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Comparative Analysis of Small Scale Irrigation in Selected Rural Kebeles of Harari Regional State, Ethiopia

Yitagus Demissie[a], Awol Akmel[b], R. Uttama Reddy[c*]

[a,b,c]*School of Geography & Environmental Studies, Haramaya University, Dire Dawa, P.O Box: 138, Ethiopia*

[a]*Email: yitie.demis@gmail.com*

[b]*Email: awlakml@yahoo.com*

[c]*Email: drreddyhu@gmail.com*

Abstract

Livelihoods of the rural people of Ethiopia depend on agriculture. However, erratic nature of rain and prevalence of drought in the country, particularly in the low lands make agricultural production a challenge. To counter this problem, use of the Small Scale Irrigation is one of the most promising options. Erer Small Scale Irrigation development was carried out in four rural Kebeles (lowest administrative division) of Erer with the aim of improving the socio-economic level of the small-scale farming households. The main objective of this study was to assess the impact of Small Scale Irrigation scheme on livelihoods and food consumptions level of small-scale farming households. Both quantitative and qualitative data were used in the investigation of the impacts of the scheme on rural small-scale farming households. The two purposively sampled kebeles, namely Woldya and Dodota, were selected because of their accessibility and existence of large number of irrigation users than the other two kebeles. The sampling frame of the study consists of 1113 Household Heads. The required data set for the study were gathered primarily through survey method from 294 randomly selected sample household heads both from irrigation users and non-users, i.e. 91 and 203 Household Heads, respectively. Semi-structured interview was also used as data collection method. The analysis which was conducted between the irrigating and non-irrigating respondents allowed the comparison in order to identify the socio-economic impacts of the Small Scale Irrigation Scheme.

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* Corresponding author.

The comparison between the two groups' socio-economic level and the independent variables were analyzed using chi-square and independent samples Mann-Whitney U-tests with the help of Statistical Package for Social Sciences-20.

The dependent variables used to capture households' socio-economic level were household's total assets, gross income and access to social services. In general, the result reveals that small scale irrigations have a positive impact on social and economic well being of households. Consequently, this empirical analysis, like many other similar studies, confirms that small-scale irrigation development would have positive impacts on socio-economic development through increasing crop diversification, cropping intensity, and crop yield at household level. This intern has a direct positive effect in raising gross farm incomes and increasing farmers' household consumption. Moreover, the increased income from higher yields helped irrigated farmers to diversify their assets holdings like houses, farm tools, house furnishings, and other materials which also have an effect in increasing household income gains.

Keywords: Assets; Erer; Household level; Impact; Income; Small scale irrigation; Socio- economic.

1. Introduction

Over the last two decades extreme poverty has declined significantly. In 1990, nearly half of the population in the developing world lived on less than $1.25 a day; that proportion dropped to 14 percent in 2015. Despite this enormous progress, even today, about 836 million people still live in extreme poverty and suffer from hunger [1]. With this regard, in developing countries agriculture plays a pivotal role. It is often the leading sector of the economy as source of income, employment and foreign exchange. Thus, improving agricultural productivity contributes a lot to economic growth and poverty alleviation [2].

Studies show that the impact of irrigation on agricultural performance, household income and poverty is significant. Qiuqiong et al. [3] argues that the green revolution in Asia would not have happened without massive irrigation development. The same source explains that without continuous irrigation, many countries would have been unable to achieve the agricultural and economic growth rates required to achieve food security and reduce poverty. In India poverty head count ranges from18 to 53% in irrigated and 21 to 66% in rain fed areas and poverty incidence is 20 to 30% lower in most irrigated areas compared to rain fed areas. Incidence of chronic poverty is 5% lower for irrigated areas in Sri Lanka (Pakistan) than adjoining rain fed areas [4].

Sub-Saharan Africa (SSA) is a water-abundant region but uses less than two per cent of its total renewable water resources. Food production in the region is almost entirely rain-fed with irrigation currently playing a minor role. Only four per cent (six million ha) of the region's total cultivated area is irrigated compared to 37 per cent in Asia and 14 per cent in Latin America [5]. It is far from achieving its irrigation potential, which is estimated at 42.5 million ha. Greater use of the region's ample water resources and expansion of the irrigated area has the potential to make a substantial contribution to agricultural development and address the problem of food insecurity [6].

Ethiopia is the second most populous country in SSA with population over 96.5 million of which 81%

dependent on agriculture and live in rural areas [7]. In 2013/14 agriculture employed 77.3% of the labour force, and accounts 40.3% of the GDP and about 90% of the foreign exchange earnings of the country [8]. Though Ethiopia has achieved strong economic growth in recent years, making it one of the highest performing economies in SSA, yet it remains one of the world's poorest countries. According to the UNDP's Human Development report of 2011, it ranks 174^{th} out of 187 countries with a low Human Development Index of 0.383 [9]. The purchasing power of rural households remains weak with almost 40% of the rural population living in poverty, and about 29 per cent of the population lives below the national poverty line with an income of less than one dollar per capita per day [10].

Ethiopia has enormous potential for agricultural development. According to [11] at present only about 25 per cent of its arable land is cultivated, and agriculture is dominated by subsistence rain fed farming, using few inputs and characterized by low productivity. The vast majority of farmers are smallholders. [11] also shows that about 12.7 million smallholders produce 95 per cent of agricultural GDP. These farmers are extremely vulnerable to external shocks such as unstable markets and drought and other natural disasters. More than half cultivate plots of one hectare or less and struggle to produce enough food to feed their households.

Ethiopia has abundant freshwater resources [12]. However, the water resource of the country is highly variable both temporally and spatially [13]. The potential irrigable land of the country is estimated to be about 5.3 million hectares. Of which, 3.7 million ha from gravity fed surface water, 1.1 million ha from ground water and 0.5 million ha from rainwater harvesting [14]. There is no dependable and reliable evidence with regard to the operational or potential Small Scale Irrigation (SSI) schemes. Based on the information available, meager as it is, only about 10- 12% of the total potential is currently under production using traditional and modern irrigation schemes [15]. Currently, there are close to half a million ha of medium and large scale projects, which are under different levels of implementation by the MoWE and respective regions. Similarly, in the area of SSI efforts are being exerted to increase irrigated area through the regular budget of the regions and the federal government and through different donors support development programs (such as Agricultural Sector Support Project (ASSP), Participatory Small Scale Irrigation Development Project (PSSIDP), Sustainable Land Management Project (SLMP) and others) and Non-Governmental Organization (NGOs).

Small-scale irrigation (SSI) schemes are commonly taken as irrigated areas having an area of about 200ha. These can be categorized as traditional and improved SSI schemes [12]. Traditional irrigation schemes are usually initiated, built and managed by the community, while modern schemes of various categories discussed below are built taking into account the available technologies and assisted by the government, NGOs and other donors. Currently, the government of Ethiopia is developing master plans for various types of irrigation, including diversion/gravity schemes from major rivers, pumping from rivers, and small storage reservoirs by giving priority to low cost SSI systems [16]. Efforts are being made to involve farmers vigorously in various aspects of management of SSI systems, starting from the process of planning through to the implementation and management facets of project development, particularly in water distribution, operation and maintenance to ensure sustainability of the performance of the scheme put in place [11].

The general objective of this study was to examine the impacts of SSI on socio-economic status of the small-scale farming households.

2. Description of the Study Area

The Harari Regional State (HRS) is one of the regional states of the Federal Democratic Republic of Ethiopia. It is located in the upstream micro-watersheds of the Wabi Shebelle River Basin. It lies between 9^0 11’ 49” North and 9^0 24’ 42” North latitudes, and between 42^0 03’ 30” East and 42^0 16’ 24” East longitudes (Figure 1).

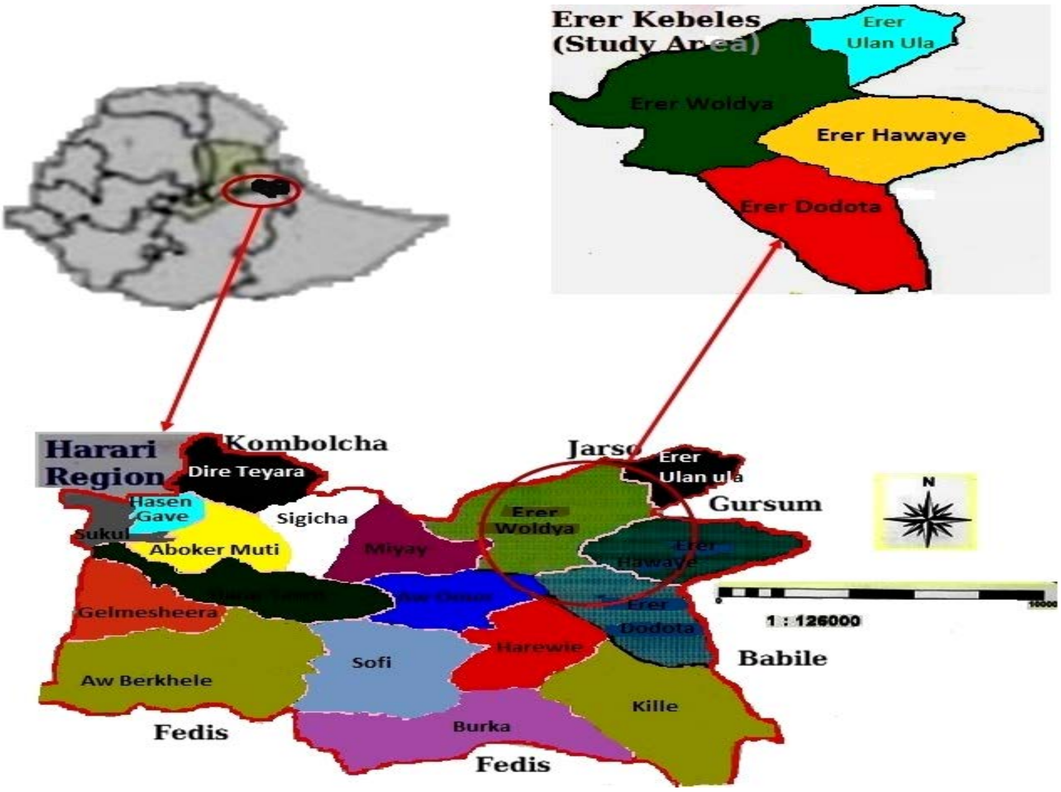


Figure 1

Source: Atlas Map of the Harari Region (HBoARD, 2011); Edited & reorganized by the investigator

3. Research Methodology

For the purpose of this study mixed, specifically triangulation concurrent research design method was used. The list of household heads in each kebeles with a separate sheet of users and non-users of the SSI scheme was obtained from the Erer Administration and Agricultural Offices. Based on the number of the total households in the sampling frame, the formula equated and reached a minimum of 294 (26.41%) respondents. The study used both primary and secondary data sources. The primary data was collected through questionnaire, interview and field observation.

4. Results and discussion

4.1 Economic Characteristics of Sample Households

4.1.1. Impact of Irrigation on the Diversity of Production System

Access to reliable irrigation has been regarded as a powerful factor which provides a greater opportunity for cropping intensity, multiple cropping and crop diversification [15]. Hence, an attempt was made in this study to analyze the impact of irrigation, particularly on crop diversification and cropping intensity. Based on the information collected from the household survey the following descriptions were found in relation to the effect of development of SSI in crop diversification, and cropping intensity.

Prior to the introduction of small scale irrigation (SSI) project, a majority of households in the study area produced cereal crop as a main staple crops such as maize, sorghum, and sweet potato.

Dry season vegetables and fruits cultivation were very limited to only those households who had access to irrigation from river diversion and also they are limited to expect the main rainy season which is called Kiremt season in Ethiopia. However, after the development of SSI, dry season horticultural crop production was found to have become common practice. The result show that many farmers are now producing high value products like vegetables such as tomato, potato, chat, onion, green pepper, cabbage, sugar cane, as well as other fruits such as mango, papaya, banana, and others.

Following the development of irrigation project in the study area, new crops were introduced; changes were identified in the diversity of cropping and cropping intensity. One change was the decrease in the size of plot of land occupied previously by cereal crops such as maize, and sorghum.

On the other hand, there was an increase in those producing marketable items such as cash crops, vegetables, and fruits. To this end, for question: “Does the development of SSI help you to diversify your cultivation system?” The survey result showed that among the sample of 91 irrigating (Household Heads)HHHs about 82.42% of them responded that “yes” because of SSI development in their farm land they were diversifying the kinds of crops being produced. The rest 17.58% of the respondents said “no” (Table 1). While explaining their reasons, the findings of this investigation showed that these farmers were unable to diversify their productions because of the small size of their farmland.

Table 1: Frequency distribution of the diversity of cropping for irrigating HHHs

Does the development of SSI help you to diversify your cultivation system?	Frequency	% of total	Cumulative Percent
Yes	75	82.42	82.42
No	16	17.58	100.00
Total	91	100.00	

Source: Field Survey, 2014

Generally, with regard to the extent of diversity of cropping, as the study result showed out of 91 sample irrigating HHHs about 82.42% of them produced two to three different types of products (cereals/fruits/vegetables) on their fields (Table 2).

Table 2: The extent of diversification of products

Diversification extent	Frequency	Percent	Cumulative Percent
Cereals, vegetables and fruits	21	23.08	23.08
Cereals and vegetables	39	42.86	65.94
Cereals and fruits	15	16.48	82.42
Cereals	16	17.58	100.00
Total	91	100.0	

As responses of interview from two experts and two Development Agents (DAs) confirmed that, this big change was the result of two factors. First, the adoption of the SSI development by the government bodies in collaboration with farmers of the study area. The other factor was Development Agents contribution. DAs encouraged the farmers to take farming as their business, and focus on those products that brought highest returns, such as tomato, onion, green pepper and potato, and other crops. The evidence provided that; tomato, chat, onion, mango, lemon, green pepper, and sugar cane and other fruits and vegetables were among the highest selling products. Most farmers, therefore; decided to diversify their production.

As far as cropping intensity is concerned, the study revealed that among the sample irrigating HHHs 61 of them could produce twice per a year. The rest 30 were reported to have harvested three times in a year, by growing the seedlings much earlier and planting short cycle crop varieties, such as tomato, onion, cabbage and potato (Table 3).

Table 3: Descriptive statistics of cropping intensity per a year for irrigating HHHs

Cropping intensity/year	Frequency	% of total	Cumulative Percent
Twice	61	67	67
Trice	30	33	100
Total	91	100	

Responses of interview from the two community leaders revealed that; farmers realized that concentrating on a single product (whatever type it was) had had a negative implication in terms of profit. Because, it caused a loss among producers, by at the end discouraged farmers to use irrigation. This problem was particularly serious when they supplied their product to the market at a similar time leading to a fall in market prices due to an oversupply of the same product in the market place. Therefore, based on the advice they got from DAs irrigating farmers decided to diversify and intensify their cultivation.

4.1.2. Impact of Irrigation on Asset Holdings

4.1.2.1. Agricultural assets

Agricultural production assets presented in the survey include: motor pumps, pedal pumps, well, sprayers, ploughs, harrows, hoe, spike, hosepipe, watering can, and Other (if any) equipment necessary for agricultural activities. Of these mentioned assets except pedal pump, sprayers, and watering can all others were possessed by the sampled (Households)HHs though there is a difference between the irrigating and & non-irrigating HHs. The agricultural assets for irrigating and non-irrigating households were compared by considering the total number of agricultural assets owned by HH and the total values of the agricultural assets of each of the groups.

The Pearson Chi-Square test result, i.e. 0.001 shows that there is a relationship between the number and values of agricultural assets with access to irrigation (Table 4). The symmetric measures also show that, this difference is statistically significant at 0.001 significance value level for both. This test result indicating that there is a linear relationship between values and numbers of agricultural assets among irrigating and non-irrigating HHs. Results of symmetric measures also show the presence of strong association between access to irrigation and agricultural assets (Table 5).

Table 4: Chi-Square Tests for number and values of agricultural assets of HH versus access to irrigation

Access to Irrigation	Sample Size	Value	df	Asymp. Sig. (2-sided)
Non-users	203	203.000	4	.000*
Users	91	70.043	15	.000**

Source: Field Survey and Personal Computation, 2014; NB: Since the significance values '*', '**' and '***' of the test are less than 0.05, statistically they are significant.

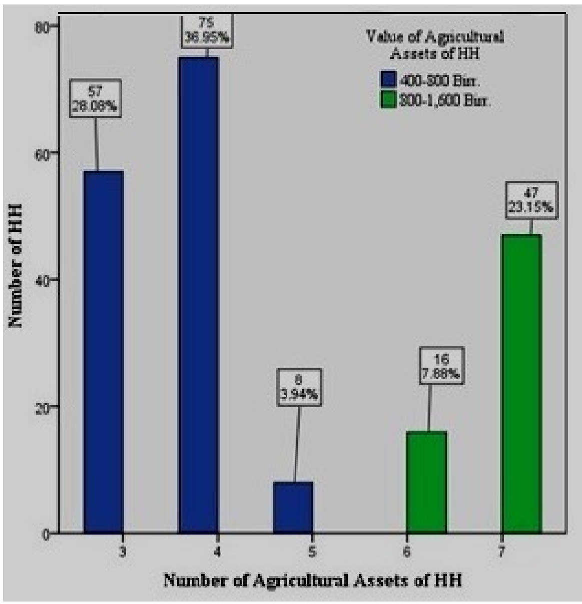


Figure 2: Number & values of agricultural assets of non-irrigating HH.

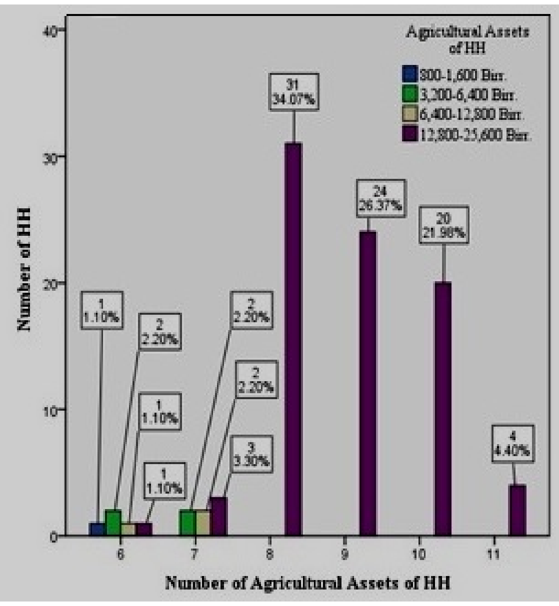


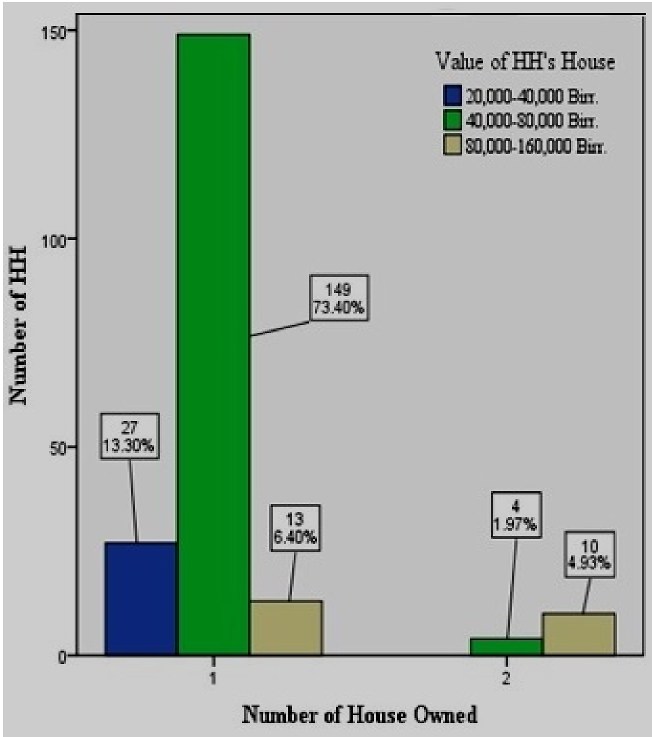
Figure 3: Number & values of agricultural assets of irrigating HH.

Table 5: Symmetric measures for number and values of agricultural assets of HH versus access to irrigation

Access to Irrigation			Value	Approx. Sig.
Non-users	Nominal by Nominal	Phi	1.000	.000
		Cramer's V	1.000	.000
		Contingency Coefficient	.707	.000
	Sample Size		203	
Users	Nominal by Nominal	Phi	.877	.000
		Cramer's V	.507	.000
		Contingency Coefficient	.659	.000
	Sample Size		91	

Source: Personal Computation, 2014; NB: Since the significance values of symmetric measures are less than 0.05 for all and the values are also greater than 0.3, these show that there is a strong relationship between access to irrigation and agricultural assets.

4.1.2.2. Number and values of houses owned



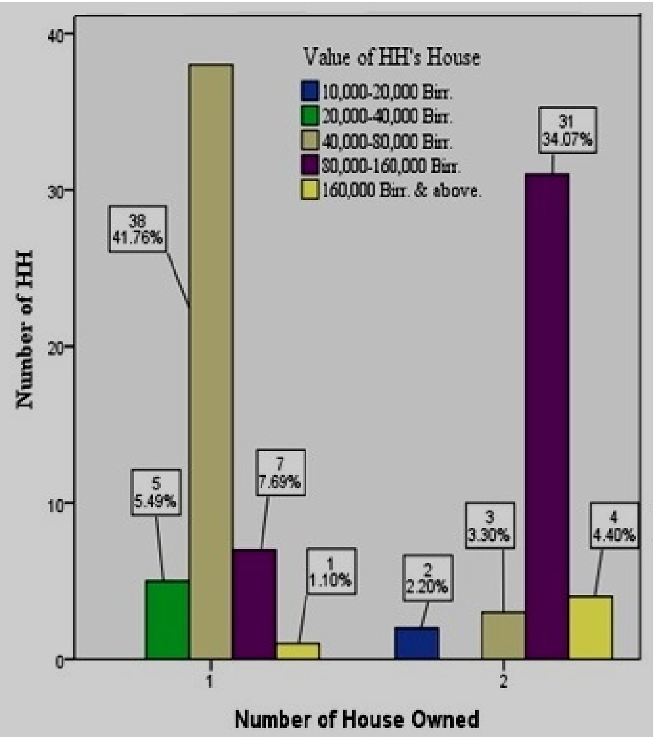


Figure 4: Number &values of house owned by irrigating HH.

Figure 5: Number &values of house owned by non-irrigating HH.

Source: Field Survey and Personal Computation, 2014

With regard to the number and values of house owned by HH the study result shows that among the sampled 294 HHHs about 240, i.e. 81.6% of them had owned a single house and the rest 54 (18.4%) HHHs possessed two houses. As far as, the two groups are concerned of all irrigating HHHs about 40 (44%) of them owned two houses while among the non-irrigating HHHs only about 14 (6.9%) had owned two houses (Figures 4 and 5). Similarly, the irrigating HHHs owned the greater values houses, i.e. about 43 (47.3%) of them possessed houses valued 80,000 to 160,000 Birr. & above that where as among the non-irrigating HHHs only about 23 (11.3%) of them owned houses which valued from 80,000 to 160,000 Birr (Figures 4 and 5).

Table 6: Chi-Square Tests for number & values of house owned with access of irrigation

Pearson Chi-Square

Access to Irrigation	Sample Size	Value	df	Asymp. Sig. (2-sided)
Non-users	203	54.305	2	.000*
Users	91	53.285	4	.000**

Source: Personal Computation, 2014; NB: Since the significance values**,** and of the test are less than 0.05, statistically they are significant.

4.1.2.3. Size and Type of Lands Owned and Actually Irrigated

Agricultural production requires resources such as labor, natural resources, agricultural tools and other capital assets. In the foregoing sections, it has been discussed the land holding size, and land types owned as well as irrigated, i.e. whether they have a critical link with access to irrigation. Therefore, the study looks the access of these resources between irrigating and non-irrigating households. Knowing this helps to judge irrigation's impact on household's assets and income difference.

Land is the major productive asset in agrarian countries like Ethiopia. Cultivated land appears to be the most important scarce factor of production. In the survey under the land type the farmer was asked whether he/she has one or more of the land type(s) among cultivated, fallow, private pasture and others. As participants noted, the

land size and land type as well as the use of irrigation are the most important factors for improvement in agricultural production between HHs. Besides, in the survey irrigating and non-irrigating farmers' land holding size and type were asked and summarized in Tables 7 and 8.

The average land size owned by the sampled HHs in the study area was about 0.99 ha, which is comparable to the national land holding of 1.0 ha, with the minimum and maximum sizes of 0.38 and 1.75 hectares, respectively (Table 7). On the other hand, the average land holding size of irrigating HHs is about 1.2 ha. Which is slightly greater than that of the non-irrigating HHs, i.e. 0.91 ha (Table 8).

Thus, the overall land holding per household among the study groups is almost similar. However, the independent samples Mann-Whitney U-test result is 0.001*. This shows that there is a significant difference between irrigating and non-irrigating households in average land holding size (Table 7).

Table 9 shows that 48.35% and 19.78% of respondents among the sampled irrigating HHs were able utilize 0.54 and 0.75 hectares of their land using the irrigation scheme, respectively. These two accounts the largest proportion by percentage. On the other hand, it was only 20.88% of respondents among the sample irrigating HHs were able utilizing more than 0.75 hectare of their land using the irrigation scheme.

This implies partly that the irrigation project in the study area could not satisfy what the beneficiaries need to have. Furthermore, had the irrigation project been in such ways that satisfy the optimal need of the farmers there would have been more output than the existing one. Generally speaking there should be a further investment of irrigation project development (Table 9).

Table 7: Descriptive statistics for land size owned by HHs of the study area

	Sample Size	Min.	Max.	Mean	Std. Dev.	CoV(%)
Land Size Owned by HH in hectare	294	.38	1.75	.9884	.28246	28.58*

Table 8: Group statistics and Mann-Whitney U-test value for land size owned by HHs of the two groups

Access to Irrigation	Land Size Owned by HH in hectare			
	Sample Size	Mean	Std. Dev.	Std. Error Mean
Non-users	203	.9112	.27848	.000*
Users	91	1.1604	.20576	

Table 9: Comparison of actual irrigated land size among irrigating households

	Irrigated land size (in ha.)							Total
	0.25	0.54	0.75	1.00	1.10	1 .25	1.32	
HHs No.	10	44	18	7	5	4	3	91
%	11.00	48.35	19.78	7.69	5.49	4.4	3.3	100

Source: Field Survey, 2014

In the study area, according to research result based on the sampled size "own land type" was the only type of land used for cultivation. However, with regard to number of land types owned by the sampled HHs, out of 294 sampled HHs about 68.7% of them owned only a single type of land while the remaining 31.3% HHs owned two different types of lands. Generally, the minimum and maximum numbers of land types owned by HHs of the study area are one and two, respectively.

The research result also shows that irrigating households have greater numbers of land types owned by themselves than non-irrigating households. In other words, about 61.5% of irrigating HHs possessed two different types of land, i.e. one additional land type (private grazing land or woodlots/ planted trees) besides cultivated land whereas this condition became true only on 17.7% of the non-irrigating HHs (Table 10 and Figure 6). Similarly, the chi-square test result, i.e. 0.001 also shows that there is a significant difference in the number of land types they owned (Table 10). This difference was might be due to the use of irrigation by irrigating HHs. This in turn may generate income and allow accumulation of other productive assets by irrigating households, which might facilitate cultivation of additional types of crops, fruits and vegetables more than non-irrigating households.

Table 10: Land type owned by HHH versus access to irrigation cross-tabulation

			Access to Irrigation		Total	Chi-square sig value
			Non-users	Users		
Land Type Owned by HH	1	Number of HHH	167	35	202	.000**
		% within Access to Irrigation	82.3%	38.5%	68.7%	
		% of Total	56.8%	11.9%	68.7%	
	2	Number of HHH	36	56	92	
		% within Access to Irrigation	17.7%	61.5%	31.3%	
		% of Total	12.2%	19.0%	31.3%	

Source: Field Survey and Personal Computation, 2014; NB: Since the significance values '**' of the test is less than 0.05, statistically it is significant.

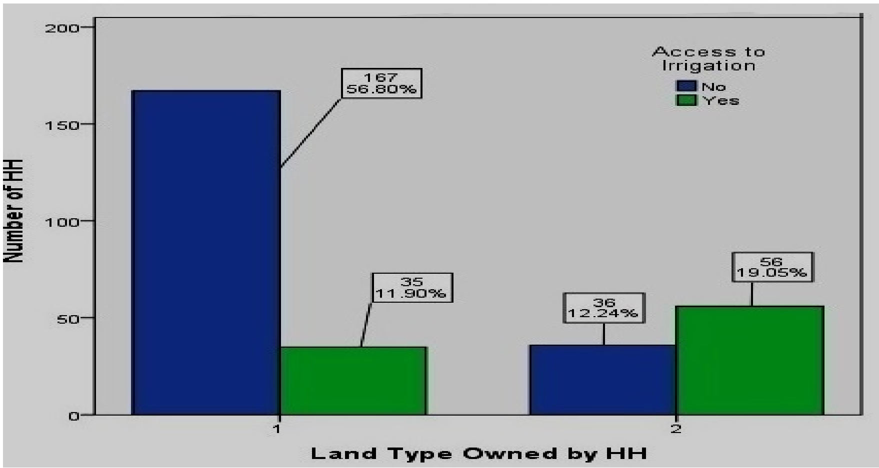


Figure 6: Land type owned by irrigating and non-irrigating HHs

Source: Field Survey and Personal Computation, 2014.

4.2.3. Impact of Irrigation on Household Income

Household gross income is derived from agricultural (crop and livestock) sales and value of crops and livestock products retained for household consumption. The value of retained crop and livestock products was calculated using annual average nominal prices. In the case of irrigating households, individual household cropping income was computed from both rain fed and irrigated crops but for non-irrigating households, cropping income was derived from only rain fed crops. The off-farm and non-farm incomes were also considered as part of survey but none of the households were generating income or involving in this activity. That was the main reason of excluding the off/nonfarm activities during the analysis processes. On the other hand the study considering planted trees in the income analysis because the non-irrigating households may use income from trees to compensate for their lack of irrigation. Therefore, to evaluate the income difference between irrigating and non-irrigating households due to irrigation, the study considers the different sources of income. As it was mentioned in the objectives and research questions part one of the purpose of this study is evaluating the income difference between irrigating and non irrigating households due to access to irrigation. Non-irrigating households may have better income in other activities as a compensation of irrigation then considering all income sources are important to evaluate impact of irrigation on household gross income.

4.2.3.1. Cropping incomes

The most common crops grown in the study area are maize, sorghum, nut, sweet potato, sugar cane and chat. These crops are grown as staple and cash crops in the study area. The estimation of gross crop income uses taking the mean annual average price for both the sold and home- consumed crops. These crops were grown as major crops by both irrigating and non-irrigating households during rain fed farming.

During irrigation time the major income source crops for irrigating households were maize, chat, sugar cane and sweet potato whereas for non-irrigating households were off. Of these chat and sugar cane were the two main sources of income from irrigating crops in the study area.

The mean income difference shows that irrigating households were better off in all cropping income than non-irrigating households except maize and sorghum. The largest income was generated from chat production using small-scale irrigation. This suggests that small-scale irrigation development increases the incomes of rural household because it directly influences the highest income source, i.e. cropping.

4.2.3.1.1. Rainfed cropping income

Rainfed crops were cultivated by both irrigating and non-irrigating households. But, unlike irrigating households, non-irrigating households depend only on rainfed cultivation. The major reasons for non-irrigating households not irrigating were lack of determination and capital to dig the well and buying motor pump. Of the sampled non-irrigating HHs while forwarding their reason 64% answered they lacked determination and capital, 23% no access to water for irrigating their farm plot and 13% shortage of family labor (Table 11).

Lack determination was the most important limiting factor; however the literature indicates that the groundwater table and surface water is high in the study area (HRFEDB, 2009). Thus, in addition to the presence of ground and surface water as a source of irrigation development an additional basic consideration might be given to enhance and promote further irrigation development in the study area.

Table 11: The reasons of non-irrigating households for not irrigating

Reasons	Number of non-irrigating HH	Percent of non-irrigating HH
Lack of determination	69	34
Lack of capital	61	30.04
No access to water	47	23.15
Shortage of family labor	26	12.81
Total	203	100

As far as rainfed cropping is concerned the mean annual production (in Kg) and gross income (in Birr) from rainfed cropping was 2348.07 kg and ETB 32,462.14 (Table 12).

Table 12: Descriptive Statistics for rainfed total/gross crop production & value of the study area

	Sample Size	Min.	Max.	Mean	Sum	Std. Dev.	CoV (%)
Rainfed Total Crop Production in Kg.	294	1745	4140	2348.071	690333.00	478.2031	20.37*
Rainfed Gross Crop Value/ Income in ETB	294	26,700	64,800	32,462.14	9,543,867.88	6,338.99	19.53**

With regard to each group the average annual rainfed crop production of irrigating non-irrigating HHs was almost equal. That was 2287.91 kg, i.e. 32,250.55 ETB for irrigating HHs where as 2375.03 kg (32,556.98 ETB) for the non-irrigating HHs, which was slightly greater than that of irrigating HHs.

4.2.3.1.2. Irrigated crop income

The mean annual gross crop production and income of irrigating HHs in the sample area were 181.67 kg and 8,489.83 ETB (Table 13). The independent samples Mann-Whitney U-test result, i.e. 0.001 shows that statistically there is a significant difference in the mean annual gross irrigating crop production and income between irrigating and non-irrigating HHs (Table 13).

4.2.3.2. Vegetation income

4.2.3.2.1. Rainfed vegetation income

When we see the rainfed vegetation farming of the sample HHs, the mean annual production (in Kg) and gross income (in Birr) from rainfed vegetation was 243.23 kg and 2,778.61 ETB (Table 36).

With regard to each group, the average annual vegetation production of irrigating HHs was 199.69 kg, i.e. 2,684.60 ETB whereas the non-irrigating was 202.46 kg (2,703.54 ETB), which was slightly greater than that of irrigating HHs (Table 15).

Table 13: Group statistics and independent samples Mann-Whitney U-test value for irrigating gross crop production

	Access to Irrigation	Sample Size	Mean	Std. Dev.	U-test sig. value
Irrigated Total Crop Production in Kg.	Non-users	203	.0000	.000	.000*
	Users	91	181.6703	205.23	
Irrigated Gross Crop Value in ETB.	Non-users	203	.0000	.000	.000**
	Users	91	8,489.83	2,961.68	

Table 14: Descriptive Statistics for rainfed gross vegetation income

	Sample Size	Min.	Max.	Mean	Std. Deviation	Sum	CoV (%)
Rainfed Total Vegetation Production in Kg.	294	.00	500.00	243.23	201.21	71,510.00	82.72*
Rainfed Gross Vegetation Value/ Incme in ETB	294	.00	6,000.00	2,778.61	2,693.27	816,910.00	96.93**

Source: Field Survey, 2014; NB: Since the coefficient of variation (CoV) '*' and '**' of the test both are much greater than 50%, statistically these show that there is strong variability of rainfed total vegetation production and income among HHs in the study area.

4.2.3.2.2. Irrigating vegetation income

The mean annual irrigating vegetation gross production and income of irrigating HHs in the sample areas were 196.33 kg and 2,446.74 ETB, respectively (Table 16).

Table 15: Group statistics and independent samples Mann-Whitney U-test value for rainfed gross vegetation income of the groups

	Access to Irrigation	Sample Size	Mean	Std. Deviation	U-test sig. value
Rainfed Total Vegetation Production in Kg.	Non-users	203	244.0640	202.45611	.917*
	Users	91	241.3736	199.68874	
Rainfed Gross Vegetation Value/ Income in ETB	Non-users	203	2,792.2167	2,703.54269	.721**
	Users	91	2,748.2418	2,684.59581	

Source: Field Survey and Personal Computation, 2014; NB: The independent samples Mann-Whitney U-test results, i.e. 0.917* and 0.721** show that statistically, there is no significance difference between irrigating and non-irrigating households in their mean annual rainfed vegetation gross production and income.

Table 16: Group statistics and independent samples Mann-Whitney U-test value for irrigated gross vegetation income of the groups

	Access to Irrigation	Sample Size	Mean	Std. Deviation	U-test sig. value
Irrigated Total Vegetation Production in Kg.	Non-users	203	.0000	.00000	.000*
	Users	91	450.6593	196.33193	
Irrigated Gross Vegetation Value/ Income in ETB	Non-users	203	.0000	.00000	.000**
	Users	91	5,449.23	2,446.738	

Source: Field Survey and Personal Computation, 2014; NB: Since the non-irrigating HHs didn't have any production there was a clear difference in gross mean income between the two groups. Furthermore, the independent samples Mann-Whitney U-test significant values result '*' and '**' of both production and income are less than 0.05. These show that statistically there is a significant difference in the mean annual gross irrigating vegetation production and income between irrigating and non-irrigating HHs.

4.2.3.3*. *Fruit income

4.2.3.3.1. Rainfed fruit income

When we see the rainfed fruit farming of the sample HHs, the mean annual production (in Kg) and gross income (in Birr) from rainfed fruit was 3395.31 kg and 21,910.03 ETB (Table 17).

Table 17: Descriptive Statistics for rain fed gross fruit income

	Sample Size	Min.	Max.	Mean	Std. Dev.	CoV (%)
Rainfed Total Fruit Prodution in Kg.	294	.00	6400.00	3395.31	1,545.68	45.52
Rainfed Gross Fruit Value/ Income in ETB	294	.00	40,800.00	21,910.03	9,781.31	44.64

Source: Field Survey, 2014; NB: The coefficient of variation (CoV) '*' and '**' of the test both are slightly less than 50%, this means that the variability of rainfed total fruit production and income among HHs is weak. With regard to each group the average annual fruit production of irrigating HHs was 1584.39 kg, i.e. 10,023.36 ETB where as the non-irrigating was 1538.87 kg (9,746.08 ETB), which was slightly less than that of irrigating HHs.

The independent samples Mann-Whitney U-test results, i.e. 0.916* and 0.946** show that statistically, there is no significance difference between irrigating and non-irrigating households in their mean annual rainfed fruit gross production and income (Table 18).

Table 18: Group Statistics and independent samples Mann-Whitney U-test value for rain fed gross fruit income

	Access to Irrigation	Sample Size	Mean	Std. Deviation	U-test sig. value
Rainfed Total Fruit Prodution in Kg.	Non-users	203	3371.8719	1538.87205	.916*
	Users	91	3447.5824	1584.38585	
Rainfed Gross Fruit Value/ Income	Non-users	203	21,760.5911	9,746.08191	.946**
	Users	91	22,243.4066	10,023.3594	

4.2.3.3.2. Irrigating fruit income

The mean annual irrigating fruit gross production and income of irrigating HHs in the sample areas were 2577.25 kg and 16,665.38 ETB, respectively (Table 19).

Table 19: Group Statistics and independent samples Mann-Whitney U-test value for irrigating gross fruit income

	Access to Irrigation	Sample size	Mean	Std. Dev.	U-test sig. value
Irrigated Total Fruit Production in Kg.	Non-users	203	.000	.00000	.000*
	Users	91	2577.253	648.177	
Irrigated Gross Fruit Income in ETB	Non-users	203	.000	.00000	.000**
	Users	91	16,665.38	4,328.66	

Source: Field Survey and Personal Computation, 2014; NB: Since the non-irrigating HHs didn't have any production there was a clear difference in gross mean income between the two groups. The independent samples Mann-Whitney U-test results, i.e. '*' and '**' of both production and income also show that statistically there is a significant difference in the mean annual gross irrigating fruit production and income between irrigating and non-irrigating HHs.

4.2.4.4. Income from private trees

When we see the income from private planted trees of the sample HHs, the mean annual production (in number) and gross income (in ETB) from trees was 105.44 and 3,165.26 ETB (Table 20).

With regard to each group the average annual tree production of irrigating HHs was 109.89, i.e. 3,296.70 ETB where as the non-irrigating was 103.45 (3,103.45 ETB), which was slightly less than that of irrigating HHs (Table 21).

Table 20: Descriptive Statistics for trees production & income

	Sample Size	Min.	Max.	Sum	Mean	Std. Deviation
Total Tree Production in Number	294	.00	2,000.00	31,000	195.44	241.52*
Gross Income from Trees in ETB	294	.00	60,000.00	930,000	3,965.26	7,245.61**

Source: Field Survey and Personal Computation, 2014; NB: The Standard Deviation '*' and '**' of the test are both much higher than the means, this means that there is strong variability of gross trees production and income among HHs in the study area.

Table 21: Group statistics and Mann-Whitney U-test value for trees production & income

	Access to Irrigation	Sample Size	Mean	Std. Deviation	U-test sig. value
Total Tree Production in Number	Non-users	203	103.45	247.24	.887*
	Users	91	109.89	229.51	
Gross Income from Trees in ETB	Non-users	203	3,103.45	7,417.14	.887**
	Users	91	3,296.70	6,885.56	

Source: Field Survey and Personal Computation, 2014; NB: The independent samples Mann-Whitney U-test results, i.e. 0.887* and 0.887** show that, statistically there is no significance difference between irrigating and non-irrigating households in their mean annual rain fed fruit gross production and income.

4.2.3.5. Livestock income

The type of agriculture in the study area is settled agriculture with a mixed farming system (i.e., integrated crop and livestock production). Livestock are the most important productive assets in the household. In the study area, livestock are important source of power for ploughing, transportation, and sources of income as well as diet. Livestock also consolidate the social organization as they serve in payment for blood compensation and gifts for relatives. They play role in religious and cultural ceremonies and serve as source of prestige. It also considered as a saved asset used during periods of financial shortage. The average livestock holding for sample HHs was 4.17 TLU, with minimum and maximum TLU of 0.60 and 8.80, respectively (Table 22).

With regard to the two groups, irrigating households possess a larger average number of livestock (6.06) than non-irrigating households (3.33). Furthermore, the independent samples Mann-Whitney U-test result shows that, statistically there is a significant difference between irrigating and non-irrigating households in the average livestock numbers (TLU) at the 0.001* significance level (Table 23).

Livestock play a significant role as a source of income in rural poor Ethiopia. Sale of live animals and their products are main livestock-related income sources in the study area. The livestock income category includes income from the sale of livestock, livestock products (i.e. milk, eggs, honey etc.) and other by-products like hide and skin. The values of sale and own consumption livestock and livestock products were estimated based on the average annual nominal prices. The livestock products were collected on a weekly basis, and converted to estimate annual income. The overall mean livestock and animals' out-put gross-income for the sample area was 791.70 ETB and 2,029.65 ETB, respectively (Table 24).

Table 22: Descriptive Statistics for number of livestock in TLU

	Sample Size	Min.	Max.	Mean	Sum	Std. Dev.	CoV (%)
Livestock Owned in TLU *	294	.60	8.80	4.1753	1227.53	1.9971	47.83*

Source: Field Survey and Personal Computation, 2014; NB: *obtained using appendix-III2. NB: Since the coefficient of variation (CoV) '*' of the test is slightly less than 50%, the variability of livestock owned in TLU among HHs is slightly weak.

Table 23: Group statistics and independent samples Mann-Whitney U-test value for number of livestock in TLU

	Access to Irrigation	Sample Size	Mean	Std. Deviation	U-test sig. value
Livestock Owned in TLU *	Non-users	203	3.3292	1.49461	.000*
	Users	91	6.0626	1.65979	

Source: Field Survey and Personal Computation, 2014; NB: *obtained using appendix-III2.

Table 24: Descriptive Statistics for livestock income

	Sample Size	Min.	Max.	Mean	Std. Dev.
Livestock income in ETB	294	.00	11,000	791.7	2,765.12*
Gross-Income from animals output/ by-product in ETB	294	.00	15,116	2,029.7	2,184.12**

Source: Field Survey and Personal Computation, 2014; NB: NB: The Standard Deviation '*' and '**' of the test are both much higher than the means, this shows that there is strong variability of livestock income and income from animals output among HHs in the study area.

With regard to the irrigating and non-irrigating households the average livestock and animals' out-put gross-income were 63.30 and 2,560.88 ETB for irrigating HHs, and 1,791.50 and 1,118.23 ETB for non-irrigating HHs, respectively. Irrigating households had larger animals' out-put income than non-irrigating households, and on the other hand the non-irrigating HHs had larger livestock income than the irrigating ones (Table 28). These might be the influence of irrigation.

However, the independent samples Mann-Whitney U-test results, i.e. 0.715** and 0.153* show that statistically for both, there were a significant difference in the mean income between the groups (Table 28).

Table 28: Group statistics and independent samples U-test value for livestock income

	Access to Irrigation	Sample Size	Mean	Std. Dev.	U-test sig. value
Gross-Income from animals output/ by-product in ETB	Non-users	203	1,791.50	1,782.52	.153*
	Users	91	2,560.88	2,825.87	
Livestock income in ETB	Non-users	203	1,118.23	3,276.54	.715**
	Users	91	63.30	137.801	

Source: Field Survey and Personal Computation, 2014

4.2.3.6. Summary of income sources at household level

The total mean annual household income in the study area was ETB 72,608.18. From the total mean annual income of a household, cropping contributes the highest income share of about 48.33%, followed by fruit which accounts about 37.28% and then vegetation, i.e. 11.29%, respectively (Table 29).

Table 29: Descriptive Statistics for income source of HH

Sources	Sample Size	Min.	Max.	Mean	Std. Dev.	CoV (%)
Gross Crop Value/Income in ETB	294	32,556.98	40,740.38	35,089.94	3,789.61	10.80
Gross Vegetation Value/ Income in ETB	294	2,792.22	8,197.47	4,465.27	2,503.09	56.06*
Gross Fruit Value/Income in ETB	294	21,760.59	38,908.79	27,068.37	7,941.08	29.34
Gross Income from Trees in ETB	294	103.45	3,296.70	1,163.27	898.4912	77.24**
Gross Income from Livestock in ETB	294	63.30	1,118.23	791.70	488.5228	61.71***
Income from animals output/ by-product in ETB	294	791.50	2,560.88	2,029.64	1,356.29	66.82****

Source: Personal Computation, 2014; NB: NB: Since the coefficient of variation (CoV) '*' '**', '***' and '****' of the test are all greater than 50%, there is strong variability in the gross incomes from vegetation, trees, livestock and animals output among HHs in the study area. For the rest income sources CoV of the test is less than 50%, this means that there is less variability of those incomes among HHs. Considering the two groups, irrigating households earn higher gross income than the non-irrigating households from almost all types of farming, except gross income from selling live livestock (Table 29).

These gross mean income differences between irrigating and non-irrigating HHs arise from the using or not-using of irrigation. Generally, the mean gross annual income of irrigating farmers exceed that of the rainfed (non-irrigating) farmers by ETB 30,644 , which has an obvious effect of SSI on the farmers' ability to reduce poverty and increase their livelihood status.

Table 30: Group means and independent samples Mann-Whitney U-test values for gross income from different sources of the two groups

	Access to Irrigation	Sample Size	Mean	U-test sig. value
Gross Income from Crop in ETB	Non-users	203	32,556.98	.000*
	Users	91	40,740.38	
Gross Income from Vegetable in ETB	Non-users	203	2,792.22	.000*
	Users	91	8,197.47	
Gross Income from Fruit in ETB	Non-users	203	21,760.59	.000*
	Users	91	38,908.79	
Gross Income from Trees in ETB	Non-users	203	3,103.45	.887**
	Users	91	3,296.70	
Gross Income from Livestock in ETB	Non-users	203	1,118.23	.715***
	Users	91	63.30	
Gross Income from animals output/ by-product in ETB	Non-users	203	1,791.50	.153****
	Users	91	2,560.88	

Source: Personal Computation, 2014; NB: The independent samples Mann-Whitney U-test results except '*'(the first three) all others, i.e. '**', '***', and '****', show that there is no significant difference between irrigating and non-irrigating households in their gross mean incomes.

5. Summary and Conclusions

The objective of this study was to assess the impact of SSI on socio-economic status, particularly on total income and assets as well as consumption at the HH level. The study was conducted in Erer Woreda, Harari Regional State, focusing on two sampled kebeles. The sampling procedure used for the study was a multi stage sampling procedure. Firstly, selection of the study area and two sampled kebeles were done based on purposive sampling. Secondly, the sample frame, i.e. 1113 HHHs was determined by using a stratified random sampling technique. Then thirdly, the sampled HHHs (294 HHHs) was selected using proportionate random sampling technique.

The study used both primary and secondary data sources. The study utilized multiple data gathering techniques, such as structured questionnaires, semi-structured interview, and direct personal observation. To compare the socio-economic impact of SSI all relevant and available document were also reviewed and served as a secondary source of data. The qualitative and quantitative data collected was analyzed using qualitative methods and descriptive statistics. Data collected from key informant interviews, and field observation was qualitatively assessed. The household was used as the basic survey unit for the analysis. To study the socio-economic impact of SSI, comparative data analysis between irrigation users and non-users was carried out using the SPSS 20 statistical software package. The purpose of the analysis was to show the relationship between different variables. Finally, outputs of the statistical analysis were discussed using tabulation, cross-tabulation, means, frequencies and percentages. Moreover, the Chi-square test and independent samples t-test was used to compare the two groups; and different significance levels were also employed to test the strength of the relationship between variables and also to compare the two groups.

As the survey of this study shows, access to irrigation increases the opportunity for crop intensity and diversification, which in turn increase HHs incomes and assets as well as consumption for many HHs in the study area. In addition to their normal rain fed cultivation, irrigating HHs cultivate cash crops, especially chat which generate high amount of income, using SSI. Generally, irrigated crops were selected due to good production potential, economic returns and ease of cultivation, respectively. The main income sources of rural HH in the study area were crop and livestock farming activities. The study result shows that irrigating HHs have significantly larger gross mean annual income than non-irrigating HHs. The average total assets of sample HHs was larger than the non-irrigating HHs.

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