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Analysis of Production Efficiency of Maize Production in Midland of Guji Zone, Southern Oromia, Ethiopia

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Abstract*— *Maize is an important food crops in midland agro ecologies increasing its efficiency of inputs in its production could enhance food security. Hence, the aim of this study was to analyze levels of production efficiency of smallholder maize producer farmers and factor affecting production efficiency of maize farmers in the midland areas Guji zone. Multi-stage sampling procedures were used to select 240 maize producer farmers. Both descriptive statistics and econometric model such as stochastic production frontier model and Tobit model were used to analyze factors affecting efficiency level of maize producer farmers. The mean technical, Allocative and economic efficiency levels of 69.8%, 62% and 44.3% were estimated respectively. The result revealed that there was inefficiency in maize production and improving efficiency levels of maize producer farmers can improve productivity of maize in the study area. Tobit model results indicated that sex of household head, education level, soil fertility status, Off-farm income and access to improved seed had a significant effect on technical efficiency of maize producer farmers, education level of household head, farm size, livestock holding (TLU), credit access and market distance had a significant effect on allocative efficiency while sex of household head, education level, soil fertility status livestock holding(TLU), access to extension visit, off farm income, credit access, training and market distance had significant influence on economic efficiency of farmers in the study area. The study concludes that a considerable variability in maize production efficiencies in the midland areas of Guji zone, and there is a room to increase the efficiency of maize producers in the study area. Based on the findings of this study, it is recommended that policy makers and development partners efforts should focus on to have an institutional environment that facilitates maize farmers' access to, batter extension services, land, livestock, education, access to improved maize seed to further increase maize production in the study area.

***Keywords*— Production Efficiency, Cobb-Douglas, Maize, Guji zone, stochastic frontier, Tobit**

I. INTRODUCTION

Cereal crops produced in most part of Ethiopia. Among these cereals crops, maize is Ethiopia's leading cereal crop, ranking first in total production volume and productivity (40kt yield per hectare), despite being second in area coverage after teff (CSA, 2022). It accounts for a significant portion of Ethiopia's total grain output, making it a vital food security and economic crop, with production reaching over 10 million metric tons with 4tonnes/hectare in recent years (CSA, 2022). Despite the increased production of maize, its productivity low and Global maize productivity significantly outpaces Ethiopia's, with world averages around 5.5 tone/hectare (t/ha) compared to Ethiopia's approximately 4 t/ha which 30.04% below(around 2022), highlighting a large yield gap, especially for smallholder farmers, due to factors like limited access to improved seeds, technology, soil fertility issues, and infrastructure challenges despite maize being a crucial food security crop in Ethiopia

Maize is one of the important staple foods where the use of input-intensive technologies (inorganic fertilizer and improved seed) has been promoted to increase production(Ahmed, 2022) Yield declines have been reported where the crops are dominant primarily due to low soil fertility, continuous mono-cropping, and removal of crop residues (Mitiku e*t al.,* 2022). Climate variability poses an additional challenge to maize productivity. Maize is overwhelmingly produced under rain-fed conditions because irrigated agriculture remains under-developed. According to agricultural survey data, the share of maize production area under irrigation is very low which only about 1.6 % of the total maize production area was under irrigation based on Central Statistical Agency estimates for 2021, indicating that nearly all maize cultivation depends on rainfall rather than irrigation infrastructure(Dejene *et al.*, 2022). While seasonal rainfall variability (erratic rainfall patterns) and high temperatures significantly affect maize production in Ethiopia (Girma *et al.,* 2012), adaptation and mitigation efforts in response to climate change remain limited (Bewket, 2018). The consequence of these minimal mitigation measures is reflected in highly variable and unstable maize yields across production seasons (Morebo *et al.,* 2023).

Maize is a crucial staple crop for food security and livelihood sustenance in Guji Zone, Ethiopia. However, according to a survey conducted by Belete, (2020), the average maize productivity in Guji Zone was reported to be only 19.2 quintals per hectare, which is significantly lower than the national average of approximately 30-40 quintals per hectare. This substantial productivity gap highlights the urgent need for targeted interventions to improve maize yields in the region. Enhancing maize productivity in Guji is essential not only for improving food availability and income for smallholder farmers but also for strengthening the resilience of local agricultural systems against climate variability and socio-economic challenges. Maize production can be improved through development and adoption of new technology and through improvement in efficiency and the re-allocation of resources. Since most farmers are poor and they face drought and credit constraints, they may not be in a position to raise productivity in their limited land holding. So, the only option left to these farmers is to raise their productivity through improvement in efficiency, given the existing technology. Furthermore, knowledge of the factors that influence maize productivity differentials among farmers is very important. This requires identifying factors that lead some farmers to produce more than others under the same technology and inputs, given their prices. This, in turn help in generating information to design appropriate policies to increase agricultural productivity of the crops by improving on factor productivity and on farm-and crop-specific efficiencies with the hypotheses that the environmental variables, sustainable agricultural intensification and socioeconomic variables affect production efficiency in study area.

Therefore, it is important to examine the production efficiency of the maize producer farmers and identify determinants which cause efficiency differentials among maize producer farmers in the study area. Hence, improving the efficiency of farmer's production is more viable to increase production and productivity and to satisfy the growing demand for maize.

General Objective

The general objective of the study was to analyze production efficiency of maize producing farmers in the study area.

Specific Objectives

The specific objectives of the study were:

- ✓ To Estimate the levels of technical, allocated and economic efficiencies of small scale maize producing farmers and
- ✓ To determine factors affecting technical and economic efficiency of farmers producing maize in the study area

II. DESCRIPTIONS OF THE STUDY AREA

The study was conducted in Guji zone of Southern Oromia. The zone is characterized by diverse agro-ecological conditions, ranging from lowland to highland areas, with altitudes between 1,000 and 2,500 meters above sea level. It experiences bimodal rainfall, with annual precipitation ranging from 800 to 1,500 mm, supporting rain-fed agriculture. Agriculture is the main livelihood, dominated by mixed crop-livestock systems. Major crops include maize, Teff, wheat, and barley. Despite favorable conditions, agricultural productivity remains low due to limited access to inputs, traditional farming practices, and market constraints. This study focuses on Adola Rede and Odo Shakiso districts, selected for their high potential in maize production and relevance to the study objectives.

Sampling Procedures and Sample size

A multistage sampling procedure was used to select maize producer sample households to undertake the study in-line with its objectives. In the first stage, three districts namely Arda Jila Mea Boko, Adola Rede and Odo shakisso were purposively selected based on their potential maize production. At the second stage, a total of eight kebeles, four from from Adola Rede, two from Odo shakiso and two from Arda Jila Mea Boko were randomly selected. At final stage a total sample of 240 maize producing households were systematically collected from each kebeles based on the sample proportional to population size for the study based on Yamane (1967) formula, sample size determination formula as follow: $\boldsymbol{n} = \frac{N}{1+N(e)^2}$

Where: n = is the sampled households, N = is the total number of households who produce maize and e = 0.09 is the level of precision defined to determine the required sample size at 90% level of precision. The sample sizes selected from each kebele were determined using probability proportional to size (PPS).

Data source and data collection method

Both primary and secondary data were collected from different sources at different levels. Primary data was collected through focus group discussions, key informant interviews, and household interviews using a checklist and a semi-structured questionnaire. Primary data was collected from 240 small farm households for the 2024/25 production season by using a semi- structured questionnaire. Secondary data relevant for this study was collected from zonal and district agricultural office, published and unpublished materials.

Method of data analysis

Both descriptive statistics and econometric model such as stochastic production frontier model and Tobit model were used to estimate farmers' technical and economic efficiency under maximum-likelihood estimation method under requirements normal distribution of assumption disturbance term or error were used to measure the magnitudes and determinants of the inefficiency in maize production in the study area.

Stochastic frontier model

In this study, stochastic frontier model of Cobb-Douglas production function was used to estimate the production and cost function of maize producers of the study area. A Cobb-Douglas functional form was employed as it meets the requirement of being self-dual that allows an examination of economic efficiency. The stochastic frontier model independently proposed by Aigner *et al.* (1977) and Meeusen and van Den Broeck (1977) were applied and recognizes components of error of term (random deviation and inefficiency) as major source of deviation from the production frontier.

$$Y_i = f(x_i, \beta_i)e^{\varepsilon_i} \quad (1)$$

The function can be transformed as in the case of this study as follows. $LnYield = \beta_o + \beta_1 LnLabor + \beta_2 LnLivestock + \beta_3 Credit + \beta_4 Extension + \beta_5 pesticide + \beta_6 seed + \beta_7 LnUREA + \beta_8 Age + \cdots + v_i - u_i$ (2)

Cobb-Douglas cost frontier function for maize farms in the study area is expressed as:

$$LnC_i = \beta_o + \beta_1 LnW_1 + \beta_2 LnW_2 + \beta_3 LnW_3 + \beta_4 LnW_4 + \beta_5 LnW_5 + \beta_6 Y_i + v_i - u_i \quad (3)$$

Where C_i is the total cost of maize production; W_1 is the average price of DAP per Kg; W_2 is the rental value of land per hectare; W_3 is the average price of Urea per Kg; W_4 is the average price of seed per Kg; W_5 is the average wage rate per day; Y_i is the maize output in quintal across each farmers in sample of the study.

$$TE_i = \frac{f(x_i,\beta_n)e^{v_i - u_i}}{f(x_i,\beta_n)e^{v_i}} \quad (4)$$

Similarly, the farm-specific Economic efficiency (EE) scores, defined as the ratio of minimum total production cost (C*) to actual observed total production cost (C), are also estimated as: $EE = C^*/C$,where economic efficiency (EE) takes values between 0 and 1. Additionally farm specific allocation efficiency (AE) is obtained from technical and economic efficiency using the formula defined by Farrell (1957) as: $AE = TE * EE$ (5)

After estimating TE, AE, and EE scores, then farm specific characteristics or variables that hypothesized to affect TE, AE and EE of small farmers household producing maize was analyzed by sing Tobit econometrics model defined by Tobin (1958) as:

$$E_i = \delta_o + \sum_{i=1}^{n} Z_i + u_i \quad (6)$$

Where E_i represents scores of technical, allocative, and economic efficiencies; δ_i is the vector parameters to be estimated; Z_i represents various explanatory variables affecting the efficiencies of maize farmers and u_i is the disturbance term.

III. RESULTS AND DISCUSSION

Descriptive Statistics

From a total of 240 sampled respondents most of them (75%) are male and 25% were female. Among the sample farmers considered, about 98.75% of them are married, 0.42% single, 0.83 and % widowed. Out of the total sampled households 29.6% cannot read and write, 18.3% can read and write and 52.1 % attained formal schooling of primary school to secondary and above (Table 2).

Table 2. Sex, marital and educational status of the sample household heads

Variables Description	Category	Frequency	Percent
Sex	Male	180	75
	Female	60	25
Education Level	Illiterate	71	29.6
	Read and write	44	18.3
	Formal education	125	52.1

Source: Own survey result, 2024/25

Table 3 Shows household's characteristics regarding age, family size, and their farm land allocation to maize production of sampled households.

Table 3. Age, family size, livestock holding, farm size and area allocation to Maize production

Variables	N	Min	Max	Mean	StDev
Age	240	20	57	38	11
Family size	240	2	12	8	4
Area allocation to Maize	240	0.125	4.25	0.77	0.74
TLU	240	.00	11.3	7.20	7.17
Farm size	240	0.125	27	3.47	3.11

Source: Own computation, 2024/25

Land tenure system of households

According to survey result in Table 4, there was observed land fragmentation in which the plot of their land ranges goes to up to one to four places. In the study area the land ownership was dominated by own farmland on which the major sampled households have cultivated maize on followed cultivation of maize on the shared land. Plot fertility indicates the perception of households whether their land is fertile or not. The number of plough can indicate an intensity of land preparation that helps for appropriate germination of the seed and it was expected to have a direct impact on productivity. The farmers in the study area hence at least plough maize land twice.

Table 4. Land fragmentation and land ownership of sample households

Variables	Category	Frequency	Percent
Number of plot	1	80	33.3
	2	105	43.7
	3	40	16.6
	4	15	6.4
Land Ownership	Owned	200	83.3
	Shared	40	16.7
plot fertility	Fertile	136	56.7
	Not fertile	104	43.3
Frequency of plough	two times	14	5.8
	three times	52	21.7
	more	174	72.5

Source: Own computation, 2024/25

Extension service: In order to give effective extension service to the farmers, there were two to three DAs in each kebele. The DAs are graduates of different colleges specializing in three agricultural streams which include crop production, animal husbandry and natural resource management. The extension workers visit farmers on different intervals. The survey result indicated that the average frequency of extension contacts during the production season in relation with maize production was about 3 times with standard deviation of 0.689 (Table 5).

Table 5. Extension contact

Extension frequency	Frequency	Percent	Mean	StDev
Daily	20	8.3		
Weekly	120	50		
Fortnightly	83	34.6		
Monthly	10	4.2		
Quarterly	7	2.9	2.691	0.689
Total	240	100		

Source: Own computation, 2024/25

Credit Service: There exist formal lending institutions that provide credit to farmers. The formal sources of credit in the study area is Oromia saving and credit (Siinqee Bank). As far as access to credit was concerned, from total respondent 72.7 % of them were used credit and about 27.3% of the respondents had not used credit in the production year (Table 6).

Training: From the total of sample household interviewed for this study, 54.7% of them indicated that they have receive training specific to maize production and about 45.3% of them have not access to training (Table 6).

Table 6. Credit and Training Services

Variables	Category	Frequency	Percent
Credit	Utilized	64	27.3
	Not	176	72.7
Training	Trained	130	54.7
	Not trained	110	45.3

Source: Own computation, 2024/25

Descriptive statistics of variables used to estimate production function

Table 7 shows minimum, maximum, mean and standard error of each of maize input variables used by households during 2024/25 production years in the study area.

Table 7. Summary statistics of variables used to estimate the production function

Variable	Min	Max	Mean	StDev
Yield(Qt)	5	180	32.1	23.37
Land(ha)	0.13	6	0.94	.77
Seed(Kg)	2.5	150	25.8	21.5
Oxen(oxen day)	3	36	12.64	6.96
Labor(man day)	9	168	30.3	21.1
NPS(Kg)	25	200	91.14	34.34
UREA(Kg)	25	100	55.4	10.37
Chem(liter)	0.14	6.44	1	0.82

Source: Own computation, 2024/25

Table 8, depicted minimum, maximum, mean and standard deviation of each of the variables used in the cost function along with their contribution to the total cost of production.

Table 8. Maize production and input costs

Variable	Min	Max	Mean	StDev
Yield(Qt/ha)	4.45	205.2	32.1	26.1
Cost of Land(Birr/ha)	2430	108,000	16,899	13727.15
Seed Cost(kg/ha)	361.16	16,669.08	2,608.25	2118.69
Oxen Cost(Birr/ha)	750.58	34,642.14	5,420.53	`4403.13
Labor Cost(Birr/ha)	1256.79	5,8005.48	9,076.25	7372.69
NPS Cost(Birr/ha)	639.85	29,531.34	4620.83	3753.53
UREA Cost(Birr/ha)	218.94	10,105.08	1581.16	1284.39
Chemical Cost(Birr/ha)	97.74	4,510.92	705.83	573.35
Total cost(Birr/ha)	5613.1	259,064.04	40,536.32	32927.88

Source: Own computation, 2024/25

Econometric Result

Estimation of Production and Cost Functions

Stochastic production frontier model of Cobb-Douglas function form was fitted with maize output produced in quintals as dependent variable along with six input variables: land in hectare, NPS fertilizer in Kg, oxen in oxen day, amount of maize seed used in Kg, Labor used in Labor man day, amount of chemical used in liter and amount of UREA fertilizer used in Kg under maximum likelihood estimation. The model result indicated that all input variables had a significant and positive affect the level of maize output production (Table 9). As observed from the estimated model result, land, NPS fertilizer, UREA fertilizer, had significantly effect on the amount of maize output produced at 1% significance level. From the result it can be observed that as the input such as land, NPS, Oxen, seed, labor pesticides and UREA would increase by 1% the maize output production will be increased by 0.57%, 0.084%, 0.13%, 0.23 and 0.13% respectively.

Table 9. Estimate of Cobb-Douglas frontier production

LnOutput	Coefficient	Standard eror.
lnLand	0.57***	0.088
LnFertilizer	0.081***	.013
LnOxen	0.084**	.033
LnSeed	0.13*	.089
LnLabor	0.23***	.083
Chemical	0.032**	.014
LnUREA	0.13***	.061
Constant	6.3***	.435
Sigma square	0.434	.101
Lambda	1.18	.196
Log likeli hood	-187.7	

Source: Own computation, 2024/25

*Note: *, ** and *** significant at 10%, 5% and 1% significance level, respectively.*

The ratio of the standard error of u_i to the standard error of v_iv known as lambda (λ) was 1.18. additionally the estimated value of gamma (γ)= λn[/ [1+λ2] = 1.3924/2.18= 0.639, which revealed that 63.9% of total variation in maize farm output among sampled maize producers farmers were due to existence of inefficiency (Table 10). The return to scale coefficient was 1.225 which revealed that 1% increased in all inputs proportionally increased maize production by 1.225% which increasing return to scale production stage. According to this value there is potential for maize producers to continue to expand maize production because they were operating in stage I production, where under use of resource is believed to be inefficient (Table 10).

Table 10. Estimate of dual cost Cobb-Douglas frontier production function

Variables	Coefficient	Standard Error
Constant	2.86***	0.733
Cost of NPS)	0.134***	0.032
LnPlabor	0.38***	0.078
LnPSeed	0.122*	0.078
LnPland	0.406**	0.058
LnPoxen	0.183*	0.066
LnpUREA	0.167***	0.079
LnPChem	0.019*	0.021
LnOutput	0.129	0.083

Source: Own computation, 2024/25

*Note: Represent price, *, ** and *** significant at 10%, 5% and 1% significance level, respectively.*

Efficiency scores

The mean technical, allocative and economic efficiencies of the sampled maize producers were 69.8%, 62% and 44.3%, respectively (Table 11). These implied that there are substantial inefficiencies in smallholder maize producer farmers in the study area. The mean technical efficiency score indicated that, if sampled smallholder maize producers households operated at full efficiency level, would possible to increased maize output through existing resource and level of technology by 31.2% or in average the input used by sampled smallholder maize producers in study area could possible decreased by 31.2% to produce the output they are currently produced. The mean score of allocative efficiency result indicated that on average the sample households could increase maize output by 38 %, if sample households used the right inputs and produced the right output relative to the input costs and output prices.

Table 11. Maize technical, allocative and economic efficiencies scores

Efficiency	Mean	StDev	Min	Max
Technical	0.698	0.108	0.3097	0.876
Economical	0.443	0.180	0.11	0.84
Allocative	0.620	0.212	0.22	0.96

Source: Own computation, 2024/25

The mean economic efficiency showed that there was a significant level of inefficiency in the production process. The mean economic efficiency 44.3% smallholder maize producers of the study area could increase maize production in average by 55.7%, if they would operate at full technical and allocative efficiency levels of production. The result of overall efficiency score shows that there was existence of technical, allocative and economic inefficiency among the smallholder maize producing farmers in the study area (Table 11).

Determinants of efficiency in Maize production

The Tobit model output results revealed that sex of household head, education level of household head, soil fertility status, off-farm income and access to improved seed had a significant effect on technical efficiency of maize producer farmers. Education level of household head, farm size, livestock holding (TLU), credit access and market distance had a significant effect on allocative efficiency while sex of household head, education level, soil fertility status, livestock holding (TLU), access to extension visit, off-farm income, credit access, training and market distance had significant influence on economic efficiency of smallholder maize producers farmers in the study area (Table 12).

Sex of the household head had positively affected technical, economic and allocative efficiency levels of maize producer smallholder farmers in study area (Table 12). Being male households efficiency increased by 2.1% in from male headed than female headed maize producer smallholder farmers which implied that, male headed maize producer farmer households were technically and economically more efficient than female headed maize producer households because male maize producer farmers to employee available resource and operate using available technology at full capacity and strong decision making behavior than female headed households in risk taking, on the exposition he could easily understand agricultural extension and apply their skills and experiences in maize production decisions. This result is similar to the study by(Belete, 2020; Asfaw et al., 2024)

Education level of the household head in smallholder maize production had positive and significant effect on technical, allocative and economic efficiency implied that more educated smallholder maize producing farmers were more technically, in resource allocation and economically efficient than those who have relatively less education smallholder maize producer farmers in study area. These due educated farmers are able to perceive, interpret and respond to new information and adopt improved technologies such as fertilizers, pesticides and planting materials much faster than non-educated smallholder farmers. The model result also revealed that, a year increase in educational level of the household head increases the probability of the farmer being technically, allocatively and economically efficient by 9%, 1.2% and 9.6 respectively (table 12). This result was consistent with the findings of (Legese *et al.,* 2024).

The coefficient for livestock holding (TLU) had positively influenced allocative and economic efficiency at 5% and 10% significance level which revealed that keeping all other factors constant, a one unit increased in livestock holding would increase the probability of a farmer being resource allocation and economically efficient by 2.4% and 4.4%, respectively in study area (Table 12). This finding was consistent with the result obtained by (Alemu et al., 2024) From the result there also was a positive and statistically significant relationship between farm size and allocative and economic efficiency at 1% significance level and a unit change in farm size would result in 8.7% and 9% increase in allocative and economic efficiency respectively keeping all other factors constant. This result implied that, those farmers with large farm size can better diversify their crops and maize production. Legese *et al.,* (2024) also reported that land holding have significant and positive effect on the maize production in west Haraghe zone.

Extension visit was positive and significantly affected the level of economic efficiencies of sample maize producers at 10% significance level. This result revealed that, keeping all other factors constant, a unit increased in extension visit would made the probability of a small maize producer farmers are being economically efficient by 0.9% in the study areas. The extension is assumed to help the farmers in adoption of improved technologies, technical know-how and skill in managing their scarce resources (Table 12). This result is in line with the findings of (Jolex, 2022; Adela and Shalamo, 2025). Results of this study also indicated that there was a positive and statistically significant relationship between use of improved maize seed and technical efficiency at 5% significance level in the study area, and improved maize seed would result in 5% change in the probability of a farmer being technically efficient keeping all other factors constant. This finding is similar to (Guye *et al.,* 2025).

Table 12. Determinants of Technical Allocative and Economic Inefficiency

Inefficiency Variable	TE		AE		EE	
	Coif	Std,er	Coif	Std,er	Coif	Std,er
Age	-0.021	0.053	0.009	0.002	0.023	0.018
Sex	-0.042*	0.023	0. 029	0.041	-0.032**	0.015
Family size	0.003	0.005	-0.003	0. 008	0.004	0.007
Education level	-0.09**	0011	-0.031*	0.018	-0.051*	0.028
Soil fertility	-0.179*	0.097	0.012	0.026	-0.096**	0.046
TLU	-0.38	0.056	-0.024**	0.012	-0.044*	0.026

Farm size	0.051	0.057	0.087***	0.039	0.090***	0.037
Maize plot	0.005	0.022	0.021	0.035	0.015	0.030
off-farm income	-0.04**	0.021	0.039	0.032	-0.048*	0.028
Credit	0.008	0.021	-0.056*	0.031	-0.046*	0.026
improved seed	-0.05**	0.022	0.008	0.017	-0.052	0.037
Extension visit	0.024	0.016	-0.050	0.032	-0.095*	.054
Training	0.008	0.039	0.027	0.046	-0.091***	0.037
Market Distance	0.003	0.005	0.036***	0.016	0.061***	0.028

Source: Own computation, 2024/25

*Note: *, ** and *** significant at 10%, 5% and 1% significance level, respectively.*

Reason of farmer's underutilization of resource in maize production

Input supply system factors were a serious problem that farmers were facing in the locality followed by poor quality seed, fertilizer and environmental factors. About 91.7 % of respondents reported that they were facing shortage of improved seed described poor quality through mixed seed, forced agro ecology by supplying midland seed to highland or lowland. Fertilizers supplied lately and additional cost added to farmers at the local area and its price is more than what government price claim. In addition the fear risk of Drought, disease and crop pest. In addition to this the respondents also reported Low productivity of local seed, seed availability and labor during peak agricultural production seasons in the study areas due to poor input supply system(Table 13).

Table 13. Agricultural production constraints

Constraints	Category	Freq	Percent	Rank
poor input supply	Improved seed	220	91.7	
	Fertilizer	10	4.2	
	Herbicide	5	2.1	1
	Insecticide	5	2.1	
Poor Quality seed	Mixed	100	41.7	2
	Forced Agro ecology	60	25	
	Supplied lately	30	12.5	
	Small quantity	50	20.8	
fertilizer	Not soil test based	165	68.8	3
	Supplied lately	40	16.7	
	Over cost	35	14.6	
Environmental factors	Drought	155	64.6	4
	Disease	60	25	
	Pests	25	12.4	

Source: Own computation, 2024/25

IV. CONCLUSIONS

This study examined the production efficiency of smallholder maize farmers in the midland areas of Guji Zone using a stochastic frontier approach and Tobit model. The results revealed that maize producers operate below the potential production frontier, indicating substantial inefficiencies in the use of available resources and existing technology.

The estimated mean technical, allocative, and economic efficiency levels of 69.8%, 62%, and 44.3%, demonstrated that farmers could significantly increase maize output without additional inputs by improving efficiency. Technical efficiency result implies that maize output could be increased by about 30% using existing resources, while the low economic efficiency indicates considerable cost inefficiency in input use and allocation decisions. The increasing returns to scale observed suggest that farmers are not yet operating at optimal input levels, indicating room for productivity improvement through better resource utilization.

The Tobit model results highlighted both socioeconomic and institutional factors play a crucial role in shaping efficiency levels. Education, soil fertility status, access to improved seed, and engagement in off-farm income activities significantly improved technical efficiency. Allocative efficiency was influenced by education, farm size, livestock ownership, credit access, and market distance, while economic efficiency was significantly affected by education, extension services, training, credit access, livestock holding, and market access. These findings emphasize that inefficiency is not only a technical issue but also strongly linked to institutional support systems and farmer capacity. Overall, the study confirms that improving production efficiency rather than expanding resource use is a viable pathway to enhance maize productivity and food security in the study area.

V. RECOMMENDATIONS

Based on the findings, the following policy and practical recommendations are proposed.

1. Improve Agricultural Extension service: Improving the frequency and quality of extension services is essential to enhance farmers' technical and economic efficiency. Extension programs should focus on, proper input utilization (fertilizer application, seed rate, and chemical use)**,** improved agronomic practices**,** Farm management and decision-making skills

2. Improve Access to Quality Input: Strengthening local seed systems and promoting certified seed distribution is critical, Ensuring timely availability of inputs aligned with the cropping calendar and Enhancing quality control mechanisms to avoid distribution of mixed or unsuitable seed varieties

3. Increase education and training for farmers: it is suggested to increase adult education and farmers field schools in order to provide hands-on skills development and training in producing maize. This includes promotion of knowledge exchange through demonstrations.

4. Improve Rural Financial Services: credit access had been shown to enhance efficiency. This implies:

- ✓ Increase access to financial credit in agriculture
- ✓ Designing flexible credit programs designed for small scale farming operations.
- ✓ Linking the provision of credit services with input supply and extension support.

5. Market and Rural Infrastructure Improvement: Distance to market had been observed to negatively impact efficiency. This means that:

- ✓ Improve road infrastructure in rural areas in order to lower transaction cost.
- ✓ Better market linkages and information system should be improved
- ✓ Farmers' cooperative have to promoted

6. Address Soil Fertility Constraints: Soil fertility significantly affects efficiency levels. Therefore:

- ✓ Promote soil fertility management practices such as integrated soil fertility management (ISFM)
- ✓ Encourage soil testing and site-specific fertilizer recommendations
- ✓ Support sustainable land management practices

7. Encourage Diversified Income Sources: Off-farm income positively influenced efficiency by relaxing liquidity constraints. Hence:

- ✓ Promote rural non-farm employment opportunities
- ✓ Support income diversification strategies

Hence, improving maize production in the study area does not primarily require new technologies, but rather better utilization of existing resources, strengthened institutional support, and enhanced farmer capacity making efficiency improvement a cost-effective and scalable pathway to agricultural transformation.

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