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DETERMINANTS OF SMALL-SCALE IRRIGATION USE AND ITS CONTRIBUTION ON HOUSEHOLD INCOME: THE CASE OF FENTALE DISTRICT, EAST SHEWA ZONE, OROMIA REGION, ETHIOPIA

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ABSTRACT

The purpose of this study was to assess determinants of Small-Scale Irrigation Practices and its contribution on household income in Fentale woreda. Both primary and secondary data were collected and used in the study. Primary data were collected from 188 household heads, 108 irrigation users and 88 non-users. Three kebeles were stratified into two strata and a systematic sampling method was employed to select the respondents' households from the population frames of two strata. The descriptive statistics and the binary logistic regression analysis were used for analyzing quantitative data**.** Secondary data were collected by reviewing different documents. The study results show that the Age of the respondent had a significant positive effect on the use of irrigation water at a 5% significant level. While the livestock holding and Distance from Market had a significant positive effect on the use of irrigation water at a 1% significance level. On the other hand, farm distance from the main irrigation canal had a significant and negative effect on the use of irrigation water at a 1% significance level. As a result, the irrigation user respondents' households obtained an excess of 2428.5 birrs of mean annual gross income that was obtained by irrigation non-user respondents' households. The study concluded that small-scale irrigation is one of the viable solutions to increase household income in the study area. Multiple linear regression was used to identify the effect of irrigation on annual gross income of household. The model result indicated that

Extension service from DAs 10%, Livestock holding 5% and Non-farm income 1%, Extension service from development agent was significant at 10% significant level of household income. Finally, it is recommended that governmental and non-governmental organization should expand access of small scale irrigation by farm households to solve the distance related problem.

Keywords: Irrigation, Income, logistic, regression.

1. INTRODUCTION

1.1. Background of the Study

The major resource bases for agriculture development are land, diverse Agro-ecology, water resources, and human resources. The agriculture sector has promising opportunities to transform itself from subsistence to a level of the modern and commercial sectors. Nevertheless, the sector faces several challenges to produce adequate food supply for domestic consumption and export earnings (Petros and Yishak, 2017).

Ethiopia has large water potentials that could be used for a wide range of irrigation development programs. It has 12 major river basins with an annual water runoff volume of more than 122 billion cubic meters. In addition, the groundwater potential is estimated to be more than 2.6 billion cubic meters. Currently, about 3% to 5% of the irrigable land is irrigated while the irrigation potential has been estimated to be about 4.3 million hectares of arable land (Derejeet al., 2016).

Irrigation contributes to livelihood improvement through increased income, food security, employment opportunity, social needs fulfillment and poverty reduction. Increase in agricultural production through diversification and intensification of crops grown, increased household income because of on/off/non-farm employment, the source of animal feed, improving human health due to a balanced diet and easy access and utilization for medication, soil, and ecology degradation prevention and asset ownership are contributions of irrigation (Asayehgn, 2012) as cited by (Petros and Yishak, 2017).

According to Haile, (2008), there are four interrelated mechanisms by which irrigated agriculture can reduce poverty, through: (i) increasing production and income, and reduction of food prices, that helps very poor households meet the basic needs and associated with improvements in household overall economic welfare, (ii) protecting against risks of crop loss due to erratic,

unreliable or insufficient rainwater supplies, (iii) promoting greater use of yield-enhancing farm inputs and (iv) creation of additional employment, which together enables people to move out of the poverty cycle.

In line with the development policy of the country, the Oromia Regional Government lays emphasis on the agriculture sector by assisting and supporting pastoralists and agro-pastoralists' trough promote production using the irrigation system. Oromia Irrigation Development Authority /OIDA/ decided to intervene in the situation, through Fentale Irrigation Based Integrated Development Projects for pastoralists and agro-pastoralists of Fentale District, that aim is to the improvement of agricultural production, with a view to realizing the objective of food self-sufficiency and food security. Accordingly, at Fentale District irrigation development is implemented to improve the livelihood of pastoralists and agro-pastoralists. It established in 2007/8 and benefits 11,116 households at Boset and Fentale District (Yohannes, 2011). However, despite regional government expands irrigation schemes in the District, the effect of small-scale irrigation on household income and determine household irrigation water use not analyzed and identified respectively in the area. Hence, this study were conducted to address the effect of small-scale irrigation on rural household income and identify the determinants that affect rural household irrigation water use in the study area.

1.2. Statement of the Problem

Agricultural production in Ethiopia is primarily rain-fed, so it depends on erratic and often insufficient rainfall. As a result, there are frequent failures in agricultural production. Irrigation has the potential to stabilize agricultural production and mitigate the negative effect of the variable or insufficient rainfall. Irrigation contributes to agricultural production through increasing crop yields and enabling farmers to increase cropping intensity and switch to high-value crops (Petrosand Yishak, 2017) quoting (Zhou, *et al*., 2008).

The development of water resources for agricultural purposes (irrigation) is rising rapidly. According to Awulachewet al, (2010), in 1990 Ethiopia had an estimated total of 161,000 hectares of irrigated agriculture, of which 64,000 ha were in small-scale schemes, 97,000 ha were in medium-and large-scale schemes and approximately 380,000 ha were under implementation. This had grown to more

than 247,000 ha by 2004, with traditional irrigation schemes alone covering more than 138,000 ha. Currently, the Ethiopian government gives more emphasis to small-scale irrigation as a means of achieving food self-sufficiency.

Fentale irrigation scheme is a new development intervention for agro-pastoralists in the area. The scheme benefits 11,116 households at Boset and Fentale woreda (Yohannes, 2011). A few studies had been done in the area regarding on impact of irrigation on agro-pastoralist food security status. For instance, the study of (Adem, 2016) focuses on the impact of small-scale irrigation schemes on household food security by taking the availability of food and calorie measurement. However, the woreda lacks In-depth studies on identifying the determinant factors that influence the use of irrigation water. That is, not well known the contribution of irrigation on household farm income and to what extent the households using irrigation are better off than those who depend on rain-fed agriculture. Therefore, this study were try to fill these gaps by assess the determinant of rural households' participation in small-scale irrigation and its contribution on rural household income.

1.3. Objectives of the Study

- To assess the status of the use of small-scale irrigation in the study area.
- To identify the determinants that affect the use of irrigation water in the study area.
- To assess the effect of irrigation on the annual gross income of the household in the study area.

2. RESEARCH METHODOLOGY

In this study a multi- stage sampling procedure was employed. In the first stage, the study area selected purposively as small-scale irrigation practice is available in the woreda. In the second stage, three Kebeles which have high access of small-scale irrigation were selected purposively. In the third stage, sampling frame (complete village household lists) was obtained from each kebele's administrative office. In the fourth stage, the total households in the three sample Kebeles will be stratified in to the two strata (irrigation water user and non-user households).

In the fifth stage, simple random sampling techniques was applied to select the sample unit from each strata at each kebele via probability proportionate to size procedure

To determine the required sample size, the study was employed a formula developed by Yamane (1967) at a 95% confidence level, 7% margin of errors as follows.

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

Where, the n= sample size for the study, N= total number of household head, the e= margin of errors at 7% (0.07). Then out of 2,449 household heads, approximately a total of 188 households (108 users and 80 non-users) respondents select and interviewed. This determined sample size of irrigation user and non-user respondents' household was selected from the population frame of irrigation users and non-users household of the respective *Kebele* through Systematic probability sampling (list sampling) technique through the following procedure:

$$I=N/K$$

Where:

I is the subject that was selected.

N is total population of each sample *Kebele.*

K is total sample size each sample *Kebele.*

The 1st subject randomly selected and then every I^{th} subject from the population frame was included up to achieve the determined sample size (C.R. Kothari, 2004).The data were collected from two sources which are primary and secondary data. The majority of primary data were collected from selected farmers through focus group discussion (FGD), semi structured interviews, field observation and informal interview. Secondary data relevant for this study gathered from the woreda office of agriculture and natural resource, Central Statistics Agency (CSA) and from published and unpublished sources.

Descriptive statistics were used to analyze and compare the socio-economic, demographic and institutional characteristics between users and non-user. The collected data were organized systematically in a way suitable for both quantitative and qualitative data analysis. In the first level, simple descriptive statistics such as percentages and frequency was used to analyze dummy or categorical variables and mean, minimum, and maximum statistics values was applied to analyze continues variables. Chi-square test was applied to check either association exists or not between dependent and

categorical explanatory variables and to examine the goodness of fit (prediction power of the explanatory variables). T-test was applied to check and to compare the mean difference of users and non-users. The data were analyzed using STATA software version 13. To identify the determinants that influence the use of irrigation water, the binary logistic regression analysis was employed. It is selected because of the model's relevance to deal with dichotomous dependent variables.

To analysis the effect of irrigation practice on the household annual gross income the multiple linear regressionwas used, because the dependent variable is annual household income. It is a continuous variable and measure in ETB.

3. RESULT AND DISCUSSIONS

3.1. The Status of Irrigation Practice in the Study Area.

3.1.1. Source of Irrigation Water

The result shows that there are two water sources in the study area Awash River and Lake Beseka. Awash River is the only water resource suitable for crop and livestock production. In the study area out of the total sample, 108 (57.45%) households were irrigation users whereas the rest 80 (42.55 %) households were non-users. The river found in the woreda is the source of water for irrigation development as well as the community consumption. Additional information gathered from FGD participants revealed that "in the area, rivers are a common resource and major source of irrigation water. However, in the study area, irrigation water, especially in the rainy season, irrigation water is available and accessible for all irrigation user farmers. But during the dry season, the volume of irrigation water from the rivers decrease and that farmland located far from these sources has less access to use irrigation water when compared with that farmland located nearest to the rivers.

3.1.2. Irrigation Water Diversion and Lifting Mechanisms in the Study Area

The commonly used water diversion and lifting up mechanisms in the study area were19.4 percent of the user respondents use traditional river diversion method, 65.7 % of the users use concrete canal river diversion methods and the rest 14.8 % of respondent use the motorized pump for water diversion. Apart from that the irrigation users also apply two types of irrigation water application methods. Surface irrigation and furrow; where the majorities (87.04%) of the irrigation users apply furrow and the rest

(12.03%) percent apply surface irrigation. Out of the total irrigation users, 93.27 % of them believed that the irrigation water is reliable throughout the year, whereas 6.73 % of the irrigation users doubted the reliability of the water.

Figure 1.Concrete water diversion method Figure 2.Traditional water diversion method

3.2. The Determinants of Rural Household participation in Small-scale Irrigation

An econometric model, binary logistic regression was employed to identify the determinants of household irrigation status. To determine the best predictors of the dependent variable, 11 independent variables (6 continuous variables and 5 dummy variables) were included in the model to estimate the parameters of all the variables using binary logistic regression analysis. The inclusion of these variables has come into ground-based on theoretical expectations and empirical studies done before. All the variables deemed to determine household irrigation status were entered into STATA (version 13) and a

binary logistic regression model was run to identify the key determining factors for rural irrigation status in the study area. The model used Pi (irrigation status of households) as a dichotomous dependent variable having the value of 1 if the household is access to use irrigation, 0 non-user of irrigation.

Since interpreting the result directly is not possible, hence a more appealing interpretation of parameter estimates in a logit model is explaining the odd ratio of each exogenous variable. Thus the odd ratio and interpretation of significant variables were presented below.

Table1. The binary logistic regression results of independent variables.

Variable	Coef	Odds Ratio	Std. Err	Z	P value
SEX	-3.190	0.0411	1.9779	-1.61	0.107
AGE	0.2067	1.2296	0.0871	2.37	0.018**
EDUC	-0.3674	0.6925	0.4785	-0.77	0.443
HHL	2.131	0.1186	0.7849	-2.72	0.007***
TLHS	-8.8574	0.0001	5.4138	-1.64	0.102
DFMIC	-0.2029	0.8163	0.0515	-3.94	0.000***
LH	1.584	4.8757	0.5535	2.86	0.004***
NFI	-1.0094	0.3644	1.3220	-0.76	0.445
UC	0.4852	1.6245	1.6158	0.30	0.764
EXN	2.508	12.281	1.4018	1.79	0.074
DFM	4.484	88.664	1.7339	2.59	0.010***
***, **, * significant at 1%, 5% and 10% probability level respectively					
Number of observation		188		Pseudo R2	0.874

LR chi2(12)	224.29	Log likelihood	16.073604
Prob> chi2	0.0000		

Source: Own computations, based on household survey data, 2019

The likelihood ratio test statistic as a measure of goodness of fit of the model exceeds the chi-square critical value with 11 degrees of freedom at less than 5 percent significance level justifying that the null hypothesis that all the slope coefficients except the intercept are simultaneously equal to zero is rejected. Therefore, the model fits the data well.

Age of respondents' (AGE): Age had a significant positive effect on the use of irrigation water at a 5% significance level. When the age increases by one year, the likelihood of using of irrigation increase by a factor of 1.229. As the ages of households increased, it is assumed that farmers could acquire more knowledge more experience and easily they adopted modern technology. In agreement with this, a study conducted by Destaw (2003) and Berehanu (2007) indicated the positive and significant relationship of age effect on participation.

Household labor: HHL had a significant positive effect on the use of irrigation water at a 1% significance level. This positive relationship shows that the probability of use irrigation access was increase with an increase in household HHL. The odds ratio favors the use of irrigation by an increase factor of 0.1186 when the HHL of the household head increases by one adult equivalent. Households who had a large number of HHL are more likely to become user of irrigation access than those households who had small HHL.

Farm distance from the main irrigation canal: DFMIC had a significant positive effect on the use of irrigation water at a 1% significance level. The odds ratio disfavoring the use of irrigation by a factor of 0.8163for the respondents' farm distance from main irrigation canals increased in 1 one km. Therefore, the respondents' household farms located far from the rivers and main irrigation canals have less chance to use irrigation water and vice versa. Because in the study area the major water source for irrigation is river. When the farm distance far from main irrigation canals which need financial and time costs to construct sub-canals towards the individual farm and minimize the chances to use

irrigation water. In agreement with this, a study conducted by Agidew (2017) indicated negative and significant relations with the use of irrigation water.

Livestock holing (LH): had significant positive effect on the use of irrigation water at 1% significance level. The odds ratio favors the use of irrigation by a factor of 4.875 when the number of livestock increase by one unit tropical livestock unit. Households with large number of livestock are more likely to become use irrigation than those who had small number of livestock. All other things constant, the probability of being used irrigation increases by probability by 4.87, as number of livestock increases by one. The possible explanation can be the household with large number of livestock can sell their animals to buy crops at the time.

Distance from Market: DFM had positive significant effect on the use of irrigation water at 1% significance level. The odds ratio supports the use of irrigation by a factor 88.66 when the household head have nearest to market. The household has available nearest to market that has to produce many agricultural products for that purpose they used irrigation access because they sell the products easily at the market.

3.3. Result of Multiple Linear Regressions

Table2. Econometric Result of Multiple Regressions

Income	Coef	Robust Std. Err	T value	P value
SEX	-2097.37	3224.93	-0.65	0.517
AGE	-121.39	106.50	-1.14	0.257
EDUC	-142.79	492.32	-0.29	0.772
IU	4432.42	1730.67	2.56	0.012**
HHL	560.59	691.53	0.81	0.419
TLHS	1605.48	3445.18	0.47	0.642
IRC	-18.662	27.35	-0.68	0.496
LH	0.656	0.2624	2.50	0.014**

NFA	11319.8	1410.97	8.02	0.000***
UC	2619.06	2293.55	1.14	0.256
EXN	2141.93	1091.53	1.96	0.052*
DFM	212.077	1150.54	0.18	0.854
_cons	3952.34	5283.89	0.75	0.456

Source: Own computations, based on household survey data, 2019

Irrigation Use: The mean annual gross income obtained by irrigation user and non-user respondents' household was 8637.03 and 6208.75 respectively. The multiple linear regression model result shows that at 5% significant level, the mean of annual gross income obtained by irrigation user respondents' household was significantly difference and better from that was obtained by irrigation non-user respondents' households. As a result, the irrigation user respondents' households obtained an excess of 2428.5 birrs of mean annual gross income that was obtained by irrigation non-user respondents' households. The irrigation user had 4432 birr additional income from the use irrigation. In agreement with this finding, the study conducted by Ayele*et al*., (2013) at Lake Tana basin has reported that access to irrigation has a significant positive role on the mean income of a household (3353birr per year) a 27% increase over the mean income for non-irrigating households and Kinfe (2012) at Central Tigray has also reported that irrigation user households with one-hectare irrigable land are better-off in well-being by 23,327.8birr than non-user households.

Livestock holding (LH): This variable was significant at 5% significance level and positive effect on the household income. All other things constant the household get income by selling of livestock increase by one birr the household income was an increase by 0.65 birr amounts. The household income from the selling of livestock increased the irrigation access that means they will purchase the irrigation material that was available to use irrigation in the study area.

Non-farm Activity (NFA): This variable was significant at 1% significant level and positive effect on the household income. The household head that has participated

(gained income from non-farm activity) that increased the irrigation access. All other things are constant to the household that has to participate in the non-farm income the household income increase by 11319. That means the household participation in different non- farm activity they would diversify the income level that increases the household income.

Extension service from development agents (EXN): This variable was significant at 10% significant level and positive effect on the household income level. The household that has to get extension service increased in irrigation activity that will increase the household income because the extension agent would advise the household to diversify the income level of the household. All other things have constant the household that gets the extension service the household income was an increase by 2141 birrs.

4. CONCLUSION AND RECOMMENDATIONS

4.1. CONCLUSION

The objective of this study was to assess the determinant of small-scale irrigation use and its contribution to household income in the study area. Small scale irrigation has played a key role in enabling sustainable food production where it is well managed by lowering the risk of crop failure. Irrigation also helps to prolong the effective crop growing period in areas with dry seasons by permitting multiple cropping per year.

The major sources of irrigation water in the study area are rivers. The availability of water from rivers is decreases during dry season so it was not that much reliable even for irrigation users' farm that located far distance from the main irrigation canal. In the study area one of main constraints for irrigation non-user respondents' household are distance from the main irrigation canal. These factor were negatively and significantly affect the use of irrigation water at 1% significant level.

Binary logistic regression model was used to identify the determinants of irrigation access in the rural households in study area. Using binary regression, from the total 11 variables five variables are significant determinants was identified to determine the irrigation status (irrigation user and non-irrigation user). From the total discussed variables, Age of respondents at 5%, Livestock holding 1% and Distance from Market at 1% and Household Labor had at 1% significant level of positive effect on the use of irrigation water. However, distance from main irrigation canal had significant

negative effect on the use of irrigation water at 1% significant level.

Multiple linear regression model was used to identify the effect of irrigation on annual gross income of household. The model result indicated that Extension service from DAs 10%, Livestock holding 5% and Non-farm income 1%, Extension service from development agent was significant at 10% significant level of household income. The household that have get the access to extension access they improved the household income.

4.2 RECOMMENDATION

- The study finding revealed that Participation in irrigation helps the households to generate additional income and diversification of household income. Therefore, development strategies and programs related to irrigation programs through agricultural production should give about the importance of irrigation. Hence, the governmental and non-governmental organizations should expand access to small scale irrigation to improve their household income.
- The study result revealed that income from non-farm activity activities used to diversify the sources of income and increase household irrigation access. Therefore, government, Non-governmental organizations and policymakers have to focus on increasing non-farm activities self-employment and trade access.
- Distance from rivers had significantly negative effect on the use of irrigation water at 1% significant level and the major sources of irrigation water in the study area are river. Therefore, in addition to river water it should be better to initiate farmers to develop and use water harvesting technology (pond and spring development) community and household level and shallow wale at household. It is likely to be valuable for future irrigation development.
- Agricultural labor had significant positive effect on the use of irrigation water. Therefore, governmental and non-governmental organizations should give emphasis on

provision of credit for farmers and that improves their financial capital to purchase improved equipment's and rent labor and that fill the gap of family labor shortage. Consequently, creates an opportunity to shift non-users to use irrigation water in the study area.

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