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Determinant of Technical Efficiency of Sesame Production in Kurmi Local Government Area of Taraba State, Nigeria.

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Abstract: *The study was carried out on the Determinant of Technical Efficiency of Sesame Production in Kurmi Local Government Area of Taraba State, Nigeria. The specific objectives of the study were to examine Socio-economic characteristic of the respondents; determine the profitability of Sesame enterprise; establish the technical efficiency of Sesame farmers and establish the determinants of the efficiency of farmers. Data were collected from primary and secondary sources. Purposive and simple random sampling technique was adopted for the study. 82 structured questionnaires were administered and were retrieved. The data collected were analyzed using descriptive statistics, Gross margin analysis and stochastic production efficiency frontier. The results of Socio-economic Characteristics revealed that males constitute the highest population with over 64.6% of the household heads, majority of the farmers were within the age bracket of 31- 40 years, constituting 48% among sampled households. The mean age of Sesame farmers was 42 years, 63.4% of the respondents were married. The result indicates that about 90.2 % of the respondents were literate at least having one form of formal education or the other with 70.7% have household sizes that are more than six with a mean of about 9 persons. Over 81% had 6-20 years of Sesame farming experience with the average years of experience of 10 years, access to extension services remains a challenge, as over 80% do not have access in the study area, 76.8 % of the respondents had no access to credit. The finding revealed that sesame production is highly profitable in the study area with profitability index of ₦ 1.8 kobo. The result of the stochastic frontier production indicates that the coefficients of the variables Seed, farm size, labour, herbicide and fertilizer were positive and significant at 1% and 5% level of probability and hence play a major role in Sesame production in the study area except fertilizer which is negative and statistically significant at 5% level. The coefficient of age, farming experience, household size, extension contact with farmers, and access to credit (-0.139, -0.168, -0.004, -0.065 and -0.039 respectively), were negative and significant and therefore, increases technical efficiency which agree with a prior expectation. The researcher concluded, Sesame farmers were found to be highly technically efficient. It recommended that since Sesame farmers are not realizing their full production potential, there is a need for sustained improvements on performance through enhanced roles by the government in educating farmers.*

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I. Introduction

Agriculture employs about 70% of the active population and sustains about 86% of household in Nigeria. Its role in the provision of foreign exchange and development of economies cannot be overstated, as it remained for a long time the main machine for the earnings (Nkamleu, *et al.,* 2010; Adeniyi and Ogunsola, 2014). However, agriculture remains in the hands of mainly small-scale farmers who use traditional methods and rudimentary tools of production, resulting in unsustainably low crop yields despite their high commercial and export potential. In Nigeria, the sector contributes 42.1% of the current GDP (Eleri *et al.,* 2012). With more than half of Nigeria's population currently employed in the agricultural sector (Manyong *et al.,* 2005), and with the vast majority of these individuals living in rural areas, the agricultural sector is key to Nigeria's economic development.

Sesame seed is an important component of Nigeria's agricultural export (Chemonics, 2002). It currently ranks second to cocoa in terms of export volume in Nigeria and is fast becoming prominent among non-oil exports because it is one of the few cash crops that can earn the country foreign exchange. Attributed to its high demand, any quantity of the product offered to the market is easily sold. Although it is quite extensively cultivated, it is mainly asmall-holder crop, often intercropped with others crops (Abu *et al* .2011). Available records show that Nigeria exported 140,800 tonnes of sesame seed worth $139 million in 2010. It was also recorded that Nigeria earned ₦210 billion from the export of sesame seed products in the first half of 2012 (Ciuci, 2013). This increasing demand for sesame seed provides Nigeria an opportunity to increase its

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production to meet the international demand for the commodity. The realization of the potential of sesame production in the acquisition of foreign currency for the country made increased production of the crop a prominent priority in the Agricultural Transformation Agenda of the Federal Government of Nigeria. To this end, farmers are being encouraged to produce sesame in all agro-ecological zones of the country. Nigeria has the technology to produce significant output of sesame for export in view of the yield potentials of the varieties released to farmers (NCRI, 2012).

Sesame is one of the cash crops grown in Kurmi Local Government Area of Taraba State. It is a very popular crop among the rural farmers. Notwithstanding the good local and international market for its seed and oil, it's whose production system is generally characterized by the use of traditional method. Despite all attempts to increase production of sesame in Nigeria, the average farmer still produces only at a subsistence level, using traditional system of farming and low-yielding varieties. Extension services have not been very effective because improved technologies of sesame production are available in research Institutes, but have not successfully reached sesame farmers (Sharon, 2016).

Efficiency according to Henderson (2003) refers to the ability of a producing unit to obtain maximum (optimal) output from a given amount of inputs. Farm production efficiency is the ability of a farm to produce a given level of output with the lowest amount of resources. The efficient method of producing a product is the one which uses the least amount of resources to get a given amount of output Ogunyinka and Ajibefun (2003). A technically efficient farm operates on the production frontier while a technically inefficient farm operates below the frontier and could be made efficient by increasing its output with the same input level or using fewer inputs to produce the same level of output. As such, the closer a farm gets to the frontier the more technically efficient it becomes (Rahman *et al.,* 2005). Technical efficiency in production is the physical ratio of output to the factor input. Technical efficiency is a principal element in economic profitability as it measures the ability of the firm to produce maximal output from a given set of inputs (Giroh 2012).

Determining the technical efficiency status of Sesame farmers is very important for policy purposes. In an economy where technologies are lacking, technical efficiency studies show the possibility of raising productivity by improving efficiency in the use of existing resources. It also helps to determine the underutilization or over utilization of factor inputs. Most empirical literature dealing with farm technical efficiency, at least in Nigeria, have been concerned with measurement of technical efficiency by using production function, profit function, or stochastic production frontier model as analytical techniques (Adepoju, 2008; Omonona *et al.,* 2010). The application of DEA is still scarce in Nigeria. Only a few studies have employed it (Yusuf and Malomo, 2007; Ajao, 2011; Jatto *et al.*,2012). This study intends to depart from the more common analytical approaches by using the DEA approach to estimate the technical efficiency of Sesame farmers in the Kurmi Local Government Area of Taraba State.

Research have been carried out on other crops but thereis no informationonthe productivity aswellaslack of pertinent research findings on the technical efficiency of the farmers in the study area and to identify the determinants of the variability of the efficiency levels among farmers. Assessing the efficiency of farmers may be one of the ways that helps improving the performance of sesame production in the area. In this regard this present study is an attempt towards analyzing the determinants of technical efficiency of the farmers in the study area and aims to bridge the prevailing information gap on the contextual factors contributing to technical efficiency differentials and sources of inefficiency in the production of sesame.

II. Objectives

The broad objective of this study was to analyze the efficiency of Sesame farmers in Kurmi Local Government Area of Taraba State, Nigeria. The specific objectives were to:

i. examine Socio-economic characteristic of the respondents;
ii. determine the profitability of Sesame enterprise;
iii. establish the technical efficiency of Sesame farmers and
iv. establish the determinants of the efficiency of farmers.

III. Methodology

Study Area

The study was carried out in KurmiLocal Government Area of Taraba State, Nigeria. Its headquarters is in Ba'issa town. Kurmi Local Government lies roughly between Latitudes 5° 31' and 7° 18'N, longitudes 10°18' and 11° 37'E at an elevation of 872 ft (265 m). Kurmi is bounded in the South by the Republic of Cameroon, in the South-east and North-east by Sardauna and Donga Local Government areas respectively. It is also bounded in the North by Bali Local Government, in North-west and south-west by Donga and Ussa Local Government areas respectively.Kurmi local government Area also bordered with Cameroon to the south. The study area has a total land area of about 1681 sqm with a population of 91,531 based on the 2006 census (Taraba State Govt, 2014). The areais richly blessed with fertile soil which grows a number of cash crops and food crops

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such as Sesame, Bananas, Plantains, Rice, Groundnuts, Oranges, Palm trees, Cocoyam and Cocoa. Others include Maize and Guinea corn. Kurmi is also a producer of high quality Timber and the only Local Government with the state owned abandoned Timber Company which was called Baissa Timber Development Corporation (Taraba State Govt, 2012). In the North western part, is grassland which also grows most off the cash and food crops. Majority of the populace being farmers, these crops are produced in large quantity for local consumption and the rest exported, either to other parts of the country or outside the country. While about 99% of the mountainous regions in the Local Government Area, are occupied by the Ndola ethnic group. The Local Government is also endowed with various natural resource including precious stones like gemstones, Forest, Waterfalls and Mountains. There are three Major ethnic groups which include: Ndola, Tigun and Itchen. Others are Kuteb, Tiv and so on. The Ndola and Tigun people are the native ethnic groups that occupy the fertile woodland of Kurmi while Itchen people occupied the grassland and a handful of Tiv farmers and also make up the population (Tarana State Government diary, 2012).

Sources and Type of Data

Data were collected from primary and secondary sources. The primary data were collected with the aid of a well-structured questionnaire, containing information such as the socio economic characteristics of the respondents (age, level of education, household size, etc.) and information on farm characteristics such as farm size, farm experience, inputs, and quantity of output used by the farmer were collected.

Sampling Technique and Sample Size

A multistage sampling technique was employed for the study. The first stage involved the purposive selection of one Sesame growing local Government (Kurmi), from the five local Governments that make up the Central zone of Taraba. The second stage involved the random selection of five major Sesame producing villages (Nyido/Tosso, Bissaula, Bente/Galea, Gatari and Ashuku/Eneme) from the selected LGA, and finally, 82 Sesame farmers were randomly selected in proportion to the size of the villages.

Analytical Technique

Descriptive statistics was used to describe the socioeconomic and farm characteristics of Sesame farmers in the study area. This was done using frequencies, percentages, mean, and standard deviation.

The Profitability of Sesame Production

The profitability of Sesame production was estimated using the Gross Margin analysis. The Gross Margin analysis involves the deduction of the total variable costs (in Naira) from the total revenue (in Naira) to obtain the gross margin for each Sesame farm. The total variable costs of production are the cost of labor, fertilizers, agro-chemicals, and other miscellaneous expenses.

The formula is given as:

$$GMi = \sum_{i=1}^{n} PiYi - Ci \quad \ldots\ldots(1)$$

Where

GMi = Gross margin of farm *i*

Pi = Farm gate price per kg of Sesame of farm *i*

Yi = Total quantity in kg of Sesame of farm *i*

Ci = Total variable costs incurred on farm *i*

i…n = Total number of Sesame farms

Stochastic production efficiency frontier

The econometric modeling of stochastic production efficiency frontier model independently proposed by (Aigner *et al.*, 1977) and applied by (Likita, 2005) and (Onyenweaku and Ohajianya, 2005) was used in the analysis of data.

The frontier production model begins by considering a stochastic production function with a multiplicative disturbance term of the form;

$Y = f(Xa;\beta)e^{E}$……...……(2)

where

Y = the quantity of agricultural output

Xa = the vector of input quantities

B = vector of parameters

E = represents exponential

E = stochastic disturbance term consisting of two independent elements V and U, where

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$E = U+V$…..…… (3)

The symmetric component V, accounts for random variation in output due to factors outside the farmer's control, such as weather, diseases and pests. It is assumed to be independently and identically distributed as N $(0,\delta^2$ v). A one-sided component, $U \leq 0$ reflects technical inefficiency relative to the stochastic frontier, f(Xa; β)e^E. Thus, U=0 for a farm output lying on the frontier and U <0 for one whose output is below the frontier as N $(0, \delta^2$ u) i.e, the distribution of U is half-normal (Battesse and Coelli, 1995).

The frontier of the farm is given by combining equations (2) and (3) as follows;

$Y = f(Xa; \beta)e^{(u+v)1}$……...…….....……..(4)

Measure of production efficiency for each farm can be calculated as;

TE = exp [E(U/E)]…….....……..…….(5)

In the efficiency analysis, the single stage model was applied, where U in equation (4) is a non-negative random variable which is the efficiency associated with technical efficiency factors in production of the sample farmers (Battesse and Coelli, 1995). It is assumed that the efficiency factors are independently distributed and that U arises by the truncation (at zero) of the normal distribution, with mean U and variance δ2 where U in equation [4] is defined as,

$U = f(Zb;\delta^2)$……..…….....……(6)

Where, Zb is vector of farmer-specific factors and δ is vector of parameters. The β and δ- coefficients in equation [2] and [6] respectively are unknown parameters to be simultaneously estimated together with the variance parameter which is expressed in the form;

$l = \delta^2u/(\delta^2u + \delta^2v)$……...…….....……..……(7)

Where l parameter has a value between zero and one.

The Empirical Model

The Cobb-Douglas stochastic frontier production function is specified as;

$LnY_{ij}= \beta_0+\beta_1 lnX_{1ij}+\beta_2 ln\ X_{2ij}+\beta_3 ln\ X_{3ij}+\beta_4 ln\ X_{4ij}+\beta_5 ln\ X_{5ij}+ V_{ij} + U_{ij}$……..…(8)

Where,

Y = Output of Sesame farmers (kg).

X_1= quantity of seed (kg).

X_2= farm size (Hectares).

X_3= labour (Mandays).

X_4= quantity of herbicide (litre).

X_5= quantity of fertilizer used (kg).

β_0 - β_5 = regression coefficients to be estimated.

V_{ij} = normal random errors assumed to be independently and identically distributed, having $N(0,\delta^2)$.

U_{ij} = non-negative random variables called technical efficiency associated with the technical efficiency of the farmers involved.

U_{ijs} are the technical inefficiency effects which are assumed to be independent of V_{ijs} such that U_{ij} is the non-negative truncation (at zero) of the normal distribution with mean U_i and Variance δ^2v where U_i is defined by;

$U_i = \delta_0 + \delta_1Z_{1i} + \delta_2Z_{2i} + \delta_3Z_{3i} + \delta_4Z_{4i} + \delta_5Z_{5i} + \delta_6Z_{6i} + \delta_7Z_{7i}$ ……..... (9)

Where,

U_i = Technical efficiency of the ith farmer

Z_1 = Age of the farmer (years)

Z_2 = level of education (number of years spent in school)

Z_3 = farming experience (years)

Z_4= household size (number of persons)

Z_5 = access to extension services (yes = 1, no = 0)

Z_6= access to credit(yes = 1, no= 0)

Z_7= membership of cooperative (membership =1, otherwise = 0)

δ, δ_1…… δ_7 = coefficients and unknown parameters to be estimated.

IV. Results and Discussion

Socio-economic Characteristics of the respondents.

The socio-economic characteristic of Sesame farmers in Kurmi LGA of Taraba State, Nigeria is presented in Table 1. As typical in African farm households, males constitute the highest with over 64.6% of the household heads while 35.4% were women. This further buttress the fact that Nigerian agriculture is still male dominated, implying that men have more access to the resources and information required to produce crops more efficiently than their female counterparts (Fasoranti, 2006; Otitoju and Arene, 2010). The majority of the farmers were within the age bracket of 31- 40 years, constituting 48% among sampled households. The mean

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age of Sesame farmers was 42 years. It is evident that most Sesame farmers are aged. This would likely affect the efficiency of the farmers in the study area. Several studies have reported that the aging of the farming population is a source of concern for production efficiency (Ojo*et al.,* 2009; Ogunniyi, 2011). In rural communities, marriage is a respected and prestigious institution that bestows social status and recognition on people. The results showed that 63.4% of the respondents were married, 23.2% were single and 13.4% were widow/widower. The high proportion of the respondents who are married is an indication that family labour could be available for sesame farmers in the study area. The result of this work is in line with the findings of Abu *et al.* (2011) and Rahman *et al.*(2009) who reported that a high proportion of married respondents will contribute widely to the use of family labour by the households as the wives and children constituted the labour force. The result indicates that about 90.2 % of the respondents were literate at least having one form of formal education or the other. This implies that there is potential for increased in sesame production since education help farmers to have access to information on new agricultural innovation which enhance their productivity. IITA (2002) reported that the level of education attained by farmers to a large extent determine the farmers level of adoption of new innovation without difficulties which in turn increase their farm output, and subsequently the profit obtain by the farmers. About 70.7% have household sizes that are more than six with a mean of about 9 persons. This implies that households are excessively large in size, which could also serve as a source of family labor. Over 81% had 6-20 years of Sesame farming experience with the average years of experience of 10 years. It is thus, reasonable to infer that farmers in the study area are well experienced in farming sesame and depicts good signal for higher productivity. This situation agrees with the findings of Abu *et al.* (2011), who reported that the average farming experience of sesame farmers in Nasarawa State was 12.8 years. However, access to extension services remains a challenge, as over 80% do not have access in the study area. This is in agreement with Ekunwe *et al.* (2008) who reported that extension services in Nigeria are poorly organized and in some cases, unavailable. About76.8 % of the respondents had no access to credit while 23.2% had access to credit. This implies that the farmers were using their personal saving to purchase farm inputs and adopt farm innovation. This low access to credit could be attributed to the fact that government seldom grants financial credit to large numbers of farmer or lack of collateral. The result agrees with the findings of Onyibe *et al.* (2012) who reported that access to formal credit is a major constraint to sesame farmers in Nigeria.

Table 1; Socio-economic characteristic of the Farmers

Variables	Frequency	Percentage
Gender		
Male	53	64.6
Female	29	35.4
Age (years)		
11 - 20	1	1.0
21 – 30	13	16.0
31 – 40	39	48.0
41– 50	19	23.0
51 – 60	10	12.0
Mean	42	
Marital status		
Single	19	23.2
Married	52	63.4
Widow/widower	11	13.4
Educational level		
No formal education	8	9.8
Primary education	12	14.6
Secondary education	43	52.4
Tertiary education	19	23.2
Household size		
1-5	24	29.3
6-10	46	56.1
11-15	7	8.5
16-20	5	6.1
Mean	9	
Farming experience		
1-5	15	18.3
6-10	39	47.6
11-15	21	25.6
16-20	7	8.5
Mean	10	
Access to extension services		
Yes	16	19.5
No	66	80.5
Membership of cooperative (years)		
Yes	22	26.8

No	60	73.2
Access to formal credit		
Yes	19	23.2
No	63	76.8
Total	**82**	**100**

Source: field survey, 2018

Profitability of Sesame Production

Cost and returns analysis was undertaken to determine the gross margin of sesame in Kurmi LGA of Taraba State. Table 2 revealed that the average total revenue generated by farmers was ₦155,350.66 per hectare and the total variable cost was ₦55,151.96 per hectare. The result also revealed a significant difference between total revenue (TR) and total variable cost (TVC). The total revenue is greater than the total variable cost which indicates that there is cost efficiency in the use of inputs by the respondents in the study area. The result also showed that the gross margin was ₦100,198.70 per hectare and the average cost incurred on labor of ₦23,050.30 was the highest among other costs. This shows that the farmers spent more on labour than other inputs. It therefore implies that labor, to a large extent, determines the viability and profitability of Sesame production as shown in Table 2. The profitability index (ratio of total revenue to total cost minus 1) was ₦ 1.8 kobo, implying that for every ₦1 invested in Sesame farming there was are turn of ₦ 1.8 kobo. This finding revealed that sesame production is h i g h l y profitable in the study area and thus any effort at expanding it would be a good decision because a significant difference were observed in terms of cost of inputs incurred and return realized. This is in line with the findings of Sharon (2016) who found that the profitability index estimated was ₦ 1.24kobo indicating that for each naira invested, there was return of ₦1.24 kobo.

Table2: Average Costsand Returns ofSesameFarmersin theStudyArea(₦/ha)

Items	**Value (₦)**
Total revenue	155,350.66
Cost of labour	23,050.30
Cost of seed	1,750.85
Cost of fertilizer	8,500.25
Cost of herbicide	16,300.50
Transport cost	3,750.06
Sacks	1,800
Total variables cost	55,151.96
Gross margin	100,198.70
Average rate of return	1.8

Source: Fieldsurvey,2018

Technical Efficiency and its determinants of Sesame farmers

Table 3 revealed the estimates of the parameters for the frontier production function and the variance parameters of the model. The variance parameters Sigma (δ^2) was 0.394 and was statistically significant at 1% level of probability. This indicates a good fit and correctness of the distributional form assumed for the composite error term. The value of gamma (γ) is estimated to be 0.950 and it was highly significant at 1% level of probability. This is consistent with the theory that true γ-value should be greater than zero. This implies that 95% of random variation in the yield of the farmers was due to the farmers‟ inefficiency. Since these factors are under the control of the farmer, reducing the influence of the effect of γ will greatly enhance the technical efficiency of the farmers and improve their yield. This result is consistent with the findings of Omolehin *et al*. (2010) who revealed that about 85% variation in sesame production in Jigawa State is due to inefficiency. The log likelihood function was 0.736. The log likelihood function implies that inefficiency exist in the data set. The log likelihood ratio value represents the value that maximizes the joint densities in the estimated model.

However, the estimated coefficients of all the parameters of production function (seed, farm size, labour, herbicide and fertilizer) were positive and significant at 1% and 5% level of probability and hence play a major role in Sesame production in the study area except fertilizer which is negative and statistically significant at 5% level.

The estimates of the coefficient of the technical inefficiency model are also shown in Table 3. Generally, a negative sign on a parameter means that the variable reduces technical inefficiency, while a positive sign increases technical inefficiency. The result shows that age, farming experience, household size, extension contact with farmers, and access to credit have negative signs while educational level and membership of cooperative society have positive signs. The coefficient of age, farming experience, household size, extension contact with farmers, and access to credit (-0.139, -0.168, -0.004, -0.065 and -0.039 respectively), were negative and significant and therefore, increases technical efficiency which agree with a prior expectation. The coefficient of education (0.247) was positive and significant 5% level. This indicates that the level of education

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attained reduce technical efficiency. This implies that high level of education is not desired for farming of Sesame and indeed, educated people opt for salaried employment in the study area. This result is in agreement with the findings of Usman (2009) among sesame farmers in Jigawa state. The coefficient of membership of cooperative society was 0.052 positive and significant at 10% level. The positive sign indicates that being a member of cooperative, the greater is the technical inefficiency.

Table 3. Maximum Likelihood Estimates of the Parameters of the stochastic Production Function

Variables	Parameters	Coefficients	t-value
Production Factors			
Constant	β_0	0.402	5.613
Quantity of seed	X_1	0.413**	2.708
Farm size	X_2	0.391***	3.083
Total labour input	X_3	0.109**	2.531
Quantity of herbicide	X_4	0.093***	3.007
Quantity of fertilizer	X_5	-0.508**	-2.511
Efficiency factors			
Constant	δ_0	8.713	4.908
Age	Z_1	-0.139*	-1.814
Level of education	Z_2	0.247**	2.916
Farming experience	Z_3	-0.168***	-3.014
Household size	Z_4	-0.004**	-2.544
Access to extension services	Z_5	-0.065**	2.551
Access to credit	Z_6	-0.039*	-1.643
Membership of cooperative society	Z_7	0.052*	1.813
Diagnostic Statistics			
Sigma-square	δ^2	0.394***	4.663
Gamma	γ	0.950	3.010
Log likelihood		0.736	
LR test		25.112	

* , **and *** denote significance at 10%, 5% and 1% levels respectively.

Frequency Distribution of Technical Efficiency of Sesame Farmers

Table 4 presents the technical efficiency distribution of the Sesame farms in the study area. The mean technical efficiency of the sampled farmers in the study area was 0.79, with 0.93 for the best farmer and 0.39 for the least farmer. This means that on the average, output fell by 21% from the maximum possible level due to inefficiency. About 81.7% of the farmers were predicted to have technical efficiency exceeding 0.61. This indicated that there are some 39% technical inefficient farmers in the study area. This agrees with the findings of Sharon (2016) who reported that the Technical Efficiency (TE) ranged from 0.432 and 0.976 with the mean TE of 0.712, suggests that an average sesame farmer in the study area still has the capacity to increase TE in sesame production by about 28.8% to achieve the maximum possible level while the most efficient one can increase output by 2.4%.The mean technical efficiency is similar to that reported by Maurice (2004) of 80% among cereal crop fadama farmers in Adamawa state in Nigeria.

Table 4: Distribution of Technical Efficiency of sesame farmers

Class	Frequency	Percentage
0.21-0.40	2	2.4
0.41-0.60	13	15.9
0.61-0.80	28	34.1
0.81-1.00	39	47.6
Total	82	100
Maximum	0.93	
Minimum	0.39	
Mean	0.79	

Source: field survey, 2018

V. Conclusion and Recommendation

Sesame enterprise was found to be profitable, and in terms of technical efficiency, Sesame farmers were found to be highly technically efficient, but have room for increasing their efficiency by 39%. The study recommends that since Sesame farmers are not realizing their full production potential, there is a need for sustained improvements on performance through enhanced roles by the government in educating farmers.

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