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ECONOMIC EFFICIENCY OF ONION PRODUCERS: THE CASE OF SMALL SCALE FARMERS IN KELAFO DISTRICT, SOMALI REGIONAL STATE, ETHIOPIA

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ABSTRACT

The purpose of this study was to analyze the economic Efficiency of onion production: the case of small scale farming in Kelafo District, Somali Regional State, Ethiopia. This study used cross-sectional data collected in the 2018 production season from a sample of 120 farm households selected through multi-stage sampling techniques. The study estimates, technical, allocative and economic efficiency using a parametric stochastic frontier; Cobb-Douglas production function. In the second stage determinant factors modeled by two-limit Tobi regression. The results show that that the mean technical, allocative and economic efficiency score was found to be 70.5, 95 and 65.9% respectively. It denotes that there is a scope to increase efficiency level of average farmers output by 29.5%, 5% and 34.1% technically, allocatively and economic efficiency respectively through the efficient use of production technology without incurring any additional costs.

The results of the Tobit model revealed that family size, Age, farm size, Education status, Experience, sex of household head, Access to extension service and Access to credit are the factors that determine efficiency of onion producers. Based on the findings the following recommendations are forwarded. strengthening the existing agricultural extension program, access to credit, and equal access of resources for females, farmers who are more educated should give due attention in managing the farm and re allocate the income from off farm activities to support onion production and productivity, efficient utilization of available farm holding and using productive labour in the family or hiring efficient labour for farm operation is vital to attained high efficiency level of farmers.

Keywords: Onion, Efficiency, Cobb-Douglas, Stochastic Frontier, Tobit Mode

1. INTRODUCTION

Agriculture sector plays a major role in the economy of many developing countries including Ethiopia, as it contributes significantly to economic growth, export earnings, employment generation, sources of nourishment for citizens and a means of livelihood for the most vulnerable members of these countries. As a consequence, raising production level through raising the efficiency of production is one of an important policy goal taken by researchers and development practitioners in most of these countries. This is mainly due to the limited available resources and opportunities for developing and adopting improved agricultural technologies are decreasing overtime in most developing countries Given the level and quality of production inputs available and existing technology, how well farmers are able to utilize existing inputs or resources without substantial addition of intermediate input increases output is the notion of efficiency improvement. (Arega, 2003; Jema, 2006). It is difficult to increase onion production by increasing the area of land under cultivation due to the limitation of land. But, there is an opportunity to increase production of onion by improving the existing production technology. Farmers may be relatively inefficient due to land fragmentation, less experience, illiteracy, etc. If farmers are found to be technically inefficient, production can be increased to a large extent using the existing level of agricultural inputs, the agricultural extension services and the available technology. Jama (2008).

The production efficiency and marketing performance of vegetables in the eastern and central parts of Ethiopia. Efficiency estimation and identification of their determinants in mixed-crop and market driven (vegetables) production systems was performed in two districts. His result showed that a significant economic inefficiency was observed for both systems, with lower efficiency scores for the market-driven farm production. His results also disclosed that lower economic efficiency scores for the market driven production was attributable to limited access to capital markets, high consumer spending and large family size. Both SFA and DEA methods were used for estimating efficiency scores. He found that the mean technical, allocative and economic efficiency indices for market-driven farm production were 66%, 64% and 43%, respectively. Jama (2008).

This study was undertaken to find out the economic efficiency of onion production of small scale irrigated farming system in the study are. The specific objectives are to Estimate technical, allocative and economic efficiencies among small scale irrigated onion producing farmers and to identify determinant factors on technical allocative and economic efficiency/inefficiency of onion producers in the study area.

2. RESEARCH METHODOLOGY

The Kelafo District is located 95 km south of Gode zone (headquarter) and 820 km from the Somali National Region capital- Jijiga. The total distance from capital of Ethiopia (Addis Ababa) is almost 1500 km. Kelafo (Somali: Qalaafe) is bordered on the south by the Somalia, on the west by Adadle, on the northwest by Gode, on the northeast by the Korahe Zone, and on the east by Mustahil. And its astronomical location is found between 5° 40′ N and 44° 10′ E. Administratively, the District comprises eleven kebeles of which two kebeles are semi urban areas, the remains are purely rural with the absence of basic infrastructure. The District is labeled as malaria prune. The topography of the study is flat and quite suitable for irrigation. The average altitude of district is 374 meter from m.s.l. The area is found in the eastern lowlands of country. Climate is hot with high average temperature and bi modal rainfall. Due to erratic nature of rainfall, the amount of rainfall per year is below 300mm and with extreme temperature ranges from 20-45 ^{0}C. The Shebelle River, flowing through this district is the life line of people, going away from it all things were declined. Such as, economic activities, settlement pattern, availability of basic infrastructure, vegetation cover availability of water supply etc. According to the Central Statistical Agency of Ethiopia (CSA-2007), .this district has a total population of 77,471, of whom 41,583 are men and 35,888 women. In total 11,346 p or 14.65% are urban inhabitants. 98.09% of the populations are Muslims and are from different Somali ethnic group. The remains 1% are Amhara and 0.91% are other ethnic groups.

a. Sampling techniques and the data

This study is adopted a cross sectional research design, in which the data were collected at a single point in a time. It was conducted during 2019. The two-stage sampling techniques are used to select respondents. Secondary data were obtained as supplementing the data collected. The sample was selected to cover major Onion producing areas in the District. The areas were selected correspond to the dominated Onion production in three Kebels (the current small administrative unit in Ethiopia.

3. METHODS OF DATA ANALYSIS

The Cobb- Douglas production function and the stochastic frontier were applied. Production functions that were used to define the stochastic production frontier along the isoquant curve was specified as;

$$Y_i = f(X_i) \ldots\ldots (1)$$

Where Yi = onion output of the ith respondent, X_i= farm specific production factors (size of land, fertilizer, improved seed, access to credit, and labour used in onion production).
A Stochastic Frontier Production Model (SFPM) proposed by Battese and Coelli (1995) in accordance with the original models of Aigner et al. (1977) is given us:

$$y_i = f(x_{i;}\ \beta) + v_i - u_i \ldots\ldots (2)$$

Where Yi measures the quantity of output of the ithfarm, X_i is a vector of the inputs used by ithfarm, β is a vector of unknown parameters, $f(x_{i;}\ \beta)$ is a suitable production function, The random disturbance term $v_i$is intended to capture the effects of the stochastic noise and is assumed to be independently and identically distributed, which is expressed by $N(0.\sigma^2\ \nu)$, . The disturbance term u_i, captures, technical inefficiency and is assumed to be independent of v_i and are assumed to be independently and identically distributed as half-normal~$[N(0.\sigma^2\ \nu)]$. The variance parameters are expressed as $\bar{\delta}^2 = \delta^2{}_u + \delta^2{}_v$. And $\gamma = \frac{\bar{\delta}^2{}_u}{\delta^2}$.The values of γ ranges from 0 to 1.

The technical inefficiency effect model proposed and described by Z_{it} is a (1 x M) vector of explanatory variables associated with the technical inefficiency effects, and δ is an (M x 1) vector of unknown parameters to be estimated. Technical efficiency (TE) of an individual firm is estimated as the ratio of the observed output Y_i to the corresponding frontier output Y_i^fboth in the original units. The measure of technical efficiency is given as:

$$TE_i = \frac{Y_i}{Y_i^f} = \frac{f(x_i;\beta)\exp(v_i - u_i)}{f(x_i;\beta)\exp v_i} \ldots\ldots (3)$$

The above SFPM estimated using equation (2) only appropriate for measuring TE. The measurement of allocative and economic efficiencies can be investigated through applying Efficiency Decomposition Techniques (EDT).
Assuming that the production function in equation (2) is self-dual (i.e. Cobb-Douglas Production functions), the corresponding parameter of the dual cost frontier can be derived algebraically and written in a general form as:

$$\ln c_i = c(w_i\, Y_i^*; \alpha) \quad \ldots\ldots (4)$$

Where

C_i is the minimum cost of the i^{th} firm associated with the outputY_i^*, W_i is a vector of input prices for the i^{th} firm. α is a vector of parameters to be estimated from primal function. The economically efficient input vector for the i^{th} firm $x_i^e$is derived by applying Shephard"s Lemma and substituting the firms input prices and adjusted the output level into the resulting systems of input demand equations.

$$\frac{\partial C_i}{\partial W_n} = X_i^e(W_{i,} Y_i^*, \alpha) \quad \ldots\ldots (5)$$

Where n=1, 2, ….., n are inputs. The observed and economically efficient costs of production of the i^{th}firm are equal to $aW_i^t X_i$ and $W_i^t X_i^e$ respectively. These cost measures are used to compute TE and EE induces for the i^{th}firm as:

$$TE = \frac{W_i^t X_i^t}{W_i^t X_i} \quad \ldots\ldots (6)$$

$$EE = \frac{W_i^t X_i^e}{W_i^t X_i} \quad \ldots\ldots (7)$$

Following Farrell (1957), the AE can be derived from equation (9) and (10) as:

$$AE = \frac{W_i^t X_i^e}{W_i^t X_i^t} \quad \ldots\ldots (8)$$

To analyse the effect of demographic, socioeconomic, farm attributes, institutional variables on efficiencies, a second stage procedure was used where the estimated efficiencies scores are regressed on selected explanatory variables using censored Tobit model. Following Tobin (1958) the model can be specified as

$$Y_i^* = \beta x_{jk} + U \quad \ldots\ldots (9)$$

$$Y_i = \begin{cases} L \text{ if } y^* \le L \\ Y \text{ if } L \;\; L < Y^* < U \\ U \text{ if } y^* \ge U \end{cases} \quad \ldots\ldots (10)$$

Where Yi is the observed dependent variable, in our case efficiency of onion production of farm
i (unobserved for values smaller than 0 and greater than 1), jk X is a vector of explanatory variables for farm k (l = 1, 2, …..,j) and i u an error term that is independently and normally distributed with mean zero and variance 2 and is independent of Xjk. The distribution of the dependent variable in the equation (16) is not a normal distribution because its value varies between 0 and 1.

The inefficiency function can be written as:

$U_i = Z_0 + Z_1gen + Z_2age + Z_3educ + Z_4Yroni + Z_5exten + Z_6hhsiz + Z_7credit$ ……………..……………………..…. (11)

Were;

U_i = inefficiencies of onion producers

a. Definition of Variables and Hypotheses

According to literatures a number of factors determine the level of efficiency of onion producers. Generally we can categories under demographic, socioeconomic, farm characteristics and institutional factors.

4. RESULTS AND DISCUSSION

The maximum likelihood (ML) estimates of the parameter of the stochastic frontier Cobb-Douglas production function results are presented in Table 1. The standard OLS estimate is also presented for comparison. The results show that coefficient estimates are significant at one, five and ten percent level of significance except to other chemicals (herbicide), seed and irrigation frequency. λ = 0.89, which measures the effect of technical inefficiency in the variation of observed output. The estimated value of $\gamma = \frac{\delta^2{}_u}{\delta^2}$ is 0.473, which is an estimate of the variance parameter and significant at one percent level of significance implying that 47.3 percent of the total variation in output is due to existence of production inefficiency.

Table 1: The maximum likelihood (ML) estimates of the parameter of the stochastic frontier Cobb-Douglas production function

Variable	Parameter	ML estimates Coefficient	OLS estimates Coefficient
Intercept	β_0	8.095***	7.081***
Ln (Land)	β_1	0.778***	0.609***
Ln (Labour)	β_2	0.021*	0.015
Ln (Fertilizer)	β_3	0.183***	0.383***
Ln (Other chemical)	β_4	0.004	0.007**
Ln (Onion seed)	β_5	0.018	0.021
Ln (Irrigation frequency)	β_6	0.0006	-0.011
Variance parameters:			
Sigma-Squared	$\delta^2 = \delta_u^2 + \delta_v^2$	0.0115***	
Gamma	$\gamma = \frac{\delta^2{}_u}{\delta^2}$	0.473***	
Log-likelihood		119.38	

Source: Computed Model result

Based on the estimated parameters of the Cobb-Douglas production function shown in Table 7, the parameters of the corresponding dual cost function were derived and formed the basis for computing AE and EE indices. The dual cost frontier is given by:

LnCi = 1.50+0.076lnCland-0.0091lnClabour +0.273LnCFertilizer +0.002Cothre chemicals + 0.027Conion seed - 0.076Cirrigation frequency + 0.577lnYPRODi

Where

Ci is the cost of onion production for the i^{th} farmer. YPRODi is total onion output in kg of the i^{th} farm, C_{Land} is the rental price of land per hectare estimated at Birr 4000, C_{Labor} is the price of labor per day estimated at Birr 50, $C_{Fertilizer}$ is the price of chemical fertilizer per kg estimated at Birr 30 and

$C_{Others\ chemical}$ is a price of herbicide per litter estimated at Birr 250.

The study found out that the average technical efficiency of the sample farmers is 0.705, with a minimum of 0.356 and the maximum of 0.99. The mean allocative efficiency of the sample farms is estimated at 0.950, with a minimum of 0.515 and a maximum of 0.99. The combined effect of technical and allocative efficiencies shows that the average economic efficiency level is 0.659, with a min of 0.352 and a max of 0.99. This result indicates that if the average efficient farmer in the sample were to reach the efficiency level of his/her most efficient counterpart, then the farmer could achieve a 29.8 percent (1-0.705/0.99=) increase in output by improving his/her technical efficiency level, with the existing inputs and technology, if the Average efficient farmer in the sample were to reach the allocative efficiency level of his/her most efficient counterpart, then the farmer could achieve a 5 percent (1-0.950/0.99=) increase in output by improving his/her allocative efficiency level and also if the Average efficient farmer in the sample were to reach the economic efficiency level of his/her most efficient counterpart, then the farmer could achieve a 34.4 percent (1-0.659/0.99=) increase in output by improving his/her economic efficiency level, with the existing inputs and technology.

The mean levels of efficiencies are comparable with the results from other similar studies in different countries. For instance, Getahun (2014) and Berhan (2014) found the mean onion technical efficiencies of 78% and 73.69%. Also Jama (2008) found the mean technical, allocative and economic efficiency indices for market-driven farm production were 66%, 64% and 43%, respectively.

Table 2: Descriptive statistics of efficiency measures

Type of efficiency	Minimum	Maximum	Mean	Std. Deviation
TE	0.356	0.999	0.705	0.22
AE	0.515	0.999	0.950	0.08
EE	0 .352	0.999	0.659	0 .22

Source: Computed Model result

After measuring the level of technical, allocative and economic efficiency scores, it was necessary to identify the determinant factors of efficiency/inefficiency of TE, AE and EE in onion production.

a. Family size

It determines onion TE, AE and EE positively at one percent level of significance. The reason behind this are more labor contribution of the family in managing in proper allocation of factors of production optimally. Shumet (2011) found same result.

b. Age

Even if Age has proxy result with experience beyond some level of age productivity and efficiency will decrease since physical capacity of farmers diminishing, which in turn brining differences in abilities of decision making and laborious farming practices. These efforts, again could create efficiency differential across the different age groups. In this study age determine efficiency negatively. It implies that the young and middle age groups of farmers are more efficient. Similar results were obtained in different studies (Endalkachew, 2012; Shumet, 2012).

c. **Education**

It has a negative and ten percent level of significant effect on AE of onion production suggesting that better-educated household head might not work at full time in farming because they may have other job so they may employ other workers who are not efficiently and optimally work on the farm. This result is in contradict with the findings by (Aynalem, 2006; Endalkachew, 2012)

d. **Farm size**

It has negative and significant effect on TE, AE, EE of onion production implying that small land holding much more efficient than large land holding because of simplicity in management for the case of Technical efficiency and fail to take advantage of economy of scale (by minimizing average of fixed cost) for the case of Allocative and Economic efficiency. Shumet (2011) found negative and significant result of farm size in determining efficiency.

e. Access to Credit

It is an important element in agricultural production systems. It allows producer to satisfy their cash needs induced by the production cycle. Credit increases farmer's efficiency because it temporarily solves shortage of liquidity/working capital. In this study, credit was hypothesized that farmers who get credit at the given production season from either formal or informal sources are more effective than those who do not. Similarly Studies conducted by Kinde (2004) and Mekdes (2011) found positive and significant relationship between credit and farmers.

f. Experience

It is important factor that determine efficiency of Onion Production. In this research onion farm experience of farmers' shows that positive at one percent level significant implies that more experienced farmers had knowledge of managing farm and farm input utilization. The Research of Mekdes (2011) supports this finding.

g. **Sex of HHH**

It determine TE and EE efficiency of Onion production positively at one percent level of significant suggesting that Men's has advantage of controlling Resources over women's. It has similar result with other studies for instance Mussa et al., 2012).

h. Access to Extension

The relationship between extension contact and TE and EE in Onion production has insignificant effect, whereas has negative and significant relationship with AE at Ten percent level of significances. That is, farmers who had extension contact during the cropping period were allocativelly inefficient. Implies that not optimal use of factors of production because most of the time extension workers advise farmers to obtain high level of production without considering optimality (cost). It is in contradict with other studies like Arega and Reshid (2005), who found that extension agents provide farmers with new information on improved agricultural technologies, better farm management practices, market and etc.

Table 3: Tobit results on technical, allocative and economic inefficiency of onion producers

	Technical Efficiency		Allocative Efficiency		Economic Efficiency	
Variables	Coefficient	Std. Error	Coefficient	Std. Error	Coefficient	Std. Error
Family size	0.047***	0.006	0.026***	0.008	0.058***	0. 009
Education	-0.005	0.006	-0.015*	0.009	-0.018*	-0.011
Experience	0.0072**	0.003	0.0077	0.006	0.014*	0.007
Sex of HHH	0.04***	0.012	0.02	0.018	0.047***	0.022
Age	-0.01***	0.004	-0.0126**	0.006	-0.0222***	0.007
Access to Extension	0.013	0.016	-0.033*	0.021	-0.0144	0.026
Access to credit	0.017*	0.011	0.0045	0.015	0.026	0.018
Farm size	-0.23***	0.023	-0.11***	0.008	-0.287***	0.037
Constant	1.32***	0.121	0.425***	0.191	1.73***	0.241

***, ** and * indicate the level of significance at 1, 5 and 10 percent, respectively.
Source: Computed results

The relationship between Age and TE, AE and EE in onion production has a negative and significant effect at one and five percent level of significances. That is, farmers who had more age were technically, allocativelly and economically less efficient than those who had less age. The reason behind this might be as age increased beyond the productive age level productivity decreased.

5. CONCLUSION AND RECOMMENDATIONS

The study found that the mean technical, allocative and overall efficiency level of farmers was 70.5, 95.0 and 65.9 per cent respectively. Onion production can be increased by 6%, 4% and 10% of output through better use of the available resources, given the current state of technologies.

The inefficiency variables that are determining factors of efficiency were also identified. Accordingly, the results showed; Family size determines TE, AE and EE positively and significantly. Farm experience, sex of household head and access to credit determine technical efficiency positively. Age and Farm size determines TE, AE and EE negatively and significantly. Education level determines AE and EE negatively. Accesses to extension service determine Allocative efficiency negatively.

Based on the findings it is vital to utilize the existing technologies and inputs of production. These require strengthening the existing agricultural extension program, access to credit, and equal access of resources for females. Education has negative impact on efficiency. The study recommended that farmers who are more educated should give due attention in managing the farm and re allocate the income from off farm activities to support onion production and productivity. Since the result reviled that large farm land holders are inefficient, efficient utilization of available farm holding or other wise use mixed cropping system to use every plots of Farm size effectively and using productive labour in the family or hiring efficient labour for farm operation is vital to attained high efficiency level of farmers.

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