SJIF IMPACT FACTOR (2013): 4.183 CRDEEP Journals
International Journal of Environmental Sciences Worku & Bashe Vol. 3 No. 3 ISSN: 2277-1948
International Journal of Environmental Sciences Vol. 3 No.3. 2014. Pp.155-165

SJIF Impact Factor (2013): 4.183

Full Length Research Paper

Diagnostic Analysis of Water Harvesting Techniques and Small-Scale Irrigation Systems on Some Selected Woreda in North Shewa Zone

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Abstract
The purpose of this study has been to analyze of water harvesting techniques and small-scale irrigation systems on some selected worodas in north shewa zone with special reference to Kewet, Basso, Jirru and Assagirt Woreda. The study has been focused on examining the social and technical aspects of irrigation by which the benefits and constraints of irrigation has been investigated and also the technique of water harvesting. In order to undertake this research household survey, through questioner were collected. In addition, relevant literatures, climatic data and essential documents were reviewed that was useful for the study. Adaptability of irrigation practice in four Woreda indicated that, using water for irrigation take as a habit which accounts 67.3 percent. However, the degree of using irrigation to agricultural product is highly different from weredas to weredas. For instance in some part of Kewet weredas 86.2 percent of the respondents are using irrigation where as 13.8 percent of the respondents are not using irrigation to produce agricultural products, this happen due to the availability irrigation water. But in Basso, Jirru, and Assagirt the habit of using irrigation for agriculture is not satisfactory 40.4 percent, 32.8 percent, and 40.4 percent of the respondents are not using irrigation. This happen due to different factor like topography specially in Assagirt, the absence and shortage of irrigation water, the type of crop that they want to produce are the main reason, suitability of the field for irrigation, absence of technology, for use different water pump. Probably due to the absence of irrigation water and lack of knowledge for water harvesting for the purpose of irrigation, lack of suitable land for irrigation are the major reasons stated. Each of the three Woreda has water users association and groups for water management. They have informal way of associations. Farmers which have water user association in Kewet and Basso weredas is much higher, 95.7 percent and 93.5 percent respectively. The survey result indicated that there is also water user in Assagirt which accounts 69.7 percent of the respondents. Even though in those three woredas there is availability of water users association, the formations of those associations are totally informal. They have not Legal document. On the contrary in Jirru Woreda there is no any association whether it is formal or in formal association. About 90.5 percent of respondents in all Woreda, 87.9, 100, 87.5, and 88.6 percent in Kewet, Basso, Jirru and Assagirt respectively stated that they do not harvest and use water for different purpose. The reasons indicated by most respondents were not adapted water harvesting were: the water harvesting process is the most tedious; financial problems (geo-membrane is very expensive), shortage of geo-membrane supply, water holding capacity of the soil is very low; absence of improved technology for water harvesting, lack of awareness and water harvesting structures take the productive land were the major problems.

Key words: *Small scale irrigation, water users association, and water harvesting.*

Introduction

The development of irrigation and agricultural water management holds significant potential to improve productivity and reduce vulnerability to climactic volatility in any country. Although Ethiopia has abundant rainfall and water resources, its agricultural system does not yet fully benefit from the technologies of water management and irrigation. Our premise is that well-managed irrigation development is a key practice to spring our country in development and overcome major challenges including population pressure; soil and land degradation; high climate variability, and low agricultural productivity. In addition, agricultural water development is crucial to improve smallholder livelihood and income in Ethiopia, since irrigation can help farmers increase their crop production, increase crop variety, and lengthen their agricultural seasons. Small scale-irrigation (SSI), which is often called community-based and traditional methods, are irrigation projects that covers less than 200 hectares. Examples of SSIs include household-based RWH, hand-dug wells, shallow wells, flooding (spate), individual household-based river diversions and other traditional methods. Small scale irrigation schemes are the responsibility of the ministry of agriculture and rural development and regions.

Water harvesting techniques and irrigation management or management of irrigation water in the field in Ethiopia is generally poor. For this reason production and productivity of irrigated fields is limited. To improve productivity and food security problems of irrigation water management in the field and water harvesting techniques should be diagnosed and recommendations should be given.

A problem-oriented diagnostic analysis of an irrigation system may be compared to the approach of a doctor questioning the patient about his sickness: instead of a complete medical check-up. The investigation is restricted to the complaints of the patient and the doctor tries to identify what is wrong and what to do to redress ill- health. The same thing is happened for irrigation systems. The output of diagnostic analysis is used for management improvement program (to improve the performance of the agricultural system).

Therefore, this study is aimed To assess the performance of irrigated agricultural systems and water harvesting techniques with special emphasis on to:

1. Assess indigenous rainwater harvesting and small-scale irrigation technologies and practices.
2. Assess the constraints and options to improve rainwater harvesting and small scale irrigation techniques.
3. Identifying the determinants of household decision to adopt rainwater harvesting for using in small-scale irrigation
4. Assess the impact of rainwater harvesting on crop yield, input use and cropping pattern.

Materials and Methods

Area description

- The research was done in different agro- climatic zones and in different food security areas around Debre Birhan
  - Basso (high land)
  - Deneba (mid altitude & food secure)
  - Assagirt (high land & food insecure)
  - Shewa robit (low land & food secure)

Data collection and analysis

- In study site, the components were visible and visited in each four woreda and the open-ended questionnaires or check lists were addressed to volunteers and/or randomly selected beneficiaries on their fields.
- The ETo, ETc and GIWR values for each month and main crops that was grown in the study area were calculated by using CROPWAT 8.0 computer package and the system design is done manually.
- A problem oriented approach of diagnostic analysis was used to find out the problems in irrigation systems and water harvesting techniques. Major problems of small scale irrigations and water harvesting techniques in each woreda were identified. Identified problems were described by its cause and effect. Possible solutions and recommendations were also stetted.

Primary field data collection activities were included: Frequent field observations were made to observe and investigate the method of water applications, and practices related to water management techniques made by the assigned persons and farmers.
Secondary sources kept by the responsible bodies or officials in each irrigation sites, Woreda Agricultural Offices, Irrigation Offices.
Meteorological data were used to estimate the potential evapotranspiration and crop water requirement.

Method of Data Analysis

To estimate the crop water requirements (CWR), irrigation scheduling and irrigation water requirement (IWR) of the irrigated crops at field levels and the irrigation project as a whole the CropWat windows (CropWat 8) was used. This program uses the FAO (1992) Penman-Monteith equation for calculating reference crop evapotranspiration. The determination of the CWR by this model depends on the determination of the reference evapotranspiration values using the available climatic data. The determination of IWR was carried out after estimation of effective rainfall by USDA soil conservation service method (Clarke, 1998).

The irrigation requirements of each irrigation projects were calculated with CropWat using the climatic data, cropping pattern, planting dates, and area of each crops. Crop data will be collected from growers of each crop and checked with references, and finally for the purpose of comparing the status of water harvesting, availability of small scale irrigation, and access of water in each Woreda cross tab was used to analysis the collected data.

Results and Discussion

Land Owner Ship

Land Size

In an agrarian society like Ethiopia, ownership of land, particularly cultivated land as well as ownership of livestock is referred to as productive assets. Land holding size is considered a critical production factor that determines the type of crops grown and the size of crop harvests. Moreover, availability of pasture land is an important issue for livestock rearing. Therefore, under subsistence agriculture, holding size is expected to play a significant role in enhancing farm households' food sufficiency level (Degefa 2002). In the survey, farmers' land size was asked and summarized in Figure 1. These assets are a prerequisite in the productive activities for agricultural production. As participants in the study noted that land size and distribution of irrigation water are the most important factors for improvement in agricultural production between households. The research then seeks to examine whether land holding per household vary among the sample study areas and household land size has relationship with type of irrigation system owned.

The household land holding in hectare was found to be above 1hectare, 58.2 percent which appears to be very proportional when compared to the national average land holding size (1.02 hectares) (CSA 1998). The researchers found out that the distribution of land ownership owned with the majority of sample households 100 percent having above 1 hectare in Basso followed by Kewet and Jirru, 40 and 38 percent respectively. However, the data revealed that in Assagirt Woreda more respondents are owned ½-1 hectare which accounts 52.8 percent than 25.8 percent having above 1 hectare, even the data indicated that the respondents in Assagirt owned 1/2hectare and ¼ hectare, 16.9 and 4.5 percent respectively which is not proportional when compared to the national average land holding size (1.02 hectares)

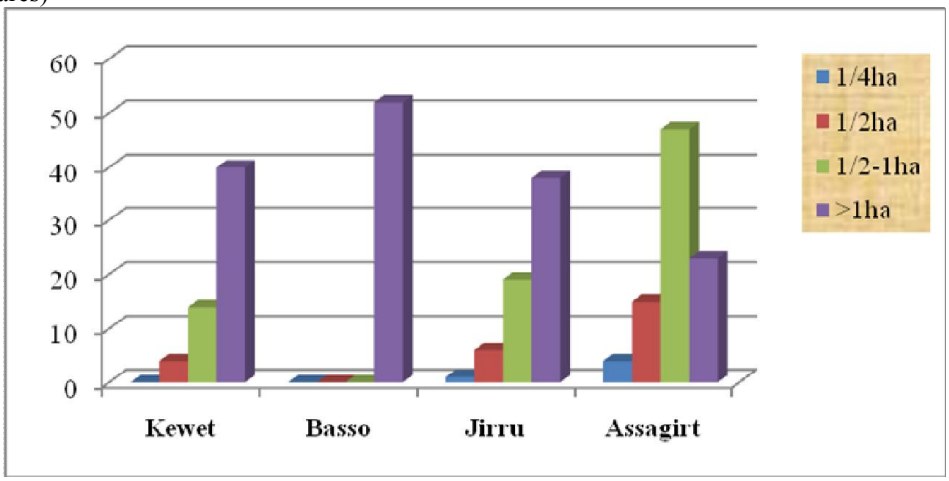

Fig 1. Average land size in hectare per house holds

Major Land Source of the Farmers

Figure 2 depicts that the source of land ownership in each Woreda on the bases of survey result, in Basso Woreda almost all households are getting their source of land by owning methods,100 percent followed by Assagirt, Jirru and Kewet 83.1, 57.8, 46.6 respectively. With the exception of Basso the remaining worodas are using all methods for source land owning such as owning, sharing, and contract.

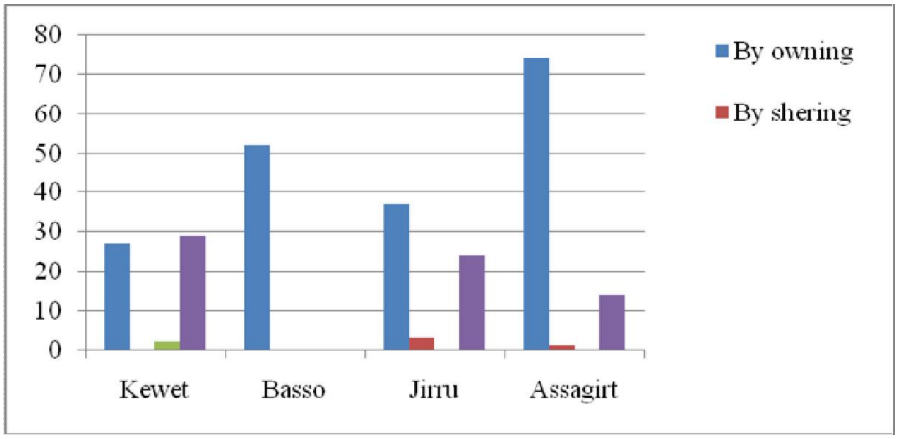

Fig 2. Source Land Holding

Status of Irrigation and Production

As general information major crops grown in Kewet Woreda are Sorghum, Teff, Maize, Mung bean and onion too. From those crops maize and mungbean are common to grow using irrigation. According to the respondents, onion is grown mainly using irrigation and sometimes rain fed. The growing season of the above crops are almost similar both in irrigation and rain fed conditions. A little bit increments in yield were indicated from the respondents. Farmers in some part of Kewet Woreda, have 2-3 cropping seasons per year where as some parts of Kewet Woreda again have only one cropping season per year. According to the respondents again major crops grown in Basso Woreda are wheat, barley, faba bean, lentil, fenugreek, potato, Garlic and onion some times. Those crops are mainly grown in rain fed condition and they have only one cropping season per year. This result indicates that irrigation is not yet adapted in the area due to different reasons. When we see the adaptability of irrigation practice in four Woredas. Table 1 indicated that in each woredas using water for irrigation take as a habit which accounts 67.3 percent. However, the degree of using irrigation to agricultural product is highly different from woredas to woredas. For instance in Kewet weredas 86.2 percent of the respondents are using irrigation where as 13.8 percent of the respondents are not using irrigation to produce agricultural products, this happen due to the availability of irrigation water is the best reason for using irrigation as a habit. But in Basso, Jirru, and Assagirt the habit of using irrigation for agriculture is not satisfactory 40.4 percent, 32.8 percent, and 40.4 percent of the respondents are not using irrigation.

This happen due to different factor like topography specially in Assagirt, the absence and shortage of irrigation water, the type of crop that they want to produce, suitability of the field for irrigation, absence of technology, and supply shortage of different water pump are the main reason. Probably due to the absence of irrigation water and lack of knowledge for water harvesting for the purpose of irrigation, lack of suitable land for irrigation are the major reasons stated.

Table 1. Status of irrigation development in each weredas

Access for irrigation			Woreda				Total
			Kewet	Basso	Jirru	Assagirt	
	No	Frequency	8	21	21	36	86
		Percent	13.8%	40.4%	32.8%	40.4%	32.7%
	Yes	Frequency	50	31	43	53	177
		Percent	86.2%	59.6%	67.2%	59.6%	67.3%
	Total	Frequency	58	52	64	89	263
		Percent	22.1%	19.8%	24.3%	33.8%	100.0%

Source of Irrigation Water

As indicated in Table 4.4 below even if the degree of using spring water for irrigation purpose is highly differed from Woreda to Woreda, it serve as the source of irrigation water which accounts 51.1 percent . According to cross tab result in Table 2 indicated below Kewet Woreda is mainly using river water as source of irrigation water followed by Jirru and Assagirt, 72, 35.7, and 15.1 percent respectively. But Basso Woreda is not totally using river as source of irrigation water. With respect to spring water highly available in Basso, 96.8 percent which is followed by Assagirt, Jirru, and Kewet, 73.6, 40.5, and 8 percent respectively. Using harvested water as source of irrigation is higher in Jirru, 16.7 percent than other Woreda which is followed by Assagirt and Kewet, 11.3 and 10 percent respectively.

Table 2. Source of irrigation water

Woreda			Source of irrigation water				Total
			River	spring	Harvested water	All	
	Kewet	Count	36	4	5	5	50
		% within Woreda	72.0%	8.0%	10.0%	10.0%	100.0%
	Basso	Count	0	30	0	1	31
		% within Woreda	.0%	96.8%	.0%	3.2%	100.0%
	Jirru	Count	15	17	7	3	42
		% within Woreda	35.7%	40.5%	16.7%	7.1%	100.0%
	Assagir t	Count	8	39	6	0	53
		% within Woreda	15.1%	73.6%	11.3%	.0%	100.0%
	Total	Count	59	90	18	9	176
		% within Woreda	33.5%	51.1%	10.2%	5.1%	100.0%

Irrigation Water Management

Traditional irrigation methods are mostly basin irrigation and Can method. Some farmers are also irrigating some gardens around the living house, using west water or residue from domestic water uses.

Analysis of the survey results in figure 3 indicated that approximately 81.7percent of the sample households in all woredas had water shortage. On the other hand in Woreda level, from the point of view of water shortage, all the respondents in Basso (100 percent), Kewet (90 percent), Assagirt (68.3 percent), and Jirru (79.3 percent) is seriously fall under water shortage. The main reasons stated in the questioner are;

- Rapid increase in the population that uses irrigation water or increase irrigation
- The decrease of flow of river and potential of streams.

Most farmers in those woredas used different remedies to overcome those problems. As evidenced from the respondents, most farmers were:

- Digging for ground water
- Choosing the crop variety that needs less water
- Some water harvesting

Still most farmers were not found a solution for the existing water shortage and their productivity decreases a lot.

In general, the miscellaneous problems of small scale irrigation are: water shortage, mismanagement of irrigation water, out of order robbery of irrigation water, salinity of springs or irrigation water, absence of improved technology, general irrigation system design problem (the canal was not lined) less attention of farmers for small scale irrigation were the major problems. The remedies that were taken by the respondents were: lining of canals from locally available materials like flat stones, spring water development, founding underground water and the like but most farmers still doesn't take any solution.

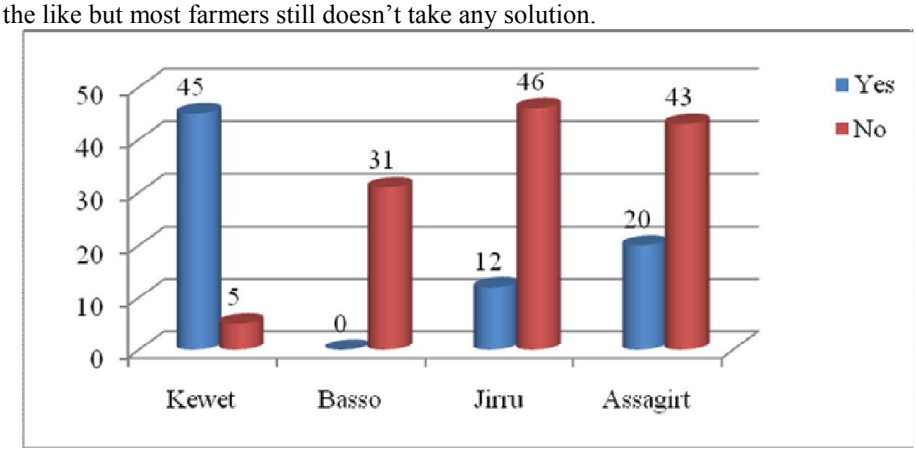

Fig 3. Water shortage

Loss of Irrigation Water

According to Table 3 below there is large volume of water loss from water source, large volume in Basso, 100 percent which is followed by Kewet, Assagirt and Jirru which account 88.7, 82.7, and 33.3 percent respectively. According to survey result there are different causes of water loose in each Woreda such as lack of awareness about the benefit of water for different purposes, absence of training about how and when to use water.

Table 3. Degree of water loss

Woreda			Water loss		Total
			No	Yes	
	Kewet	Count	6	47	53
		% within Woreda	11.3%	88.7%	100.0%
	Basso	Count	0	31	31
		% within Woreda	.0%	100.0%	100.0%
	Jirru	Count	28	14	42
		% within Woreda	66.7%	33.3%	100.0%
	Assagirt	Count	9	43	52
		% within Woreda	17.3%	82.7%	100.0%
Total		Count	43	135	178
		% within Woreda	24.2%	75.8%	100.0%

Impact of Irrigation on Agriculture

Access to reliable irrigation has been regarded as a powerful factor which provides a greater opportunity for cropping intensity, multiple cropping and crop diversification (Saleth et al 2003). Hence, an attempt is made in this study to analyze the impact of irrigation, particularly different sources of irrigation, on cropping intensity and crop diversification. Based on the information collected from the household survey the following descriptions were found in relation to the effect of cropping technique on water usage.

Majority of households in the study areas produced main staple crops such as teff, maize, sorghum, wheat, faba beans, peas and barley and cash crop production like "Gesho" and coffee. On the other hand dry season vegetable and fruit cultivation were limited only to households who had access to irrigation from river diversion and springs such as mango, sugarcane, cabbage and avocado. According to table 4.6 below from the survey result indicated that 70.6 percent in all Woreda said cropping technique do not have influence on water usage. Largely in Assagirt, Jirru, and Basso, 88.2 percent, 87.5 percent, and 78.9 percent respectively of the respondents respond that their cropping technique had an influence on their water usage. This is due to lack of awareness on how to use water for irrigation. On the contrary 18.4 percent from the Basso said that they don't know whether there is influence or not on their water usage followed by Kewet, 13.8 percent.

Table 4. Influence of water usage on cropping pattern

Woreda			Influence of water usage on cropping pattern			Total
			No	Yes	I Don't know	
	Kewet	Count	22	28	8	58
		% within Woreda	37.9%	48.3%	13.8%	100.0%
	Basso	Count	30	1	7	38
		% within Woreda	78.9%	2.6%	18.4%	100.0%
	Jirru	Count	35	5	0	40
		% within Woreda	87.5%	12.5%	.0%	100.0%
	Assagirt	Count	45	6	0	51
		% within Woreda	88.2%	11.8%	.0%	100.0%
Total		Count	132	40	15	187
		% within Woreda	70.6%	21.4%	8.0%	100.0%

Irrigation Scheduling

Analysis of the survey results in Table 5 indicated that approximately 85.2percent of the sample households had applying water for crop in different way and different volume of water. However, 12.1 percent of the respondents said that they are applying uniform volume of water throughout the life span of crop on the field. On the contrary 24.1 percent in Kewet and 18.4 percent in Basso from the respondents said that they do not know when they are applying more water throughout the life span of crop on the field.

Table 5. Total volume of water applied for a given crop

Woreda			Volume of water applied for a given crop			Total
			Uniform	Different	I don't know	
	Kewet	Count	7	37	14	58
		% within Woreda	12.1%	63.8%	24.1%	100.0%
	Basso	Count	0	31	7	38
		% within Woreda	.0%	81.6%	18.4%	100.0%
	Jirru	Count	0	41	0	41
		% within Woreda	.0%	100.0%	.0%	100.0%
	Assagirt	Count	0	52	0	52
		% within Woreda	.0%	100.0%	.0%	100.0%
Total		Count	7	161	21	189
		% within Woreda	3.7%	85.2%	11.1%	100.0%

Table 6. Time and amount of water application

Woreda			application of more water				Total
			Germination	development	Flowering	Harvesting	
	Kewet	Count	0	11	38	0	49
		% within Woreda	.0%	22.4%	77.6%	.0%	100.0%
	Basso	Count	26	0	0	5	31
		% within Woreda	83.9%	.0%	.0%	16.1%	100.0%
	Jirru	Count	2	2	38	0	42
		% within Woreda	4.8%	4.8%	90.5%	.0%	100.0%
	Assagirt	Count	10	4	38	0	52
		% within Woreda	19.2%	7.7%	73.1%	.0%	100.0%
Total		Count	38	17	114	5	174
		% within Woreda	21.8%	9.8%	65.5%	2.9%	100.0%

Time and Amount of Water Application

According to the data obtained from sample households' survey in Table 6, large volume of water in Kewet Woreda applied during flowering season which account 77.6 percent while 22.4 percent of the sampled household applied during crop development season, on the contrary in Basso Woreda large volume of water is applied during germination period, 83.9 percent while 16.1 percent of the sampled households are applying water for crop during harvesting season. While in Jirru Woreda large volume of water is applied during flowering period which accounts 90.5percent, followed by germination and development season. While in Assagirt Woreda 73.1 percent from the respondents is applying during flowering period, they are also applying water during germination and development season, 19.2 percent and 7.7 percent respectively. Generally large volume of water in all Woreda is applying during flowering period, 65.5percent which is followed by 21.8 percent during germination and 9.8 percent of the respondents said during development periods.

Method of Irrigation

There are different techniques of applying water for the crop. Those irrigation methods are selected based on different criteria. Most small scale irrigations are irrigated by surface irrigation methods. According to the survey result, basin irrigation is relatively highly selected followed by furrow irrigation method.

When we come to the detailed woredas, our survey result indicated that, most farmers in Kewet Woreda use Basin irrigation method (61.2 %) followed by furrow & basin irrigation technique in conjunction (36.7 %). According to the result, only 2% of the respondents were use the sole furrow irrigation method.

Table 7 also indicated that, 83.9 % of the respondents' use furrow and basin irrigation methods simultaneously. In different with Kewet Woreda which have (2%) sole furrow irrigation users, it shows a little bit higher persentage12.9% of the respondents in Basso were used the sole furrow irrigation method. Results in similar table also revealed that, 85.7% of the respondents in Jirru Woreda use basin irrigation techniques and 14.3% of the respondents use simple can to irrigate their crops. As it shown in the table below, no one of the irrigator in Jirru uses furrow irrigation. It may be because of their crop and soil type is convenient for basin irrigation and those of who use can are simple gardens around home, which the source of water may be water harvesting and residual water from domestic uses.

All, furrow, Basin and can methods were in practice in Assagirt Woreda. Around 40.8% of the respondents were practiced Basin irrigation and 30.5% uses both furrow and basin. Where as the sole furrow irrigation users are 19% and 9.8% are use can method. (Table 7)

Table 7. Irrigation methods

Woreda		Irrigation methods				Total
		Furrow	Basin	Canning	Furrow and Basin	
Kewet	Count	1	30	0	18	49
	% within Woreda	2.0%	61.2%	.0%	36.7%	100.0%
Basso	Count	4	1	0	26	31
	% within Woreda	12.9%	3.2%	.0%	83.9%	100.0%
Jirru	Count	0	36	6	0	42
	% within Woreda	.0%	85.7%	14.3%	.0%	100.0%
Assagirt	Count	28	4	11	9	52
	% within Woreda	53.8%	7.7%	21.2%	17.3%	100.0%
Total	Count	33	71	17	53	174
	% within Woreda	19.0%	40.8%	9.8%	30.5%	100.0%

Supplementary Irrigation

In general around 51.4% of the respondents were indicated that they were applying supplementary irrigation in the shortage of effective rainfall, to save their crops from suffering from drought due to dry spells and early secession of rainfall. Surprisingly, 48.6% of the respondents showed that there is use of supplementary irrigation while the shortage of rainfall in all the woredas. As indicated in Table 8, high number of population, 72.5% of the respondents in Assagirt Woreda use supplementary irrigation followed by 69.4% of the sample population at Kewet Woreda use supplementary irrigation, which is very high as compared to Jirru and Basso, 37% and 9.7% respectively. Even if supplementary irrigation is a life saving practice when the natural precipitation is not enough for crop growth, woredas like Jirru and Basso doesn't practice well. As a result production and productivity will be highly affected by climate change.

Table 8. Supplementary irrigation

Woreda			Supplementary irrigation		Total
			No	Yes	
	Kewet	Count	15	34	49
		% within Woreda	30.6%	69.4%	100.0%
	Basso	Count	28	3	31
		% within Woreda	90.3%	9.7%	100.0%
	Jirru	Count	29	17	46
		% within Woreda	63.0%	37.0%	100.0%
	Assagirt	Count	14	37	51
		% within Woreda	27.5%	72.5%	100.0%
	Total	Count	86	91	177
		% within Woreda	48.6%	51.4%	100.0%

Water Users' Association

Each of the three Woreda has water users association and groups for water management. They have informal way of associations. Farmers which have water user association in Kewet and Basso woredas is much higher, 95.7 percent and 93.5 percent respectively. According to the survey result indicated that there is also association in Assagirt which accounts 69.7 percent of the population. Even though in those three woredas there is availability of water users association, the formations of those associations are totally informal. They have not Legal document. On the contrary in Jirru Woreda there is no any association whether it is formal or in formal association. If those association have the ability to register in a formal way, they have a right to get inputs, market facilities, credit service etc. from the government and NGO's while the non-registered have legal entity problems. With respect to controlled by the informal association, the survey result in Table 9 indicated that 88.9 percent of the respondents are controlled by under the informal rule and regulation. Exceptionally, in Jirru Woreda there is no any water users association and it is better to have water users association or any control mechanisms for some violence in the community.

Table 9. Water users association

Woreda	Water user association in each Woreda				Total
	No		Yes		
	Frequency	Percent	Frequency	Percent	
Kewet	2	4.3	45	95.7	47
Basso	2	6.5	29	93.5	31
Jirru	35	100	0	0	35
Assagirt	14	30.4	32	69.6	46
Total	53	33.3	106	66.7	159
Woreda	rules and regulation of the association				Total
	No		Yes		
	Frequency	Percent	Frequency	Percent	
Kewet	1	2.2	45	97.8	46
Basso	2	6.5	29	93.5	31
Jirru	0	0	0	0	0
Assagirt	4	11.1	32	88.9	36
Total	7	6.1	107	93.9	113
Woreda	Members those controlled by rules and regulations				
	No		Yes		
	Frequency	Percent	Frequency	Percent	Total
Kewet	9	19.6	37	80.4	46
Basso	0	0	29	100	29
Jirru	0	0	0	0	0
Assagirt	1	3	30	99.9	31
Total	10	9.3	96	88.9	106

While using irrigation and irrigation water, water-users association plays a significant role in water management and conflict resolution. As females are effective water users for domestic and agricultural purpose, the involvement of females in water user's

association results in better water management. As indicated in Table 10, a total of 87.7% of the respondents show that there are females in their association. Especially in Basso Woreda, 100% of the respondents indicate that females are active participant in water users association. It may be due to the involvement of females in each association that there is no conflict in water users association in Basso Woreda. As evidenced in Table 4.13 below, around 97% of the respondents in Basso Woreda indicated there is no conflict among water users.

Table 10. Females' participation in water users association

Woreda			Participation of females in the association		Total
			No	Yes	
	Kewet	Count	10	37	47
		% within Woreda	21.3%	78.7%	100.0%
	Basso	Count	0	29	29
		% within Woreda	.0%	100.0%	100.0%
	Assagirt	Count	5	41	46
		% within Woreda	10.9%	89.1%	100.0%
Total		Count	15	107	122
		% within Woreda	12.3%	87.7%	100.0%

Even if there is a water users association in each the three woredas a little conflict is observed among water users. As evidenced in Table 11, 48.9% in Kewet, 40% in Assagirt and 3.2% in Basso Woreda showed that there is conflict in water users association. This figure indicated further some conflict resolution methods are still required for better water use. Rules and regulation should be also registered and the power of those rules and regulations and father of the water should be acknowledged. In different with those the three woredas, which the water users associations were available, in Jirru, that there is no any water users association, all the respondents indicate there is conflict among water users. This figure also indicates that the availability of water users association is a basic tool to minimize or even eliminate conflict from the water users. Beyond the importance of forming associations, involving females in those associations is also best solution for effective water management and for conflict resolution.

Table 11. Conflict over the water resource

Woreda			Conflict over water resource		Total
			No	Yes	
	Kewet	Count	24	23	47
		% within Woreda	51.1%	48.9%	100.0%
	Basso	Count	30	1	31
		% within Woreda	96.8%	3.2%	100.0%
	Jirru	Count	0	1	1
		% within Woreda	.0%	100.0%	100.0%
	Assagirt	Count	27	18	45
		% within Woreda	60.0%	40.0%	100.0%
Total		Count	81	43	124
		% within Woreda	65.3%	34.7%	100.0%

Water Harvesting Practices

Many sample reported that, from the onset of construction it was started without adequate consultation with the community and it was mainly guided based on a quota driven approach. This has led to a negative perception towards water harvesting and has created an unenthusiastic view of the possibilities of stored water in ponds as a productive undertaking. This was evident by many sample household's lack of effort to make their pond hold the maximum possible water by repairing the damaged pond structures and plastic sheets. The survey result in Table 12 result showed that about 90.5 percent of respondents in all Woreda, 87.9, 100, 87.5, and 88.6 percent in Kewet, Basso, Jirru and Assagirt respectively stated that they do not harvest and use water for different purpose. As the survey result indicated that there are different reasons;

Construction of the pond in their farm plot was promoted directly through government initiative measures and the price of plastic are too expensive. The second most commonly reported problem was due to the improper design and site selection. A considerable number of ponds were found to have seepage problems; which lead to a considerable amount of water loss, and this in turn limited the pond owners from fully utilizing the harvested water for irrigation purposes. The third most commonly reported problem was soil

silting of the pond: this has meant pond owners have had allocate labor repeatedly to do the cleaning maintains of the pond which is time and labor intensive. Lack of experience in utilizing and managing stored water in the pond was also another issue that contributed to the poor performance of pond water harvesting irrigation. The researcher has had a chance to visit more than 10 ponds of which some ponds were found to be constructed on farm plots which are at a great distance from the owner's residence. This has increased the pond owner's lack of motivation to use the stored water in the pond. This was particularly problematic in all Woreda study areas. FAO, (1992 cited in Darout ,2004) noted the importance of strong extension as follows ''The path to irrigated agriculture, for a farmer who has participated in rain-fed farming all his/her life can be long and financially painful if he/she is left to his/her own device and to the trial and error methods of learning.'' The low performance of pond water harvesting irrigation could also be attributed to the high losses of evaporation resulting from high surface area to volume ratio. As a study in Pakistan showed on average small ponds can lose 50% of their impoundments to evaporation in arid and semi-arid areas (Sakthivadivel et al., 1997).

The reasons for most respondents were not adapted water harvesting were: the water harvesting process is the most tedious; financial problems (geo-membrane is very expensive), shortage of geo-membrane supply, water holding capacity of the soil is very low; absence of improved technology for water harvesting, lack of awareness and water harvesting structures take the productive land were the major problems. Making pond in groups and roof water harvesting are their traditional water harvesting techniques especially in some parts of Kewet. Respondents also indicated that most harvested water were not used for irrigation practice because of the harvested water too little to use for irrigation; irrigation practice from harvested water is tedious; because of serious water shortage harvested water is used for animal drink and domestic use. A positive impact of water harvesting was seen in some woredas like increasing cropping pattern and crop calendar. The implication of water harvesting is also availability of water throughout the year; therefore it has again a positive impact on productivity and input uses. Health and nutrition of the livelihood is also improved due to water harvesting that mostly uses of vegetable gardening around the home which is totally household consumption.

Table 12. Water harvesting practice

Woreda			Water harvesting in each Woreda		Total
			No	Yes	
	Kewet	Count	51	7	58
		% within Woreda	87.9%	12.1%	100.0%
	Basso	Count	52	0	52
		% within Woreda	100.0%	.0%	100.0%
	Jirru	Count	56	8	64
		% within Woreda	87.5%	12.5%	100.0%
	Assagirt	Count	78	10	88
		% within Woreda	88.6%	11.4%	100.0%
Total		Count	237	25	262
		% within Woreda	90.5%	9.5%	100.0%

Conclusion

Even if the development of irrigation and agricultural water management holds significant potential to improve productivity and reduce vulnerability to climactic volatility in any country, findings in this research shows that, agricultural sector is mainly dominated by productive aged male farmers. Most of those farmers have got basic education. From the above result, it is also concluded that the more educated the respondents, the more likely they would be willing to adapt irrigation water and irrigation water management since they might know the benefit of using water for irrigation. Majority of the farmers have their own farm lands which are mainly above one hectare. As we revealed from the above result, most farmers which have accesses for irrigation were used irrigation practices. The main reason for not adapting irrigation practice in some woredas of North Shewa zone is the absence of irrigation water. The main sources of irrigation water are river and springs. Most small scale irrigations are irrigated by surface irrigation methods. According to the survey result, basin irrigation is relatively highly selected followed by furrow irrigation method. Majority of the farmers were suffered from water shortage even the shortage sometime lead to crop failure. We conclude that those shortages were due to unplanned use of irrigation water and low awareness for water harvesting to save their crops from failure. Supplementary irrigation is also not adapted as well to save crops from failure.

In general there is a little water harvesting practices but almost all harvested water were not use for irrigation purpose because the amount of the harvested water is very little, the practice is very tedious and due to water shortage is very serious and instead of crop

production priority should be given for house hold consumption and animal drink. While using irrigation and irrigation water, water-users association plays a significant role in water management and conflict resolution. Exceptionally, in Jirru Woreda there is no any water users association and it is better to have water users association or any control mechanisms for some violence in the community. As females are effective water users for domestic and agricultural purpose, the involvement of females in water user's association results in better water management. As indicated in Table 12, a total of 87.7% of the respondents show that there are females in their association. Spatially in Basso Woreda, 100% of the respondents indicate that females are active participant in water users association. It may be due to the involvement of females in each association that there is no conflict in water users association in Basso Woreda. As evidenced from Table 4.13, around 97% of the respondents in Basso Woreda indicated there is no conflict among water users.

Recommendations

- Expanding basic education throughout the farmers is recommended
- Awareness creation on the importance of water harvesting and possibility of using harvested water for irrigation is recommended
- Selection of appropriate irrigation method should be in accordance with crop type, crop growth stage, and soil type is recommended
- Using supplementary irrigation is recommended even in rainfaid condition.
- Water users associations should be well organize and functional

References

Degefa 2002: Irrigation Policies, Strategies and Institutional Support Conditions in Ethiopia. Proceedings of Symposium on Best Practices and Technologies for Agricultural Water Management in Ethiopia, March 7-9, 2006, Addis Ababa Ethiopia

FAO (1992). Ethiopia small scale irrigation consolidation project report; Addis Ababa, Ethiopia.

FAO.1977. Crop Water Requirements. Food and Agricultural Organization. Irrigation and Drainage Paper No 24. Rome, Italy.

Muluneh, M. 2001. Impact of population pressure on land resources as reflected in Land use/land changes in Ethiopia: Lessons learned from West GuragelandJll:

Tilahun, H. and Paulos D. 2004. Results to date and future plan of research on irrigation and its impact. Workshop on Impact of Irrigation on Poverty and Environment, Workshop Proceedings (in Press), April 2004.