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Full Length Research Paper

Comparative analysis of technical efficiency of smallholder irrigated and rain-fed farm production: The case of Girawa District, Oromia, Ethiopia.

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Irrigation is one means by which agricultural production can be increased to meet the growing food demands in the world. This study evaluated the farm household technical efficiency of smallholder irrigated and rain-fed farm production. The specific objectives of this study are to compare farm households' technical efficiency of irrigation users and non-users and to identify factors influencing farm households' technical efficiency in Girawa district, Oromia, Ethiopia. Both primary and secondary data were collected for the study. Primary data were collected from 200 sample respondents drawn from both participant and non-participant households. Preliminary statistics and econometric model were employed for data analysis. The results of Stochastic frontier model applied to assess the determinants of technical efficiency revealed that education, cultivated area, Extension contact livestock holding, access to irrigation, training and social status significantly determined technical efficiency. The results revealed that households that participate in irrigation practice have got an improvement of 8.92 percent in technical efficiency than those households that were not participated in irrigation practice. All results obtained from different models revealed the positive effect of irrigation on farm household technical efficiency. Therefore, policy makers should give due emphasis to the aforementioned variables to increase farm household efficiency and improve the livelihood of rural households.

Keywords: Irrigation, rain-fed, farm household, technical efficiency, and stochastic frontier model.

INTRODUCTION

Ethiopia is an agrarian country where around 95% of the country's agricultural output is produced by smallholder farmers (MoARD, 2010). Agriculture contributes about 41% of the country's GDP, employs 83% of total labour force and contributes 90% of exports (EEA, 2012). Despite its dominance, in 2011 alone Productive Safety Net Program supported 7.4 million people, whereas an additional 4.5 million people were requiring emergency humanitarian assistance. According to UNDP (2011) 39 percent of the population lives on less than US$1.25/day. On the United Nations Development Program's 2011 human development index, Ethiopia ranks 174 out of 187 countries. Human development indicators are low, with exceptionally alarming statistics regarding food security and women's status and well-being.

As the result of this, extreme poverty is widespread in Ethiopia. The major causes of poverty and food insecurity in rural areas include land degradation, recurrent drought, population pressure, low input subsistence agricultural practices, lack of employment opportunities and limited access to services and technology. As a result more than 38% of rural households fall below the food poverty line and 47% of children under five suffer from stunting (WFP, 2010; MOARD, 2009b).

Though agriculture remains to be the most important sector of the Ethiopian economy, its performance has been disappointing and food production has been lagging behind population growth (Demeke, 2008), which is unable to fulfill the requirement of the ever-increasing number of mouths. Poor use of modern inputs can partly explain the low productivity of the sector and the internal inefficiency of the farmers in using the available agricultural resources. Increased productivity in agriculture through irrigation also leads to increased opportunities in businesses which supply the agricultural sector. These effects are felt directly in sales of irrigation equipment and indirectly in sales of seed, fertilizer, pesticides, herbicides, and agricultural machinery. This expected increase in sales assumes that irrigated agriculture will lead to increased profits over dry-land or rain-fed agriculture(Baley *et al, 2010)*

The total irrigable land potential in Ethiopia is 5.3 million hectares assuming use of existing technologies, including 1.6 million hectares through RWH and ground water. There are 12 river basins that provide an estimated annual run-off of ~125 billion m^3per year, with the potential of irrigating total of 3,731,222ha from surface water. The potential available estimates for RWH range from 40,000 to 800,000 ha. The area under irrigation development to-date is estimated to be 640,000 hectares for the entire country which is 5% of the potential irrigable (Awulachew *et al*., 2010).

Irrigation benefits the poor through higher production, higher yields, lower risk of crop failure, and higher and year-round farm and non-farm employment. Irrigation enables smallholders to adopt more diversified cropping patterns, and to switch from low value staple production to high-value market-oriented production. Increased production makes food available and affordable for the poor (Asayehegn et a.l, 2011).

In the light of the foregoing this study examined farm household' technical efficiency of smallholder irrigated and rain-fed farm production in Ethiopia, using Girawa district of Oromia national Regional State as a study area. Specifically, this study;

- to compare technical efficiency of irrigation user and non-user households and,
- to identify factors affecting farm households' technical efficiency in the study area

RESEARCH METHODOLOGY

The study was conducted in Girawa district, Oromia National Regional State, Ethiopia. According to CSA (2010), the district has a total population of 263,924 of which 133,780 are male and 130,144 are female and total area of the district is about 1109.41 km^2 with density of 237.9. The climate condition of the study area 48.9%, 31.1% and 20% of the district is ola, Woina dega and Dega of Agro-ecological zones, respectively. It is also characterized by different land scapes with the altitude ranging from 1215 to 3405 meter above sea level (m.a.s.l). The annual rainfall ranges from 550mm to 1100 mm with annual temperature ranging from 20 ºc - 27ºc. The livelihood of the district basically originates from mixed farming. It comprises crop production and livestock rearing. Major types of crops grown in the area are sorghum, maize, common beans, highland pulses and many other vegetable crops like potatoes, onion, garlic, and leafy vegetables. Livestock rearing is the secondary source of livelihood for the rural people in the area (BoARD, 2012).

As sources of information both primary and secondary data sources were used. The primary data were collected using semi-structured questionnaire that was administered by the trained enumerators. In addition to primary data, secondary data were also collected from relevant sources such as published and unpublished documents of the district and other relevant institutions (Care Gara Muleta) for general description and to augment primary data.

The sampling procedure used was two stage random sampling. In the first stage out of the kebeles exist in the district two kebeles were purposively selected due to availability of irrigation. In the second stage, to select sample respondents from the two kebeles, first the household heads in the two kebeles were identified and stratified into two strata: irrigation users and non-users. Then the sample from each stratum was selected randomly based on probability proportion to size. Finally, a total of 200 sample respondents; 100 users and 100 non-users were interviewed.

Data analysis

To address the objectives of the study, both preliminary statistics and stochastic frontier approach were employed. The preliminary statistics such as mean, percentages, standard deviation, and frequency of occurrence, chi-square and t-test were used to analyze socio-economic characteristics of respondents and farm households' technical efficiency of irrigation users and non-users

Tests of difference of the means for continuous variables and chi-square for discrete variables were used to determine the differences in demographic and socio-economic characteristics between households that used irrigation and non-users of irrigation technology

Stochastic production frontier model

Following Aigner et al. (1977) and Meeusen and van den Broeck (1977), the SFP model is defined as.

$$Y_i = f(X_i ; \beta) + \varepsilon_i \quad (1)$$

Where: Y_i is the annual total agricultural output of household expressed in monetary term (birr) $f(X_i,\beta)$ and ε_i respectively, represent the deterministic part and the stochastic part of the production frontier, ε_i, represents the random error term, and β is a vector of parameter to be estimated. Besides allowing for technical inefficiency such stochastic production frontier models also acknowledge the fact that random shocks outside the control of the farm operator can affect output. But more importantly, the stochastic production frontier models provide a great virtue that the impact of shocks due to variations like in vagaries of weather, etc on output can at least in principle be separated from the contribution of variation in technical efficiency (Kumbhakar, 2000). The total error term in equation (1) could be decomposed into its respective two components as:

$$\varepsilon_i = V_i - U_i \quad (2)$$

Where v is the symmetric error term accounting for random variations in output due to factors outside the control of the farmer, whereas, u represents the technical inefficiency related to the stochastic frontier and assumes positive values. The distribution of the symmetric error component V is assumed to be independently and identically as N(0, σ^2_V). The normal error term provides the production frontier to be stochastic and, hence, allows the frontier to vary across or over time for the same producer. However, the distribution of the one sided component U is assumed to be half-normal. That is, it assumed to be identically and independently distributed as N (0, σ^2_U) and it follows that:

$$\sigma^2 = \sigma^2_V + \sigma^2_U \quad (3)$$

Considering that f (X_i, β_i) most probably takes the log-linear Cobb-Douglas form, then the stochastic production frontier model in equation (1) could be rewritten as follows:

$$lnY_i = ln\, f(X_i, \beta) + V_i - U_i \quad (4)$$

Once the model is specified as in equation (4), the parameters of the stochastic frontier model can be estimated using maximum likelihood estimation procedure. Following the estimation, the white noise and farm technical inefficiency effects can be decomposed since, the assumptions of statistical distributions of V and u would allow as generating the conditional mean of U. The empirical stochastic frontier production model that was applied to the analysis of data was specified as follows:

$$\ln VAO_i = \beta_0 + \beta_1 \ln LAB_i + \beta_2 \ln OXN_i + \beta_3 \ln CULA_i + \beta_4 + \ln FRT_i + \beta_5 \ln OFRT_i \beta_6 \ln SEED_i + V_i - U_i \quad (5)$$

Where subscripts i refer to the number of observation of the $i^{\tau\eta}$ farmer;
ln = logarithm to base e, VAO_i = represents the annual total agricultural output of household in monetary term (birr), OXN_i = total ox power utilized (oxen-days), $CULA_i$ = total area under cultivation (in hectares), LAB_i = total human labor in man days utilized, $CFRT_i$ = material inputs of chemical fertilizer (kg), $SEED_c$ = costs of seeds (birr) and $OFRT$ = organic fertilizer. It is assumed that the inefficiency effects are independently distributed and U_i arises by truncation (at zero) of the normal distribution with mean U_i and variance σ^2. Where $U_i$is defined by the equation:

$$U_i = \delta_0 + \delta_1 EDU_i + \delta_2 Age_i + \delta_3 NEC_i + \delta_4 Fas_i + \delta_5 Lsh_i + \delta_6 Trm_i + \delta_7 Sex_i + \delta_8 Cula_i + \delta_9 Ofi_i + \delta_{10} Sfs_i + \delta_{11} Eam_i + \delta_{12} Ftr_i + \delta_{13} Sos_i + \delta_{14} WRd_i + \delta_{15} IRP_i \quad (6)$$

Where: U_i = technical inefficiency of the i^{th} farmer; Age = Age of household head; Fas = Family size; Lsh = Livestock holding; $Cula$ = cultivated land area; Sex = sex of household head; Ofi = off/non farm income ; Sfs =Soil fertility status; Edu = years of formal education of the i^{th} farmer; Trm = transportation means; Eam = Economic active members; Ftr = Farmers training; Sos = Social status of the head; WRd = Whether road distance; NEc = Number of extension contact per cropping season; IRP= participation to irrigation farming; i = number of respondent ; The β_i and δ_i -coefficients are unknown parameters to be estimated, by the method of maximum likelihood, using the STATA Software. A Cobb-Douglas functional form which includes both the conventional inputs and exogenous factors believed to affect inefficiency was the one considered in this specific study. The final version of the model estimated was indicated as below.

$$\ln VAO_i = \beta_0 + \beta_1 \ln LAB_i + \beta_2 \ln OXN_i + \beta_3 \ln CULA_i + \beta_4 + \ln FRT_i + \beta_5 \ln OFRT_i + \beta_6 \ln SEED_i + V_i - (\delta_0 + \delta_1 Edu_i + \delta_2 Age_i + \delta_3 NEc_i + \delta_4 Fas_i + \delta_5 Lsh_i + \delta_6 Trm_i + \delta_7 Sex_i + \delta_8 Cula_i + \delta_9 Ofi_i + \delta_{10} Sfs_i + \delta_{11} Eam_i + \delta_{12} Ftr_i + \delta_{13} Sos_i + \delta_{14} WRd_i + \delta_{15} IRP_i) + \varepsilon \quad (7)$$

Where; $\beta_1,\ldots,\beta_6$ are the coefficients of parameter estimates of input variables, IRRP is a dummy variable having value of 1 if household has access to irrigation technology and value of 0 if household has no access to irrigation technology, $\delta_1,\ldots, \delta_{15}$ are the coefficient of parameter estimates of the inefficiency variables and, ε, is the disturbance term included in the model and other variables are as defined in equation (5) and (6).The technical efficiency of production for the i^{th} farm is defined by:

$$TE_i = \exp(-U_i) \quad (8)$$

The prediction of the technical efficiencies is based on its conditional expectation, given the observable value of (V_i - U_i). The technical efficiency index is equal to one if the farm has an inefficiency effect equal to zero and it is less than one otherwise.

RESULTS AND DISCUSSIONS

Results of analysis of socio-economic characteristics of the surveyed households are presented in Table 1. They show that the mean annual farm income of sample household was found to be Birr 77637.04. Irrigation users had mean annual income of Birr 87290.45 and the average for the non-users was Birr 67983.62. The t-test analysis revealed that the mean annual farm income of the two groups was statistically significant at less than 1% probability level. average year of formal schooling of the users and non-users were grade 4 and 2 respectively. The mean difference of the two groups was statistically significant at 1 percent probability level. Similarly the average numbers of extension contacts with farmers was 26 for users and 13 for that of non-users. The t-test indicated that there was statistically significant difference between two groups in terms of frequency of extension contact for advice or service at less than 1% probability level. The study also showed that out of the 200 sample households 190 own (rear) livestock. The mean livestock holding for user households was 4.296 TLU and 2.987 TLU for non-users. The mean comparison for the two groups showed that there was statistically significant difference between two groups in terms of livestock holding at less than 1percent probability level.

Table 2 shows that 63 percent of the sample households have got farmers training; of which 38 percents users and 25 percents were non-users. The chi-square test indicated that there was statistically significant difference between two groups in terms of training at 1% probability levels. From the sample respondents who have participated in leadership of social organizations, 24.5 percents and 10 percents was users and non-users, respectively. The chi-square test for participation in social organization between the two groups was tested and the differences was found to be significant at 1% probability level.

The stochastic frontier model was used to measure the farm household technical efficiency and to determine the factors that affect technical inefficiency of small-holder farmers in the district. To run the model STATA version 11.2 for windows statistical software was used.

Following Gujarati (2003), multicollinearity problem for all explanatory variables was assessed using a technique of variance inflation factor (VIF) and the test resulted in the rejection of the existence of multicollinearity hypothesis. Moreover, heteroscedasticity was tested by using Breusch-Pagen test. This test also resulted in rejection of the existence of heteroscedasticity hypothesis as (p= 0.7803).

For the estimation of frontier model a single stage estimation procedure was applied. Table 3 summarizes the Cobb-Douglas production frontier result of the efficiency estimation parameters used in the model in which total values of agricultural output is the dependent variable and total labor, both inorganic and organic fertilizers, oxen power, cultivated area and seed cost are an input variables. The result shows that labor, both inorganic and organic fertilizers, oxen power and seed costs were significant variables.

As presented in Table 3 labor, inorganic fertilizer, organic fertilizer, oxen power and seed cost have a coefficient of 0.307, 0.021, 0.017, -0.006 and -0.098 respectively. The production elasticity with respect to labor is positive as expected and statistically significant at less than 1% probability level. This implies that labor is a significant factor that influences changes in output of agriculture. And both fertilizers were the main inputs in determining the agricultural farm outputs positively. Whereas oxen power utilized in ploughing activities affect the farm output negatively this is because of the chat coverage of farm land. Area under cultivation was the only variable found to be insignificant. This result is found to be similar to the findings of Tewodros (2001), Sekhon et al. (2010) and Tesfay (2006).

The estimated parameters of the frontier production function equation and related statistical test results obtained from the analysis are presented in Table 3. The inefficiency component of the disturbance term (u) is

Table 1: Preliminary statistics for continuous variables

Variables	All sample (N=200)		participants (N=100)		Non-participants (N=100)		t-value
	Mean	SD	Mean	SD	Mean	SD	
Income	77637	27529	87290	28098	67984	23358	-5.28***
Age	41.59	11.59	38.96	11.57	44.22	11.05	3.288***
Active force	2.92	1.01	3.164	1.04	2.67	0.92	-3.589***
Education	3.08	3.98	4.18	4.23	1.99	3.39	-4.037***
Extension	19.58	23.5	26	28.4	13.2	14.9	-4.004***
Livestock	3.64	2.43	4.30	2.53	2.987	2.15	3.945***
N-F income	1049.2	3819	1694.48	4924.42	404	2057.4	-2.418**
Whether road dist	92.32	33.47	80.10	28.87	104.55	33.42	5.537***

Source: Own survey result.*,**,*** significant at 10% ,5%and 1% probability level respectively

Table 2: Preliminary statistics for discrete variables

Variables	Irrigation-users (N=100)		Non-users (N=100)		Total (N=200)		χ2-value
	Number	%	Number	%	Number	%	
Soil fertility status							
Fertile	84	42	44	22	128	64	
Not fertile	16	8	56	28	72	36	34.722***
Social status							
Participated	49	24.5	20	10	69	34.5	
Not	51	25.5	80	40	131	65.5	18.608***
Training							
Participated	76	38	50	25	126	63	
Not	24	12	50	25	74	37	14.500***

Source: Own survey result.***,* significant at 1% and 10% probability level

significantly different from zero. Therefore, the null hypothesis of technical inefficiency (H_0: Sigma u=0) is rejected. This indicates that there is statistically significant inefficiency in the data. The lamda (λ) value is also greater than one in all the cases. This is a further indicator of the significance of inefficiency. It is evident from the results presented in Table 3 that the estimate of gamma (γ) is large and significantly different from zero, indicating a good fit and the correctness of the specified distributional assumption.

Moreover, the estimate of γ, which is the ratio of the variance output to variance of error term, was 0.75. This means that more than 75% of the variation in output among the farm households is due to differences in technical inefficiency. The likelihood ratio test is highly significant at 10% indicating that the in-efficiency effects are significant in the stochastic frontier model and suggest the suitability of it than the ordinary least squares (OLS) estimation technique in the traditional production function model.

Determinants of technical efficiency

As it was indicated in Table 4, the results indicate that technical efficiency is significantly influenced by seven explanatory variables. These are; Level of education, size of livestock in TLU, extension contact, farmers training, area of cultivated land, social status of household head and household participation in small-scale irrigation.

Education enhances the ability of farmers to see, decipher and make good use of information about production inputs, thus improving the efficient use of inputs. That is, an educated farmer has the capacity to understand and adopt improved technology that would shift his or her production frontier upwards. In this study; educations significantly and positively affect technical efficiency at 5% probability level, which was similar with most empirical findings. Abdulahi and Eberlin (2001), Biswajit et al. (2012) and Amaza et al. (2006).

Table 3: Maximum-likelihood estimates of the frontier model

Variables	Coefficient	SE	Z
Constant	10.200***	0.348	29.3
Labor	0.307***	0.054	5.7
Land	0.025	0.03	0.83
Fertilizer	0.021***	0.004	5.68
Organic	0.017***	0.003	6.01
Oxen	-0.006**	0.003	-2.35
Seed	-0.098***	0.034	-2.85
Sigma-squared	0.106	0.027	
Lambda ($\lambda = \sigma_U / \sigma_{V_2}$)	1.679	0.098	Number of obs = 200
Gamma ($\gamma = \lambda^2/(1+\lambda^2)$)	0.748	Prob > chi^2 = 0.0000	
Log-likelihood function =	65.103		

Source: own survey result. ** and *** means significant at 5% and 1% probability levels ,respectively

Table 4: Maximum-likelihood estimates of the frontier model for inefficiency effect

Variables	Coefficient	SE	Z
Constant	-1.645	1.573	-1.05
Age	0.007	0.015	0.48
Sex	0.357	0.500	0.71
Education	-0.333**	0.140	-2.37
Non/off-farm income	0.0001	0.00006	1.44
Family size	0.110	0.112	0.99
Economically active force	-0.131	0.220	-0.59
Cultivated land	-1.795*	1.036	-1.73
Livestock holding	-0.172*	0.089	-1.94
Irrigation participation	-1.531***	0.425	-3.61
Farmers training	-0.785**	0.346	-2.27
Extension	-0.034*	0.018	-1.86
Transportation	-0.305	0.378	-0.81
Social status	0.834**	0.403	2.07
Soil fertility	-0.071	0.376	-0.19
Weather road distance	0.009	0.006	1.45
Log-likelihood function = 65.103	Wald chi^2 (6) =225.76		
Number of obs = 200	Prob > chi^2 = 0.0000		
Mean efficiency = 0.815			

Source: own survey result. *, ** and *** mean significant at10%, 5% and 1% probability level respectively.

Livestock provides draught power, transport service; manure and cash income to finance crop production. Besides, pack animals are used for timely transportation of the crops to a threshing point. Since threshing is conducted using animal power, the availability of livestock especially during peak periods is vital. It helps reduce post harvest loses. Therefore, in this study livestock holding positively affect the level of technical efficiency at 10% statistical level of significance. As regards livestock holding, the result in this study is in line with the findings of several other empirical works (Abdulahi and Eberlin, 2001; Fekadu, 2004; Ayalneh *et al*., 2005; Ahmed *et al*., 2002).

Extension contacts were positive and statistically significant at 5% probability level. Extension services are assumed to help in diffusion and adoption of new

Table 5 : Technical efficiency structures of sample farmers, by farmer group

Technical Efficiency	Irrigation-users (N=100)		Non-users (N=100)		Total (N=200)		t-value
	Number	**%**	**Number**	**%**	**Number**	**%**	
≤60	1	0.5	6	3	7	3.5	
61-80	21	10.5	60	30	81	40.5	
81-100	78	39	34	17	112	56	
Total	100		100		200		
Mean	**0.85**		**0.78**		**0.815**		**-6.94*** **

Source: Own survey result.*** means significant at 1% probability level

technologies. Besides this, extension Services offer guidance to the farmers related to the use of various resources such as fertilizer and provide consultancy services when farmers face the problems of disease and pest attacks on their crops by managing their scarce resources more efficiently. This result is consistent with other findings of Fekadu (2004) and Haileselassie (2005).

Results of this study indicated that there was a positive and statistically significant relationship between cultivated area and technical efficiency. This variable is mainly justified on the ground that those farmers with big cultivated area can better diversify their crops. Kamruzzaman et al. (2007) found similar results for Bangladeshi wheat farmers. It is not unlikely that large farms can quickly utilize existing resources and might have a greater ability to access modern inputs on time. This result is in fact related to the findings of Mohammed et al. (1999) and Biswajit et al. (2012).

Participation in small-scale irrigation was positively and significantly affect farm households' technical efficiency even at less than 1% probability level. Household with irrigation can use their land properly throughout the year by producing short term vegetable and chat to obtain cash needed. Irrigation also used to escape from risk of crop failure and diversify their source of income. This finding is in confirmation with findings of Dasta (2004), Biswajit et al. (2012) and Ayalneh et al. (2005).

Farmers' training has positive and statistically significant relationship with technical efficiency at less than 5% probability level. This may be due to the fact that training provides the farmers with new information in terms of input utilization, soil conservation with multipurpose vegetative crops, risk aversion, storage, keep from wild damage, marketing their final outputs, technology adoption and saving aspects. This result is in fact related to the findings of Fekadu (2004).

Social status has negative and statistically significant relationship with technical efficiency at less than 5% probability level. The effect of social status on efficiency is mainly justified on the ground that those farmers with big social obligation were busy and cannot better manage their farm. This result is consistent with the findings of Shehu and Mshella (2007).

Technical efficiency scores of sample household by access to irrigation

The study grouped farm households technical efficiency scores based on their access to irrigation. Accordingly, the mean technical efficiency of total sample households is 81.5, whereas mean technical efficiency of irrigation user households were found to be 85%. For non-user households, the mean technical efficiency was 78%. This clearly shows that access to irrigation has a significant impact on farm households' technical efficiency of the study area. This mean efficiency score result shows that users and non-users of irrigation can reduce the amount of inputs used by 15% and 22% without reducing the values of agricultural outputs respectively.

The frequency distribution of individual technical efficiency of farm is presented in Table 5. This shows that irrigation users are relatively more technically efficient than non-users. About 39% of users and 17% of non-users were found in the range of 81-100 efficiency scores. A statistical test has also confirmed that the mean technical efficiency of the two groups of farms was significantly different at 1% level of significance. This result was almost consistent with the findings of Sharif and Ashok (2011) and Desta (2004).

CONCLUSIONS AND RECOMMENDATIONS

This study was undertaken with the objective of comparing the farm households' technical efficiency of smallholder farmers of irrigated and rain-fed farm production in Girawa district of Oromia National State of

Ethiopia. The study employed the stochastic frontier approach and both primary and secondary data were used. Primary data were collected through household survey from a sample of 200 households using semi-structured questionnaire. Secondary data were collected from relevant sources to supplement the primary data. Data analysis was carried out using preliminary statistics and econometric techniques.

The Cobb-Douglas stochastic frontier production was estimated, from which TE extracted. The results from the production function showed that fertilizer, inorganic, labour, oxen power and seed cost were statistically significant. The study also indicated that 85% and 78% were the mean levels of TE, under irrigated and rain-fed farm, respectively. This in turn implies that farmers can increase their farm production on average by 15% and 22% respectively when they were technically efficient.

In the second step of the analysis, relationships between TE and variables that expected to have effect on farm efficiency were examined. This was relied on maximum likelihood estimation of frontier model of inefficiency effect, where technical inefficiency, expressed as functions of 15 independent variables. Among them, education, frequency of extension contact, livestock holding, cultivated area, farmers training; social status and participation to irrigation were found to be statistically significant to affect the level of technical efficiency.

Thus, the results of the study give information to policy makers and extension workers on how to better aim efforts to improve farm efficiency as the level and specific determinant for technical efficiency. These findings stresses the need for appropriate policy formulation and implementation to enable farmers reduce their inefficiency in production as this is expected to have multiplier effects ranging from farm productivity growth to economic growth and poverty reduction at macro level.

Based on the study findings therefore, the following recommendations were made; Education was very important determining factor that has positive and significant impact on farm household TE in the study area. Thus government has to give due attention for adult education through strengthening and establishing both formal and informal type of framers' education.

Livestock holding has a significant influence on the technical efficiency of smallholders. Therefore, farmers have to get information on artificial insemination and animal husbandry has to be improved to get better level of technical efficiency.

The work indicated that extension contact has positive and significant contribution to technical efficiency. Since extension services are the main instrument used in the promotion of demand for modern technologies, appropriate and adequate extension services should be provided.

Access to farmers training has a positive influence on technical efficiency. Therefore, better training facility has to be produced via the establishment of adequate rural institutions and strengthening of the available farmers training to improve farm productivity.

The analysis also indicated that participation to small scale irrigation is a crucial factor in determining technical efficiency of farmers. Therefore, farmers have to work to improve the irrigation infrastructure and increase their participation to irrigation farming to diversify both crops and income base sources in farm household production.

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