Research Article
Volume 14:1, 2025

Irrigation & Drainage Systems Engineering

ISSN: 2168-9768 Open Access

Effect of Small-Scale Irrigation Practices on the Economic Condition of Farmers in North Wollo Zone, Ethiopia

Destaw Fentaw[1*], Hailemariam Meaza[2] and Birhan Tadesse[1]

[1]*Department of Geography and Environmental Studies, Woldia University, Weldiya, Ethiopia*

[2]*Department of Geography and Environmental Studies, Mekelle University, Endayeus (Main) Campus Mekelle, Ethiopia*

Abstract

This study investigates the effect of small-scale irrigation practices on the economic condition of farmers in the North Wollo zone of Ethiopia. Given the region's vulnerability to drought and inconsistent rainfall, small-scale irrigation is increasingly seen as a vital strategy for enhancing agricultural productivity and improving livelihoods. Through a combination of qualitative and quantitative methods, data were collected from a sample of farmers utilizing different irrigation techniques. The findings reveal that farmers engaged in small-scale irrigation experience significantly higher crop yields, income levels and food security compared to their rain-fed counterparts. Additionally, the study highlights the importance of access to resources, such as financial support and training, in optimizing the benefits of irrigation practices. The results suggest that promoting small-scale irrigation could be a crucial intervention for sustainable agricultural development and poverty alleviation in the region. This research underscores the need for policy measures that facilitate access to irrigation technologies and support farmers in adopting effective irrigation practices.

Keywords: Economic condition • Farmers • Agricultural water management

Introduction

Agriculture is the spine of the Ethiopian economy. This particular sector determines the growth of all other sectors and consequently, the whole national economy. Ethiopia's dominating agriculture-based economy accounts for 37 percent to GDP, one of the highest shares in sub- Saharan Africa, as well as to 83.9 percent of exports. Moreover, the sector employs around 72 percent of the total population [1].

However, agricultural crop yield is very low, as compared to other developing countries [2]. Besides, in many parts of Ethiopia, agricultural production is affected by environmental extremes like drought, high soil salinity, etc and the country has been seriously affected by recur climate change and related hazards. Consequently, millions of people have been left without sustenance mode of life every year mainly in the low-lying areas. Thus, a number of efforts such as irrigation schemes have been embarked to minimize these effects of the recurrent drought [3].

In Ethiopia, traditional irrigation has been practiced since many centuries ago [4]. Moreover, in the highlands of Ethiopia, irrigation practices have long been in use since ancient times for producing subsistence food crops [5]. Spate irrigation has also been used traditionally in Ethiopia. Particularly in Southern Tigray and in some semi-arid areas in Oromia region [6]. The history of modern irrigation agriculture in Ethiopia dates back to 1960 when it started with the production of industrial crops (sugar and cotton) on large-scale farms by private investors in the Awash area. However, local farmers had already been practicing traditional irrigation during the dry season using water from river diversions for subsistence crop production [7].

The dependence of smallholder farmers on rain fed agriculture has made the Ethiopia's agricultural economy extremely fragile and vulnerable to the impacts of weather and climatic variability. This leads to crop failure, which in turn resulted in food shortages. Unreliable rainfall, recurrent drought and limited use of the available water resources, coupled with heavy reliance on rain-fed subsistence agriculture, have contributed adversely to the economy of Ethiopia [8]. As a response to the hydrological drought, irrigation and improved agricultural water management have been introduced in the country.

***Address for Correspondence:** Destaw Fentaw, Department of Geography and Environmental Studies, Woldia University, Weldiya, Ethiopia, Tel: 251913618243; E-mail: fdestaw80@gmail.com*

Received: 19 February, 2024, Manuscript No. IDSE-24-127853; **Editor assigned:** 22 February, 2024, PreQC No. IDSE-24-127853 (PQ); **Reviewed:** 08 March, 2024, QC No. IDSE-24-127853; **Revised:** 14 February, 2025, Manuscript No. IDSE-24-127853 (R); **Published:** 21 February, 2025, DOI: 10.37421/2168-9768.2025.14.471

The development of irrigation and agricultural water management holds a significant potential to improve productivity and reduce vulnerability to climactic variability [9]. Although Ethiopia has abundant water resources, its agricultural system does not yet fully benefit from the technologies of water management and irrigation. The majority of rural dwellers are among the poorest in the country, with limited access to agricultural technology, limited possibilities to diversify agricultural production given underdeveloped rural infrastructure and little or no access to agricultural markets and to technological innovations. These issues, combined with increasing degradation of the natural resource base, especially in the highlands, aggravate the incidence of poverty and food insecurity in rural areas [10]. Hence Ethiopia is highly affected by drought and millions of people are left without sustenance frequently. As an option, small-scale irrigation schemes are important to reduce vulnerability and increase productivity.

In Amhara region, different ranges of small-scale irrigation schemes have been practiced to reduce the effect of drought and rainfall variability [11]. Small-scale irrigation system in the region comprises about 75% of the region's total improved irrigated area. The regional government has been paying high attention in expanding irrigation activities especially in dry areas. More importantly, small-scale irrigation has been practiced to supplement the rainfall.

Part of Amhara, Northern Wollo area is among the most-disaster prone areas of the region in which drought, crop failure, famine and variability of rain fall have repeatedly struck it for many years. The livelihoods of the households of the zone depend on subsistence farming. To compensate the erratic nature of rainfall distribution and drought there are traditional irrigation schemes activities. Among the droughts prone areas of this Zone Gubalafto Woreda is one of them. Climatic variability leading to famine is common in the area. It is a dry area in which most people are suffering from continuous crop failure and food insecurity. Farmers cannot produce enough crops to feed their family. Therefore, their only option was receiving food aid from the government and NGOs. This determined serious occasion and persistent nourishment help needs of the society pushed the government to grow small scale water system hone by utilizing the locally accessible surface water supply. Therefore, the objectives of the study are:

- To identify the type of agricultural products produced by the small-scale irrigation practice.
- To examine the contribution of small-scale irrigation schemes for farmers as a sources of income.
- To identify the key challenges of small- scale irrigation practices in the study area.

Methods and Materials

Study area description

The study was carried out in North Wollo Zone, Amhara region of Ethiopia. Part of the North Wollo zone, Gubalafto Woreda is bordered in the south by South Wollo Zone, in the West by Delanta and Gazo Woredas, in the North West by the newly formed Woreda called Angot in the North by Gidan and on the South East by Habru. Astronomically the area is located between 11034'54"N-11058'59"N and 39012'09"E-39045'58"E. Towns in this Woreda include Hara, Sanka, Beklo Manekia and Doro Gibir. The study woreda surrounded Woldia town which is the capital of North Wollo zone.

Nature and sources of data

Both primary and secondary data sources (qualitative and quantitative) were applied. The primary data were gathered from both irrigator and non-irrigator household head farmers, from agricultural experts and Gubalafto woreda agriculture office personnel. Moreover, the data were collected through field observation. Secondary data were also used to supplement the primary data.

Sample size and sampling procedure

The study Woreda contained 34 Keble's, among these ten (10) of them are practicing small scale-irrigation by using small streams and perennial rivers. Three small-scale irrigation schemes (Jarssa, Debot and Gebrie amba) were selected in simple random sampling technique. The total irrigator household heads found in the three small-scale irrigation schemes were Jarssa (874), Debot (643) and Gebrie amba (811). In reverse, the numbers of non-irrigator HHs in the sample kebeles were 428, 311 and 406 respectively, which were totally 3473 target population. In order to select the total sample households, the formula of Kothari (2004) was applied and 179 sample household head farmers of each respective scheme were proportionally selected.

Data collection tools

To collect the primary data from individual HHs (irrigators and non-irrigators) both open ended and close ended questionnaires were used. To find out the necessary information for the study, key informants interview have given also a concern. Field observation was done to witness the overall activities of farmers in irrigation activity and to observe the overall movements of farmers and irrigation practices.

Data analysis

First of all, the distribution of normality of the data was checked using box plot (Figure 1). Outliers were excluded from the analysis since it would have an impact on mean value of annual income of irrigators.

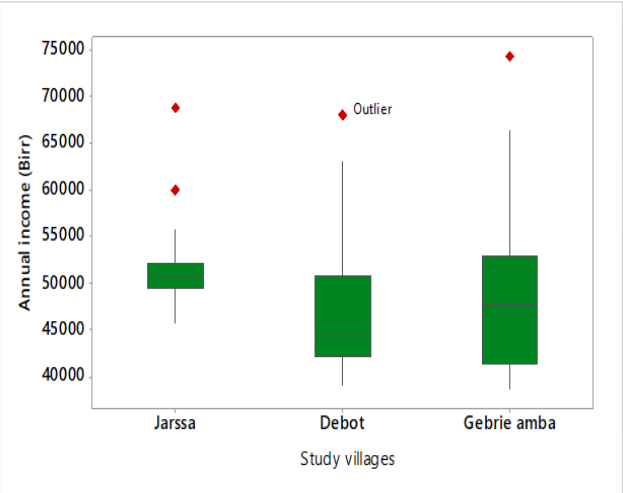

Figure 1. The distribution of annual income of the respondents in the study area

Simple descriptive statistics (mean, standard deviation and frequencies) were used to analyze the collected data on types of agricultural products produced by small-scale irrigation activities, the annual income of respondents and the challenges of small-scale irrigation. Two-sample test was used to compute the annual income for irrigators and non-irrigators. Besides this, one-way ANOVA model was used to compare the annual income of the respondents among the study area (the three villages) spatially and to compare the annual incomes of the respondents among 2020, 2021 and 2022 study years.

Results and Discussion

General background of respondents

Background information of respondents (Sex, age, education, family size and livelihood) (Table 1).

Table 1. Background information of respondents (Sex, age, education, family size and livelihood).

Sex composition											
Jarssa				**Debot**				**Gebrie amba**			
Male	**Female**	**Total**	**%**	**Male**	**Female**	**Total**	**%**	**Male**	**Female**	**Total**	**%**
56	11	67	37.4	26	23	49	27.4	34	29	63	35.2
Age of respondents											
Age category				**Frequency**				**Percent**			
20-30				16				8.9			
31-40				48				26.8			
41-50				66				36.9			
51-60				37				20.7			
>60				12				6.7			
Educational status											
Level of education			**N**			**Valid percent**				**Cumulative percent**	
Illiterate			88			49.2				49.2	
Read and write			62			34.5				83.8	
1-4			20			11.2				95	
5-8			6			3.4				98.3	
9-10			3			1.7				100	
Total			179			100					
Family sizes											
Family size			**Frequency**			**Valid percent**				**Cumulative**	
1-2			17			9.5				9.5	
3-4			70			39.1				48.6	
5-6			90			50.3				98.9	
Above 6			2			1.1				100	
Total			179			100					
Livelihood of respondents											
Sources of livelihood			**N**			**Percent**				**Cumulative %**	
Agriculture			179			100				100	
Non agriculture			-			-				-	

Small-scale irrigation activities and agricultural products

In the three selected sample kebeles (Jarssa, Debot and Gebrie amba) most of the farmers have been practicing small-scale irrigation to the overall productivity of agriculture. Larger numbers of farmers have both irrigable and non-irrigable farmland and in contrast, some of them have not irrigable land totally. All of the sample farmers (100%) have the farmland, however; its ownership status is owned, rented from others and confiscated from their families (Table 2).

Table 2. Responses of household heads on status and size of farm land.

			Size in timad	
Status of farmland	**N**	**%**	**Min**	**Max**
Own	159	88.8	2.5	6.5
Rented from others	4	2.2	2	4.5
Own and rented	16	9	2	6

Note: Survey data, 2022; Min=minimum; Max=maximum; NB: Timad is ¼ of a hectare

As illustrated in Table 2, all of the farmers in the three sample kebeles are engaged in agricultural activities. Among the total (n=179) sample household heads (88.8%) farmers have their own farmland and (2.2%) household heads have not their own farmland and rented from others. Whereas (9%) household heads responded that their farmland is both rented from others and owned. This indicates us how farmers are cultivating crops by renting farmland from others either who have labor limitation or reserve farmland.

Types of agricultural products

In these three small-scale irrigation schemes there are a wide range of cereals, fruits and vegetables are producing using irrigation in the “Bega” season. The interviewed irrigator farmer stated that, as they are really happy of being irrigator and throughout the year they produce a variety of products. Certain parcels of land can give a product three times per year. The farmers are benefited by producing a wide range of agricultural products and have been gaining more income. Usually, these farmers are cultivating variety cereals, vegetables and fruits by considering their market value, time length of harvesting and yield (product) quantity.

As it is depicted in Table 3, the different types of crops are found in each irrigation scheme. Due to climatic and other related difference of the village farmers did not grow the same types of crops. Teff is a major crop type in Jarssa (60%) and Gebrie amba (52.4%) small-scale irrigation schemes, while Teff, barley and wheat are common in Debot village. On the second hand maize is also one of the common crop types grown among the three villages. One unique thing that we can understand from Table 3 is barley and wheat is the only crop type produced only in Debot small-scale irrigation scheme.

Table 3. Types of cereals and its production by irrigation activities.

Types of crops	**Jarssa**				**Debot**				**Gebrie amba**			
	N	**%**	**Quantity in quintal**		**N**	**%**	**Quantity in quintal**		**N**	**%**	**Quantity in quintal**	
			Min	**Max**			**Min**	**Max**			**Min**	**Max**
Teff	27	60	3.5	6	11	33.3	2	4	22	52.4	3	4.5
Barely	-				13	39.4	2.5	4.5	-			
Wheat	-				19	57.6	2	2.5	-			
Maize	18	40	2	3.5	8	24	2	4.5	17	40.5	2	5

Teff and maize are a common crop type in all villages of the study area (Figure 2). To supplement the product (yield) that can be gained in the summer (meher season) irrigation activity played a vital role in yield increment. The other cash crop which has been cultivating in the two study villages (Jarssa and Gebrie amba) is sugarcane. The unit of sugarcane is not in quintal but can be sell in the market by using a single unit like one sugarcane per birr (Table 4).

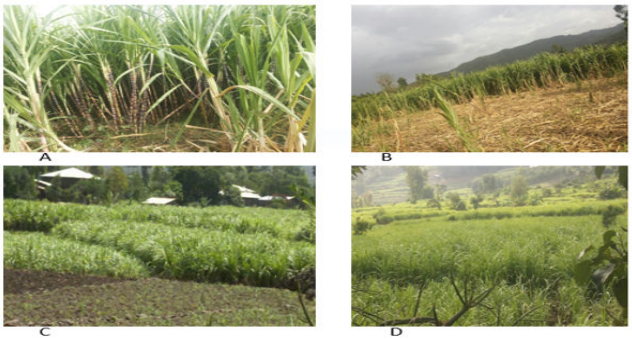

Figure 2. Partial views of Teff and Maize crops in the SSI schemes.

Table 4. The current price of sugarcane.

Measurement	Price
Very long (2 m)	70 birr
Long (1.5 m-1.75 m)	60-65 birr
Medium (1 m-150 m)	50-55 birr
Short (0.50 cm-0.75 cm	40-47 birr

When they sell to the distributors (wholesalers) half (1/2) timad size of sugarcane plant can sell 75000-82000 birr per three years. Such amount of money varies from time to time.

As can be seen from Figure 3, sugarcane has been producing extensively by the irrigation activities. It is cultivating by a small number of farmers (n=19) from two study villages (Jarssa and Gebrie amba) and remaining one village (Debot) does not planting sugarcane. When farmers and kebeles agricultural experts explain about why sugarcane producers are lower in number they said; "to cultivate sugarcane, it needs high labor from the beginning of plantation to harvesting, so these producers should have either large family size to work in cooperation or hire a labor which requires cost. As well as sugarcane cannot harvest within a short period of time and it needs at least three years. But they indicated as, if irrigators are able to cultivate the farmland successfully they can produce other types of crops, vegetables and fruits three times per year with less demand of labor."

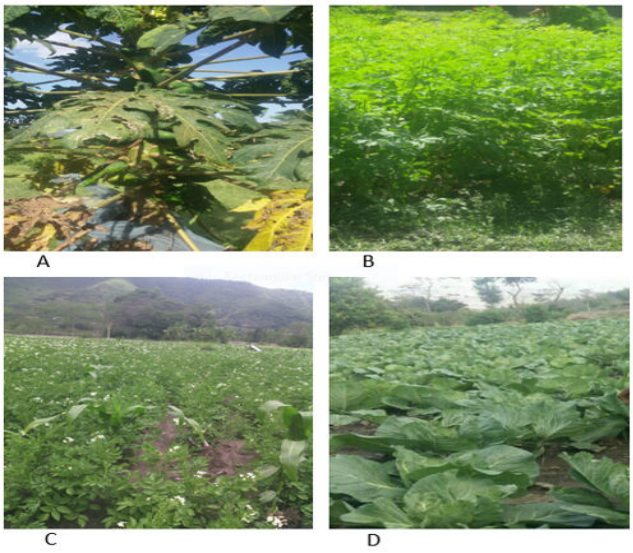

Figure 3. Sugarcane plantations (Jarssa and Gebrie amba SSI schemes): Jarssa SSI scheme (A and B), Gebrie amba SSI scheme (C and D).

Findings of the survey revealed that (Table 5) there are variety of fruits and vegetables in each small-scale irrigation scheme. Some of the fruits and vegetables are not found in all study kebeles. Among the vegetables onions, potato and cabbage are dominantly cultivating in all small-scale irrigation schemes. Onions have been producing by 73.3%, 48.5% and 73.8% household heads of Jarssa, Debot and Gebrie amba respectively. Besides potato is the highest producing vegetable which accounts 86.7%, 81.8% and 95 in Jarssa, Debot and Gebrie amba villages respectively. The last common vegetable cultivating in the study areas is cabbage. Cabbage is produced in these three irrigation schemes by 57.8%, 30% and 90.5% household

household heads respectively in the above manner. Fruits are also cultivating in each SSI scheme.

Table 5. Types of vegetables and fruits.

Types of vegetables and fruits	Jarssa				Debot				Gebrie amba			
	N	%	Size in timad	Amount in quintal	N	%	size in timad	Amount in quintal	N	%	size timad	Amount in quintal
Onion	33	73.3	0.2- 0.4	8-14	16	48.5	0.1-0.15	2-2.5	31	73.8	0.2-0.4	8-14
Garlic					22	66.7	0.2	2-3	-		-	
Tomato	27	60	0.2	15-16	-				33	78.6	0.1	12
Orange					2	6	0.1	4-5	16	38	<0.1	4-5
Papaya	11	24.4	>0.1		8	24	0.1		16	38	<0.1	
Banana									22	52	<0.1	6
Potato	39	86.7	0.5	16-18	27	81.8	0.2-0.5	10-14	40	95	0.25-0.4	15-20
Cabbage	26	57.8	0.5	15-18	10	30	0.2-0.4	13-15	38	90.5	0.2-0.4	15
Lettuce and Swiss chard									34	80.9	0.25	38
Mango					4	12	<0.1		11	26	<0.1	>10
Apple					11	33.3	<0.1	10-12	16	38	0.1	10-15
Avocado					5	15	<0.1	9-12	7	16.7	<0.1	12
Guava	7	15.5	<0.1	17					24	57	0.1	22-25
coffee	14	31	0.1-0.2	14-18					12	28.6	0.1	10-12
Carrot and beet root	36	80	0.25	8-10	18	54.5	0.1-0.2	15-20	28	66.7	0.2-0.4	9-22

Agricultural products in Jarssa SSI scheme

As displayed in Table 5, potato (86.7%) shares the largest percentage followed by carrot and beetroot (80%) and onion (73.3%) respectively. Tomato is also commonly producing in this irrigation scheme which accounts (60%). It is possible to say that vegetables are more common than fruits. Generally, the most common types of vegetables and fruits are onion, tomato, papaya, potato, cabbage, guava, coffee and carrot and beet root (Table 5).

Agricultural products in Debot SSI scheme

On top of these, among the type's vegetables and fruits in the second SSI scheme (Debot) some of them are different from Jarssa SSI scheme. As can be seen from Table 6, similar to Jarssa SSI scheme potato (81.8%) is the most common agricultural product followed by garlic (66.7%) in Debot. Garlic is totally not cultivated in Jarssa and Gebrie amba small-scale irrigation schemes. Therefore, contrary to farmers of Jarssa SSI, in Debot SSI scheme garlic, apple, avocado, mango and orange are commonly cultivated. Hence, farmers in Debot SSI scheme have been produced more types of vegetables and fruits than Jarssa SSI scheme. Particularly garlic is producing by a larger number of farmers in this village.

Agricultural products in Gebrie amba SSI scheme

In the third SSI scheme (Gebrie amba) there are many types of agricultural products in which some of them are similar to the rest two SSI schemes (Jarssa and Debot) and some of them are not commonly found in the rest villages. As Table 5, revealed that this small-scale irrigation scheme contained around 14 types of vegetables and fruits which are the largest shares than the rest two (Jarssa and Debot) SSI schemes. Farmers are more interested in cultivating vegetables and fruits than cereals. There are many fruits and some vegetables which are not found in Jarssa and Debot SSI schemes but found in Gebrie amba SSI scheme. It includes potato, cabbage, lettuce and Swiss chard, tomato, carrot and beet root, guava and so on in extensive way. It does not mean that all farmers can produce all these types of products rather they cultivate it alternatively and each types are different from farmer to farmer.

Therefore, when we compare the types of agricultural products among the three SSI schemes, Gebrie amba has a multiple type of vegetables and fruits than the two villages (Jarssa and Debot). When agricultural experts expressed this reason, they said that; "producing vegetables and fruits is better than producing cereals since they can give a yield within a short period than cereals on a small parcel of land. Even it is possible to produce large amount of product per small area of farmland than the product of cereals in terms of price. But, sometimes if the farmland has large size producing cereals is better."

Among the types of these vegetables and fruits, some of them are displayed in the following (Figure 4).

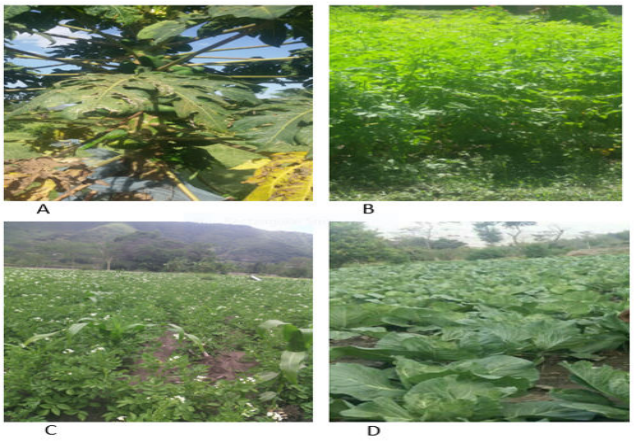

Figure 4. Partial view of vegetables and fruits in the study villages: Papaya plant at Gebrie amba (A), Potato plant at Debot (B), Potato at Jarssa (C), Cabbage at Jarssa villages (D).

The contribution of small-scale irrigation activities as sources of income

As presented above small-scale irrigation is important to gain different social and economic benefits. It has a paramount importance to upgrade the income and yield of irrigators.

As can be seen from Table 6, there has been a great change of annual income of irrigators (n=120) which is 23362.53 ± 7159.000, 27591.03 ± 4568.717 and 49209 ± 6836 (Mean ± SD) in 2020, 2021 and 2022 respectively. Therefore, we can say that the contribution of small-scale irrigation to the income contribution from year to year was significantly increasing.

Table 6. Annual income of irrigators and non-irrigators (2020-2022).

Category	Year	N	Range	Minimum	Maximum	Sum	Mean	Std. deviation
Irrigators	2020	120	64450	15125	79575	2803503	23362.53	7159
	2021	120	19110	19300	38410	3310923	27591.03	4568.717
	2022	120	30602	38240	68842	5655125	49209	6836
Non-irrigators	2020	59	26400	2100	28500	1317847	22336.39	3315.289
	2021	59	14582	20000	34582	1605071	27204.59	3188.436
	2022	59	15050	24900	39950	1819798	30844.03	3139.942

The annual income of farmers in using rain feed agriculture is absolutely different from irrigators shown in Table 7. Their annual income (n=59) is 22336.39 ± 3315.289, 27204.59 ± 3188.436 and 30844.03 ± 3139.942 (Mean ± SD) in the three successive years (2020, 2021, 2022) respectively. Therefore, we can say that like the annual income of irrigators the annual income of non-irrigators has been increasing from year to year however, it amounts has a wide difference.

It was expected to that the income of irrigators and non-irrigators is not the same. In this regard, the income of irrigators and non-irrigators can be tested. Accordingly, the mean annual income of irrigators is 49209 ± 6836 birr (mean ± SD) whereas; the mean annual income of non-irrigators is 30844 ± 3140 birr (2022). T-test indicates that the average annual income of the irrigators (n=120) is significantly different from non-irrigators (n=59) ($P<0.001$).

In addition to this, the significance of annual income difference of irrigators (n=120) in three years (2020, 2021 and 2022) (temporal difference) is shown in one-way ANOVA model as follows:

The mean annual income of irrigators is 29914 ± 5283; 39793 ± 4133 and 49209 ± 6836 (mean ± SD) birr for 2020, 2021, 2022 respectively. Temporally, one-way ANOVA model indicates that the average annual income of the respondents is (n=120) significantly varied among 2020, 2021 and 2022 years ($P<0.001$).

Beside on the above, the spatial difference in annual income of irrigators (n=120) in 2022 is described on Figure 5.

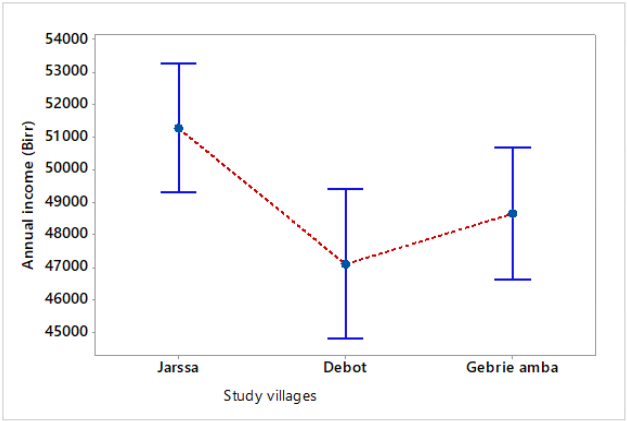

Figure 5. The annual income difference among the study villages.

The annual income of irrigators (n=120) among the three villages is different. Jarssa village has more income followed by Gebrie amba and Debot. Therefore, we can conclude that irrigators in Jarssa village (n=45) are richer than Gebrie amba (n=42) and Debot (n=33). Moreover, Debot is the least and Gebrie amba is the second in terms of their annual income in 2022 (Figure 5).

The mean annual income of irrigator's of among the three villages was 51286 ± 3597, 47089 ± 7007 and 48651 ± 8645 birr (Mean ± SD) for Jarssa, Debot and Gebrie amba respectively. Spatially, ANOVA model indicates that the average annual income of the respondents (n=120) is significantly varied among the study villages for 2022, (P<0.022).

Perceived challenges of small-scale irrigation practices

In the study villages, there have been different obstacles that hinder irrigation activities. As the survey data indicated, to use irrigation there are many preconditions which needs cooperation among the farmers and between the government and the local society. Such preconditions could not be feasible over-night and even some of them were difficult to manage. It required money, labor, accessible water supply, agricultural expert support and other related conditions.

The collected data also indicated that farmers faced many challenges while they used irrigation and some of them are still having not been solved. Even the interviewed agriculture experts of each irrigation scheme at the kebeles level and the Woreda agricultural office worker said that irrigation requires huge amount of budget allocation to construct and reconstruct irrigation canals from the water source to the farmland. The 2021 report of the Woreda indicated that more than 1.5 million birr per year was lost to reconstruct different small-scale irrigation canals found in the woreda in the last five and six years. The following (Table 7) shows the various challenges of irrigation practices in the three irrigation schemes.

Table 7. Challenges of small-scale irrigation.

Challenges	Jarssa			Debot			G/amba		
	N	%	Rank	N	%	Rank	N	%	Rank
Seasonality of water sources	5	11	5	17	51.5	3	35	83.3	3
Topographic problem to build irrigation canal	18	40	3	26	78.8	1	21	50	4
Lack of government support	8	17.8	4	6	18	4	13	31	5
Limitation of technology	21	46.7	2	1	3	6	36	85.7	2
Large number of irrigation user	45	100	1	24	72.7	2	41	97.6	1
Man power related problem	-	-	-	4	12	5	3	7	6

The main challenges of irrigation reflected by respondents were multiple. Their severity is unequal, but there was no single challenge among the study areas. Hence, there have been many challenges in which all of them were not equally found in each of the three irrigation schemes (Table 7). The first is seasonal variation of water volume was not a serious challenge in Jarssa small-scale irrigation scheme (11%) while it was a serious challenge in Gebrie amba irrigation scheme (83.3). Secondly, the presence of large number of irrigators are the main challenges of in Jarssa and Gebrie amba SSI schemes while it is the second main challenge in Debot small-scale irrigation scheme. On top of this 72.7% of Debot SSI farmers believed that government has been supporting them in their irrigation and agricultural activities while, the rest 27.3% of farmers reacted as some limitations have been found from woreda agricultural expert's involvement.

Third, the canals have been filled by sediments and the irrigation head of water have usually collapsed in the rainy season. The survey data also displayed that, government has been challenging in allocating appropriate budget. The reconstruction and rebuilding of canals involved Woreda agriculture office. In this case (Table 7) revealed that the government intervention in small-scale irrigation activity was found worthy, however, some limitations have been challenging the activity. Fourth, irrigation in the study villages was problems happen around the diversion area from the main river, particularly in Jarssa small-scale irrigation scheme. The water in this irrigation scheme is diverted from one major river named as "Abakolshe" which is one of the rivers that contained high volume of water throughout the year. Fifth, challenges around the diverting area in the rainy season its volume has become very high and destructs the water way (in Jarssa SSI). Because of this the government has lost a budget to reconstruct of canals and farmers have been out of irrigation until the reconstruction completed. The most common option around such diversion area was putting gabion, however; it could not resist the whole force of the river.

The sixth is topographic feature. The presence of a cliff or abysm required the government to build bridges and it denied some farmers to get water supply. In some villages canals are built up in a good way

that can pass water in challenging topographic structure and others are easily crushable traditionally built up bridges (Figure 6). But these bridges have not been durable and it requires maintenance every year after summer rain has passed. Because it could be easily collapsed when flooding becomes high.

Figure 6. Malfunction of waterway transmission bridges of SSI scheme: Water Way Bridge at Gebrie amba SSI (A), Water Way Bridge at Jarssa SSI (B).

As depicted in the picture above (Figure 6) these irrigation canal needs maintenance regularly. There is also the dissipation of materials after or before maintenance. These have been other challenges faced by the woreda administration which caused additional expense. The lack of responsibility in caring of water way bridges by the irrigators are among the constraints. Challenges in relation to transportation, market accessibility and agricultural inputs like herbicides, pesticides and improved seeds have been also a constraint in the study Villages (Table 8).

Table 8. Challenges in relation to transportation and agricultural inputs.

Which inputs have been the main constraints of agricultural productivity in your village?	Villages					
	Jarssa		Debot		Gebrie amba	
	Yes	No	Yes	No	Yes	No
Transportation problem	14	31	3	30	36	6
Improved seed inputs problem	5	40	7	26	2	40
Pesticides input problem	3	42	2	31	5	37
Herbicide input problem	1	44	4	29	8	34
Market related problem	33	12	18	15	24	18
Fertilizer supply shortage	8	37	22	11	13	29

As can be seen from Table 8, these challenges were not found equally among the study villages. The severe challenge at one village is not found the major constraint in another village. Transportation problem has been the main challenging factor to take products in Gebrie amba kebele, in contrast such case was not severe challenge in Debot. The other major constraints have been market related problem. In this case no near local markets are found and their common market to all villages is Woldia. They lacked real market information about the price of products to the other market center. Hence, 73.3%, 54.5% and 57% of respondents in Jarssa, Debot and Gebrie amba villages respectively reflected as market related problem have been another main challenge. When we compared and contrast these challenges spatially Jarssa SSI scheme has less challenges except transportation accessibility and fertilizer supply problem in some extent than the res two study villages.

Moreover, improved seed inputs problem, pesticides input problem, herbicide input problem and fertilizer supply shortage were less constraint than the other challenges, except the problem of fertilizer in Debot and Gebrie amba villages. The challenge to the non-irrigators is topographic challenge and the farthest of their farmland from the main SSI canal. As the data from the woreda agriculture office more than 90 farmers will have a chance to use irrigation until the beginning of 2025, by expanding the irrigation canals.

Conclusion

The overall objective of the study was to investigate the effects of small-scale irrigation practices on the economic condition of farmers in Gubalafto wereda of North wollo zone. The study conducted in Gubalafto wereda selected three small-scale irrigation schemes named as Jarssa, Debot and Gebrie amba kebeles mainly using 179 irrigators and non-irrigators farmers' respondents from SSI schemes. The collected data were analyzed using simple descriptive statistics and inferential statistics.

The finding of this research revealed that the Gubalafto woreda was rich in terms of surface water supply which paved the way for small-scale farmers to be benefited in using small-scale irrigation. In the three selected small-scale irrigation user village's different types of agricultural products are found and identified. Accordingly, teff, maize, onion, cabbage, tomato and potato are commonly produced in each SSI area. However, wheat, banana, tomato, sugarcane and avocado were not commonly cultivating in all irrigated villages. The study shows that small-scale irrigation brought economic progress among the smallholder farmers. Income generation, agricultural productivity, yield increment, food security and employment opportunity are important benefits of irrigation. Also, non-irrigator farmers are employed by the irrigators.

However, the study shows that there are a variety of challenges in relation to practicing SSI activities. For example, topographic nature of the irrigation scheme (in Jarssa), water volume fluctuation (Gebrie amba) and market related problem and poor irrigation schedule are common challenges in the study area. In fact, the magnitude of the challenges is not common to all of the study villages rather one is more severe than the other in each village. Provided the above growing challenges, small-scale irrigation practices contribute to the socio-economic improvements of the smallholder farmers in Amhara region.

References

1. Amhara Region Agriculture Bureau (2017) Annual Report on Productivity and Challenges of Agriculture in Amhara Region.
2. Awulachew, Seleshi Bekele. "Improved Agricultural Water Management: Assessment of Constraints and Opportunities for Agricultural Development in Ethiopia." In Best practices and Technologies for Small Scale Agricultural Water Management in Ethiopia. Proceedings of a MoARD/MoWR/USAID/IWMI Symposium and Exhibition held at Ghion Hotel, Addis Ababa, Ethiopia, p. 23. 2006.
3. Awulachew, Seleshi Bekele, Douglas Merrey, B. Van Koopen and Abdul Kamara. "Roles, Constraints and Opportunities of Small-Scale Irrigation and Water Harvesting in Ethiopian Agricultural Development: Assessment of Existing Situation." In ILRI workshop, pp. 14-16. 2010.
4. Ayele, Getaneh Kebede. "The Impact of Selected Small-Scale Irrigation Schemes on Household Income and the Likelihood of Poverty in the Lake Tana Basin of Ethiopia." PhD diss., Cornell University, 2011.
5. Bacha, Dereje, Regassa Namara, Ayalneh Bogale and Abonesh Tesfaye. "Impact of Small-Scale Irrigation on Household Poverty: Empirical Evidence from the Ambo District in Ethiopia." *Irrigat Drainage* 60 (2011): 1-10.
6. Yeshitela, Bekele, Nata Tadesse and Bheemalingswara Konka. "Preliminary Study on the Impact of Water Quality and Irrigation Practices on Soil Salinity and Crop Production, Gergera Watershed, Atsbi-Wonberta, Tigray, Northern Ethiopia." (2012): 29-46.
7. Fao FAOSTAT. "Food and Agriculture Organization of the United Nations." Rome, (2018): 403-403.
8. Fikirie, Kalkidan, Yemiru Tesfaye and Ephrem Tesema. "Gender Dynamics in Small Scale Irrigation Agriculture among Smallholder Farmers in Lume District in the Central Rift Valley of Ethiopia." *J Cult Soc Dev* 24 (2016): 1-11.
9. Mehari, Abraham, Frank Van Steenbergen and Bart Schultz. "Modernization of Spate Irrigated Agriculture: A New Approach." *Irrigat Drainage* 60 (2011): 163-173.
10. MoA (Ministry of Agriculture) Natural Resources Management Directorates, (2011a) Small-Scale Irrigation Situation Analysis and Capacity Needs Assessment, Addis Ababa, Ethiopia.
11. MoWE (Ministry of Water and Energy) (2011) Water and Development Quarterly Bulletin MWR: Addis Ababa.

How to cite this article: Fentaw, Destaw, Hailemariam Meaza, and Birhan Tadesse. "Effect of Small-Scale Irrigation Practices on the Economic Condition of Farmers in North Wollo Zone, Ethiopia." *Irrigat Drainage Sys Eng* 14 (2025): 471.