Hindawi
Advances in Agriculture
Volume 2024, Article ID 4979184, 13 pages
https://doi.org/10.1155/2024/4979184

Research Article

Exploring Farmers' Perception and Constraints on the Adoption of Small-Scale Irrigation in Hulet Eju Enesie District, North-Western Ethiopia

Getasew Daru and Sinkie Alemu

Department of Rural Development and Agricultural Extension, Mekdela Amba University, College of Agriculture and Natural Resource, P.O. Box 32, Tulu Awulia, Ethiopia

Correspondence should be addressed to Getasew Daru; getasewdaru19@gmail.com

Received 9 March 2023; Revised 18 December 2023; Accepted 28 December 2023; Published 18 January 2024

Academic Editor: Ijaz Ahmad

Irrigation farming is one approach to reduce climate-related risks, and make production possible throughout the year. Nevertheless, farmers were limited to using small-scale irrigation (SSI) in the study area. This study mainly analyzed the perception of farmers' and their constraints to use irrigation. The study used a multistage sampling technique to collect the primary data from 102 nonuser and 82 irrigation user respondents. Likert rating scale, relative importance index (RII), and descriptive statistics were used to analyze the data. The result of the RII indicates that, irrigation ensures high-net income (0.87), high-market demand for products (0.84), and insurance against drought (0.82) were highly perceived as advantageous attributes of the irrigation. Whereas, production cost (0.85), skill requirements (0.74), and declining soil fertility (0.65) were strongly perceived as relative disadvantage attributes of irrigation. Plant disease, input shortages, ineffective water distribution, and poor transportation are identified as major constraints for farmers to practice irrigation. Overall, farmers commonly noted the importance of irrigation. However, irrigation users highly perceived the positive attributes; whereas nonusers extremely perceived the negative attributes of irrigation. This implies the existence of perception differences between the two groups of farmers. Therefore, concerned stakeholders should strive to close the perception gap toward irrigation through interventions.

1. Introduction

1.1. Background of the Study. Agricultural practices have an indispensable role to reduce hunger around the world, but it is susceptible to climate change. Expanding irrigation farming has a critical role to meet the future global food demand and also a potential climate change adaptation strategy to reduce the climate variability and extremes [1]. In many African countries, the development of agricultural sector is crucial to combating hunger, reducing poverty, and achieving rapid economic growth [2]; while agricultural production in sub-Saharan Africa is highly vulnerable to variability in precipitation. Thus, implementation of effective water management through irrigation is vital option for raising agricultural production and productivity [3].

Likewise, agriculture is an essential sector for Ethiopian economic development. The sector contributes over 33.3% of the gross domestic product [4], provides 80% of employment opportunities, and supplies raw materials for 70% of the country's agro-industries [5, 6]. About 79% of foreign exchange is also derived from exports of the agricultural products in Ethiopia [7]. Despite all these facts, agricultural production in Ethiopia is traditional and underdeveloped for several reasons, including high dependency on a rain-fed and backward production system. As a result of its high dependence on rainfall, the agriculture sector faces high impacts of climate change in different parts of the country [8, 9].

As an agrarian economy, irrigation farming has been promoted as a climate-smart agriculture (CSA) technique to increase productivity and diversify livelihood to minimize the impact of climate change on food production [10].

Accordingly, the Ethiopian government gives considerable attention to the development of irrigation agriculture. It encouraged small-scale irrigation (SSI) as one of the most practical strategies to enhance the production and productivity of agriculture, raise the income of the farm household, improve food security, and alleviate overall poverty through the production of different crops two or three times within a year [11–14]. Although Ethiopia has 3.7-million hectares of irrigable land potential, only 5% of it has been utilized [12, 15]. Despite the benefits of SSI, until now, farmers have been highly dependent on rain-fed agricultural production, which produces 97% of the food crops [16].

Several studies [17–22] conducted on small-scale irrigation were mainly focused on the economic implication of irrigation and most of these scholars realize the significant contribution of irrigation on farmers income and food security. On the other hand, some other studies [23–26] were focused on the technological effectiveness of SSI system. The other studies identified the challenges of SSI practice in different parts of the country [27–29].

Furthermore, studies by Bojago and Abrham [10] and Agidew et al. [30–33]] were conducted on the determinants of the adoption of SSI and identified several institutional (extension services, input supply, training, and credit services), economical (household income, land, and livestock ownership), demographic (farmers' age, educational status, family size, and dependency ratio), and social factors (membership status and social linkage) as determinant of the irrigation adoption by smallholder farmers.

However, only a few studies have shown that farmers' perception influence their adoption and scaling-up decisions of the farm technologies [34–36]. Farmers have different levels of knowledge about improved agricultural practices and also have different perception toward risk-taking, and some are unwilling to invest in new agricultural activities due to high risks in production and marketing. Hence, the perceptions and views of the community are at the center of the adoption of irrigation farming. However, none of the previous studies considered the perceptions of farmers' in irrigation farming and were also limited to assessing the location specific challenges of farmers to practice irrigation particularly in the study area. Filling this gap, this study provides insights by analyzing the perceptions of farmers toward the pros and cons of irrigation farming.

Particularly, in the study area (Hulet Eju Enese district), rain-fed agricultural production is the major livelihood option for the smallholder farmers. Even though the district is gifted with huge water and irrigable land resource potential, around 1,200 ha of land is covered by irrigated agriculture [37]. This indicates the participation of farmers in SSI is inadequate compared to the irrigation potential of the district. To encourage the participation of farmers, knowing farmers' perceptions, their adoption status, and their constraints toward SSI is crucial. However, in the study area such type of study was not conducted. Therefore, with the pursuit filling this knowledge gap, the objectives of this study were to analyze the farmers' perceptions, their adoption status, and their constraints toward SSI in the study area.

1.2. Research Questions

(1) What is the adoption status of farmers on small-scale irrigation in the study area?
(2) What is the perception of farmers toward small-scale irrigation farming?
(3) What are the major constraints of farmers to practice small-scale irrigation?

2. Research Methodology

2.1. Descriptions of the Study Area. The study was conducted in Hulet Eju Enesie district in 2020. The district is located in East Gojjam zone, north-western Ethiopia. It is one of the 19 districts of the East Gojjam zone. The district consists of 29 total rural Kebeles and three rural subcities. The total population of the Hulet Eju Enesie district is estimated to be 154,109. The district is geographically located at 10° 45 $00^{'-}$11° 10 00 N latitude and 37° 45 69–38° 10 00 E longitude. The district has an altitude range of 1,290–4,030 m above sea level. The total land area of Hulet Eju Enese is 138,336 ha. From the total land size of the district, 66.7% is cultivable land, 13% is grazing land, 7.2% is bush and forest land, 12.96% is unutilized land, and 0.14% is settlement area [38, 39]. Figure 1 shows the map of the study area.

2.2. Determination of Sample Size and Sampling Techniques. To address the objective of this study, sample respondents were identified using multistage sampling techniques. In the first stage, Hulet Eju Enesie district was purposefully chosen from the East Gojjam zone because of its irrigation potential. Then, in the second stage, out of the 29 total rural Kebeles in the district, two Kebeles (Shege keranio and Konter kebele) were chosen using the purposive sampling technique in consultation with the district agricultural office. In the third stage, the sample units (household heads) were chosen from each Kebele by obtaining a list of households from the respective Kebele administrations. Finally, a stratified simple random sampling procedure was used to select the sample respondents from each kebele proportional to the population in each kebele (Table 1).

To determine, the appropriate sample size the study used Yamane's [40] sample size determination formula as follows:

$$n = \frac{N}{1 + N(e)^2}, \tag{1}$$

$$n = \frac{1{,}861}{1 + 1{,}861(0.07)^2} = 184, \tag{2}$$

where

n = total sample size of this study;

N = total household head of the two kebele (population size);

e = confidence level (0.07).

After determining the total sample size (184), sample households from two selected Kebeles were determined

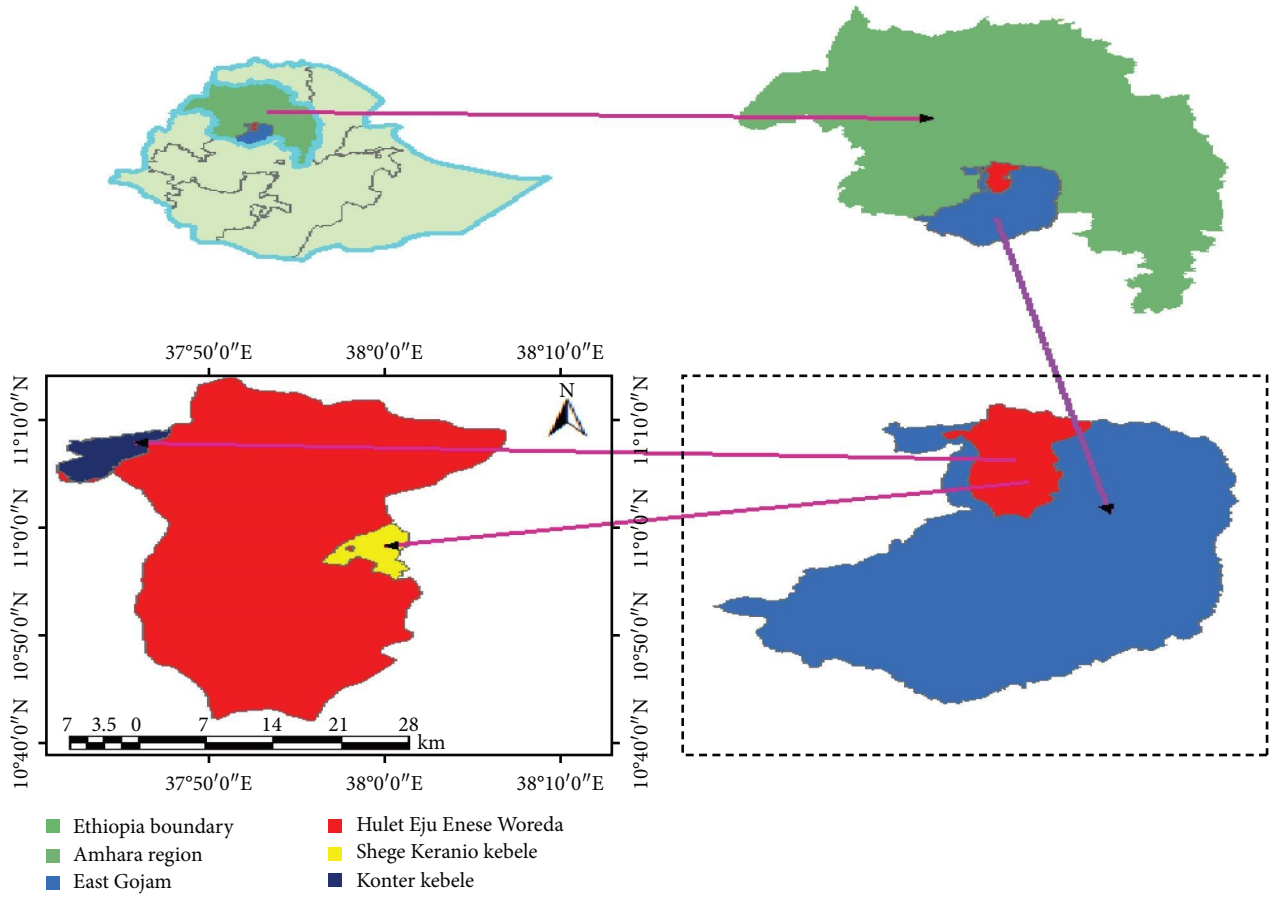

Figure 1: Map of the study area (Hulet Eju Enesie district) Source; District Land Administration Map service (2020).

Table 1: Proportional sample distribution for each Kebeles.

Name of kebeles	Total household	Total user	Total nonuser	Sample from user	Sample from nonuser	Total sample
Konter kebele	721	285	436	31	40	71
Shege Keranio kebele	1,140	402	738	51	62	113
Total	1,861	687	1,174	82	102	184

Source: Own summary (2021).

proportionally to the sample population in each Kebeles. Accordingly, from the total sample size, 82 irrigation user and 102 nonuser respondents were selected proportionally for both Shegie Keranio and Konter Silasie Kebeles.

2.3. Data Source and Methods of Collection. The primary data were collected from sample respondents using a questionnaire, interview schedules, FGD, key informant interviews (KII), and field observations. The researcher paid careful attention to data collector (enumerator) selection by considering their level of education, their communication ability in the local language, and their willingness to participate in this study as data collectors. The secondary information was obtained from several sources, such as published documents, including research journals, reputable articles, proceedings, websites, and other unpublished secondary sources like the reports of the agricultural office.

2.4. Method of Data Analysis. Likert scale: A Likert rating scale was used to analyze the respondents' attitudes and perceptions toward a product, service, activity, and more [41]. In this study, respondents were asked to indicate their level of agreement and specify their opinion about irrigation farming practices. The set of alternatives provided to the farmers were "strongly disagree" (1), "disagree" (2),"neutral" (3), "agree" (4), and "strongly agree" (5). The highest value (5) indicates how highly farmers were perceived in the statement, and the statement presented for assessment is being embodied. The lowest value (1) indicates the weakest agreement of farmers, and the statement being presented is not being embodied. Overall, a value less than three indicates farmers were poorly perceived, and a value greater than three indicates farmers were highly perceived by the Likert statements.

Relative importance index (RII): The RII was used to analyze the relative importance of the Likert statements [42]. In this study, an RII was used to determine which

Table 2: Description of variables and expected relationship with farmers perception toward irrigation.

Variables	Expected sign	Adapted and modified from
High market demand for products	+ve	[44]
Achieving food security	+ve	[45]
Ensure high net income	+ve	[44]
Creates job opportunity	+ve	[46]
Socially acceptable practice	+ve	[45]
Insurance against drought	+ve	[47]
Reduces soil fertility	−ve	[44]
Bureaucracy of extension services	−ve	[44]
Susceptible to production risk	−ve	[46]
High cost of production	−ve	[45]
Require skill and knowledge	−ve	[44]
Negative environmental effect	−ve	[46]

Source: Own summary (2020).

statement from the total positive and negative Likert statements was more important and less important as perceived by farmers. According to Le and Tam [43], the RII ranges from "0" to "1". The highest RII (i.e., close to "1") indicates that the farmers highly perceived that Likert statement (an attribute of SSI); whereas the lowest RII (i.e., close to 0) indicates the farmers poorly perceived statements. The rank was given for positive and negative Likert items separately based on their RII score. Moreover, the study used descriptive statistics and narration of words to analyze the challenges facing farmers toward SSI in the study area.

The equation for an RII is described as follows:

$$\mathrm{RII} = \frac{\sum W}{(A \times N)} \text{ or simply,}$$
$$\mathrm{RRI} = \frac{5(n5) + 4(n4) + 3(n3) + 2(n2) + 1(n1)}{5(n1 + n2 + n3 + n4 + n5)}, \quad (3)$$

where

W = sum of Weight given to each factor by the respondent households;

A = highest weight (i.e., 5 in this case);

N = the total number of respondents;

Or simply, $n1$, $n2$, $n3$, $n4$, $n5$ = number of respondents who selected strongly disagree, disagree, neutral, agree, and strongly agree, respectively.

2.5. Description Variables and Farmers' Perceptions toward Irrigation Farming. Farmers were expected to have a different perceptions toward the adoption of agricultural technology and practices. Therefore, understanding their perceptions is necessary to encourage the adoption of farm technology and SSI.

Table 2 shows the description of Likert statements (positive and negative variables) that are identified through intensive review of the several literatures. These statements were identified as a component to measure the perception of farmers toward SSI.

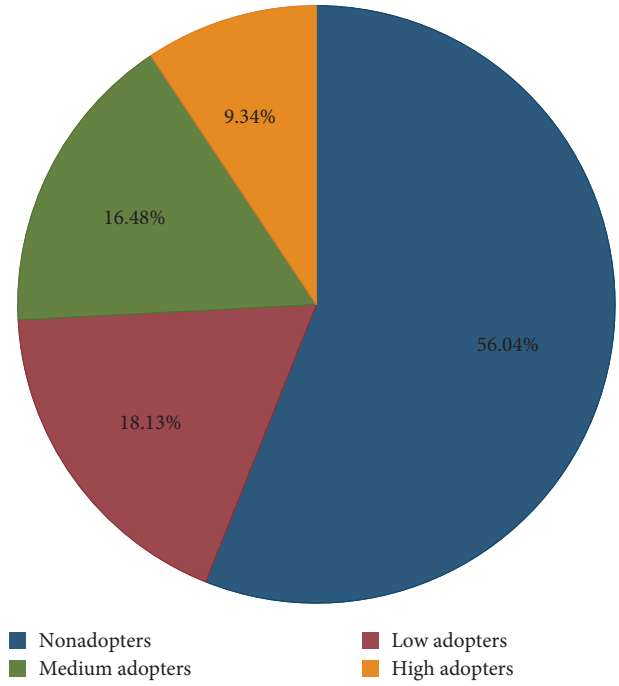

Figure 2: Farmers' adoption status on small-scale irrigation in the study area. Source: own survey (2021).

3. Results and Discussion

3.1. Farmers' Adoption Status of Small-Scale Irrigation in the Study Area. Currently, the government of Ethiopia initiated different irrigation programs and strategies to expand the application of irrigation throughout the country. However, as shown in Figure 2, in the study area, 56.04% of the farmers were not adopters of SSI practices. This implies that the livelihoods of most farmers still mainly depend on rain-fed production systems, and their production is highly vulnerable to unexpected risks from biophysical and climatic factors.

As shown in Figure 2, in the study area, 44% of respondents adopted SSI within three adoption categories. From the

Table 3: Farmers' perception on the relative advantage of small-scale irrigation (SSI).

List of attributes	Irrigation user samples ($N = 82$) Distribution of respondents (%)						Nonuser samples ($N = 102$) Distribution of respondents (%)						χ^2
	SD	D	N	A	SA	Me	SD	D	N	A	SA	Me	
Irrigation ensure high-net income	—	3.6	0	15.8	80.5	4.7	—	8.8	18.6	26.6	46	4.0	28.25***
There is high demand for irrigation products	—	3.7	1.2	17.1	78	4.7	—	4.9	27.5	49	18.6	3.8	68.95***
Irrigation contribute to achieving food security	—	0	6.1	58.5	35.4	4.3	—	2.9	38	52.9	5.9	3.8	17.52***
Irrigation creates job opportunity	—	—	4.9	79.2	15.9	4.1	—	1.9	21.6	70.6	5.9	3.8	15.40***
Irrigation is socially acceptable practice	—	7.3	23.	51.2	18.3	3.8	—	8.8	28.4	50	12.7	3.6	1.54
Irrigation serves as insurance against drought	—	1.2	7.3	18.3	73.2	4.6	2.9	7.8	16.7	57	14	3.7	65.46***

Where SA = strongly agree, A = agree, N = neutral, D = disagree, SD = strongly disagree. Me = mean score. *** = Significant at 1% significant level, Ns = "nonsignificant". Source: Own survey data, (2021).

Table 4: Farmers' perception on relative disadvantage attributes of small-scale irrigation (SSI).

List of attributes	Irrigation user samples ($N = 82$) Distribution of respondents (%)						Nonuser samples ($N = 102$) Distribution of respondents (%)						χ^2
	SD	D	N	A	SA	Me	SD	D	N	A	SA	Me	
Irrigation reduces soil fertility	—	15	30.0	51.2	2.5	3.4	—	12.0	54.9	32.3	—	3.1	12.92***
Long bureaucracy to get extension services for irrigation	10	48	7.3	30.5	2.4	3.3	3.9	30	23.5	39	2.9	3.2	15.5***
Irrigation is susceptible to production risk	23	52	8.5	13.4	2.4	2.1	17	39	16.7	21.5	4.9	2.5	7.165
Irrigation requires high cost of production	—	—	6.1	87.8	6.10	4	—	—	9.81	29.4	60.8	4.5	66.05***
Irrigation needs some level of skill and Knowledge	—	2.4	21	73.1	2.44	3.7	—	1.9	31.4	65.7	0.98	3.6	2.494
Irrigation has negative environmental effect	4.8	63	14	14.6	2.44	2.4	9.8	59	20.6	6.7	2.9	2.4	5.141

Where; SA = strongly agree, a = agree, N = neutral, D = disagree, SD = strongly disagree. Me = mean score. *** = Significant at 1% significant level,

adoption categories, 18.13% were recorded as low adopters of SSI practices. On the other hand, 16.48% of farmers were categorized as medium adopters. But, only 9.34% of respondents' were classified as high adopters of SSI in the study area. Similarly, the study conducted in Offa district, Southern Ethiopia indicates that when the number of users is compared to the number of nonusers in the district, the current state of SSI use is quite low. Even those who implement irrigation farming do not fully employ all SSI techniques [33]. This implies that most of the farmers were categorized as low adopter of SSI, and they apply irrigation on small plots around their dwellings to grow vegetables, such as potatoes, tomatoes, onions, and cabbage. Only a small number of farmers used their full-irrigable land potential to produce both vegetables and cereal crops (wheat, maize, and tef) because they grow both around their dwellings and apart from their residence and cover a large area of irrigation land.

3.2. Farmers' Perceptions toward Small-Scale Irrigation Practice. To measure the perception of farmers, both negative and positive Likert statements were equally included in the analysis. As shown in Table 3, positive Likert statements were prepared by considering the relative advantages of SSI. Similarly, negative Likert statements were also prepared by considering the relative disadvantages of irrigation farming (Table 4).

3.2.1. Farmers' Perceptions of the Relative Advantages of Small-Scale Irrigation Practices. As shown in Table 5, from the total advantageous attributes of irrigation, irrigation ensures high-net income, high-market demand for the irrigation products, irrigation serves as insurance against drought, contribution to food security, creating job opportunities, and social acceptability take 1st, 2nd, 3rd, 4th, 5th, and 6th ranks, respectively. The detailed farmers' perception toward SSI is discussed in Tables 3 and 4.

(1) Small-Scale Irrigation Ensures High-Net Income. The result of the RII revealed that "profitability of irrigation" takes the "1st" rank, and farmers highly perceived the profitability of SSI in the study area (Table 5). The result in Table 3 also show that, 80.5% irrigation users and 46% of nonusers strongly agreed on the profitability of irrigation. But nonuser households were perceived as being slightly lower than the irrigation user households. The same finding was reported by the scholars such as [45, 48], which described that irrigation user farmers perceived irrigation as a best option to improve their income. This implies that most irrigation nonuser households' lack of an understanding on the role of irrigation on income improvement compared to the user households.

(2) High-Market Demand for Small-scale Irrigation Products. Based on the RII score, "high market demand" takes the 2nd rank among positive Likert statements (Table 5).

Table 5: Relative importance index of advantageous attributes of small-scale irrigation.

List of attributes	Total sample (184)	
	RII	Rank of attributes
Irrigation ensures high net income	0.876	1st
There is a high demand for irrigation products	0.843	2nd
Irrigation serves as insurance against drought	0.828	3rd
Irrigation contribute to achieving food security	0.813	4th
Irrigation contributes to creating job opportunity	0.785	5th
Irrigation is a socially acceptable practice	0.745	6th

Source: Computed from own survey data, (2021).

Moreover, as shown in Table 3 among total irrigation user respondents, most of them (78%) strongly perceived the availability of high-market demand, whereas among nonuser respondents, only 18% of them strongly agreed on the availability of high-market demand for irrigation products. In contrast with this result, the empirical study by Lebeta [27] indicates that lack of access to market and market information had a significant and adverse influence on irrigation adoption by farmers. The other study conducted by Kudaze et al. [44], reports irrigation-user farmers practically understand the availability of high-market demand for irrigation products better than the nonuser respondents. Hence, the availability of high market demand is crucial in enhancing the profitability of irrigators and inspiring nonuser households to participate in the irrigation practices.

(3) Small-Scale Irrigation Serves as Insurance against Drought. According to Table 5, this Likert statement takes the 3rd rank among positive attributes. The survey result also indicates that almost all irrigation-user farmers perceive the role of SSI as insurance against drought; similarly, a slight number of nonuser respondents positively perceive the role of irrigation as a response to drought (Table 3). This result is in line with the study by Kamwamba-Mtethiwa et al. [49] and Chinasho et al. [50] that point out the significant contribution of irrigation as an adaptation to the climate change-related problems. These results imply the significant role of SSI on responding the impact of climate change and on improving overall farm productivity to supply sufficient food demand for the growing population.

(4) Small-Scale Irrigation Contributes to Creating Job Opportunities. The result of the RII puts this statement at the 5th rank among the relative advantage attributes of SSI (Table 5). Furthermore, as shown in Table 3, the majority of irrigation users (79.2%) and nonuser respondents (70.5%) positively perceive the contribution of irrigation to creating employment opportunities for family members throughout the years. The result of this study agrees with the finding that indicates the significant role of irrigation on providing job opportunities to the rural community [48, 51]. During FGD one farmer explained the role of irrigation on job opportunity as, *"Most of the farmers were jobless during the winter season and they apply irrigation as possible source of income during this season. So, it was a source of employment for idle family members throughout the years."* This result implies that farmers greatly acknowledged the contribution of irrigation on creating job opportunities for household members through the years. This indicates that irrigation has a significant role on reducing joblessness.

(5) Small-Scale Irrigation Has a Contribution in Achieving Food Security. As shown in Table 3, the majority of irrigation user respondents positively agreed on the significant contribution of SSI in achieving food security. On the other hand, almost half of the nonuser respondents agreed positively with the contribution of irrigation in achieving household food security. This result is consistent with several empirical studies [17, 26, 45, 52], which report the significant contribution of irrigation on improving household food security status. This indicates that, SSI plays a vital role in achieving food self-sufficiency at the household level in particular and the national level in general. Similarly, during the FGD, farmers indicated that irrigation improves household food consumption by increasing the diversity and frequency of production throughout the years.

(6) Small-Scale Irrigation Is a Socially Acceptable Practice. As shown in Table 3, from the total respondent households, almost half of irrigation users and nonusers perceive the social acceptability of SSI. Moreover, key informant interview participants explained that SSI is socially acceptable and applicable to communities without any social, cultural, or religious restrictions. Similar with this result a previous study indicates the social acceptability of irrigation since it does not clash with cultural and religious rules [44]. The adoption of new agricultural practices and technologies is influenced by different social factors, including religious laws, values, norms, taboos, and customs. Farming technologies and practices that do not fit with social needs were less likely to be utilized by the farmers. However, the result implies that irrigation farming was acceptable on the face of religious laws, values, norms, taboos, and customs of the community. The Figure 3 indicates the overall graphical display of positive attributes of SSI.

3.2.2. Farmers Perceptions of the Relative Disadvantages of Small-Scale Irrigation. As shown in Table 6, the disadvantageous attributes of irrigation include; requirement of high cost of production, require some level of skill and knowledge, reduce soil fertility, bureaucratic irrigation extension services, production risk, and negative environmental effect take 1st, 2nd, 3rd, 4th, 5th, and 6th ranks, respectively.

(1) Small-Scale Irrigation Requires a High Cost of Production. According to the result of RII, out of a total of six

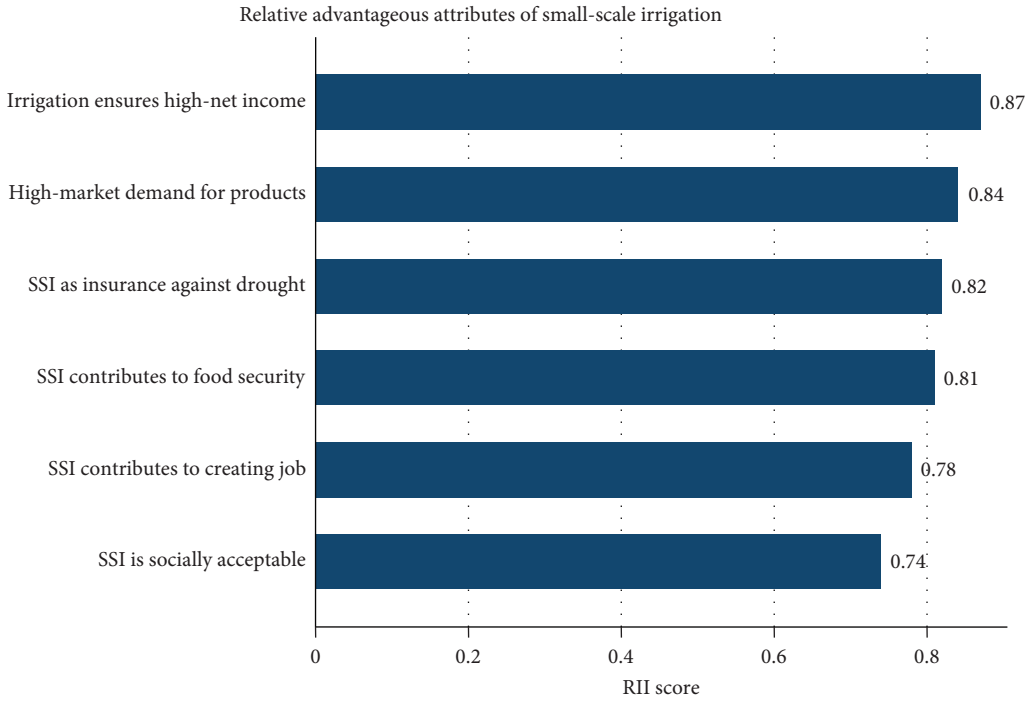

Figure 3: Relative importance index of relative advantage attributes of small-scale irrigation. Source: Computed from own survey (2021).

Table 6: Relative importance index (RII) of disadvantageous attributes of small-scale irrigation.

List of attributes	Total sample (184)	
	RII	Rank of attributes
Irrigation requires high cost of production	0.85	1st
Irrigation needs some level of skill and knowledge	0.74	2nd
Irrigation reduces soil fertility	0.65	3rd
Long bureaucracy to get extension services for irrigation	0.57	4th
Irrigation is susceptible to production risk	0.48	5th
SSI has a negative environmental effect	0.47	6th

Source: Computed from own survey data, (2021).

negative Likert statements, requirement of high capital and labor takes the "1st" rank (Table 6). Based on the survey result in Table 4, both irrigation user and nonuser respondents agreed on the requirement of high capital and labor resources to carry out SSI. Specifically, the result demonstrated that nonuser farmers highly perceived than irrigation-users on the requirement of high capital and labor resources for irrigation practice. Similarly, during FGD, respondent households strongly emphasized that SSI requires financial and labor capital to apply irrigation practices efficiently and effectively. More specifically, nonuser household heads mentioned a lack of starting capital as the constraint that hampers participation in SSI. The result of this study agrees with an empirical study that indicates availability of startup capital would encourage households to participate in irrigation activities by providing different irrigation inputs [53]. The result of this study implies that farmers consider the cost of production when applying a kind of technology; if they consider it profitable, they will implement it, and the reverse is true. But, most of households exaggerated the requirement of startup capital and labor resources, which hampered their participation in irrigation farming as well as other farm technologies.

(2) Small-Scale Irrigation Requires Skill and Knowledge. As shown in Table 4, 73.1% of irrigation users and 65.6% of nonusers perceived the requirement for skill and knowledge for irrigation practice. Based on the RII, this Likert statement takes the 2nd rank from negative attributes (Table 6). The perceptions of irrigation users and nonuser households were almost similar to this statement. The empirical study reported by Gebremeskel et al. [54] indicates that farmers' technical knowledge of irrigation has a positive effect on farmers' adoption of drip irrigation. This indicates that, farmers faced several difficulties during the implementation of agricultural technologies; those difficulties emerged from a lack of knowledge and skill on how to conduct the implementation. It is expected that irrigation requires some sort of skill and knowledge to implement efficiently and effectively.

(3) Small-Scale Irrigation Reduces the Soil Fertility of Farmland. In the study area, irrigation reduces soil fertility

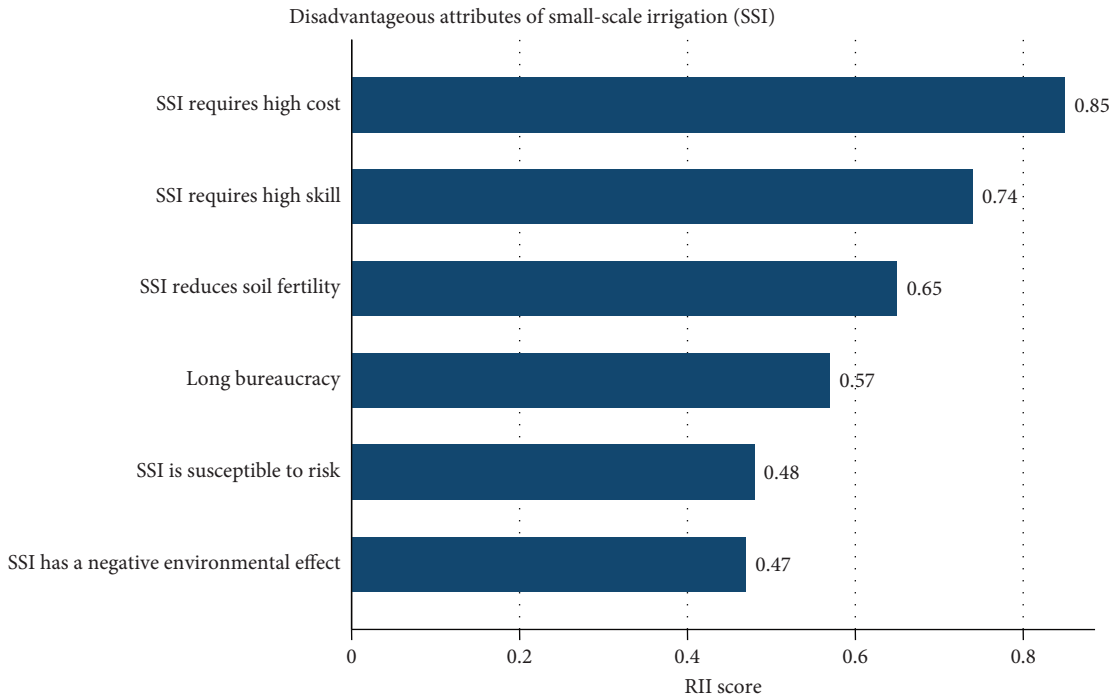

Figure 4: Relative importance index of negative attributes of small-scale irrigation (SSI). Source: computed from own survey (2021).

because of high water logging problems. The survey result indicated that more than half (51.2%) of irrigation user farmers agreed with this statement, while 32% of nonuser respondents agreed on the soil fertility impact of irrigation based on their past irrigation farming experience (Table 4). Based on the RII, this Likert statement takes the 3rd rank as a negative attribute of irrigation (Table 6). Furthermore, the key informant interview participants also assured that irrigation reduced the fertility of their farming land, and as a result, the output obtained from that land was low during the rainfed production season. The result of this study is consistent with the empirical study by [55]. This indicates that, despiteits positive role, irrigation can cause to soil fertility deterioration through water logging and increases soil acidification, which causes declining production and productivity.

(4) The Bureaucracy Is a Long to Get Irrigation-Related Extension Services. Based on the survey result shown in Table 4, a slight number of irrigation user respondents agreed on the bureaucratic nature of irrigation-related extension service; on the contrary, an average number (39.2%) of nonuser respondents agreed on the bureaucratic nature of irrigation-related extension service. Similarly, FGD participants indicated that farmers dislike the long bureaucracy of irrigation; this could happen when irrigation production faces more tasks than rainfed production. This implies that the labor-intensive nature of technologies may hinder farmers' participation and the sustainability of adoption. This finding is similar to the fact that reported credit service bureaucracy, such as group collateral, was constrained to increase irrigated agriculture production [51]. This result implies that nonuser respondents highly frustrated the huge workload of irrigation production. For this reason, they would not participate in the SSI practices.

(5) Small-Scale Irrigation Is Susceptible to Production Risk. The survey result also indicates that only a small number of irrigation users (2.4%) and nonuser respondents (4.9%) strongly perceived the susceptibility of SSI to production risks (Table 4). This result implied that both irrigation users and nonuser farmers were less likely to perceive irrigation's susceptibility to several production risks. However, relatively nonuser households were highly sensitive to the production risk of SSI. In argument with this result, the studies conducted by [56, 57] implies that irrigation farming increases farmers responsiveness to irregular weather patterns. The result of this study infers that, irrigation-user farmers positively perceived irrigation as a response to climate change, whereas nonuser farmers frustrated the production risk and that hinders them from adoption of SSI.

(6) Small-Scale Irrigation Has a Negative Environmental Effect. The result shows, both irrigation users and nonuser respondents were less likely to agree on the negative effect of irrigation on the environment (Table 4). Similarly, during FGD, respondents greatly emphasized the positive effect of irrigation by keeping the environment green, enhancing honey bee production, and being a source of animal fodder throughout the entire year. However, some farmers list increasing land degradation, reducing soil fertility, increasing water contamination, and reducing grazing land as the negative impacts of irrigation on the environment. This result is similar to the finding that, in addition to its positive effect, irrigation enhances the soil salinity of farming land [55]. Figure 4 indicates the overall RII score on a graphical display for negative attributes of SSI.

3.3. Constraints of Small-Scale Irrigation in the Study Area. In the study area, SSI practice is constrained by different

Table 7: Percentage of severity of constraints to small-scale irrigation practice in the study area.

Irrigation user samples (82)			
Constraints of SSI	Labels	Frequency	Percept (%)
Water shortage	Yes = 1	55	67.6
	No = 0	27	32.4
Plant disease and insects	Yes = 1	68	82.9
	No = 0	14	17.1
Shortage of irrigation input	Yes = 1	52	63.5
	No = 0	30	36.5
Insufficient road and transport	Yes = 1	47	57.4
	No = 0	35	42.6
Inadequate storage facilities	Yes = 1	60	73.4
	No = 0	22	26.6
Lack of labor force	Yes = 1	45	54.8
	No = 0	37	45.2
Other constraints (insufficient experts, administration problem, lack of startup capital, and weather fluctuation). no. = 0	Yes = 1	44	53.6
	No = 0	38	46.4

Source: Own survey data (2021).

environmental, institutional, and natural problems. As shown in Table 7, the major constraints of SSI were plant disease and insects, ineffective utilization and water shortage, inadequate storage facilities, shortage of irrigation inputs, inadequate road, transportation access, and lack of labor force.

3.3.1. Plant Disease and Insects. The majority of respondent households mentioned that the incidence of plant disease and insects was the first major constraint for farmers to implement SSI practices in their locality (Table 7). Key informant interview participants also explained that crop diseases such as cutworms and root rot damage the production of different vegetables (onion, tomato, pepper, salad, carrot, and others). To control the problem, farmers applied chemicals, but the cost of the chemicals was very high, and even some chemicals did not control the disease. Due to these reasons, some farmers minimized the production of highly vulnerable vegetables such as tomatoes and onions and shifted their production toward less-vulnerable cereal crops. This result agrees with the study by Yihdego et al. [58] that reports the negative impact of plant disease and pests on the adoption of small-scale irrigation farming in Benishangul–Gumuz Region, Ethiopia. The implication of this result indicates that the occurrences of disease, weeds, insects, and rodents were very high during the irrigation season, and this problem is a headache for irrigation user farmers in the study area.

3.3.2. Ineffective Water Distribution and Water Shortage. In the study area, ineffective water distribution systems were a common feature of SSI. Accordingly, most irrigation user respondents were constrained by the problem of poor water distribution, which in turn causes a shortage of irrigation water. The major cause of this problem is the amount of water available and the system for utilizing the available water. In the study area, rivers are the major source of irrigation water, and after some seasons, the water size of rivers becomes small, causing insufficient water availability to downstream irrigation users. Moreover, poor water distribution systems and inappropriate use of water resources were common problems in SSI practices in the study area. This result is likely with the result reported by Eshete et al. [29] and Yohannes et al. [55] that found a shortage of water, caused a decline in the production and productivity of irrigated crops. This implies that, the application of SSI consumes huge amount of water that emerges from the various sources, thus improving the efficiency of water utilization and management are the main concerns of the country to boost irrigation agriculture.

3.3.3. Shortage of Safe Storage Facilities. As Table 7 shows, irrigation user farmers were confronted by the problem of poor storage facilities for irrigation products. In addition, insufficient postharvest handling systems and inadequate product grading systems worsen the problem of product loss. This result is similar to the study conducted by Assefa et al. [59], who reported that most of the farmers grow similar products that are often harvested by farmers at the same time, which leads to high-product availability at the market and a decline in prices. This is due to the unavailability of good storage facilities to keep products for a long time. These problems forced farmers to sell their products within a very short time at a low price, causing them to lose the benefits that must be gained from the irrigation products.

3.3.4. Inadequate Market, Road, and Transportation Access. In the study area, farmers move long distances to get the market, and animals are the major transportation option for moving irrigation products to the local market. Farmers reported that inadequate market access, road infrastructure, and transportation services as impediments for irrigation application. This result is consistent with the study that reports the negative impact of poor infrastructure on smallholders' adoption of SSI [60]. Overall this indicates, the poor transportation system and lack of road infrastructure increase the complexity for irrigation user farmers to

transport different irrigation inputs and output products, which in turn reduces their profitability. In this regard, key informants reported that a lack of market and transport caused the farmers not to participate in irrigation or forced them to irrigate lower areas of land.

3.3.5. Delay and Shortage of Irrigation Inputs. Furthermore, respondents indicate that input delay, shortages, and high cost of necessary inputs, challenges them to participate in SSI (Table 7). More importantly, the high cost of improved seeds, inorganic fertilizer, insecticides, herbicides, motor pumps, and fuel increases the cost of production and reduces the profitability of irrigator households. During the FGD, farmers also reported that some irrigation inputs were not timely available and caused the loss of irrigation seasons. Moreover, some improved seeds had the problem of germination in their irrigation farmland, and they are highly worried about getting quality improved seeds. According to Assefa et al. [59], the lack of modern inputs such as improved seeds has challenged the participation of farmers in SSI. In addition, the result of this study indicates that lack of irrigation skill and knowledge, insufficient irrigation experts at district and Kebele levels, administration problems, a lack of startup capital, and weather fluctuations are difficulties faced by irrigation user farmers in the study area. Besides, strengthening farmers income, land utilization, access to training, and extension services would increase farmer participation in SSI [61]

4. Conclusion and Recommendation

The study examined the farmers' perception and their constraints toward irrigation farming in the study area. The result of the Likert scale revealed that, there exists a significant perception difference among irrigation-user and nonuser farmers toward irrigation farming. This study confirmed that farmers highly perceived the profitability of irrigation, high-market demand for the irrigation products, the role of irrigation as insurance against drought, and its contribution to food security as critical positive attributes of SSI. The findings also verify that even if farmers perceived the significance of irrigation, they also agreed on the requirement of the high cost of production, a requirement of skills and knowledge, depletion of soil fertility via more water logging, and the bureaucratic nature of irrigation as disadvantageous attributes of SSI. Particularly, the result indicates that nonuser farmers highly perceived production risk, the requirement of capital, and the long bureaucracy attributes of irrigation than the user respondents, that would frustrate them from participating in SSI. The study also identifies the presence of plant disease and insects, poor water distribution system, insufficient storage facilities, inadequate road and transportation access, and delays and shortages of input as the major constraints to SSI in the study area.

The study makes vital contributions to the theoretical and empirical literature, as well as to proving insight into smallholder farmers' perception toward SSI. However, this research was conducted in one single district (two kebeles) of the Amhara region Northern part of Ethiopia, due to budget and time limitations. This make the research should be conducted on location specific manner. Because of this, the study is partial to generalize the result to the overall irrigation schemes which are found in the country. So, for future scholars, it is better to incorporate more Kebeles and irrigation schemes to get a full understanding on the perception and challenges of farmers toward SSI. In addition, this research is mainly focused on the perceptions and constraints of the farmers on irrigation practices in the Hulet Eju Enesie district. For future investigation, scholars may focus on assessing the multidimensional socioeconomic impact of irrigation and the effectiveness of irrigation water management by applying good research design to address those research problems.

The study recommends that the stakeholders of SSI should be keeping their eye on the uniqueness of farmers. Especially, most of the nonuser respondents were highly frustrated by the production risk and bureaucratic nature of the irrigation. Thus, the concerned stakeholders (DAOs and DAs) should assist smallholder farmers to acquire training since they are faced by lack of understanding about irrigation farming. Second, most of the farmers were restricted from participation in irrigation because of a lack of startup financial capital. Thus, their participation could be increased by enhancing household asset formation and by providing credit services in the study area. The occurrence of plant disease and insects are the common challenges of SSI in different irrigation schemes, including the studied kebeles. Therefore, the government and other concerned bodies should supply well-functioning antidisease, insecticides, and insecticide chemicals to farmers promptly, easily, and at a tolerable price. This study also identified the necessity to encourage, create a conducive environment for, and build up local irrigation infrastructures to enable farmers to easily transport products to market and reduce postharvest losses.

Data Availability

The data sets are used and/or analyzed and included in the current study, and can be available from the corresponding authors upon request.

Conflicts of Interest

The authors declared no potential conflicts of interest.

Authors' Contributions

Getasew conceived the project idea and prepared the research proposal and instruments together with all co-authors. Data were collected by Getasew and co-authors have contributed to data analysis, manuscript write-up, and review. All authors read and approved the final manuscript. Sinkie Alemu contributed equally to this work.

Acknowledgments

The authors sincerely acknowledged the University of Gondar, Woldia University and Mekdela Amba University for their support in undertaking this study. The authors also acknowledged the support of the research assistants who

helped in the data collection and the respondents in the Hulet Eju Enesie district for their collaboration and willingness for the interview. This study is financially supported by the Ministry of Science and Higher Education.

Supplementary Materials

Table S1: irrigated agricultural products and its land coverage in the district. Figure S1: water sources to irrigation practice in the study area. Figure S2: frequency distribution on farmers' perception toward ensuring high income. Figure S3: frequency distribution on farmers' perception toward high demand for SSI products. Figure S4: farmers perception on the role of irrigation to create job opportunity. Figure S5: frequency distribution on farmers' perception on the role of irrigation as insurance against drought. Figure S6: farmers' perception toward requirement of high capital and labor resource to SSI. Figure S7: farmers perception on skill and knowledge requirement to SSI practice. (*Supplementary Materials*)

References

[1] L. Rosa, "Adapting agriculture to climate change via sustainable irrigation: biophysical potentials and feedbacks," *Environmental Research Letters*, vol. 17, no. 6, 2022.

[2] N. Mango, C. Makate, L. Tamene, P. Mponela, and G. Ndengu, "Adoption of small-scale irrigation farming as a climate-smart agriculture practice and its influence on household income in the Chinyanja triangle, Southern Africa," *Land*, vol. 7, no. 2, Article ID 49, 2018.

[3] H. Xie, L. You, Y. T. Dile et al., "Mapping development potential of dry-season small-scale irrigation in sub-Saharan African countries under joint biophysical and economic constraints—an agent-based modeling approach with an application to Ethiopia," *Agricultural Systems*, vol. 186, Article ID 102987, 2021.

[4] G. Tesso, "Review of the impact of COVID-19 on economic growth, unemployment and progress out of poverty in Ethiopia. *Impact of COVID-19 On Ethiopian economy*," 2020.

[5] K. Berhanu and C. Poulton, "The political economy of agricultural extension policy in Ethiopia: economic growth and political control," *Development Policy Review*, vol. 32, no. S2, pp. S197–S213, 2014.

[6] G. Diriba, *Agricultural and Rural Transformation in Ethiopia: Obstacles, Triggers and Reform Considerations*, EEA, Ethiopia, 2020.

[7] M. Belay and M. Mengiste, "The ex-post impact of agricultural technology adoption on poverty: evidence from north Shewa zone of Amhara region, Ethiopia," *International Journal of Finance & Economics*, vol. 28, no. 2, pp. 1327–1337, 2023.

[8] B. M. Campbell, S. J. Vermeulen, P. K. Aggarwal et al., "Reducing risks to food security from climate change," *Global Food Security*, vol. 11, pp. 34–43, 2016.

[9] G. Tigre and A. Heshmati, "Smallholder farmers' crop production and input risk analysis in rural Ethiopia," *Applied Economics*, vol. 55, no. 6, pp. 671–689, 2023.

[10] E. Bojago and Y. Abrham, "Small-scale irrigation (SSI) farming as a climate-smart agriculture (CSA) practice and its influence on livelihood improvement in Offa district, Southern Ethiopia," *Journal of Agriculture and Food Research*, vol. 12, Article ID 100534, 2023.

[11] M. T. G. Yihdego and S. Ghosal, "The impact of small scale irrigation on household income in Bambasi Woreda, Benishangul–Gumuz region, Ethiopia," *International Journal of Scientific and Research Publications*, vol. 6, no. 6, pp. 401–406, 2016.

[12] M. Tesfaw, "Small scale irrigation development," *Irrigation Drainage System Engineering*, vol. 7, no. 1, p. 206, 2018.

[13] B. Terefe, *Determinants of small-scale irrigation use and its implication on poverty reduction: empirical evidence from Bogena river catchment in Awabel district, East Gojjam, Ethiopia*, Ms.c Thesis, AdisAbeba University, Ethiopia, 2019.

[14] M. Tesfaye and H. Beshir, "Impact of small scale irrigation on the livelihood of rural farm households: the case of Oromo zone, Eastern Amhara, Ethiopia," *Saemaul Studies*, vol. 3, no. 2, pp. 131–160, 2018.

[15] MoA (Ministry of Agriculture), "Small-scale irrigation situation analysis and capacity needs assessment," in *Directorate of Natural Resources*, Ministry of Agriculture, Addis Ababa, 2011.

[16] F. N. Bachewet, G. Berhane, B. Minten, and A. S. Taffesse, "Agricultural transformation in Africa? Assessing the evidence in Ethiopia," *World Development*, vol. 105, pp. 286–289, 2018.

[17] J. Ahmed, "The role of small scale irrigation to household food security in Ethiopia: a review paper," *Journal of Resources Development and Management*, vol. 6, pp. 20–25, 2019.

[18] L. Legesse, A. Ayele, W. Tasewu, and A. Alemu, "Impact of small scale irrigation on household farm income and asset holding: evidence from Shebedino district, Southern Ethiopia," *Journal of Resources Development and Management*, vol. 43, pp. 8–15, 2018.

[19] Y. Jambo, A. Alemu, and W. Tasew, "Impact of small-scale irrigation on household food security: evidence from Ethiopia," *Agriculture & Food Security*, vol. 10, Article ID 21, 2021.

[20] G. Muleta, M. Ketema, and B. Ahmed, "Impact of small-scale irrigation on household food security in central highlands of Ethiopia: evidences from Walmara district," *Journal of Economics and Sustainable Development*, vol. 12, no. 3, 2021.

[21] H. Maru, A. Haileslassie, and T. Zeleke, "Impacts of small-scale irrigation on farmers' livelihood: evidence from the drought prone areas of upper Awash sub-basin, Ethiopia," *Heliyon*, vol. 9, no. 5, Article ID e16354, 2023.

[22] G. Mulatu, "Adoption of small-scale irrigation and its impact on household's income in Dugda districts, East Shewa Zone, Oromia, Ethiopia," *Economics and Business Journal*, vol. 1, no. 4, pp. 349–366, 2023.

[23] M. A. Gebul, "Trend, status, and challenges of irrigation development in Ethiopia—a review," *Sustainability*, vol. 13, no. 10, Article ID 5646, 2021.

[24] A. Tafesse, S. Dema, and A. Belay, "Irrigated onion production efficiency in Humbo district, Southern Ethiopia," *Cogent Economics & Finance*, vol. 11, no. 1, Article ID 2207928, 2023.

[25] D. B. Hirko and J. A. Du Plessis, "Assessing the effectiveness of Koftu's small-scale irrigation schemes in enhancing water resource utilization in Ethiopia." 2023.

[26] A. M. Belay, T. T. Assefa, S. A. Belay, and A. Y. Yimam, "Evaluating the performance of small-scale irrigation schemes in subhumid Ethiopian highlands," *Irrigation and Drainage*, vol. 72, no. 1, pp. 224–239, 2023.

[27] T. H. Lebeta, *Participation in and impact of small-scale irrigation practice on household income: the case of Abay Chomen district of Oromia national regional state, Ethiopia*, MSc THESIS, Haramaya University, Haramaya, 2017.

[28] M. Mesfin, B. Matusala, and M. Teketel, "Assessing the challenges of irrigation development in Ethiopia: a review,"

International Journal of Engineering Research and Technology, vol. 9, no. 1, pp. 215–221, 2020.

[29] D. G. Eshete, B. G. Sinshaw, and K. G. Legese, "Critical review on improving irrigation water use efficiency: advances, challenges, and opportunities in the Ethiopia," *Water-Energy Nexus*, vol. 3, pp. 143–154, 2020.

[30] A. Agidew, "The determinants of small-scale irrigation practice and its contribution on household farm income: the case of Arba Minch Zuria Woreda, Southern Ethiopia," *African Journal of Agricultural Research*, vol. 12, no. 13, pp. 1136–1143, 2017.

[31] I. D. Mume, "Small scale irrigation farming adoption as a climate-smart agriculture practice and its impact on household income in Ethiopia. A review paper," *Journal of Economics and Sustainable Development*, vol. 23, no. 17, 2021.

[32] T. Geddafa, E. Abera, and F. Gedefa, "Determinants of smallholder farmers' participation and level of participation in small-scale irrigation practice in Gemechis district, West Hararghe zone, Ethiopia," *Cogent Engineering*, vol. 8, no. 1, Article ID 1960250, 2021.

[33] Z. Zemarku, M. Abrham, E. Bojago, and T. B. Dado, "Determinants of small-scale irrigation use for poverty reduction: the case of Offa Woreda, Wolaita Zone, Southern Ethiopia," *Advances in Agriculture*, vol. 2022, Article ID 4049868, 16 pages, 2022.

[34] E. Asiedu-Darko, "Farmers' perception on agricultural technologies a case of some improved crop varieties in Ghana," *Agriculture, Forestry and Fisheries*, vol. 3, no. 1, pp. 13–16, 2014.

[35] M. Mwangi and S. Kariuki, "Factors determining adoption of new agricultural technology by smallholder farmers in developing countries," *Journal of Economics and Sustainable Development*, vol. 6, no. 5, 2015.

[36] S. Jha, H. Kaechele, M. Lana, T. S. Amjath-Babu, and S. Sieber, "Exploring farmers' perceptions of agricultural technologies: a case study from Tanzania," *Sustainability*, vol. 12, no. 3, Article ID 998, 2020.

[37] DAO, *District Agricultural Office Annual Report*, Hulet Eju Enese, Motta, Ethiopia, 2020.

[38] D. Fentie, B. Fufa, and W. Bekele, "Determinants of the use of soil conservation technologies by smallholder farmers: the case of Hulet Eju Enesie district, East Gojjam Zone, Ethiopia," *Asian Journal of Agriculture and Food Sciences*, vol. 4, no. 1, 2013.

[39] D. Lamesegn, F. Tegegne, Y. Mekuriaw, and H. Ayalew, "Husbandry practices of sheep in HuletEjuEnesie district, East Gojjam zone, Ethiopia," *Online Journal of Animal and Feed Research*, vol. 8, no. 6, pp. 150–157, 2018.

[40] T. Yamane, *Statistics, an Introductory Analysis*, Harper and Row, New York, 2nd edition, 1967.

[41] R. A. Likert, "Technique of measurement of attitude," *Journal of Archives of Psychology*, vol. 140, no. 44, 1932.

[42] T. Khaleel, Y. Nassar, T. S. Al-Attar, M. A. Al-Neami, and W. S. AbdulSahib, "Identification and analysis of factors affecting labour productivity in Iraq," *MATEC Web of Conferences*, vol. 162, Article ID 02032, 2018.

[43] K. N. Le and V. W. Y. Tam, "A survey on effective assessment methods to enhance student learning," *Australasian Journal of Engineering Education*, vol. 13, no. 2, pp. 13–20, 2015.

[44] S. Kudadze, A. J. Imoru, and W. Adzawla, "Farmers' perception on irrigation farming and the factors influencing access to and size of irrigable lands in Northern region, Ghana," *Asian Food Science Journal*, vol. 8, no. 3, pp. 1–14, 2019.

[45] G. M. A. Nonvide, D. B. Sarpong, G. T.-M. Kwadzo, H. Anim-Somuah, and F. Amoussouga Gero, "Farmers' perceptions of irrigation and constraints on rice production in Benin: a stakeholder-consultation," *International Journal of Water Resources Development*, vol. 34, no. 6, pp. 1001–1021, 2018.

[46] I. Hussain and M. A. Hanjra, "Irrigation and poverty alleviation: review of the empirical evidence," *Irrigation and Drainage*, vol. 53, no. 1, pp. 1–15, 2004.

[47] A. Mekonnen, A. Tessema, Z. Ganewo, and A. Haile, "Climate change impacts on household food security and adaptation strategies in southern Ethiopia," *Food and Energy Security*, vol. 10, no. 1, 2021.

[48] W. A. Workneh, J. Takada, and S. Matsushita, "The impact of using small-scale irrigation motor pumps on farmers' household incomes in Ethiopia: a quasi-experimental approach," *Sustainability*, vol. 12, no. 19, Article ID 8142, 2020.

[49] J. Kamwamba-Mtethiwa, K. Weatherhead, and J. Knox, "Assessing performance of small-scale pumped irrigation systems in sub-Saharan Africa: evidence from a systematic review," *Irrigation and Drainage*, vol. 65, no. 3, pp. 308–318, 2016.

[50] A. Chinasho, B. Bedadi, T. Lemma, T. Tana, T. Hordofa, and B. Elias, "Farmers' perceptions about irrigation roles in climate change adaptation and determinants of the choices to WUE-improving practices in southern Ethiopia," *Air, Soil and Water Research*, vol. 15, 2022.

[51] A. E. Kassie, "Challenges and opportunities of irrigation practices in Ethiopia: a review," *Journal of Engineering Research and Reports*, vol. 9, no. 3, pp. 1–12, 2020.

[52] T. Damtew, *The effect of small scale irrigation on household food security in Bona Zuria Woreda, Sidama zone, Southern Ethiopia*, Doctoral dissertation, Hawassa University, 2017.

[53] A. Abiyu, M. Tebeje, and E. Mekonnen, "Determinants of small-scale irrigation utilization by smallholder farmers' in Rift Valley Basin, Wolaita Zone, Ethiopia," *Journal of Natural Sciences*, vol. 5, no. 21, 2015.

[54] G. Gebremeskel, T. G. Gebremicael, H. Hagos, T. Gebremedhin, and M. Kifle, "Farmers' perception towards the challenges and determinant factors in the adoption of drip irrigation in the semi-arid areas of Tigray, Ethiopia," *Sustainable Water Resources Management*, vol. 4, no. 3, pp. 527–537, 2018.

[55] D. F. Yohannes, *Innovative irrigation water management: a strategy to increase yield and reduce salinity hazard of small scale irrigation in Ethiopia*, Doctoral dissertation, Wageningen University and Research, 2020.

[56] C. Salazar and J. Rand, "Production risk and adoption of irrigation technology: evidence from small-scale farmers in Chile," *Latin American Economic Review*, vol. 25, Article ID 2, 2016.

[57] I. Dawid, J. Haji, and M. Aman, "Evaluating farm household resilience and perceptions of the role of small-scale irrigation in improving adaptability to climate change stress: evidence from eastern Ethiopia," *Frontiers in Climate*, vol. 5, Article ID 1193910, 2023.

[58] A. G. Yihdego, A. A. Gebru, and M. T. Gelaye, "The impact of small-scale irrigation on income of rural farm households: evidence from Ahferom Woreda in Tigray, Ethiopia," *International Journal of Business and Economics Research*, vol. 4, no. 4, pp. 217–228, 2015.

[59] E. Assefa, Z. Ayalew, and H. Mohammed, "Impact of small-scale irrigation schemes on farmers livelihood, the case of

Mekdela Woreda, North-East Ethiopia," *Cogent Economics & Finance*, vol. 10, no. 1, 2022.

[60] B. T. Temesgen, *Determinants of Small-scale irrigation use and its implication on poverty reduction: empirical evidences from Bogena river catchment in Awabel district, East Gojjam, Ethiopia*, *MSc Thesis*, http://etd.aau.edu.et/handle/123456789/19249, Addis Ababa University, Ethiopia.

[61] G. Daru, D. Melak, W. Awoke, and S. Alemu, "Farmers' participation in small-scale irrigation in Amhara region, Ethiopia," *Cogent Economics & Finance*, vol. 11, no. 1, 2023.