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Technical Efficiency Variation for Irrigated Maize Producers: A Stochastic Frontier Approach

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Abstract

The study was conducted to estimate technical efficiency levels of irrigated maize farmers and to identify efficiency influencing variables among them supplemented by Tibila surface water Irrigation scheme which is found in the Great Rift Valley of Ethiopia. A stochastic frontier production model was used to estimate the levels of technical efficiency for randomly selected 113 irrigated maize producers and provides an empirical analysis of the determinants of inefficiency so as to search out the way to increase smallholders' maize production and productivity using one step estimation technique. The descriptive result revealed that the mean of maize yield per quarter of hectare is 960 quintal which is lower than the plot level agronomic standard of the project i.e. 12 quintal. The classical test for the production variables indicates that they were not used at the plot level agronomic standard input requirement of the project.The econometric result of the study found that old aged household head, low levels of education, lack of credit services and limited livestock holding were found to have a positive effect on technical inefficiency of irrigated maize farmers. Providing irrigated maize producers with accurate and reliable information when they use factors of production, granting credit facility, strengthening households' livestock ownership and livestock marketing system, improving educational level of farmers through necessary aids and reliefs are recommended policy implications.

Keywords: Technical Efficiency, Irrigated Maize, Smallholder Farmer, Stochastic Production Frontier, Tibila irrigation project.

1. Introduction

Ethiopia is one of the few countries registering double digit economic growth in sub-Sahara African countries for the past ten years. However, economic growth is coupled with high population growth is resulting in increase in food demand and thereby more land falling into agricultural production to meet the basic subsistence of the people. In such development trend the need for cultivable land, where the economy is led by agricultural sector, is becoming the limiting factor in meeting the growing food demand implying that farm output growth needs to be achieved through productivity enhancement (Rockström, et al, 2003). Hence, increasing crop production and productivity in line with rapid population growth to meet their basic subsistence through increasing farming efficiency is highly demanded.

The production of basic food crops is dominated by smallholders in Ethiopia (Alemu, 2005) aand grows annually keeping rainy season only. This bittered demand for food though the sector in general accounts for 80 % of employment, 88 % of export and 46.4 % of GDP. In spite of its importance, agriculture production is largely based on traditional system. Therefore, to meet the objective of 2025, that is achieving middle income status and making substantial inroads against food insecurity will require concentrated and strategic choices in agriculture sector which requires a productivity revolution in smallholder farming. (ibid).

But, smallholder farmers of developing countries are characterized by various aspects of livelihoods like differences in resource endowments, knowledge of farming practices, cultural practices, socio-economic conditions, and efforts to transfer technologies and market linkages that leads difference in their technical efficiency/optimal resource use (Cresensia, 2012). In majority of the country, farmers are not growing enough food to feed themselves throughout the year implying that given the average land holding size, farmers are producing at a very low productivity (Fitsum, 2003). So, knowing levels and determinants of farmers' technical efficiency has paramount implications for country's choice of development policies and strategy (Zenebe et.al, 2005). This can be realized by having sufficient knowledge and understanding on the determinants/sources of the smallholder farmers' technical efficiency variations particularly those of supplemented by development intervention projects since most of the time they were the most needy segment of the society.

In light of this ,the study was motivated to have sufficient knowledge and understanding on the determinants of the smallholder farmers' technical efficiency variations at crop level particularly for irrigated crop since it is believed to be instrumental for policy design and formulation on development intervention projects. But till today there is no empirical works that has been undertaken to estimate technical efficiency levels of lowland smallholder farmers supplemented by development intervention projects with a purpose of identifying ways of improving their efficiency. Thus, understanding the technical efficiency of smallholder development intervention beneficiary farmer is an important issue for both academic and development planners.

2. Statement of the Problem.

Obviously speaking, productivity of irrigated maize at farm level is still low for the majority of Ethiopian smallholder farmers even if the government supports them through many aspects like canal construction. This was reasoned out as poor farmers' Perception towards new technologies, poor targeting of policy makers and research institutions to deliver appropriate and demand driven technologies. Although most research outputs (technologies) are superior in terms of enhancing productivity and economic return, there might be some exceptional cases where the new technologies may not be compatible to the farmers' situations.

Studies carried out by Susan Chiona, (2011); Msuya et al, (2008); Oyewo and Fabiyi, (2008) Ephraim, (2007); Joachim (2005) and Tsegaye and Ernst, (n.d), shows that smallholder maize productivity varies due to the fact that most smallholders do not practice high-yield farming methods such as use of chemical fertilizers, improved seeds and agrochemicals due to the high costs of agricultural inputs and services. None of these studies have been able to address variation in productivity among smallholders' irrigated maize farmers which might be due to management factors or efficiency gaps really relies on these technologies or not. In the study area maize production has remained highly variable ranging between 6qts/ha to 36 qts/ha. However, maize is still the dominant staple food contributing basic subsistence and filling lees sly commercial need of smallholder farmers i.e. the beneficiaries of Tibila irrigation project[1].

A study by Nega and Simeon, (2006) in Central Ethiopian Highlands and Bamlaku et al (2010) in East Gojjam confirms that farmers training can improve farm household production efficiency bringing substantial productivity gains. However, these studies lacks in identifying whether the farmers problem relies on specific food crop level or not. Similarly, a study by Shumet (2012) and Endrias et al (2010) shows that access and better use of modern agricultural technology and agricultural inputs have significant effect on production and productivity by enhancing efficiency gain. But, provision of improved agricultural technology is a supply side issue for smallholder farmers, understanding end users capacity and demand to adopt the technology will have immense contribution in explaining the problem of productivity and technical efficiency, particularly for farmers under consideration. Therefore, identification of sources of technical efficiency variation and estimating the level of technical efficiency of smallholder irrigated maize producers of Tibila surface water irrigation scheme is the main motive of this study.

Since most of development interventions are targets the most needy segment of the society, the effort to enhance productivity and efficiency is expected to have a far reaching impact in bringing livelihood improvement. In view of this, the study is motivated to assess those factors which have important policy implications for poor and marginalized farmers living in the Great Rift Valley with particular emphasis on their technical efficiency variation in maize production. Therefore, the policy recommendations drawn from these empirical works to address sources of technical efficiency variation and inefficiency are more relevant to the conditions of the lowland area smallholder farmers where the study tries to concentrate.

3. Objective of the Study

General objective

The general objective of this study is to estimate technical efficiency variation and identify efficiency influencing variables in irrigated maize production for smallholder farmers supplemented by Tibila surface water Irrigation scheme.

Specific objective

- ✓ To estimate Technical Efficiency level of smallholder irrigated maize farmers.
- ✓ To investigate the determinants of technical inefficiency of irrigated maize producers in the area.
- ✓ To give baseline information on the sources of Technical Efficiency variation to the government for early intervention.

4. Methodology of the study

The study was conducted in Sire and Jeju districts of Arsi Zone, Oromia Regional State.

Both Primary and secondary sources of data were used. Primary data was collected using Multi-stage sampling procedure to select 113 sample units. First, Sire and Jeju districts were selected purposively since project is fully operational in these districts. Second, three peasant administrations: Koloba Hawas from Sire and Huruta Dore and Alaga Dore from Jeju who are supplemented by the project were selected purposively. Third, a sample of farm household (unit of analysis) was selected randomly by the enumerators from each peasant associations. After the data collection was completed, information was compiled for data processing and was analyzed using a computer software program called FRONTIER-4.1.version computer program.

In order to identify factors that impede the capacity of farm households not to reach their productivity potential, the stochastic frontier model (SFM) which was independently proposed by Aigner et al. (1977) and Meeusen and van den Broeck (1977) is applied for analysis of data. Technical efficiency (TE) can be estimated using one- or two-step approaches. Taking the limitations of two-step approach in to account, one-step approach

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[1] The project on which the study was conducted. The project command area covers three districts of Arsi zone. These are, Marti, Sire and Jeju

is used in this study.

Following the prime work of Aigner et al (1977), Cobb-Douglas stochastic production function for cross-sectional data set can be specified as follows;

$$\mathrm{Yi} = \mathrm{f(Xi, Bi)}e^{\varepsilon_i}$$

Taking the natural logarithm of the already specified Cobb-Douglas production function we can reach on the following linear production function which is easily estimable.

$$\ln \mathrm{Yi} = \beta_0 + \sum_{n=1}^{5} \beta_n \ln X_{ni} + \varepsilon_i$$

Because, natural logarithm for constant number can give us a constant number i.e. ln (A) =βo and natural logarithm for 'e' is one. An alternative Log-quadratic (translog) stochastic production frontier model can also expressed as follow;

$$\ln \mathrm{Yi} = \beta_0 + \sum_{n=1}^{5} \beta_n \ln X_{ni} + \sum \sum_{n=1}^{5} \beta_n \,(\ln X_{ni})(\ln X_{ni}) + \varepsilon_i$$

Where ln = natural logarithm and n = 1, 2,…, 5
Yi = Amount of maize harvested for ith farmer expressed in quintal.
X_{ni} =vectors of traditional inputs used for the production of irrigated maize
$\beta_n' s$ = unknown parameters to be estimated
ε_i = composed error term i.e. $\varepsilon_i = v_i - u_i$
v_i = represents factors outside the control of the smallholder maize producer.
u_i =represents the non-negative random variables which are Ui~ $N^{+}(0, \delta_u{}^2)$ reflecting the technical efficiency relative to the frontier production function.

As far as the study is to provide a practical exploration on the determinants of productivity variability/inefficiency gaps among smallholder irrigated maize farmers supplemented by Tibila surface water irrigation scheme, knowing farmers technically inefficiency might not be useful unless the sources of the inefficiency are well identified and verified. Thus, the inefficiency function is given as;

$$\mathrm{TE_i} = \frac{\mathrm{f(Xi,} \beta_n) e^{\mathrm{vi-ui}}}{\mathrm{f(Xi,} \beta_n) e^{\mathrm{vi}}} = e^{-ui} \quad => e^{-\mathrm{ui}} = e^{f(Z_i, \delta_j) + \omega_i}$$

As to collie and Battese (1995) the inefficiency function can also be expressed as follow;

$$U_i = \delta_0 + \sum_{j-1}^{7} \delta_j Z_j + \omega_i$$

Where U_i -is inefficiency scores for ith farmer; and j = 1, 2, …7
Z_j= vectors of determinants of technical efficiency for irrigated maize farmers.
δ_i = Vector of unknown parameters to be estimated and
ω_i= Unobservable random variables, which is assumed to be independently distributed, obtained by truncation of normal distribution with mean zero & Unknown variance, $\delta_\omega{}^2$.

5. Results and Discussion of the Data

a. Descriptive results

Descriptive result of the study revealed that almost all traditional production variables for sampled households' were used sub-optimally.

A classical one-sample mean-comparison test was conducted to test sampled farmers' level of input utilization against the plot level agronomic input requirement standard of the project. Test result showed that irrigated maize producers were not performing at standard. The following table clearly shows test result.

Table 1. Tests for production variables at the agronomic standard input requirement.

Variable Type	***Obs***	***Actual Mean per hectare***	***0. Min***	***Max***	***Standard Mean per hectare***	***0. t-value***
Irrigated maize (in Qtl)	113	9.61	4.5	15	12	-13.55*
Labor man-days	113	20.31	8	29	13.25	10.114*
Oxen power-days	113	4	2	7	5	-9.845*
Inorganic fertilizer (kg)	113	71.37	25	150	37.5	12.969*
Seed rate (kg)	113	6.41	5	8	5	10.666*
Agrochemicals (lt)	113	0.65	0	2	1.125	-9.373*

Note: * all are significant at one % level of precision.

b. Econometric results

Before proceeding to examination of the parameter estimates of the production frontier and the factors that affect the inefficiency of the irrigated maize producers, some tests for variables incorporated under the estimation of stochastic production frontier and investigate the existence of inefficiency among irrigated maize producers are necessary.

First, test for the existence of the inefficiency component of the composed error term of the Stochastic Frontier Model. The null hypothesis is rejected at five % significance level since calculated Chi-Square exceeds tabulated Chi-Square (Kodde and Palm, 1986). Hence, stochastic frontier approach best fits the data under consideration.

Second, test for the selection of the appropriate functional form for the data; Cobb-Douglas versus Trans log production function; depends on the calculated (generalized) likelihood ratio, LR_1 (λ)[1] which is equivalent to 16.08. Therefore, the null hypothesis, Cobb-Douglas production function represents the data adequately is rejected at five % significance level. Hence, Translog production function defined by Sargan (1971) as log-quadratic production[2] function adequately represents the behaviour of the irrigated maize production.

Third, null hypothesis the investigator explored is that farm-level technical inefficiencies are not affected by the farm and farmer-specific variables, and/or socio-economic variables included in inefficiency model i.e. $\text{Ho}: \delta_1 = \delta_2 = \cdots = \delta_7 = 0$. This hypothesis is rejected as well at 95 % level of confidence, suggesting the variables included in the model have significant contribution in explaining technical inefficiency of maize farmers.

Fourth, test whether the stochastic frontier production function is characterized by constant returns to scale or not. Looking the sum of all inputs elasticity of output i.e. $\beta_1 + \beta_2 + \cdots + \beta_{10}$, it is possible to decide on whether the returns to scale is decreasing or increasing. The sum of partial elasticity of output is 5.44 i.e. an increase all inputs by 1% will increase irrigated maize production by 5.44 %. The result of the test at 3 degrees of freedom with upper 10 % level of significance confirms that the calculate log likelihood-ratio test (11.13) is greater than the critical value x^2 (10.50) showing null hypothesis Translog production function is characterized by CRS is strongly rejected.

Table 2. Variances parameters of stochastic frontier model

Variance parameters		*Cobb-Douglas*		*Log-Quadratic*	
Sigma-squared	σ^2	0.0327	0.04(0.01)***	0.032	0.04(0.01)***
Gamma	γ		0.61(0.11)***		0.68(0.08)***
LR		35.83	53.65	40.725	61.85
Generalized LR est.	λ		35.64		42.24
Mean efficiency			91.66%		91.37%

Stochastic Production function Frontier Results.

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[1] Represents the generalized likelihood ration statistics for one side error and computed as $\lambda=-2(LH_0-LH_1)$

[2] Thanda Kyi and Matthias von Oppen (1999) also used log-quadratic production function as best functional form presenting the behaviour of irrigated rice farmers in Myanmar.

Table 3. Parameter Estimates of the Stochastic Production Frontier

		Cobb-Douglas		*Log-Quadratic*[1]	
Production Function		**OLS**	**MLE**	**OLS**	**MLE**
Variable	**Coef**	**Est.**	**Est.**	**Est.**	**Est.**
constant	β_0	1.01(0.25)***	1.56(0.23)***	1.250(1.95)	0.52(0.97)
Lnland	β_1	0.07(0.05)	0.01(0.05)	-0.226(0.44)	2.33(0.51)***
Lnlabour	β_2	0.18(0.05)***	0.20(0.05)***	1.815(0.79)**	1.13(0.67)*
Lnoxendays	β_3	0.09(0.07)	0.05(0.06)	1.658(0.77)**	2.34(0.56)***
Lnfertil	β_4	0.04(0.04)	-0.02(0.58)	0.321(0.41)	-0.74(0.38)**
Lnseed	β_5	0.18(0.09)**	0.10(1.18)	-0.028(1.47)	0.38(0.99)
(Lnland)^2	β_6			0.066(0.07)	0.82(0.25)***
(Lnlabour)^2	β_7			0.636(0.39)*	-0.18(0.12)
(Lnoxendays)^2	β_8			-0.319(0.16)**	-0.47(0.11)***
(Lnfertil)^2	β_9			0.056(0.05)	0.87(0.42)**
(Lnseed)^2	β_{10}			0.056(0.34)	-0.05(0.22)

Note: ***, ** and * represents significance level at 1%, 5% and 10% respectively.
: Values in the bracket show the standard error.
Source: Author's calculation from survey data (2013)

As can be seen from above table, four out of five the classical inputs were found to be significant contributors to irrigated maize output (fertilizer with unexpected sign). This negative sign for chemical fertilizer may show that irrigated maize farmers apply excess inorganic fertilizer and hence each additional unit of inorganic fertilizer used is poorly affecting maize production (i.e. its contribution is negative). Hence, farmers were over utilized fertilizer compared to the stated standard of the project. This could be related to ineffective and inefficient use of fertilizer.

The coefficient of Land area under maize production has expected positive sign with an elasticity of 2.33 and is statistically significant at one % significance level. This finding is similar with Kidanemariam's (2013) finding in the northern Ethiopian and Msuya et al (2008) in Tanzania.

Labor was found to have a positive sign and statistically significant at ten %, and which is consistent with my expectation expected sign with an elasticity of 1.13. This implies that increase in labour will significantly and positively increase irrigated maize output, keeping other variables constant. This study did not decompose labour variable in to family and hired labour.

Oxen power-days variable was also found to be an important variable for the production of irrigated maize and statistically significant at one % significance level.

The coefficient of seed rate is statistically insignificant and carries expected positive sign. This implies that a one % increase in seed rate will increases irrigated maize yield by 0.38 %, if they are planted using improved planting method (usually with the proposed seed rate), other variables kept constant. The coefficient estimated for seed rate and seed rate square indicates the existence of positive relationship with maize yield and diminishing returns to scale.

Technical inefficiency model results

The mean efficiency estimate of irrigated maize producers was about 91.37 % with a maximum efficiency score of 98.29 % and minimum efficiency level of 58.21 %. This disparity shows the existence of room for improving the level of irrigated maize production through capacitating maize irrigators' performance (See table 1.).

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[1] The production function also called Translog production as to Sargan D. (1971) and used by Matthias & Thanda(1999)

Table 4. Parameter estimates of inefficiency model

Maximum Likelihood Estimates of Inefficiency Model Parameters.			
		C-D function	**Translog. function**
Constant	δ_0	0.16(0.22)	0.137(0.26)
AgeHHH	δ_1	0.01(0.01)	0.009(0.01)*
Dependency ratio	δ_2	0.05(0.05)	0.054(0.06)
EducationHHH	δ_3	-0.04(0.02)*	-0.04(0.02)***
Livestockholdingtlu	δ_4	-0.06(0.02)***	-0.06(0.02)***
Distance	δ_5	-0.00(0.00)	-0.003(0.00)
Amntofpesticide	δ_6	-0.13(0.12)	-0.01(0.14)
Crreceived	δ_7	-0.58(0.31)*	-0.56(0.29)*

Note: ***, ** and * represents significance level at 1%, 5% and 10% respectively.
: Values in the bracket show the standard error.
Source: Author's calculation from survey data (2013)

Understanding the source of technical inefficiency and its extent is very important for policy making to address the problem in earlier. In this regard, demographic, socio-economic farm and farmer-specific and institutional variables were hypothesized to affect level of technical efficiency of irrigated maize producers of the study area.

Accordingly, the inefficiency model parameters were estimated by using one step maximum likelihood estimates.

Age of the farmer (δ_1) is assumed to be the best proxy variable for farming experience implying older household heads are less efficient than younger household heads, as they are believed to be reluctant to change their methods of production compared to younger household heads. The result concurs with the hypothesis that as age of household head increase the inefficiency level increase in same direction. This finding contradicts with the findings of Kidanemariam (2013), Shumet (2011) and Haileselassie (2005) in Ethiopia. But it is similar with the findings of Bernadette (2011) in Zambia and Ahmed et al (2002) in Pakistan.

Dependency ratio (δ_2) is another source of technical efficiency variation for irrigated maize producers and has strong association with family size and irrigable land area owned by the household. The variable has expected positive sign even though statistically non-significant. The study finding is similar with the finding of Mohammed (2011) on technical efficiency estimation for extension participant and non-participant farm households and Shumet (2011) on crop producing smallholder farmers though statistically insignificant and not different from zero. Hence, Household with high dependency ratio will have high inefficiency score than the low dependency ratio.

Educational level of household head (δ_3);Education equips farm household with the necessary knowledge of how to allocate their scarce resource in appropriate way by increase the adoption and spread technological innovations that shifts their production frontier outward. The variable has expected negative sign and statistically significant at one % significance level. This finding of the study is similar with findings of Kidanemariam (2013), Shumet (2011), Haileselassie (2005) and Weir and Knight (2000) in Ethiopia and Ephraim C. (2007) in Malawi, Olatomide and Omowumi (2010) in Nigeria and Bernadette (2011) in Zambia.

Livestock holding (TLU) (δ_4); Ownership of Livestock for smallholder farmer is perceived as prestige and accumulation of wealth status. It influences farmers' efficiency level through equipping the farmer to have more income to buy improved agricultural technologies such as seed, pesticides, etc. It has expected negative sign and statistically significant at one % level of significance. This finding is supported by the finding of Shumet (2011) and Tsegaye and Ernst in Jimma zone though the magnitude is relatively big in this study. This might be because of the fact that the area was predominated by pastoralists and agro-pastoralists.

Distance of plot from homestead (minutes) (δ_5);Distance is the time span required to reach the plot under irrigated maize production from homestead of the farm household and is essential variable in explaining the capacity of the farmers to perform on the plot. Households nearer to plot have better chance for managing and seeing ever growing of the maize which in turn will improve maize production and productivity. However, the study outcome shows distance has unexpected negative sign and statistically insignificant and its effect on technical inefficiency was not different from zero.

The negative sign supports the argument that farmers become more efficient when their plot far from their homestead they permanently live since they prefer to build temporary house called locally 'Godoo' on the plot until maize harvested than going here and there. This finding contradicts with other findings like Kidanemariam (2013) and Mohammed (2011) in the northern Ethiopia and Msuya et al (2008) in Tanzania.

Received credit (δ_7); Access to credit enables farmers to purchase inputs that they cannot afford from their own resources. The acquisitions of these inputs in turn require more advanced production technique that enhances production and productivity. Hence, smallholder farmers who received credit to finance the acquisition of expensive improved inputs are more efficient than their counterpart. The coefficient has the expected negative sign and statistically significant at 10%. The negative sign shows that credit recipient are more efficient than their counterpart. This empirical result is similar with the findings of Shumet (2011), Bernadette C. (2001), Msuya et al (2008), Haileselassie (2005) and Ahmed et al (2002).

6. CONCLUSION AND RECOMMENDATIONS

CONCLUSION

The study used the household survey data covering randomly selected 113 irrigated maize farmers in two districts of Arsi zone. Parameter estimates for the stochastic frontier production function including inefficiency model was made by using one step estimation technique. All production variables used in the study shows a positive relationship with irrigated maize production and productivity except the variable fertilizer which has a negative sign against the prior expectation indicating a one % increase in inorganic fertilizer, decreases irrigated maize output by 0.61% at an increasing rate. Hence, inorganic fertilizer is not used as recommended by the plot level standard input requirement.

The result of the study within a limit of partial productivity analysis indicates that labour inputs, oxen-days, fertilizer and improved maize seed rate are very important inputs for irrigated maize production by smallholder farmers benefited from Tibila surface water irrigation scheme. Hence, increasing these inputs can increases irrigated maize production via productivity enhancement. The sum of partial elasticity of irrigated maize output is 5.44 implying an increase in all inputs by one % will increase irrigated maize production by 5.44%.

The stochastic frontier production function estimation show that there is technical efficiency variation among smallholder irrigated maize producers. Based on estimation result the variation in efficiency among maize irrigators was explained by age of farmer, dependency ratio within a household, educational level of household head, livestock holding, distance of irrigated maize plot from the residence of the household, amount of agrochemicals used and uptake of credit. The efficiency result shows on average smallholder farmers are producing at higher level though some farmers are operating far from the production frontier. This indicates the existence of significant possibility to expand irrigated maize production and productivity by enhancing production efficiency of these smallholder farmers though they are operating closer to production frontier on average.

RECOMMENDATIONS

Based on study result the following policy recommendations are drawn.

➢ ***Focus on productivity-enhancing approaches.***

The positive and statistical significance of major traditional inputs show the importance of convectional inputs in subsistence farming implying better access and use of these inputs could lead to higher irrigated maize production and productivity for target group. However, the farmers of the study area are familiar for a long time with pastoral practices. For this reason they may have knowledge gap in cropping up by irrigation with the plot level standard agronomic inputs requirement recommended on the introduced project. Thus, to reverse such condition;

- Capacity building programs should be arranged and executed to capacitate the beneficiaries of project through vigorous grass-root level extension work, farmers' active participation, and on-farm demonstration by the regional government.
- Land use planning should be implemented so as to ensure optimum and sustainable land use by putting all irrigation command areas into production.
- Integrated soil fertility management should be organized and implemented by the government than mobilizing farmers to take inorganic fertilizer as best technology.

➢ ***More attention on technical efficiency-enhancing approaches.***

As far as the study result indicates 62% of productivity variations observed among smallholder farmers are mainly related to the variance in irrigated maize farm management, there should be some sort of institutional set up such as FTC, demonstration sites, farmers' field day, etc. in which management tasks can be shared and resource management strategies can and should be adjusted towards efficiency-enhancing approaches for younger smallholder farmers.

➢ ***Encouraging livestock ownership***

Promoting farmers ownership of livestock asset through livestock credit programme can serve as useful policy aimed at increasing agricultural productivity since it influence farmers' efficiency level through equipping the farmer to have more income used for financing maize inputs and better opportunity to have draught power. Therefore, intervention to improve livestock varieties should be encouraged.

➢ ***Expanding credit facilities***

Credit empowers smallholder farmers to purchases inputs that they cannot afford from their own resources, which enhance production and productivity of irrigated maize. Hence, the government should establish and expand the service rendered by credit providing institutions such as microfinance institutions in the area.

➢ ***Improving educational level of farmers***

Education equips farm household with the necessary agricultural farming knowledge thereby facilitating information dissemination regarding modern agricultural technology, input utilization, technical know-how and environmental preservation that shifts their production frontier outward. However, the area is prone to flooding that usually obstructed the movement of farmers and their children not to go to school beyond certain kilometers for education. Therefore, intervention to improve educational status of farmers by the government and non-governmental organizations should be promoted.

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