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PRODUCTION EFFICIENCY OF SESAME IN SELAMAGO DISTRICT OF SOUTH OMO ZONE, SOUTHERN ETHIOPIA

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ABSTRACT

The aim of the present study was to measure the levels of technical, allocative and economic efficiencies of sesame producer and identify factors affecting them in selamago district of south Omo zone, Southern Ethiopia. The study was based on the cross – sectional data collected in 2011/12 production season from 120 randomly selected farm households. Stochastic production frontier model was used to estimate technical, allocative and economic efficiency levels, whereas Tobit model was used to identify factors affecting efficiency levels. The results indicated that there was substantial amount of inefficiency in sesame production in the study area. Accordingly, the mean technical, allocative and economic efficiencies of sample households were 67.1 per cent, 67.25 per cent and 45.14 percent respectively. Labor and seed were the variables that positively affected the production of sesame. Results of the Tobit model revealed that soil fertility, non farm income and credit access positively and significantly affected TE. Soil fertility had positive and significant effect on AE. On the other hand experience in sesame production, distance of sesame farm form residence, non farm income and extension contact affected AE negatively and significantly. Soil fertility, non farm income and credit access had positive and significant impact on EE. However, extension contact affected EE negatively and significantly. These indicate that there is a room to increase the efficiency in sesame production of the study area. Therefore, government authorities and other concerned bodies should take into consideration the above mentioned socio economic and institutional factors to improve productivity of sesame in the study area.

Keywords: Technical efficiency, Allocative efficiency, Stochastic production frontier, Tobit, Selamago, Sesame.

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Contribution/ Originality

In this paper the production efficiency of farmers in the study area and the factors that affect their efficiency in sesame production are identified. This study can be used as a reference for fellow researchers who are interested in the area of production economics specifically that deals with production efficiency.

1. INTRODUCTION

Ethiopia is mainly an agrarian country. The agricultural sector accounts for roughly 43 percent of GDP, and 90 percent of exports. Nevertheless, food security remains a critical issue for many households, and for the country as a whole. Moreover, expansion of the cropped area to more marginal lands has led to severe land degradation in some areas. With a total area of about 1.13 million km^2 and about 51.3 million hectares of arable land, Ethiopia has tremendous potential for agricultural development. Only about 11.7 million hectares of land, however, are currently being cultivated; just around 20 percent of the total arable area. Nearly 55 percent of all smallholder farmers operate on one hectare or less [1].

Sesame seed has become one of the most important oilseeds for Ethiopia's export earnings and for increasing the potential of generating income for the local population. In the last few years, sesame production and marketing has demonstrated highly significant growth. In 1997, the total area under sesame production was about 64,000 ha [2]. In nearly fourteen years time (up to 2011), the total area of sesame production has increased by more than 500% to about 384,683 ha. The practice of sesame production has also expanded from the traditionally known regions (Northwest Humera, Wellega and North Gonder) to many new areas, including Benishangul, Illubabor and many other places. Similarly, the quantity of sesame produced during the same period, which is mainly intended for export, has also increased from 42,000 tones to about 327,740.9 tones [3] which is again an increment of over 650%. The potential to increase the area, production and productivity of sesame is still large [4].

In Ethiopia, the existing production system of sesame suffers from traditional farming practices, unimproved seed, low fertilizer use, etc. This situation has caused productivity of the crop to be far below the estimated FAO potential, which is about 16 quintals/ha (Wijnands *et al.*, 2007 as cited in Sorsa [4]). The Ethiopian Statistical Agency report of 2011 indicated that the crop's productivity level was 8.52 quintals per hectare countrywide. However, it is understood that the current productivity level of sesame in Ethiopia in general and in the study area in particular is far below the average level. Moreover, there was no study regarding the efficiency of sesame production in the study area.

Agricultural output can be increased either through introduction of modern technologies or by improving the efficiency of inputs such as labour and management at the existing technology. In other words, productivity can be increased through dissemination of improved technologies such as fertilizer and high yielding varieties (HYV) and/or by improving the productive capacity of saying the manager (the farmer). These two are not exclusive because the introduction of modern technology could not bring the expected shift of production frontier, if the existing level of efficiency is low. This implies the need for the integration of modern technologies with improved level of efficiency [5]. If farmers are sufficiently efficient then increases in productivity require new inputs and technology to shift the production possibility frontier upward. But, on the other hand, if there are significant opportunities to increase productivity through more efficient use of farmers' resources and inputs with current technology, a stronger case could be made for productivity improvement through ameliorating the factors or determinants of inefficiency.

So it is relevant to ask, what are the existing levels of technical, allocative and economic efficiencies in the production of sesame in the study area? Is there any room for improvement in the level of efficiency? What are the main causes for the existing levels of inefficiencies in the area (if any)? What are the main possible solutions to reduce the existing levels of inefficiencies? By what level can inputs be reduced given the existing level of output? By what level can cost be reduced given the existing level of output? These are important research questions that have to be answered first if an intervention aiming at improving production and productivity of farmers is to be made. And this study has attempted to answer these questions. The general objective of this study was to assess economic efficiency of smallholder farmers in the production of sesame in Selamago district of South Omo zone. The specific objectives were:to estimate the level of technical, allocative and economic efficiencies of sesame production in the study area; and to identify the sources of differences in technical, allocative and economic efficiencies in the study area.

2. METHODOLOGIES

Selamago district is one of the eight districts found in South Omo zone of SNNPR, Ethiopia with an area of 4450.1 km^2 and is located at 5.32-6.46^0 N and 35.81-36.45^0 E. It has a human population of 32135 with a population density of 7 persons per km^2. It is bordering with Keffa zone and Basketo special district in north, Dasenech, Gnangatom and Benatsemay districts in south, South Ari district in east and Bench Maji zone in west. There are 20 kebeles in the district. The altitude of the district ranges between 485 and 2500 m, a.s.l. The traditional agro ecologies *woinadega*, *kola* and *kefilbereha* cover 32, 66 and 2 percent respectively. The mean annual rainfall ranges between 400 mm and 1600 mm whereas the mean annual temperature ranges between 17.6^{0}c. and greater than 27.5^{0}c.

The study was conducted in Selamago district which is purposively selected due to its large extent of sesame production. Even though the district consists of 20 kebeles, only 5 kebeles were engaged in the production of sesame. Out of these, 2 kebeles were selected randomly and the number of sample households from each kebele was determined randomly based on the probability proportional to size of households in each kebele. The sample size was 120 which is determined on the basis of the following formula given by Yamane [6].

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

For this study, both primary and secondary data from different sources were used. The primary data on socio-economic variables such as demographic characteristics, extension visits, credit access, livestock holding, price data, wealth indicators, amount and cost of labour used, the amount and cost of inputs used such as seed and fertilizer and the amount of outputs obtained were collected using structured questionnaire which was administered by trained enumerators from February 1-7, 2013. Before starting the actual data collection some preliminary information about the overall farming system of the district was assessed through informal survey. Pre-testing of the questionnaire was also conducted and appropriate refinements and modifications were made in the questionnaire. Secondary data were collected by reviewing relevant sources such as documents of the office of agriculture of the district and other relevant organizations.

To address the objectives of the study, both descriptive statistics and econometric models were employed. Accordingly, in the descriptive part, simple measures of central tendency, frequency and percentages were used; and in the econometric analyses, a stochastic frontier approach and a Tobit model were used to estimate the level of technical, allocative and economic efficiencies and the relation between farm level socio-economic and institutional variables and inefficiencies, respectively.

The stochastic frontier production function was employed to assess the technical, allocative and economic efficiencies of sesame producers. The function was autonomously developed by Aigner, et al. [7] and Meeusen and Van Den Broeck [8]. The approach offers some sensible advantages over the other methods that are usually used in efficiency analysis. In the first place, it is easy to implement and interpret. Most importantly, the model allows segregating the effect of statistical noises from systematic sources of inefficiency. Besides, the technique is consistent with most of the agricultural production efficiency studies [9-11].

Following Aigner, et al. [7] and Meeusen and Van Den Broeck [8] the SPF model is defined as:

$$\ln Y_i = \beta_o + \ln \sum \beta_j X_{ij} + \varepsilon_i \qquad (2)$$

$$\varepsilon_i = v_i - u_i$$

Here ln denotes the natural logarithm; j represents the number of inputs used; i represents the i^{th} farm in the sample; Y_i represents the observed sesame production of the i^{th} farmer; X_{ij} denotes j^{th} farm input variables used in sesame production of the i^{th} farmer; ß stands for the vector of unknown parameters to be estimated; ε_i is a composed disturbance term made up of two elements (v_i and u_i). The random error (v_i) accounts for the stochastic effects beyond the farmer's control, measurement errors as well as other statistical noises and u_i captures the technical inefficiency.

Stochastic frontier functional approach requires a priori specification of the production function to estimate the level of efficiency. Cobb-Douglas production function met the requirement of being self dual and has been employed in many researches dealing with efficiency [9, 10, 12]. Therefore, it was adopted for this study.

The production function could also be estimated through an alternative form, called dual, such as cost or profit function. Sharma, et al. [13] suggests that the corresponding dual cost frontier of the Cobb Douglas production functional form in equation (1) can be rewritten as:

$$C_i = C\,(W_i, Y_i^*; \alpha) \qquad (3)$$

Where i refers to the i^{th} sample household; C_i is the minimum cost of production; W_i denotes input prices; Y_i* refers to farm output which is adjusted for noise v_i and α's are parameters to be estimated. The economically efficient input vector of the i^{th}household X_{ie} is derived by applying Shepards' lemma [14] and substituting the firms input prices and adjusted output level, a system of minimum cost input demand equation can be expressed as:

$$\partial C_i / \partial W_n = X_{ie}(W_i, Y_i^*; \alpha) \quad (4)$$

Where n is the number of inputs used. The observed, technically and economically efficient costs of production of the i^{th} farm are then equal to $W'X_i$, $W'X_{it}$ and W'_{ie}; respectively.

The minimum cost is derived analytically from the production function, using the methodology used in Arega and Rashid [14]. Given input oriented function, the efficient cost function can be specified as follows:

$$\text{Min} \sum_x C = \sum_{j=1}^{5} X_j W_j$$

Subject to $\quad Y_i^* = \hat{A} \prod X_j^{\hat{\beta}_j} \quad$ (5)

Where $\hat{A} = \text{Exp}(\hat{\beta}_o)$

The solution for the problem in the above equation is the basis for driving dual cost frontier. Substituting the input demand equations derived using shepherd`s lemma (Eq. 3) and Yield adjusted for stochastic noise (predicted value of yield) in the minimization problem above, the dual cost function can be written as follows:

$$C(Y_i^*, w) = HY_i^{*\mu} \prod_j W_j^{\alpha_j} \quad (6)$$

where; $\alpha_j = \mu\hat{\beta}_j$, $\mu = (\sum \hat{\beta}_j)^{-1}$ and $H = \frac{1}{\mu}(\hat{A} \prod \hat{\beta}^{\beta_j}{}_j)^{-\mu}$

All the Parameters are known; hence we can calculate the minimum (efficient) cost of production.According to Sharma, et al. [13] the above cost measures are used to estimate the technical, allocative and economic efficiencies respectively.

We can define the farm–specific technical efficiency in terms of observed output (Yi) to the corresponding frontier output (Yi*) using the existing technology.

$$TE_i = Y_i / Y_i^* \quad (7)$$

The farm specific economic efficiency is defined as the ratio of minimum observed total production cost (C*) to actual total production cost (C).

$$EE = C^*/C \quad (8)$$

Following Farrell [15] the AE index can be derived from Equations (6) and (7) as follows:

$$AE = EE/TE \quad (9)$$

After estimating the level of efficiency, tobit model was estimated to identify factors affecting TE, AE and EE.Following Gujarati [16] the tobit model was estimated as follows:

$$E^* = \delta_0 + \delta_k Z_i + v, \; v/z \approx \text{Normal}(0, \delta^2)$$

(10)

$$E = \max(0, E^*)$$

Where I represents the i^{th} farm in the sample; k is the number of factors affecting efficiency; Z_i represents farm specific factors affecting efficiency; δ is parameter to be estimated; E is efficiency(TE, AE and EE) measure.

Equation (10) implies that the above observed variable, E, equals E* when E*> 0, but E = 0 when E*≤ 0.

In SPF hypothesis tests can be made using ML ratio test that are not possible in non-parametric models. A number of tests of hypotheses were made in this study using the usual Likelihood Ratio (LR) test given by Equation (10).

$$LR = \lambda = -2\ln[L(H_0)/L(H_1)]$$

$$\lambda = -2[\ln L(H_o) - \ln L(H_1)] \quad (11)$$

Where, λ is the likelihood ratio (LR),

$L(H_o)$= the log likelihood value of the null-hypothesis,

$L(H_1)$ = log likelihood value of the alternative hypothesis, and

ln is the natural logarithms.

All the tests were carried out using generalized likelihood ratio statistics. The test statistics is defined by $\chi 2 = -2\ [L(H_0) - L(H_1)]$, where $L(H_0)$ and $L(H_1)$ are the values of the likelihood function for the model under the null hypothesis, H_0, and the alternative hypothesis, H_1, that are involved.

3. RESULTS AND DISCUSSION

3.1. Summary of Variables Used in the Model

Before embarking on estimation of the model, it is preferable to see the characteristics of variables considered in the model. The production function for this study was estimated using five input variables. To draw some picture about the distribution and level of inputs, the mean and range of input variables is discussed as follows:

Table-1. Summary statistics of variables used to estimate the production function

Variable description	Minimum	Maximum	Mean	Std. deviation
Output (Qt)	1	24	4.83	3.65
Land (ha)	0.125	2	0.775	0.44
Seed (Kg)	1	40	11.4	6.36
Labor (MDs)	12.5	122.5	44.26	22.1
Oxen (Oxen days)	1.88	32.5	11	6.68
DAP (Kg)	0	200	27.62	37

Source: Own survey (2013)

On average farmers produced 4.83 quintal of sesame, which is dependent variable in the production function. The land allocated for sesame production, by the sample households during the survey period, ranges from 0.125 to 2 ha with average of 0.775 ha. The other very important variable is seed. The average amount of seed that sample households' used was 11.4 Kg. Like other inputs human and animal labor inputs were also decisive, given a traditional farming system in the study area. Sample households, on average, use 44.26 man equivalent labor and 11 oxen days for the production of sesame during 2012 production season. In the study area farmers use only DAP for sesame production and on average farmers used 27.62 Kg of DAP.Similar to the production function, the mean and standard deviation of each of the variables used in the cost function are depicted as follows:

Table-2. Summary statistics of variables used to estimate the cost function

Variable description	Minimum	Maximum	Mean	Std. deviation
Output (Qt)	1	24	4.83	3.65
Total cost of production (Birr)	732.88	10290	3561.9	1930.14
Cost of land (Birr)	46.9	1000	318.62	175.05
Cost of seed (Birr)	12	480	136.7	76.38
Cost of human labor (Birr)	500	4900	1770.5	884.18
Cost of oxen labor (Birr)	150	2600	878.75	534.47
Cost of DAP (Birr)	0	3312	457.33	612.86

Variable Source: Own survey (2013)

On average, the total cost of 3561.9 Birr was required to produce 4.83 quintal of sesame. Among the various factors of production, the cost of human labor accounted for the highest share (1770.5 Birr). Following the cost of labor, cost of oxen labor takes major share out of total cost of production which is 878.75 Birr. Among other inputs, cost of seed takes the smallest (136.7 Birr) share out of the total cost of sesame production. A total of 11 variables were hypothesized to affect efficiency of sesame producers, out of which five of them were dummy variables. Table 3 portrays summary of these variables.

Table-3. Summary of efficiency model variables

Variables	Mean	Std. dev.	Percentage of the mean with dummy = 1	Percentage of the mean with dummy = 0
Age	36.11	11.14	-	-
Education	2.53	2.8	-	-
Family size	5.76	2.58	-	-
Sesame prodn. Experience	5.36	1.87	-	-
Proximity to sesame farm	36.92	25.29	-	-
Number of oxen	1.97	1.39	-	-
Soil fertility	-	-	35.8	64.2
Non-farm income	-	-	53.3	46.7
Credit access	-	-	75	25
Extension contact	-	-	98.3	1.7
Training	-	-	72.5	27.5

Source: Own survey (2013)

4. ECONOMETRIC RESULT

4.1. Hypothesis Testing

The first important hypothesis test carried out was checking for the existence of the inefficiency component of the total error term of the stochastic production function. Using Cobb-Douglas functional form and assuming a half-normal distribution of one-sided error term (u_i), the hypothesis to be tested was whether technical inefficiency is absent in the model and hence the conventional (average) production function is appropriate or not.Tests of hypotheses for the parameters of the frontier model are conducted using the generalized likelihood ratio statistics, λ, defined by Equation 10. As explained in Table 4, one-sided generalized LR test of γ =0 provide a statistic of 9.36 for sesame production; which is significantly higher than the critical value of χ^2 for the upper 5% at one degree of freedom (3.84). Rejecting the null hypothesis implies that the average response function estimated by OLS, which assumes all farmers are technically efficient is an inadequate representation of the data, given the stochastic frontier and the inefficiency effects model. Consequently, the null hypothesis that sesame producers in the area are fully efficient is rejected.

Table-4. Generalized LR test of hypotheses for parameters of SPF

Null hypothesis	Critical value (χ2 , 0.95)	LR	Decision
H0: $\gamma = 0$	3.84	9.36	reject H0
H0: ui = δ0 = δ1 = …= δ11 = 0	19.68	46.42	reject H0

Source: Own computation (2013)

The second hypothesis tested was that all coefficients of the inefficiency effect model are simultaneously equal to zero (i.e. H_0: $\delta_0 = \delta_1 = \delta_2 \ldots = \delta_{11} = 0$) against the alternative hypothesis, which states that all parameter coefficients of the inefficiency model are different from zero. It is to mean that the explanatory variables in the inefficiency effect model do not contribute significantly to the explanation of the inefficiency variation for the sesame producing farmers. Using the formula in Equation (10), the LR value obtained was 46.42, which is higher than the critical χ^2 value (19.68) at the degree of freedom equal to the number of restrictions to be zero (in this case the number of coefficients of the inefficiency effect model which are 11). As a result, the null hypothesis is rejected in favor of the alternative hypothesis that explanatory variables associated with inefficiency effects model are simultaneously different from zero.

4.2. Estimation of Production and Cost Functions

The ML estimates of the parameters, of the SPF specified in equation (1), were obtained using the STATA 11 computer program. These results together with the standard OLS estimates of the average production function are presented in Table 5.

Table-5. OLS and MLE results of the production frontier for the sample households

	OLS		MLE	
Variables	**Coefficients**	**Std. Err**	**Coefficients**	**Std. Err**
Constant	1.8099**	0.7725	0.7514***	0.6278
Land	0.03668	0.2074	0.1002	0.1700
Seed	0.3122***	0.0941	0.2134***	0.0820
DAP	-0.0053	0.0055	0.0004	0.0044
Labor	0.9264***	0.1548	0.8284***	0.1218
Oxen	0.0082	0.1611	0.0681	0.1328
R2	0.7337			
F statistics	62.81***			
σ2 = σv2 + σu2	-	4.1054***		
λ = σu/ σv	-	0.3297***		
Log likelihood	-		-41.223	

Note: ** and *** refers to 5% and 1% significance level, respectively.

Source: Own computation (2013)

From the total of five variables considered in the production function, two (labor and seed) had a significant effect in explaining the variation in sesame yield among farmers. The coefficients of the production function are interpreted as elasticity. Hence, high elasticity of output to labor (0.8284) suggests that sesame production was highly sensitive to labor. As a result, 1% increase in amount of labor will result in 0.8284% increase in sesame production, keeping other factors constant. Alternatively, this indicates sesame production was responsive to labor and seed.

The diagnostic statistics of inefficiency component reveals that sigma squared (σ^2) was statistically significant at 1 percent (Table 5). This indicates goodness of fit, and the correctness of the distributional form assumed for the composite error term.

The returns to scale analysis can serve as a measure of total factor productivity [17]. The scale coefficient was calculated to be 1.21, indicating increasing returns to scale (Table 6). This implies that there is potential for sesame producers to continue to expand their production because they are in the stage I of the production surface, where resource use and production is believed to be inefficient. In other words, a percent increase in all inputs proportionally will increase the total production by 1.21%. This result is consistent with Ajibefun [17], Fekadu [5] and Amos [18].

Table-6. Elasticity and returns to scale of the parameters in the production function

Variables	Elasticity's
Land	0.1002
Seed	0.2134
DAP	0.0004
Labor	0.8284
Oxen	0.0681
Return to scale	1.2105

Source: Own computation (2013)

The dual cost function which is specified in equation (2) and derived analytically from the stochastic production function is given as follows:

$lnCsi=2.27 + 0.083lnW1+ 0.176lnW2 + 0.0004lnW3+ 0.056lnW4 + 0.684lnW5 + 0.826lnYi^{*}$

Where Cs is cost of producing sesame; W1 refers to the price of land, W2 is cost of seed; W3 is cost of DAP; W4 is cost of oxen; W5 is cost of labor; Y is output; i refers to the i^{th} sample household.

4.3. Efficiency Scores

The results of the efficiency scores indicate that there were wide ranges of differences in TE, AE and EE among sesame producer farmers. The mean TE of sample households during the survey period was 67.11%. The TE among the households ranges from 23.45 to 95.81%, with standard deviation of 0.1805. Similarly, the mean AE and EE of sample households were 67.25 and 45.14%, respectively. Unlike TE and EE there was high average AE score. Generally there is a considerable amount of efficiency variation among sesame producer farmers in all measures of efficiency. This result is consistent with study of Jema [9].

Table-7. Descriptive statistics of efficiency measures

Efficiency parameter	Minimum	Maximum	Mean	Std.dev
TE	0.2345	0.9581	0.6711	0.1805
AE	0.4383	0.8454	0.6725	0.0977
EE	0.1332	0.7305	0.4514	0.1362

Source: Own computation (2013)

The distribution of the TE scores showed that the majority (more than 61%) of the sample households had TE score of greater than 60% (Table 8). But there were also some households whose TE levels were limited to the range 20 to 40%. Households in this group have a room to enhance their sesame production at least by 60%, on average. Out of the total sample households, only 7.5% had TE greater than 90%. This implies that about 92.5% of the households can increase their production at least by 10%. Moreover, 50% of the sample households can increase their production at least by 32.9%.

Table-8. Distribution of technical, allocative and economic efficiency scores

Efficiency range	Number of households		
	TE	AE	EE
0 - 9.99	0	0	0
10 – 19.99	0	0	3
20 – 29.99	4	0	16
30 – 39.99	6	0	21
40 - 49.99	10	4	35
50 – 59.99	26	31	24
60 – 69.99	20	30	17
70 – 79.99	17	40	4
80 – 89.99	28	15	0
90 – 99.99	9	0	0

Source: Own computation (2013)

According to Table 8, the AE distribution scores indicate that the largest efficiency group of sesame producers (58.33%) operated between 60% and 79.99%. Households in this group can save at least 20% of their current cost of inputs by behaving in a cost minimizing way. Only 12.5% of the total sample households had an AE score that ranged between 80 and 89.99%. This shows that all sesame producing farmers (100%) can at least save 10% of their current input cost by reallocation of resources in cost minimizing way.

The distribution of EE scores (Table 8) implies that the majority of the farmers were performing under the average efficiency level. The low average level of EE was the total effect of both technical and allocative inefficiencies. This also indicates the existence of substantial economic inefficiency in the production of sesame during the study period.

4.4. Determinants of Efficiency Differentials Among Farmers

The results obtained from the first stage estimations indicated that the average efficiency scores were low and there existed efficiency variations among farmers. The technical, allocative and economic efficiency estimates derived from the model were regressed on socioeconomic and institutional variables that explain variations in efficiency across farm households using Tobit regression model (Table 9).

Table-9. Tobit model estimates for different efficiency measures

	TE		AE		EE	
Variable	Marginal Effect	Std.Err	Marginal Effect	Std.Err.	Marginal Effect	Std.Err.
AGEHH	0.0012	0.0014	0.0004	0.0009	0.0009	0.0011
EDULVL	0.002	0.005	0.004	0.0031	0.0037	0.0039
FAMSIZ	-0.005	0.0065	-0.0049	0.004	-0.0059	0.005
SESPROEXP	0.0071	0.0074	-0.0099**	0.0046	-0.0014	0.0057
PROX	0.0006	0.0006	-0.0008**	0.0003	-0.0002	0.0004
SOILFERT	0.1767***	0.0281	0.0517***	0.0173	0.1560***	0.0214
NOFOXEN	0.0116	0.0116	-0.0019	0.0071	0.0036	0.0088
NONFRMINC	0.0997***	0.028	-0.0316*	0.0172	0.0431**	0.0213
EXTN	-0.0648	0.1098	-0.2239***	0.0677	-0.1951**	0.0836
CRDT	0.0859***	0.0306	0.0106	0.0188	0.0637***	0.0233
TRNG	-0.0304	0.1303	0.0219	0.0186	-0.0089	0.023
LOG L	65.55		123.7		98.36	

Note: *, ** and *** refers to 10%, 5% and 1% significance level, respectively.

Source: Own computation (2013)

As can be seen in Table 9, perceived soil fertility had a significant and positive impact on technical, allocative and economic efficiencies, as expected. This implies that fertility of land is an important factor in influencing the level of efficiency in the production of sesame. In other words, farmers with fertile farm were more efficient than farmers with less fertile farm. The result is consistent with that of Fekadu [5]. The positive and significant coefficient of the non-farm income in technical and economic efficiencies suggests that the income obtained from such non-farm activities could be used for the purchase of agricultural inputs and augment financing household expenditures which would otherwise put pressure on on-farm income. This could be due to the fact that most of the non-farm activities (butchery, grinding mills, handicraft, and selling of local drinks) performed by the sample households do not compete with time allocated for farm activities. The result is consistent with Jema [9] but inconsistent with Dolisca and Curtis [19]. Unexpectedly, extension contact was found to have a negative and significant relationship with allocative and economic efficiency of farmers. This might be due to the fact that the involvement of extension workers in many non-extension activities such as credit applications processing, input distributions, and collection of loans. Jema [9] also found a negative relationship between extension visit and technical efficiency.

Credit has been found to be an important variable in explaining the variation of technical and economic efficiency among farmers. The positive and significant impact of credit in this study implies that credit availability enables farmers to make timely purchases of inputs that they cannot provide otherwise from their own resources. In other words, farmers who had access to credit were more technically and economically efficient than farmers who had no access to credit. This result is consistent with Kinde [20] and Dolisca and Curtis [19]. As hypothesized distance of sesame farm from farmers' residence was found to be negatively and significantly related to allocative efficiency. This implies that as the distance of the farm from home increases the allocative efficiency decreases. Increased farming experience may lead to better assessment of importance and complexities of good farming decision, including efficient use of inputs. Unexpectedly, experience in sesame production was found to have a negative and significant relationship with allocative efficiency. Wilson, et al. [21] also found a negative relationship between experience and efficiency in potato production in UK, implying that farmers with fewer years of experience achieved higher levels of efficiency. Rahman [22] also reported similar results for Bangladesh rice farmers. The reason may be that those with little experience are likely to seek out for new technology, unlike those with experience or are better at managing their resources.

5. CONCLUSION

An important conclusion stemming from the analysis of the efficiency of sesame production is that, there exists a considerable room to enhance the level of technical, allocative and economic efficiency of sesame producer farmers. Result of the production function indicated that labor and seed were limiting constraints, with positive sign as expected. The positive coefficients of these variables indicate that, increased use of these inputs will increase the production level to greater extent. The average TE, AE and EE values of the sample households were 67.11, 67.25 and 45.14%, respectively. This implies that farmers can increase their sesame production on average by 32.9% if they were technically efficient. Similarly, sesame producers can reduce current cost of inputs, on average, by 32.75% if they were allocatively efficient. The result also indicated that if these farmers operate at full efficiency levels, they on average could reduce their costs of production by 54.85% and still produce the same level of output.

The factors that affect the level of efficiency were identified, to help different stakeholders to enhance the current level of efficiency in sesame production. Accordingly, soil fertility, non-farm income and credit access positively and significantly affected TE. This implies that farmers with fertile land, better access to credit and more non-farm income were technically efficient than their counterparts. Soil fertility had positive and significant impact on AE. This again implies that farmers with fertile land were allocatively efficient than others. But experience in sesame production, distance of sesame farm, non-farm income and extension contact affected AE negatively and significantly. From this, we can conclude that households who had a distant farm, more years of sesame production experience, better non-farm income and extension contact were allocatively less efficient than others. Soil fertility, non-farm income and credit access had positive and significant impact on EE. Here, we can conclude that farmers with fertile land, more non-farm income and better access to credit were economically efficient than the rest. However, extension contact affected EE negatively and significantly in contrary to the expectation.

6. RECOMMENDATIONS

1. Even though non-farm income was related negatively to allocative efficiency, it had a positive impact on technical and overall efficiency. This indicates that there is a need to introduce activities that could enhance the non-farm/off farm income of households without affecting their farm time allocation so that the farmers would be in a position to invest the required amount of resources in sesame production.
2. Access to credit affected both technical and economic efficiency of sesame producers positively. Hence policy makers should devote a great effort to create more access to credit services for farmers in the study area.
3. Fertility of sesame farm affected technical, allocative and economic efficiency of farmers positively. Therefore, development programs should give due emphasis to improve and maintain the fertility of land through awareness creation and introduction of technologies that improve and maintains fertility so that the efficiency of the farmers increases.

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