were taken away to eat and drink someone had to take care of the animals. In both cases people were needed for the job.

5.2 Water availability

The availability of water is a problem in the area. Only 4 out of 19 farms, had access to tap water (Figure 4). Many people had no choice but taking water from an unsafe source, both salty water and dirty water was common. Dirty water and scarcity of water can lead to water borne diseases such as cholera and diarrhea (Obanago, 2011). Diseases affect the family negative, having an impact on income, food safety and the potential to develop (IFAD, 2011a).

Dirty water was in this project connected to rivers and ponds (Figure 6). People living downstream a river can face the risks of contamination from waste products from both industries and domestic use, as was shown in a study by Scheren *et al.* (2000). People also wash their cars in the rivers and ponds contaminating them with grease and other poisonous substances (Ongeri *et al.*2010; Obango, 2011). If the family had access to tap water the money issue became a problem instead (Figure 8). The farmers had to pay money (5 shilling=0.33 SEK /20 L) and stand in line for tap water and therefore chose to use the dirty, free water instead. This was the case in the whole area (Agwanda, 2011; Obango, 2011) and that is partly due to the fact that 60 percent of the people in the area live below poverty line. They uses less than 1.25 USD (8.25 SEK) per person and day (SCC, 2006) and thereby have problems paying for water. The farmers also mentioned an insecurity to rely on tap water since the water access was unevenly distributed. Some days there was plenty of water and some days there was no water.

Some of the farmers visited tried to improve their everyday life by making the access of water easier. The whole community cooperated and built together water pipes drawn from uphill down to the village. Instead of going all the way up on the mountain the people collected the water from pipes near by. This led to shorter distances to the water source and thereby a lot less work for the people responsible for the fetching. In the same village many of the farmers visited had upgraded animals. This was mainly due to one woman, that several years ago, was brave enough to buy a pure-bred cow. She spread her knowledge and other people in the area saw her concept and that it work and thereby they also had the courage to do the same thing.

5.3 Distance

The distance to the water source plays an important role for the family. The fetching of water takes both time and energy. The distance varied widely in the project. Some people had the water source on the farm and some had a one way distance of two kilometers (Table 3). As assumed in the hypotheses the average one way distance to the water source was more than 500 meters (575 m). There was however no correlation between distance to the water source and amount of water used per person in the household (Figure 5). As stated in the hypotheses that less water would be used for the families with their water source further away could not be show statistically. Further there was no correlation between number of people in the household and total amount of water used. The family had regardless of conditions to spend time collecting water since it is an essence of life. Even though no statistical significant correlation could be seen between number of persons in the household and total amount of water used a relationship could be seen. Connecting factors for the families using a small amount of water per person and day (10 L or less) were that they had many family members and unreliable water sources (Appendix 4). They used for example tap water without access everyday, they had to walk long distances and one used a water tank that just had a limited amount of water that had to last until the next rain. The families with a lot of water per person and day were fewer family members and had more reliable sources. As in the study by Lasage *et al.* (2008) a reliable source close to the home plays an important role for the family since it improves their living conditions. A reliable source close to the home means larger water consumption which leads to higher yields and thereby more money.

5.4 Workload

On 7 out of 19 farms women were responsible for the fetching of water (Table 3). The procedure of collecting the water was tightly linked to distance to water source (Figure 7). If having a distance of further than 700 meters, 4 out of 5 families had some sort of help, a donkey or a bike, and this could not be seen on the shorter distances. Both donkeys and bikes cost money but apparently it is profitable to have help when having longer distances. The time the farmers can save can be used for other purposes. The medium distance was almost taken care of by women and on the short distance, less than 200 meters, anyone in the household could collect the water. Anyone, meaning the person taking care of the farm and in 15 out of 19 cases a woman was responsible for the work done (Table 1). The gender aspect that a woman often takes care of the farm, as is the case in parts of rural Kenya (IFAD, 2011b), was showed in this project. Men found it very strange to help out with the fetching of water. Roles are however shifting and the old traditional way of doing things is disappearing more and more (Agwanda, 2011).

A woman's life can change a lot if the water source is easy to access (IFAD, 2011b). In the most extreme cases in this study one person could walk a total distance of 21 km per day and collect almost 200 liters (Table 3) and this is a task taking a lot of energy. In this project the distance to the water source was measured and walked. The paths were sometimes very tricky to walk on. They were rocky and steep both down hill and uphill (Visual analysis). The women carried 20 liters on their heads and it was common that they had to stay in line by the water source. Some of the farmers also had to dig for water during the dry periods when the river was dried out. Waking up early was also necessarily since coming late to the water meant long ques. Collecting water does not only affect women during dry periods, it is a procedure affecting the whole family (Obango, 2011). The family members have to wake up early to fetch water far away. Girls skip school in order to collect water and the boys cannot attend school either since they have to take the animals grazing and drinking.

5.5 Yearly changes

The part of the country where this study took place has a varying annual rainfall ranging from 190 mm/month during the rainy periods to 50 mm/month during the dry periods (BBC, 2011). These variations lead to the area being very dry during some periods. All farmers in the study mentioned a change in the water access throughout the year (Appendix 4) with the rainy season leading to easier access of water. Many of the farms had options of smaller water sources close to the farms during wet periods and had to walk further distances during dry periods. This is the same finding as Lasage *et al.* (2008) did in their study. The people also had possibilities to collect rainwater from the roof during the rainy periods which all farmers did (Appendix 4). The climate changes further add to the problems, the dry periods are becoming even drier and the wet periods even wetter (IFAD, 2011a). Heavier rains fall during shorter periods creating floods. The variation and the irregularity of the seasons make it hard for the farmers since they have always grown their crops dependent on the rain (Agwanda, 2011). Now it is hard for them to determine when to start planting since they can no longer predict when the rain will begin to fall.

5.6 Water shortage

Some of the families visited had to use unsafe drinking water since they did not have any other option. Both dirty and salty water was drunk. “You get used to it” a woman visited said about salty water. Some farmers boiled the water before using but this was not always the case. It is time consuming and requires more resources, for example more fire wood (Agwanda, 2011). Since scarcity of clean water is a big issue in the area, organizations try to help people building taps and boreholes continually, but it takes time before everyone have gotten an access to tap water since the conditions now are very bad (Agwanda, 2011). Many of the farmers did also mention a change in the water access over the past ten years (Figure 10). As suggested in the hypothesis that it would be harder to find water today was incorrect. Many of the farmers have instead got an improvement in the water access including the possibility to use shallow wells, taps and water tanks.

Farmers visited stated water shortage as a problem for not keeping more animals and this was also one of the hypotheses. 5 out of 19 farmers mentioned it as a direct factor. They were not able to provide more animals then they had with drinking water. If the water was not a problem the feed was limiting since scarcity of water leads to scarcity of feed. During dry periods the grass becomes very limiting and the famers have to walk long distances to collect feed for their animals (Appendix 4). Considering the feed, 8 out of 19 mentioned water as an indirect factor for not having more animals. They would not be able to give their animals enough feed if they had more numbers. Since livestock is an indicator of wealth the water is an indirect factor for people living in poverty.

Even though water is a big issue in itself it is not an isolated problem, but linked to other factors. The farmers mentioned feed as a reason for not having more animals so more feed per animal would be valuable. This can be reached in several different ways. The farms visited were very small in size (Table 1) therefore an opportunity for each famer to have more land to grow feed on would be very important. A better use of the land would also be positive and education about farming and fertilizers to get higher yields would therefore be essential. To get high yield or grow certain crops and vegetable requires water. Building dams that can hold water for drier periods would therefore be an option. In a study by Lasage *et al.* (2008) building of dams was done and it led to higher yields and more money for the farmers. For this to be done in the area education about the procedure would probably be a great help for the people living there. Fewer free-grazing animals would reduce the high pressure on the land. Today a great share of the farmers has smaller animals as goats and sheep only as insurance (sold if money is needed) or as a meal for special occasions (Agwanda, 2011). They graze the land and are not used in the mean time. Being able to have livestock that produce milk or wool would give the farmers something in return. If having high producing animals fewer animals would also be needed, but having one animal instead of ten is a bigger risk for the farmer.

6 Conclusion

Farmers in the area have problems with water. Both distance to the water source, scarcity of water and water quality are daily problems for the farmers. It is however hard to find a solution of the problems. Many organizations are building water taps and bore holes, but since the conditions are very bad it takes a long time to reach everyone. To get an improvement the farmers have to do something themselves. Some of the farmers visited had visions; they cooperated and tried to improve the living conditions for the whole village, by for example decreasing the distance to the water source. Cooperating is of major importance since doing things by yourself is expensive and time consuming. Making people be aware of the advantages of cooperating, being able to use each others knowledge, resources and capital, is central. Women are the people doing most of the work on the farm, such as the fetching of water. Traditions are somehow holding back the development. Men find it very strange to collect water themselves. “It is women duty” a man visited said. Theses traditions are however changing, more and more men are taking part in the daily work (Agwanda, 2011). Being more people collecting water decreases the workload for each person. Reaching farmers with new knowledge is an ongoing project in the area for among all organizations as Vi Agroforestry. Knowledge is essential in many of the procedures leading to development and better living conditions for the farmers; how to build bore holes and create dams, what to do to get higher yields and high producing animals. It requires courage to take the risk of selling all your local cows and buy one upgraded animal. Knowledge of how to take care of it and knowing what are the advantages are essential. Reaching water has however become easier over the past ten years. There has been an improvement of water facilities, taps and bore holes has been built. This progress will proceed but people also have to think ahead, save for poorer periods, learn from each other and cooperate.

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Appendix 1-questionaire

Without colour used in this part of the study, grey colour used by Lina Wallberg.

Questionnaire **Date:_____**

Farm-name/-number:_____

Owner:_____
Supervisor (who takes care of the farm):_____
How big is the farm (acre)?_____
What school background do you have (supervisor)? _____

If you got 100 000 shillings for improving your farm, what would you like to do? _____
_____
_____

1a.How many children are living/taken care of on the farm?_____
1b. How many of them are girls and how many are boys? Girls:_____ Boys:_____

2. What do the children living on the farm do?

	In school	At home	In school and at home
Boys			
Girls			

3. How many people are helping out on the farm in total?_____

Farmliving woman	Farmliving man	Other person

If other person:_____

4. How many animals do you have? (separate paper)

5a. Do you have all your animals together? Yes: _____ No: _____
5b. If no, how do you keep them?_____
_____
_____
5c. What do you do with the calves? (feed, age when not sucking) _____

_____
_____

6. How do you decide what male you will use? Access to males? _____
_____
_____
_____

7a How many and what times of the day do you milk your animals?_____
_____

7b. What do you do with the milk after milking?
Use it directly:____ Part:_____ How?_____
Store it:_____ Part:_____ If yes, how? Where?_____
Sell it:_____ Part:_____ If yes, to whom?_____

8. Do you milk all the time between the offspring? Yes: _____ No: _____
If no, how long are they not milking?_____

9a. What feed do you give them? (ask until they don't answer any more) _____
_____
_____
_____

9b. Any dairy meal?_____
_____

9c. How often and what time of the day?_____
_____

9d. How much/each time?_____

10. What distance do you have to walk to reach feed for your animals? (With or without animals?)
Kilometres:_____ Time:_____ Around the farm:_____

11. Do you store feed? Yes:_____ No:_____ If yes, how and where?_____
_____
_____

12a. Do you give your animals salt? _____
12b. Do you know if there is any salt in their feed? _____
_____

13a. How do you get your water?_____
_____
_____

13b. Do you use the same water resource for animals and people/everyone on the farm?
Yes:_____ No:_____ If no, what are the differences?_____
_____
_____

13c. If collecting, how does this work?_____
_____

_____

How much per time:_____
Water resource:_____
How often/day:_____
How many collect each time: Man:_____ Woman:_____ Girl:_____ Boy:_____
Other methods to collect water (rainwater):_____

14a. Do you store water? (for drier periods) Yes:_____ No:_____ If yes, how?_____
_____
_____

14b. Do you reuse water in any way? (washing hands, vegetables)_____
_____

15. Do the access to water vary between the seasons?
Yes:_____ No:_____ If yes, how?_____
_____

16. How much water do you give your animals per day? _____
_____

17. Would you be able to collect water for another animal? Is water limiting?
_____
_____
_____

Our own measurements:
1. Weighing feed/animal:_____
_____
2. Collect feed (about 1 kilo).
3. Weighing the milk amount:_____
_____
4. GPS-positions.
GPS-positions: Farm:_____ Water:_____
5. Wright down the distance between the farm and water resource:_____
6. Weigh the water for animals/day:_____

Visual analysis:
1.Watertray:_____
_____
2.Milkbucket:_____
_____
3. Milk storage:_____
_____
4. Feed storage:_____
_____
5. Waterstorage:_____
_____

Take pictures of:

1. Watertray
2. Milkbucket
3. Milk storage
4. Feed storage
5. Water storage
6. Water resource
7. Other water resource
8. Animals

How many animals do you have?

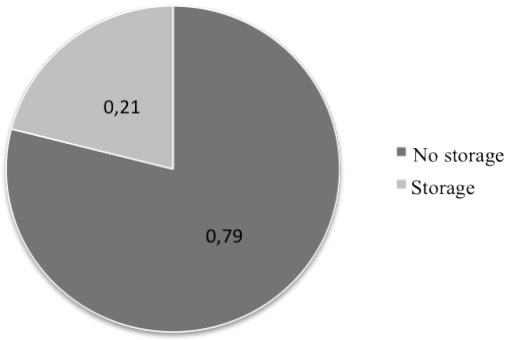
	Cow	Goat	Chicken	Age	Gender (F/M)	Pure breed	Local breed	Cross breed	Fenced	Unfenced	Partly fenced	Milk amount/liter	Last calf/month	Birthrate/year	Stable
1															
2															
3															
4															
5															
6															
7															
8															
9															
10															
11															
12															
13															
14															
15															
16															
17															
18															
19															
20															

Appendix 2-livestock on the farms

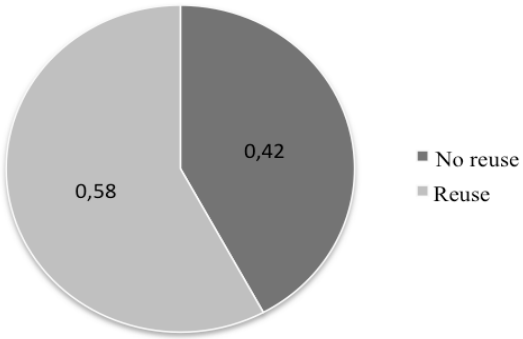
No. livestock on each farm, the goats and the cows divided in local breeds and upgraded breeds.

Animal \ Farm	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19
Local cow	5	0	11	8	1	10	12	0	0	1	4	0	3	4	3	0	5	3	3
Local goat	0	5	0	1	3	0	0	3	3	3	0	0	0	6	0	4	4	7	3
Local sheep	0	4	12	13	0	10	0	3	3	5	1	0	8	0	4	5	0	0	2
Chicken	0	10	15	8	4	15	28	20	35	20	11	9	10	2	29	36	4	4	40
Upgraded cow	0	2	0	0	0	7	0	3	2	3	1	0	2	0	0	3	0	0	0
Upgraded goat	0	0	0	0	0	0	0	0	0	0	7	1	7	3	3	2	2	2	0
Donkey	0	0	0	0	0	0	2	2	0	1	1	0	2	0	0	0	0	0	0

Appendix 3-water storage/reuse



Water storage on more than a daily basis.



Reuse of water in any way (watering plants or used as drinking water for animals).

Appendix 4- all consolidated data

	Owner	Supervisor	Farm size/ha	School back-ground	100 000 shillings	Children (B/G)	Adults working	Children acti-vity	Employee	Water resource
1	Margaret	Margaret	0,2	No school	1,4	3B 3G	1+0	3a, 2c, 1d	none	Tap/tap+grazing
2	Helena	Helena	0,6	Primary	1,2,4	2B 3G	1+0	5c	1 full time	Tap/tap
3	Dan Ford Otelo	Mum	0,8	Secondary	2	2B 2G	1+2	4c	6 seasonal	River/grazing
4	Margret Anyango	Margret Anyango	1,2	No school	1	5B 2G	3+0	5c 2d	none	River+tap/tap+grazing
5	Helene Auma	Helene Auma	0,8	No school	1,2,4	2B	1+1	2c	1 seasonal	Pond/pond
6	Elisabeth Oteno	Elisabeth Oteno	0,6	University level	3	5B 4G	1+0	7c 2d	2 full time	Shallow well/shallow well
7	Philip Njalik	Philip Njalik	0,6	Secondary	1	3B	1+1	3c	none	River/grazing
8	Milka Kongo	Milka Kongo	0,8	No school	1,3,4	2B	0+1	2c	1 full time	Mountain well/mountain well
9	Dickens Muga	Dickens Muga+wife	0,3	University level	1,3	1B 4G	1+1	5c	none	Mountian well/spring
10	Salomon Omndi	Salomon Omndi+wife	1,4	University level	1,3,4	5B 4G	1+1	1b 8c	none	Mountain well/mountain well
11	Willliam Juma	William Juma+wife	1	University level	1,3	5B 5G	2+0	10c	none	Shallow well/shallow well +grazing
12	Esta Ohma+husband	Esta Ohma	0,1	University level	3,4	6B 1G	1+1	1a 6c	none	Tap water+river/river
13	Nellie	Nellie	1,2	Primary	2,3	1B 3G	1+0	1a (young) 3c	2 full time	River/river+grazing
14	Michael Nyakach and wife	Michael Nyakach and wife	1,4	University level	3	2G	2+0	2c	none	Shallow well/shallow well
15	Malenja Otieno and husband	Malenja Otieno and husband	1,4	University level	3	1B	2+0	1a	none	Shallow well/shallow well
16	Ruth Osano and her husband	Ruth Osano and her husband	2	University level	1,3,4	5G 1B	2+0	4c 1b 1a	none	Tank/tank
17	Siprina Apiyo	Siprina Apiyo	0,8	Primary	1,2,3	2B	1+0	1b 1c	none	Shallow well/shallow well
18	Benta Akinui	Benta Akinui	1,2	Primary	1,2,3,4	3B 5G	1+0	1d 2a (1 young) 5c	none	Shallow well/shallow well
19	Eunice Modi Aloo	Eunice Modi Aloo	1,2	Primary	1,3,4	1G 5B	1+0	3b 3c	1 seasonal	Shallow well + river/shallow well

	Collecting	Amount/day (l)	Times/day	Persons collecting	Rainwater	Water storage	Reuse	Access	Limiting	Waterhistory	Biggest problem
1	Carry	600/-/-/-	10	1 W 2G	Yes	Daily	No	Yes	Yes	Tap	Money
2	Carry	200/140/0/60	10	1 W	Yes	Daily	Plants	Yes	No/animalkeeper	Tap	Money
3	Carry	200/200/0/0	5	2 W	Yes	Daily	No	Yes	No	No change	Time
4	Carry	200/140/0/60	5	2 W	yes	Daily	Plants	Yes	Yes	Tap	Money
5	Carry	80/40/0/40	4	1 W (2B)	yes	Daily	No	Yes	No/money	No change	Dirty
6	Carry	400/200/0/200	on farm	anyone	Yes	Daily	No	Yes	No/feed	No change	No problem
7	Bike (3 buckets)	60/60/0/0	1	1M (1W 3B)	Yes	Daily	No	Yes	No/feed	Shallow well	Dirty
8	Donkey (3 buckets)	240/160/0/80	2	1M(2 donkeys)	Yes	Yes	Plants	Yes	Yes	Pipe	Time
9	Carry	180/100/0/80	5+4	1W	Yes	Daily	Animal water	Yes	No/feed	Pipe	Time
10	Donkey(3) and wife	320/80/0/240	4	1M(1 donkey)1W	Yes	Daily	Animal water	Yes	No/feed	Pipe	Time
11	Carry	80/20/0/60	4	anyone	Yes	Daily	No	Yes	No/feed	Shallow well	Salty
12	Carry	240/100/100/40	12	anyone	Yes	Daily	Plants	Yes	No/feed	Tap	Money
13	Donkey (4 buckets)	320/250/20/50	2	1E (2 donkeys)	Yes	Daily	Plants	Yes	Yes	No change	Dirty
14	Carry	320/100/140/80	on farm	anyone	Yes	Yes	Plants	Yes	No	No change	Salty
15	Carry	0/-/0/180	on farm	anyone	Yes	Daily	No	Yes	No/feed	Shallow well	Salty
16	Carry	120/40/20/60	on farm	anyone	Yes	Yes	Plants	Yes	Yes	Tank	Scarcity
17	Carry	200/80/0/120*	5	1W	Yes	Daily	No	Yes	No/feed	River dries out	Salty
18	Carry	160/80/0/80	4	2W	Yes	Daily	Plants	Yes	No	Shallow well	Salty
19	Carry	140/80/0/60	7	anyone (employee)	Yes	Yes	Plants	Yes	No	No change	Salty

	Chicken	Sheep	Donkey	Goat	Cow	Breed (cow)	Kept (goat/cow)
1	0	0	0	0	3/0/2	Local	Grazing
2	10	4	0	5	1/0/1	Cross	Zero
3	15	12	0	0	3/4/3.	Local	Grazing
4	8	13	0	1	3/0/5	Local	Partly grazing and zero
5	4	0	0	3	1/0/0	Local	Grazing
6	15	10	0	0	3/1/3 (0/6/4)	Pure/ashire (Locals)	Zero (Grazing)
7	28	0	2	0	2/5/5.	Local	Grazing
8	20	3	2	3	1/0/2	Pure (ashire)	Zero
9	35	3	0	3	1/0/1	Cross (freishian)	Zero
10	20	5	1	3	1/0/1 and 0/0/1(0/0/1)	Pure (ashire) and cross (Local)	Zero
11	11	1	1	3	1/0/0 (1/2/1)	Pure (freishian) (Local)	Zero (Grazing)
12	9	not around	0	4/1/2.	0		Zero
13	10	8	2	1(cross saanen)	1/0/1 (0/2/1)	Cross (ashire,freshian) (Local)	Zero (grazing)
14	2	0	0	4./1/2	3/0/1	Local	Zero/grazing
15	29	4	0	3/0/0 (6)	0/0/3	Local	Zero/grazing
16	36	5	0	2/1/0	1/0/2	Cross	Zero/grazing
17	4	0	0	1/0/1 (4)	1./2/2	Local	Zero/grazing
18	4	0	0	1/0/1 (7)	0/0/3	Local	Zero/grazing
19	40	2	0	3	2/0/1	Local	Grazing

School background Primary = finished class 8
Secondary = finished class 12
Collage=finished collage
No school

Children activity a=at home
b=in school=boardingschool
c=at home and in school
d=off farm income

Employee None
Seasonal
Full time

Access Yes=rainwater, closer water source, less tapwater→less carrying

Cow Female/Male/Calf [locals (cross)]

Water source People/animals

Amount/day Total/household/crops/animals

Water storage Daily=bigger bucket they pour it in

Adults working Full time/partly

1000 shilling
1. plant= fertilizers and buy seed and plant crops,fruits
2. Buy land
3. improve animal production
4. organize= business, employee and planning