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Factors Influencing Technical Efficiency of Sunflower Production among Smallholder Farmers in Chemba District, Central Tanzania

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Ikisiri

Nia ya utafiti huu ilikuwa ni kutathmini ufanisi wa kiufundi wa wakulima katika uzalishaji wa alizeti katika Wilaya ya Chemba. Utafiti ulitumia modeli ya utendaji wa uzalishaji "stochastiki" katika uchanganuzi ili kubainisha athari za utendakazi wa kiufundi wa anuwai za kijamii na kiuchumi. Takwimu mtambuka ilikusanywa kutoka kwa wakulima 92 katika vijiji viwili vya Kata ya Paranga. Matokeo yalifichua kuwa mapato ya nje ya shamba na muda unaotumika kufanya kazi ndio sababu kuu zinazoathiri mabadiliko chanya katika pato la alizeti. Athari ya eneo la ardhi kwenye kiwango cha alizeti ni chanya na inaonyesha kupata alizeti zaidi bila kuongeza eneo la ardhi. Matokeo yanaonesha kuwa kuna uzalishaji hafifu wa alizeti. Mkengeuko kwa sababu ya uzalishaji hafifu ni 39%. Wastani wa makadirio ya ufanisi wa kiufundi kwa wakulima wadogo ni kati ya 7% hadi 92% na wastani wa ufanisi wa kiufundi ni 61%. Uchambuzi pia unaonesha kuwa jinsi ya wakulima, huduma za ugani, kikundi cha wakulima na mapato yasiyo ya shamba ni sababu kuu za kijamii na kiuchumi ambazo ziliathiri kwa kiasi kikubwa ufanisi wa kiufundi wa wakulima na pato la alizeti kwa 10%, 1% na 5% mtawalia. Utafiti unaonesha kwamba ufanisi wa kiufundi katika uzalishaji wa alizeti katika Wilaya ya Chemba unaweza kuongezeka kwa 39% kupitia matumizi bora ya rasilimali zilizopo, kwa kuzingatia hali ya sasa ya teknolojia. Utafiti huo ulibainisha changamoto zinazokabili uzalishaji wa alizeti kuwa ni pamoja na; ukosefu wa mafunzo, kutokushiriki kwenye kikundi cha wakulima, ukosefu wa mikopo, gharama za pembejeo na magonjwa ya mimea. Serikali inashauriwa kuboresha mafunzo ya wakulima ili kupata maarifa muhimu ya kutosha kuhusu mbinu za uzalishaji alizeti, kuandaa mara kwa mara warsha za mafunzo kwa wakulima wa alizeti kuhusu vyama ili kuwarahisishia wakulima kupata taarifa za soko na uzalishaji na kuzingatia utoaji wa mikopo yenye riba nafuu kwa ajili ya ununuzi wa vifaa vya kilimo na pembejeo.

Abstract

The intention of this study was to assess the technical efficiency of farmers in sunflower production in Chemba District. Specifically, the study determined Technical Efficiency of sunflower production in the study area, estimated the level of responsiveness (elasticity) of yield with respect to the factor inputs and examined the factors affecting the technical efficiency in sunflower production. The study used stochastic production function model in the *analysis to specify technical inefficiency effects of socioeconomic variables. It applied Maximum Likelihood Estimation (MLE) technique using cross sectional data collected from 92 randomly selected sample farmers in two villages of Paranga Ward. The MLE results revealed that off farm income and labour man days are the major factors influencing positively changes in the sunflower output. The effect of land area on the output is positive and the coefficient is found to be significant, implying the economies of scale. The test result indicates that there is inefficiency in the production of sunflower in the study area. The relative deviation from the frontier due to inefficiency is 39 %. The average estimated technical efficiency for smallholder farmers ranges from 7% to 92% with a technical efficiency mean of 61%. The analysis also reveals that famers sex, extension service, and farmer's organization and off farm income are the major socioeconomic factors that significantly influenced farmers' technical efficiency and sunflower output at 10%, 1% and 5%, respectively. The implication of the study is that technical efficiency in sunflower production in the study area could be increased by 39% through better use of available resources, given the current state of technology. The study identified the challenges facing sunflower production which include; trainings, organizations, lack of credit facilities, cost of inputs and plant diseases. The government is advised to improve farmers training to acquire necessary and adequate knowledge on sunflower production techniques, periodically organize training workshops for sunflower farmers on associations to facilitate farmers acquire market and production information and focus on provision of low interest rate credit for purchase of farm equipment and inputs*.

Keywords: Technical efficiency, smallholder farmer, sunflower production

1.0. Introduction

The sunflower (Helianthus annuus L.) ranks first in the production of oil seeds and nuts in Tanzania; it is mainly grown in the regions of Dodoma, Singida, Tabora, and Manyara. Currently, sunflower contributes about 65.5 percent of local edible oil production. Other sources of edible oil include; oil palm, groundnuts, sesame, and cotton. The country ranks 11th in the world for the largest sunflower seed production and is the second largest producer in Africa behind South Africa, accounting for 35 percent of the continent's total production yet the country imports nearly 50 percent of edible oil. African countries account for 5.5 per cent of the world's production (FAO, 2017).

Globally, sunflower occupies the fourth position among vegetable oilseeds after soybean, oil palm and canola (Ahmad *et al*., 2011). Although sunflower is generally regarded as a temperate zone crop, it is currently cultivated on approximately 23 million hectares in 40 countries worldwide, including some countries in the humid tropical Africa due to its rustic nature and can perform well under varying climatic and soil conditions (Kaleem *et al*., 2011). The major goal of growing sunflower is for its seed (achene) that contains oil (36–52%) and protein (28–32%) as reported by Rosa *et al.* (2009). The crop has been receiving steady attention from various scientists from diverse disciplines in the recent past because sunflower oil is a premium oil with a light colour and is widely used in the diets of heart patients because it contains very low cholesterol and a high (90%) unsaturated fatty acid concentration (Qahar *et al*., 2010). The productivity of sunflower in terms of seed yield, oil and protein output varies widely depending on multifarious factors of the environment such as radiation (Dosio *et al*., 2000), temperature (Kaleem *et al*., 2011), rainfall distribution (Lawal *et al*., 2011; Olowe *et al*., 2013), agronomic practices like time of sowing (de la Vega and Hall, 2002; Lawal *et al*., 2011; Anjum *et al*., 2012), plant density and nitrogen nutrition (Ali *et al*., 2012), varying planting pattern (Yasin *et al*., 2013) and sowing of improved varieties and hybrids (Ali *et al*., 2011). Consequently, there is a disparity among the reported African (812 kg/ha) and Nigerian (1,000 kg/ha) averages by Olowe *et al*. (2013) and the world average of 1,520 kg/ha (USDA, 2012).

A Bank of Tanzania (BoT) research paper entitled, 'Potentiality of Sunflower Sub-sector in Tanzania of March 2017' shows that local production of both factory and home extracted sunflower seed oil in Tanzania contributes about 40 percent of edible oil requirement of 330,000 tones. The 60 per cent gap is filled by imports. To further its work in increasing domestic production of sunflower oil, in 2019 Agricultural Non State Actors Forum (ANSAF) planned to steer a study based on collecting information on Open Pollinated Varieties of sunflower seeds and the distribution channel and support the Agricultural Seed Agency (ASA) to update its marketing strategy, provide support to processors by registering them and help to develop business plans, organizing meetings to advocate for zero Value Added Tax (VAT) charged on post-harvest technologies, and scale-up implementation of the sunflower development strategy (ANSAF, 2019).

The report by URT (2018) shows that the Dodoma region had the largest sunflower-planted area (33.3 percent) followed by Singida (22.8 %) and Tabora (13.9 %). However, apart from Dodoma being the region with the largest planted area and the good climatic conditions favouring the production of sunflower, it is revealed that there is low production in the region. The widespread use and adoption of new agricultural technologies in the form of improved varieties, fertilizers, pesticides, agricultural machinery, and methods of cultivation like proper spacing could significantly increase production in developing countries. The adoption of improved technologies can lead to increased productivity for smallholder farmers (Umar *et al*., 2009). According to FAO (2017), sunflower yields in Tanzania increased from 640 kg per ha in the year 2000 to 1,000 kg per Ha in 2014. Compared yields between 1,200 and 1,800 kg per ha in South Africa, there is still potential for improvement (Vilvert *et al*., 2018). Lower levels of skills with respect to the use of modern farming techniques and the adoption of new technologies are one of the challenges facing sunflower production. According to Khatib and Makame (2010), the adoption of improved rice varieties, proper application of chemical fertilisers and associated agronomic technologies were still low in Zanzibar.

A review of the literature and extensive stakeholder consultations revealed a number of constraints in the sunflower sector, which affect its long-term performance and productivity. The following are the challenges that need to be addressed to ensure the efficiency of sunflower production. These include; availability and accessibility of high-quality certified sunflower seeds, availability of agricultural inputs, including fertilizers and pesticides, management capacities of farmers' associations to sustainably increase sunflower production, adoption of Good Agricultural Practices (GAP), access to finance and use of insurance across the value chain and postharvest losses (URT, 2016).

The effort to increase sunflower production is still facing a big challenge in Chemba district. According to the statistics from URT (2019), the production of sunflower for the financial year 2018/2019 is 103,163.6 tonnes. However, the situation in Chemba was different from Kongwa district whereby annual production was low and it was 23.88 (that is 24,637 tonnes) percent whereby Kongwa had the highest production of 31.7 (32,703.0 tonnes) percent.

The country intends to increase the production and productivity of sunflower which is produced within the country in order to facilitate more contributions to income generation and poverty reduction among the people. The question arises on what level of technical efficiency of sunflower production in the study area and the associated factors that influence the technical efficiency. Technical efficiency in agriculture production is the ability of the farmer to produce the maximum output from a given level of inputs. It is concerned with relationship between resource inputs (in the form of labour, capital and equipment) and output (yield, revenue) (Palmer and Torgerson, 1999).

It is expected that one hectare of sunflower should produce from 850 up to 1,700 kg per ha. However, the situation is quite different in Chemba district, where the productivity is 400 kg per ha (URT, 2018). Therefore, this study is intended to assess the technical efficiency of sunflower production in the study area so as to come up with necessary recommendation on the prevailing problem of low production and productivity.

Given the importance of sunflower production, the country intends to increase the production and productivity of sunflowers which are produced within the country in order to facilitate more contributions to income generation and poverty reduction among the people. The question arises of what level of technical efficiency of sunflower production is in the study area and the associated factors that influence the technical efficiency. Therefore, this study intended to assess factors influencing the technical efficiency of sunflower production in the study area.

2.0. Methodology

The study was conducted in Chemba district at Paranga ward that involved Sori and Kelema Kuu villages, where sunflower production is among the predominant activities.

2.1. Research design and sampling

The study employed a cross sectional research design using both qualitative and quantitative research approaches. This design was used on the basis that it allowed the collection of data from different groups of respondents at a time.

The sampling frame in the study involved the entire population of farmers engaged in sunflower production from the two selected villages of Kelema Kuu and Sori in Paranga Ward. The sample size comprised of 92 respondents who were randomly selected from the two villages of Sori and Kelema Kuu and the four (4) key informants which make a total of 96 respondents.

This study used probability and non-probability sampling procedures, in the case of probability sampling, simple random selection was used to obtain smallholder farmers and in case of non-probability sampling, purposive sampling was used to obtain key informants, members of the focus group discussion and the study area. Data were collected through questionnaire survey and key informants' interview.

2.2. Data analysis

Stochastic Frontier Analysis (SFA) Version 4.1 was used in the study to undertake technical efficiency estimation for sunflower production. During the estimation of the technical efficiency level of sunflower production, technical efficiency was computed whereby the outcome score was used to determine whether sunflower farmers were efficient or not.

SFA was used by the founders Aigner *et al.* (1977) for the estimation of technical efficiency through an equation below:

$$Y_i = f(X_i; \beta_i) + V_i - U_i \quad \text{(i)}$$

Where:

Y_i = Output level of sunflower or production of the i-th farm,

X_i = The amount of input quantities used by the ithfarm,

β_i= The number of unknown parameters to be estimated,

f () = Represents an appropriate function (Cobb-Douglas).,

V_i = symmetric error

U_i = Non-negative random variable representing inefficiency in production relative to the stochastic frontier

Technical Efficiency (TE) model is thus:

$$T.E = Y_i / Y_i^* = f(X_i; \beta) \exp(V_i - U_i) / f(X_i; \beta) \exp(V_i) \exp(-U_i) \quad \text{(ii)}$$

The advantages of using this production function are: first, it introduces a disturbance term representing statistical noise, measurement error, and exogenous shocks beyond the control of production units which would otherwise be attributed to technical efficiency. Second, it provides the basis for production structure and the degree of inefficiency.

Technical Efficiency (TE) is defined in terms of the observed output relative to the production frontier, given the available technology, such that $0 \le TE \le 1$.

In order to use the Least Square Estimation procedure, the Cobb Douglas production function used four variables which was expressed in logarithmic form as follows:

$Ln\ Q = \beta o + \beta 1 lnXi + \beta 2\ lnX2 + \beta 3lnX3 + \beta 4lnX4 + Vi - Ui$ ………………………………………………… (iii)

Where:

ln = refers to natural logarithm
Q = Sunflower output in Kg,
βo = Constant
β1- β4 = Regression coefficients that is unknown parameters to be estimated, and
Xi = Factor inputs in sunflower production: Farm size (acres), quantity of seed (kg), labour used (man days) and family labour/hired labour (labour size)
Vi = random variables in the production that cannot be influenced by the farmer.
Ui = deviation from maximum potential output attributable to technical inefficiency

In order to identify the factors that contribute to inefficiency of the farms, the technical inefficiency model was specified as follows:

$Ui = \delta 0 + \delta 1z1 + \delta 2z2 + \delta 3z3 + \delta 4z4 + \delta 5z5 + \delta 6z6 + \delta 7z7 + \delta 8z8 + \delta 9z9 + \delta 10z10$………. (iv)

Where:

Z1 = Farmer's age (years)
Z2 = Farmer's sex (dummy, 1=male, 0=female)
Z3 = Farmer's experience (Number of years in sunflower production)
Z4 = Farmer's education (years)
Z5 = Household size (number)
Z6 = Extension service (1, access to extension officer, 0, Otherwise Dummy)
Z7 = Credit facility (dummy, 1=Yes, 0=No)
Z8 = Farmer's organization (dummy, 1=Yes, 0=No)
Z9 = Farmer's training (dummy, 1=Yes, 0=No)
Z10 = Off farm income (dummy, 1=engaged, 0=Non-engaged)
Where δ1, δ2, ………δ10 are unknown parameter to be estimated

3.0. Results and Discussion

3.1. Demographic characteristics of the respondents

The results on demographic characteristics of sunflower farmers show that 73.9% of the respondents were males while 26.1% were females. The results imply that the cultivation of sunflowers is dominated by males. Males are found mostly involved in sunflower production in Chemba district than women since in rural areas men are often viewed as being responsible for producing cash crops, while women are responsible for producing substance crops for home consumption and domestic activities. Also, findings revealed that 39.1 % of respondents were aged between 46 - 55 years, followed by 26.1% with ages between 36 - 45 years, and a few (4.3 %) of them aged between 15-25 years, these findings are in line with Bempomaa and Acquah (2014) who indicated that production in rural areas is done mostly by mature and older people. About 6.5% of the farmers had no formal education, 73.9% attained primary education, 10.9% had secondary education, 6.5% attended vocational training, and 2.2% attained university education. This implies that the majority of the farmers who engaged in sunflower production in the study area had a primary education which is a minimum level of formal education which might probably lead to low productivity. This is supported by Liu, (2006) in Kenya where education is arguably an important factor that affects maize productivity and efficiency. Kumbharkar *et al*. (1989) suggest that education increases the productivity of labour and land on Utah dairy farms while Kumbharkar *et al*. (1991) also show that, education affects production efficiency.

3.2. Technical Efficiency Level of Sunflower Farmers and Returns to Scale

The Maximum Likelihood (ML) estimates of the parameters on the technical efficiency level of sunflower farmers show that labour used, labour size, farm size and quantity of seeds used were significant factors at 1 percent. The results show that labour used and labour size have a positive coefficient as shown in Table 1 below. The positive coefficient indicates that the current inputs used were not at optimal levels. This finding implies that the output level of sunflower production would increase as the amount of labour used and labour size increased. The findings accord with those of Aboki *et al*. (2013) who reported that the major factors affecting cassava production in Nigeria were farm size, family labour and hired labour. On the other hand, farm size and seed quantity used have a negative effect on the output of sunflower production. This implies that any increment in the size of the farm and quantity of seeds used above the recommended rate would decrease sunflower production because much more inputs use lead to an increase in plant population above the population size per area which has an effect on plants' competition for nutrients leading to low productivity. This is in line with the study conducted by Bempomaa and Acquah (2014) in Nigeria which justified that, more seeds used above recommended rate had a negative effect on output. Likewise, the study by Ngango and Kim (2019) in Rwanda indicates that land is an alternative input variable that can improve coffee production.

Table 1: Estimates of Maximum Likelihood Stochastic Frontier Model

Variables	Parameters	Coefficients	Standard-error	t-ratio	P-value
Constant	Bo	0.38	0.14	2.81	0.000
Size of the farm (acres)	β1	- 25.79	0.80	- 32.41	0.985*
Quantity of seeds (Kg)	β2	- 0.02	0.01	- 2.25	0.820*
Labour used (man days)	β3	1.96	0.03	75.60	0.042**
Labour size (number)	β4	8.67	0.25	34.43	0.001***
Mean Efficiency		61			
Variance parameters					
Sigma-squared	δ^2	0.66**			
Gamma	Γ	0.84**			

*** p<0.01, **p<0.05 and *p<0.10

The results in Table 1 further show that the sigma value (δ^2) of 0.66 is statistically significant and different from zero at 5%. The results signify that, a good fit and the correctness of the specified assumption of the distribution of the error term. However, it is revealed that the estimated gamma value is 0.84 and this is in line with the theory that the parameter of gamma shows the total variation of the desired output from the frontier output, the actual output is attributed to inefficiency factors if the value is closer to one the observed output is attributed to random factors. Also, if the value is closer to zero therefore, the sigma value of 0.66 is significant from zero to one. Therefore, this value is closer to one, suggesting that the variation in sunflower production is attributed to inefficiency factors among the respondents. This concurs with Battese and Coelli (1995).

About 66 % of the variation in sunflower output is caused by factors within the farmer's control. The result, therefore, reveals that 34 % of the variation in output for the sunflower farmers interviewed is due to factors beyond the farmer's control (stochastic noise) such as weather, risk, pests, and an outbreak of diseases. This finding is in line with Lwelamira *et al*. (2016) study on the production of grapes in Dodoma, which revealed a value of 0.752 for Sigma squared ($\sigma2$) which is different from zero indicating a good fit and correctness of the specified distributional assumption of the composite error term.

Results in Table 1 revealed that the summation of the output elasticity was found to be -15.8 indicating that, the production function of sunflower farmers is decreasing returns to scale. The proportion of the increase in input would result in less output. This is supported by Baha *et al*. (2013) whereby the sum of the elasticity was found to be negative and hence, a decreasing return to scale with a consequent decrease in the production of maize for three consecutive years.

3.3. Percentages distribution of Technical Efficiency (TE) scores

TE was estimated in order to analyse farmers' performance. As revealed in Table 2, the technical efficiency mean of the estimated sampled sunflower farmers is 61%, while the minimum efficiency is 7% and the maximum efficiency is 92%. The majority (75%) of the farmers had technical efficiency ranging from 51 to 99. This means that there is still room to further improve the technical efficiency of sunflower production in the study area. This is also supported by the study conducted by Bekele (2013) in Ethiopia whereby the TE of irrigated maize smallholder farmers ranges from 0.54 to 0.98 with a mean of 0.92. The finding implies that sunflower farmers in Paranga ward in Chemba district were not operating at the technical efficiency level of 100% or 1. In this regard, all the sampled sunflower farmers' production is below the frontier output. In this view, the result shows that sunflower farmers could bridge the gap between their actual and frontier output by 31 % with the same level of existing resources. Comparing the TE mean from this study with other studies indicated that, TE from the study is similar to the result of Baha (2013) in Babati whereby the mean technical efficiency was found to be 62.3% suggesting that an estimated 37.7% of the inefficiency in maize production in the study area resulted from the combination of both technical and allocative inefficiency which implies that, there is still room to enhance technical efficiency given the same level of inputs and technology.

Table 2: Percentages distribution of TE scores

TE: Range (100%)	Percentage
1-9	1.1
10-50	25.0
51-99	75.0
Total	100.0
Maximum Efficiency	92
Minimum Efficiency	07
Mean Efficiency	61

3.4. Factors influencing Technical Efficiency in Sunflower Production

The factors influencing technical efficiency were estimated by using the parameter estimate of inefficiency effects through maximum likelihood coefficients obtained through the model. The significant factors influencing the technical efficiency of farmers in the study area were the farmers' age, experience, training, household size, and credit facility. The credit facility, farmer's age, and training were significant at 1 percent (P<0.01), and household size and farmer's experience at 5 percent (P<0.05) as shown in Table 3 below. All of them have been shown to have a negative coefficient implying that they reduce the farmers technical inefficiency.

Table 3: Maximum Likelihood Estimates of the Inefficiency Model

Variables	Coefficients	Std Error	t ratio	P-Value
Constant	-111.023	0.58	-91.66	0.000
Farmer's age (years)	- 0.005	0.04	- 0.11	0.001**
Farmer's sex	0.094	0.12	0.81	0.785
Farmer's experience (years)	-0.006	0.02	- 0.40	0.047*
Farmer's education (years)	0.017	0.02	0.92	0.062
Household size (number)	-0.087	0.12	- 0.75	0.031*
Extension service	0.070	0.02	3.12	0.321
Credit facility	- 0.103	0.12	- 0.86	0.000**
Farmer’s organization	0.032	0.11	0.29	0.643
Farmer’s training	- 0.100	0.09	- 1.05	0.004**
Off farm income	40.994	0.14	300.18	0.085

Note: * = Significant at 5% and **= Significant at 1%

The result indicates that older farmers have a tendency to have less inefficiency than young farmers due to the fact that, they have accumulated more knowledge and experience in sunflower production techniques. This result is in line with Bempomaa and Acquah (2014) whereby the coefficient of age in the inefficiency model is negative at a 1% significant level. This suggests that older farmers are more technically efficient than younger farmers. Likewise, the study by Abdul-Rahaman (2016) in Ghana indicates that the age of smallholder cotton farmers was found to have a positive effect on technical efficiency and was statistically significant at 1% implying that as smallholder cotton farmers advance in age, technical efficiency also increases.

The increase in family size has the tendency to decrease technical efficiency. The results are similar to the study by Asante *et al*. (2014) indicated the negative effect of household size on technical efficiency and suggested that farmers with small family sizes tend to be more technically efficient than those with larger farm. Large household sizes normally place a huge demand on food requirements. The study by Wollni (2007) and Haji (2006) indicated the impact of family labour on technical efficiency through the economies of size. Technical inefficiency is realized when family labour is employed beyond optimal levels of production.

Credit is an important component in sunflower production as it facilitates the availability of inputs and meets cultivation costs. The study by Marco (2016) revealed the importance of household organization membership indicating that for small-scale farmers, it is important for them to form an organization in order to get access to credit which they can use to buy new and improved inputs, especially seed to increase technical efficiency. The study by Bekele (2013) about Ethiopia on Technical Efficiency Variation for smallholder irrigated maize producers indicated that the use of external inputs such as access to credit and better financing increases farm size, and economies of scale may be attained as farm size increases.

The level of the farmer's training is an important factor that determines technical efficiency. Similarly, Hanan and Mohamed (2017) revealed that trained farmers are more technically efficient because they can improve their skills, knowledge, and agricultural information about input usage efficiently. Similarly, Asante *et al*. (2014) in Ghana indicated that continuous provision of training through the establishiment and strengthening of linkages between farmers and agriculture institutions is recommended to enhance the smooth transformation of adoption efforts into efficient rice production among smallholder rice farmers in the country.

4. Conclusion and Recommendations

On measuring technical efficiency level, the results have shown that labour used (man days) and labour size have a positive relationship with the sunflower output; the current inputs used were not optimal. The findings imply that the output level of sunflower production would increase as the amount of labour used and labour size increased. The quantity of seeds and the size of the farm have a negative coefficient, implying that an increase quantity of while farm size remain the same would lead to a reduction in sunflower output. The variation in sunflower production is mostly attributed to inefficiency factors within the farmer's control, and the factors beyond the farmer's control (stochastic noise) like weather, risk, pests, and an outbreak of diseases. The distribution of the technical efficiency in sunflower production shows that farmers were not operating at the technical efficiency level, meaning that all the sampled sunflower farmers' production is below the frontier output. Elasticity and return to scale show that the production function of sunflower farmers is decreasing returns to scale i.e., the proportion of the increase in input would result in less output. The results from the inefficiency model show that the farmer's age, farmer's experience, household size, credit facility, and farmer's training were significantly increasing technical efficiency.

Given that sunflower production is below the frontier, the gap between their actual and frontier output will be bridged without the use of any additional resources. As variation in sunflower, the output is caused by factors within the farmer's control; there is a need to train the sunflower farmers on good production practices. The training should focus on using improved seed varieties and controlling risks, pests and diseases affecting sunflower plants. Due to the fact, the production function is experiencing decreasing returns to scale, it is recommended that farmers should not increase the inputs, but rather focus on the quality of the available inputs so as to reach the frontier output. There is a need to assure the farmers of credit availability in order to meet the needs for improved sunflower agro inputs and chemicals.

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