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Economic Efficiency of Onion Production in East Shewa Zone, Oromia Region, Ethiopia

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Authors' contributions

This work was carried out in collaboration among all authors. All authors read and approved the final manuscript.

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ABSTRACT

In an economy where resources are scarce and opportunities for new technologies are lacking, efficiency studies able to show the possibilities to raise productivity by improving efficiency of farms without increasing the resource base or developing new technology. This study investigated Economic Efficiency of Onion Production in East Shewa Zone, Oromia Region, Ethiopia. Both primary and secondary source of data were used. Semi- structured questionnaires were used to collect data from Lume, Bora and Dugda districts. Totally 94 respondents randomly selected from each districts based on sample size determination. A stochastic production frontier function was fitted to the sample households. Tobit model was applied to determine factors affecting economic efficiency of onion production. The result revealed that the mean Technical, Allocative and Economic efficiency of onion production was about and 67.60%, 98.99% and 66.91% respectively. The tobit model result revealed that Onion Technical and Economic efficiency were positively and

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significantly affected by Experience in Onion production, frequency of Extension contact and Non-and off income activities while land allocated for Onion production affect Technical and economic efficiency negatively and significantly. District office of Agriculture, stockholders and concerned bodies should focus on extension service regarding of full package of production, provision of technical support and farmers should practice different Non-and Off-fam activities to improve his/her income that contribute to the improvement in efficiency of Onion production in the study area.

Keywords: Efficiency; East Shewa; frontier model; tobit model.

1. INTRODUCTION

1.1 Background of the Study

"The economy of Ethiopia, which relies heavily on agriculture as a source of income Agricultural Sector contributes about 34.1% to the gross domestic product, Accounts for 79% of foreign earnings and the major sources of raw material and capital for investment and market" [1].

"Horticultural crop production in Ethiopia is scattered throughout the country on patches of land in peasant smallholder farm. Large scale production and processing of vegetables is carried out only by state organizations" [2]. "This commercial production is concentrated in the eastern parts of the country, rift valley areas. Ethiopia has a variety of fruits, leafy vegetables, roots and tubers adaptable to specific locations and altitudes. The major producers of horticultural crops are small scale farmers, production being mainly rain fed and few under irrigation. Vegetables, supply essential micro-nutrient in human nutrition that act as preventive agents to several ailments. Its production increment may improve food security and offer employment opportunities to the populace, especially women who form a substantial proportion" [3]. "Varieties of vegetable crops are grown in Ethiopia in different agro ecological zones, as a source of income and food" [4].

"Onion (Allium cepa) is a main bulb crop in Ethiopia. Onion was introduced to the agricultural community of Ethiopia in the early 1970s" [5]. It was newly introduced and rapidly becoming acceptable by producers and consumers. Currently, it is widely grown by small-holder farmers and commercial growers throughout the year for local use and export market.

"Onion is a high-value bulb crop that has produced by smallholder farmers and commercial growers for both local and export markets in Ethiopia" [6]. "It ranked the second in production of all vegetable crops next to Onion, which has been concentrated in the central rift valley of the country particularly in the upper Awash and Lake Ziway areas" [7]. "Onion is currently becoming a popular crop relatively despite to its recent introduction to the country because of its yield potential per unit areas, the ease of propagation method both by seed and bulb method, and the presence of high domestic and export markets" [8].

"Onion production play an important role in improving household's income, nutrition and food security" [4]. "Onion, the principal alliums, ranks second in value after onions on the list of cultivated vegetable crops" [9]. "Onion covers 14.67% of the land allocated for root crops production of the land that allocated for vegetable production. From the total annual production of vegetable onion shared 7.07% of root crop production [10]. Onions are low value products but important for many farmers in Ethiopia. Onion is produced for both consumption and market" [11]. East Shewa zone is known by onion production in Ethiopia. However, the production and productivity of Onion is very low compared to the potential yield in the in general and in East Shewa zone in particular.

1.2 Statement of the Problem

Population pressure, traditional agricultural production technology, weak institutional support and natural catastrophe are the major constraints to agricultural growth of Ethiopia [12]. The traditional agricultural production technology includes poor and backward farm tools and farming practices, limited application of modern inputs (improved seeds and fertilizers), and poor animal breed, poor and inadequate transportation and storage facilities, primitive and weak irrigation system and inadequate credit facilities [13]. According to [14], the performance of agricultural sector was very poor at grass root level due to limited financial resources and poor agricultural technologies.

The average onion yields at national level was 9.76 ton/ha (CSA, 2017). But, the average yields of onion on research station was 35 ton/ha. This indicated that the productivity of onion is very low compared to their potential yields. This gap may occurs due to in efficient use of modern technologies (improved varieties, modern irrigation schemes, fertilizers, chemicals, mechanization and other improved practices). Due to the fact of onion is an important vegetable crop in Ethiopia daily diet and people's livelihood. However, the production and productivity of the crop are far below (10.02t/ha) the world average (19.7t/ha) despite to its year-round production scenarios [15]. It is important to determine the economic efficiency of onion production to increase production. Thus, this study initiated to identify gaps on onion economic efficiency in selected districts of East Shewa zone and generate location specific information.

1.3 Objectives of the Study

The overall objective of this study was to examine producers' technical, allocative and economic efficiencies of onion production in East Shewa zone of Oromia region, Ethiopia.

The specific objectives of the study were:

1. To estimate technical, allocative and economic efficiencies of onion producing smallholder farmers.
2. To identify factors affecting the level of technical and economic inefficiencies of onion producing farmers.

2. METHODOLOGY

2.1 Description of the Study Area

The study was conducted in East Shewa Zone which found in central part of Oromia National Regional State, Ethiopia. East Shewa Zone lies between 60o 00' N to 70o 35'N and 380o 00'E to 400 00'E. East Shewa Zone has different agro-ecologies which categorized as highland, midland and lowland agro-ecologies. In the Zone, 18.70% of the agro-ecology is high land, 27.50% is midland and 53.80% is lowland. The Zone received 350mm-1150 mm annual rain fall and has uni-modal nature of rain fall pattern. This Zone was received 12^{o}C-39^{o}C annual temperature per year [16]. The sample districts were Lume, Dugda and Bora. Lume district is one of the district potential for onion and tomato production. The district agro ecologies consists about 30% high land, 45% midland and 25% low land. The average temperature is about 23^{o}C and altitude of 1604 above sea level [17].

Dugda district is one of the potential onion producer found in East Shewa zone. The district is located 132 km south of the capital, Addis Ababa and has an altitude ranging from 1500 to 2300m above sea level. Dugda district has a land size of 146,800 ha and a population of 144,910 [18]. Bora district is one of the district potential for onion and tomato production. The district 100% low land agro ecologies. The average temperature is about 23^{o}C and altitude of 1880 above sea level [19].

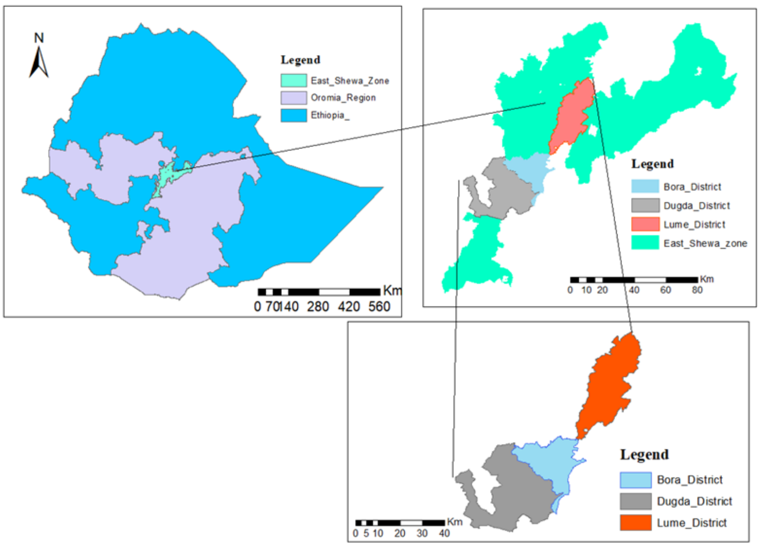

Fig. 1. Map of the study area

Source: Own sketch Arc map version 10.1, 2022

2.2 Data Types, Sources and Methods of Data Collection

Both qualitative and quantitative types of data were used. Primary and secondary source of data were used for this study. Primary data was collected by interviewing sample onion producers households by preparing semi-structured questionnaire. Key informant interview and focus group discussion was also conducted to exhaustively identify production problem pertain to onion before conducting primary data collection. Secondary data relevant for this study was collected from East Shewa office of agriculture and natural resource, CSA, and from published and unpublished sources.

2.3 Sampling Procedure and Sample Size

The target population for this study onion producers in East Shewa Zone. East Shewa zone is known onion production. Multi-stage sampling procedure was employed in order to select the sample. The first stage sampling encompasses random selection of onion producer districts from the list of onion producers' districts. In second stage, Representative Kebeles was selected randomly. In third stage sampling involves the random selection of farming households.

In the second stages 94 sample households were randomly selected from five sample *kebeles* based on probability proportional to size sampling technique. The sample size was determined based on Yamane (1967) formula:

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

Where: n = is the sample of onion producer households that will be taken from onion producer households in the district, N = is the total number of onion producer households in the zone and e = 0.1% is the level of precision.

The total number of households is 1567, so sample size is calculated as follows:

$n = \frac{1567}{1+1567(0.1)^2} = \frac{1567}{16.67} = 94$. Therefore, 94 sample households were selected randomly formal interview.

2.4 Methods of Data Analysis

Descriptive statistics and econometric model were used for analyzing the data.

2.4.1 Descriptive statistics

Descriptive statistics such frequency distribution, mean, standard deviation and percent as well as t-test and chi-square test will be used to describe data and to see the relationship between the variables in the study.

2.4.2 Econometric model specification

This study was employed stochastic efficiency decomposition method of [20] to decompose TE, EE and AE.

"Economic efficiency (EE) refers to the complete minimization of economic waste either, for any observed level of output, inputs are minimized, or for any observed level of inputs, outputs are maximized, or some combination of the two" [21].

"Technical efficiency (TE) the physical component of production which measures the ability of a farmer to produce the maximum feasible output from a given bundle of inputs or produce a given level of output using the minimum feasible amounts of inputs" [22]. "It is a measure of a farm's success in producing maximum output from a given set of input" [23].

Table 1. Sampling frame and sample size

Name of sampled kebeles	Total onion producers households (number)	Proportion sampled Households (%)	Number of sample household heads (number)
Walda Makdala	230	21.28	20
Walda Kelina	207	19.15	18
Koka Nagawoo	229	21.28	20
Dungugi Bekele	184	17.02	16
Mellima	230	21.28	20
Total	**1080**	**100**	**94**

Source: DOANR and Own computation, 2020

“Allocative efficiency (AE) involves the selection of an input mix that allocates factors to their highest valued uses and thus introduces the opportunity cost of factor inputs to the measurement of productive efficiency” [24].

Stochastic Frontier approach (SFA) was used for its ability to distinguish inefficiency from deviations that are caused by factors beyond the control of farmers. Farmers possess the potential to achieve both technical efficiency (TE) and allocative efficiency (AE) in farm enterprises, but inefficiency may arise due to a variety of factors, some of which are beyond the control of the farmers [25]. The assumption that all deviations from the frontier are associated with inefficiency, as assumed in DEA, is difficult to accept, given the inherent variability of agricultural production due to many factors like climatic hazards, plant pathology and insect [26]. The stochastic frontier model can be expressed in the following form.

$$Yi = \mathrm{f}\,(\mathrm{Xi};\beta)\ \text{i=1, 2, 3,..., n} \tag{1}$$

Where Yi is the production of the ith farmer, Xi is a vector of inputs used by the ith farmer, β is a vector of unknown parameters, Vi is a random variable which is assumed to be N$\sim(0,\delta 2)$ and independent of the Ui which is nonnegative random variable assumed to account for technical inefficiency in production. The variance parameters for Maximum Likelihood Estimates are expressed in terms of the parameterization

$$\delta s^2 = \delta v^2 + \delta^2 \text{ and } \gamma = \frac{\delta^2}{\delta s^2} = \frac{\delta^2}{\delta v^2 + \delta^2} \tag{2}$$

Where,

σ^2 is the variance parameter that denotes deviation from the frontier due to inefficiency
$\sigma^2 v$ is the variance parameter that denotes deviation from the frontier due to noise
σs^2 is the variance parameter that denotes the total deviation from the frontier

Cobb–Douglas stochastic production frontier function will be used to estimate the production function and the determinants of economic efficiencies among onion producers in the selected districts of East Shewa zone. The nature of the Cobb-Douglas production and cost functions provides the computational advantage in obtaining the estimates of TA and EE. According to [27] inadequate farm level price data together with little or no input price variation across farms in Ethiopia precludes any econometric estimation of a cost function [28]. Indicated that the corresponding dual cost frontier of the Cobb Douglas production function could be rewritten as:

$$Ci = C(Wi, Yi*;\ \alpha) \tag{3}$$

Where i refers to the ith sample household; Ci is the minimum cost of production; Wi denotes input prices; Yi* refers to farm output which is adjusted for noise vi and α’s are parameters to be estimated. To estimate the minimum cost frontier analytically from the production function, the solution for the minimization problem given in Equation 4 is essential [27].

$$\mathrm{MinCx} = \sum \omega_n X_n$$

$$\text{Subject to } Y^{i}_{k}{}^{*} = \hat{A}\textstyle\prod_{n} X_n{}^{\beta}{}_{n} \tag{4}$$

where;

ω_n =input price
β_n = parameter estimates of the stochastic production function
Y_{ki}*= input oriented adjusted output level

The economically efficient input vector for the i^{th} farmer derived by applying Shepard’s Lemma and substituting the firms input price and adjusted output level into the resulting system of input demand equations.

$$\frac{\alpha Ci}{\alpha \omega n} = Xi(\omega i, Yi*; \theta) \tag{5}$$

where θ is the vector of parameters and n=1,2,3,...N inputs

The observed, technically and economically efficient cost of production of the ith farm are equal to, $\omega i Xi$ and $\omega i' Xi^t$. Those cost measures are used to compute technically and economically efficient indices of the ith farmer as follows:

$$\mathrm{TE_i} = \frac{\omega i' Xit}{\omega i' Xi} \tag{6}$$

$$\mathrm{EE_i} = \frac{\omega i' Xit}{\omega i' Xi} \tag{7}$$

Following [29] allocative efficiency index of the i^{th} farmer can be derived from Equations 7 and 8 as follows;

$$\mathrm{AEi=EEi/TEi} = \frac{\omega i' Xit}{\omega i' Xi} \tag{8}$$

2.4.3 Determinants of efficiency scores

To determine the relationship between socioeconomic and institutional factors and indices of efficiencies will be computed, a two-limit tobit model will be used. The model is adopted because the efficiency scores are double truncated at 0 and 1 as the scores lie within the range of 0 to 1 [30]. The following relationship expresses the stochastic model underlying tobit [31]:

$$\mathrm{Yi} = \beta o + \sum \beta_m Z_{jm} + \mathrm{Ui} \tag{9}$$

Where yi* = latent variable representing the efficiency scores of farm j, β_o and β_m = a vector of unknown parameters, Zjm = a vector of explanatory variables m (m = 1, 2, ..., k) for farm j and μ_j= an error term that is independently and normally distributed with mean zero and variance σ^2.

$$Yi = \begin{cases} 1 \text{ if } \mathrm{yi} * \geq 1 \\ \mathrm{yi} * \text{ if } 0 < yi * < 1 \\ 0 \text{ if } \mathrm{yi} * < 0 \end{cases} \tag{10}$$

2.4.4 Explanatory variables and description

Table 2. Summary of variables description and hypothesis

Dependent variables			
TE (Technical Efficiency) and EE (Economic Efficiency)			
Independent variables	**Variable description and measurement**	**Unit**	**Expected signs**
Age	Age of household head	Years	**+**
Household size	Number of persons per household	Number	**+**
Education	Number of years of formal education	Years	**+**
Livestock	Total number of livestock owned	TLU	**+**
Experience in onion farming	Experience of farmer onion and onion production	Years	**+**
Farm size	Total farm size of the household	Hectare	**+/-**
Extension contact	Frequency of extension contact during cropping period	Number	+
Distance to farmers training centre (FTC)	Distance of farmer house from farmers training centre	kilometers	-
Credit	Use of credit for onion and onion (1= yes, 0 = no)	Dummy	**+**
Distance to all-weather roads	Distance of farmer house from nearby road	Kilometers	-

3. RESULTS AND DISCUSSION

3.1 Descriptive Statistical Results

The average age of the sample respondents were found to be 31 years. This result implied that the sample respondents were work age group and can increase production if they get technology and training. The average family size of the sample households was 4.12 persons per household, which is less than the national average of 4.6 persons per household [32].

The farming experience of Onion production was about 5.94 years. This implies that the producers can increase the efficiency as their experience increase since they were work age groups. The average areas covered by Onion was about 1.17 hectares. The average livestock holdings measured in terms of tropical livestock unit (TLU) were found to be 5.77 (Appendix Table 1). The average distances to travel from farm to the farmer training center and market center were 2.24 and 5.28 kilometers by sample farmers in the study area respectively. The average distance all-weather road from the study area was 3.98 km. The sample households in study area are sale their product at farm gate, as a result there is a problem of road directly connects from farm site to all-weather road (Table3).

Table 3. Summary of descriptive continuous variables

Continuous variable	Mean	Std.Dev.
Age of households	30.68	6.50
Onion production experience (Years)	5.94	3.84
Family size (Numbers)	4.12	2.47
Land allocated for Onion (Hectares)	1.17	0.77
Number of livestock (TLU)	5.77	5.35
Distance to Weather roads (Kilometer)	3.98	3.29
Distance to Farmer training centre (km)	2.24	1.88
Distance to Market centre (km)	5.28	3.43

Source: Own survey result, 2020

Table 4. Summary of descriptive dummy variables

Dummy variables	Percent	
	Yes	No
Off/non-farm	11.70	88.3
Education (Literate and illiterate)	97.87	2.13
Access to extension service	62.77	37.23
Access to credit	24.47	75.53

Source: Own survey result, 2020

Out of the total households interviewed only 11.70% participated in non/off-farm activities. The result implied that participation of non/off-farm activity is low. About 97.87% were literate and 2.13% illiterate. This shows that farmers can easily understand agricultural instructions and advice provided by the extension workers. About 62.77% of sample respondents get extension service from development agents, NGOs, district agricultural office and research center. The extension services given to sample respondents were mostly focused on input use, production and post-harvest management of main crops but not such on Vegetables. During the reference cropping season, 12.77% of the sample farmers had access to credit either in the form of cash or kind. However, the majority of sample respondents (about 87.23% of them) had not used credit because of high interest rate, shortage of credit service, amount of credit low and inappropriate payback period of received loan (Table 4).

3.2 Results of the Econometric Model

Hypotheses stated in the model specification part and validity of the model which is used for analysis has to be tested before estimating the parameters of the model.

The appropriateness of the stochastic frontier model over the convectional production function can be tested using the statistical significance of the Stochastic Production Frontier Ordinary Least Square parameter gamma, Ý. The estimated value of gamma is equal to 0.983 for production of Onion which is statistically significant at 1% level of significance. The estimated value of gamma signifies that 98.3% of the variation in output is due to the variation in technical inefficiency among the farmers while the remaining 1.7% of output variation is due to due to variation in random shocks. This indicates that there is wider room to increase productivity of farmers in the study area through identification of principal factors affecting technical efficiency. Hence, the production function estimation using SPF analysis is more appropriate than convectional production function.

The other hypothesis testing is the test for returns to scale. The results of the estimation made under both model specifications, constant and variable return to scale, show that the value of log-likelihood functions equal to -48.108 and -55.612 respectively for Onion production. Thus, the log likelihood ratio test is calculated to be 15.01 for production. When this value is compared to the critical value of $\chi2$ at 5 degrees of freedom with 1% level of significance equals to 14.325, the null hypothesis that the Cobb-Douglas production function is characterized by constant return to scale is strongly rejected for Onion production function. The null hypothesis of production in efficiency was accepted.

The gamma (γ) of the MLEs of stochastic frontier production is 0.983. This value is statistically significant implying that 98.3% of variability of production efficiency from Onion production is attributed to output.

The results of the estimated parameters revealed that all the coefficients of the physical variables conform to a priori expectation of a positive signs except fuel. The coefficients of the three physical variables, land, labor and seed are significant even at 1% and 5% level of significance. The positive coefficient of land, labor and seed implies that as each of these variables is increased, ceteris paribus, Onion output increased. The coefficient of the variable associated with fertilizer, agro chemical and fuel although positive, is statistically not significant even at 10% level of significance. Therefore these are the less factors explaining onion production in study the area. The finding agrees with [33].

The appropriateness of the stochastic frontier model over the convectional production function can be tested using the statistical significance of the Stochastic Production Frontier Ordinary Least Square parameter gamma, Ý. The estimated value of gamma is equal to 0.3964 for Onion cost of production. The estimated value of gamma signifies that 100% of the variation in output is due to the variation in allocative inefficiency among the farmers. Hence, the production function estimation using SPF analysis is more appropriate than convectional production function. The gamma (γ) of the MLEs of stochastic frontier production is 0.3964. This value is statistically not significant implying that 39.64% of variability of cost efficiency from cost where 61.36% variability of cost efficiency were attributed from Onion output (Table 5).

The production function estimation using SPF analysis is more appropriate than convectional production function. Therefore the Trans log frontier was used to predict allocative efficiency of onion cost function. Accordingly more inputs except cost of land and tractor cost for ploughing were significant at 1% significance level (Table 6).

3.3 Estimation of Technical, Allocative and Economic Efficiencies of Onion Producing Smallholder Farmers

The study indicated that 67.6%, 98.9% and 66.9% were the mean levels of technical, allocative and economic Efficiency of Onion production respectively. This in turn implies that farmers can increase their Onion on average by 32.4% at the existing level of inputs and current technology by operating at full technical efficient level. There is huge gap among farmers in sample study which range 19.5% to 92.4% for Onion production. This result needs to extension intervention by arrange experience sharing between farmers to reduce the efficiency gap (Table 7).

Table 5. Estimated Onion stochastic production and cost frontier function

Variables	**Production frontier**		**Variables**	**Cost frontier**	
	ML estimate			**ML estimate**	
	Coefficient	**Std.Err**		**Coefficient**	**Std.Err**
Intercept	6.826***	0.699	Intercept	2.027***	0.187
LnLand	0.381***	0.142	LnLandcost	0.050	0.065
LnLabor	0.482***	0.123	LnLaborcost	0.448***	0.029
LnSeed	0.191**	0.086	LnSeedcost	0.168***	0.015
LnFertilizer	0.082	0.081	LnFertilizercost	0.086***	0.017
LnChemical	0.061	0.048	LnChemicalcost	0.076***	0.009
LnFuel	-0.008	0.068	LnFuelcost	0.115***	0.013
			Lntractorcost(land ploughing cost)	0.024	0.062
	∑β= 1.188				
$\sigma^2=\sigma^2u+\sigma^2v$	2.403 ***			0.0096	
$\lambda=\sigma u / \sigma v$	7.715***	2.423		0.810	0.800
γ (gamma)	0.983 ***			0.3964	
Log likelihood	-48.108			101.91	
LR test	15.01			-0.00058	

***and ***, Significant at 5% and 1% significance level respectively. Source: Own computation, 2020*

Table 6. Estimated Onion cost of production by Trans log function

Variables	Cost frontier ML estimate Coefficient	Std.Err
Intercept	10.68***	1.090
$LnLandcost^2$	0.083	0.086
$LnLaborcost^2$	0.494***	0.028
$LnSeedcost^2$	0.203***	0.016
$LnFertilizercost^2$	0.115***	0.020
$LnChemicalcost^2$	0.105***	0.011
$LnFuelcost^2$	0.143***	0.014
$Lntractorcost^2$	0.022	0.082
Lambda	0.017	0.750
Log likelihood	-98.41	

***and ***, Significant at 5% and 1% significance level respectively. Source: Own computation, 2020*

Table 7. Efficiency estimation by stochastic production frontier model

Types of commodity	Efficiency	Mean	St.dev.	Minimum	Maximum
Onion	Technical Efficiency	0.676	0.195	0.096	0.924
	Allocative Efficiency	0.989	0.00008	0.0.98	0.99
	Economic Efficiency	0.669	0.193	0.095	0.914

Source: Survey data, 2020.

Table 8. Returns to scale of Onion inputs parameters of stochastic frontier

Variables	Onion Elasticities
LnLand	0.381
LnLabor	0.482
LnSeed	0.191
LnFertilizer	0.082
LnChemical	0.061
LnFuel	-0.008
Returns to scale	**1.188**

Source: Survey data, 2020.

3.4 Returns to Scale Onion Production

The return to scale (RTS) analysis, which serves as a measure of total resource productivity, is given table 5. The maximum likelihood estimates (MLE) of the Cobb-Douglas based stochastic production function parameter of 1.188 the estimated inputs (elasticities) of Onion. It indicates that Onion production in study area is stagy I of increasing returns to scale where resources and production were believed to be efficient. This means an increase in all inputs at the sample mean by one percent will increase Onion by 1.484% in the study area (Table 8).

3.5 Determinants of Technical and Economic Efficiencies in Onion Production

Variance inflation factors (VIF) was computed for all explanatory variables that are used in the Tobit model and the result shows VIF values of less than 10 indicating multicollinearity was not a problem. Robust method was also employed to correct the possible problem of heteroscedasticity. Outliers were checked using the box plot graph so that there were no serious problems of outliers and no data get lost due to outliers.

The model chi-square test indicates that the overall goodness-of-fit of the Tobit model was statistically significant at 1% probability level which in turn indicates the usefulness of the model to explain the relationship between the dependent and at least one independent variable. The result of Tobit model estimation shows that the technical efficiency of Tomato production in East Shewa Zone is significantly influenced by the variables Onion farming experience, Extension contact and non and off farming affect efficiency positively while, land for Onion production affect technical efficiency negatively (Table 8).

Experience of Onion farming: Experience of the household head in Onion farming had positive relationship with Technical and Economic efficiency as prior expectation significantly at 1% significance level. This implies that experienced farmers are expected were more technical efficient because they use improved variety and agricultural technology than other farmers. Experience of farmers in onion production increase by one year, would Technical and Economic efficiency would increase by 2.9 and 2.8% respectively keeping all other factors constant. This result is in conformity with the finding of [34].

Land for Onion Production: Land for Onion sample farmers in Onion farming had negative relationship with Technical and Economic efficiency as prior expectation significantly at 5% significance level. This implies that some studies suggested that small farm size is expected to be more efficient than large farm size because of its simplicity in management and transaction costs. Land allocated for Onion production increase by hectare, Technical and Economic efficiency would decrease by 3.70 and 3.70% respectively keeping all other factors constant. This result is opposite of the finding of [35].

Frequency of extension contact: Frequency of extension contact was found to have a positive and significant influenced on Technical and Economic efficiency of sample Onion producers at 1% and 10% level of significance respectively. This significance indicates that for each additional extension contact Onion producer farmers are more likely to produce Onion efficiently than others. The result implies that an additional unit of extension contact would increase farmers’ technical efficiency and Economic efficiency by 2.9% and 2.8% respectively than others, keeping all other factors constant. They farmers who got the chance to more frequently visit by extension professionals are more efficient than their counter parts. Because it improves the technical knowhow and skill of the farmers thereby exchange of experience will improve the efficiency. Unit of increase extension contact would Technical and Economic efficiency would increase by 0.3 and 0.3% respectively keeping all other factors constant. This is in line with the findings of [36].

Off and non- farm income: The result reveals that off-farm activity has positive and significant effect (at 1% level of significance) on farmers' efficiency. Of course being involved in off/non-farm activities may have a systematic effect on the technical efficiency of farmers. This is because farmers may allocate more of their time to off/non- farm activities and thus may lag in agricultural activities. On the other hand, incomes from off/ non-farm activities may be used as extra cash to buy agricultural inputs and can also improve risk management capacity of farmers. Participation of non/off-farm activity would increase Technical and Economic efficiency by 9 and 8.9% respectively keeping all other factors constant. This is in line with the findings of [37].

Table 9. Tobit results of determinants of technical and economic efficiencies in Onion production

Variables	TE				EE			
	Coefficient	**Robust Std.Err.**	**p>|t|**	**Marginal effect**	**Coefficient**	**Robust Std.Err.**	**p>|t|**	**Marginal effect**
Constant	0.482***	0.070	0.000		0.477***	0.069	0.000	
Age	0.001	0.004	0.747	0.001	0.001	0.004	0.746	0.001
Education level	0.003	0.004	0.524	0.003	0.002	0.004	0.524	0.003
Family Size	-0.015	0.012	0.217	-0.015	-0.014	0.012	0.216	-0.015
Onion	0.029 ***	0.004	0.000	0.029	0.028***	0.004	0.000	0.028

Variables	TE				EE			
	Coefficient	**Robust Std.Err.**	**p>|t|**	**Marginal effect**	**Coefficient**	**Robust Std.Err.**	**p>|t|**	**Marginal effect**
Farming Experience								
Total livestock Unit	-0.002	0.003	0.653	-0.002	-0.002	0.003	0.652	-0.002
Land for Onion production	-0.037**	0.016	0.021	-0.037	-0.037**	0.016	0.021	-0.037
Distance to FTC	-0.025	0.037	0.494	-0.025	-0.025	0.037	0.494	-0.025
Extension contact	0.003***	0.002	0.089	0.003	0.003*	0.002	0.089	0.003
Distance to Weather road	0.054	0.038	0.156	0.054	0.053	0.037	0.156	0.054
Access to credit	-0.058	0.050	0.253	-0.058	-0.057	.050	0.253	-0.057
Non and off farm income	0.090***	0.033	0.008	0.090	0.089***	.033	0.008	0.089

****, **, *: implies statistical significance at 1%, 5% and 10% level respectively. Survey Result, 2020*

4. CONCLUSIONS

The overall objective of this study was to examine producers' technical, allocative and economic efficiencies of onion production in East Shewa zone of Oromia region, Ethiopia. To conduct the study, primary data was collected from 94 randomly selected household heads through semi-structured questionnaire. Secondary data were also collected from different sources including CSA, agricultural office and from published and unpublished sources to supplement primary data. In this study both descriptive statistics and econometric analysis were employed. The primary data was analyzed using descriptive statistics and stochastic efficiency decomposition method to decompose technical efficiency, allocative efficiency and economic efficiency. Stochastic Frontier approach (SFA) was used for its ability to distinguish inefficiency from deviations that are caused by factors beyond the control of farmers.

The descriptive analysis frequency and mean was used to analysis demographic characteristics of sample households. The result also revealed that the mean technical, allocative and economic efficiencies were about 67.6%, 98.9% and 66.9% of for Onion production in study area. The result of Tobit model revealed that, out of total 11 explanatory variables included in the model. Total of three variables found significantly determined technical and economic efficiency of Onion production. To this effect, Onion farming experience, Non- and Off-farming income and frequency of extension contact positively influenced households technical and economic whereas, land for Onion production negatively affected sample households technical and economic of Onion production.

5. RECOMMENDATIONS

Based on the findings of this study, the following recommendations are made.

There is huge efficiency gap among onion producer farmers. Agricultural office and Agricultural research should be focus on farmers experience sharing among farmers to reduce onion efficiency gap.

Off and non-farm affect onion technical and economic efficiency. Therefore farmers should be participate in off and non-farm to in order to sufficient income for purchase onion inputs.

Onion farming experience and frequency of extension contact positively influenced households Technical and Economic efficiency. Therefore Development Agent, Agricultural experts and researcher should focus on extension provision of using improved production technologies and better management practices demonstrate at farm level.

CONSENT

As per international standard or university standard, respondents' written consent has been collected and preserved by the author(s).

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COMPETING INTERESTS

Authors have declared that no competing interests exist.

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APPENDIX

Appendix Table 1. Conversion factors used to compute tropical livestock units (TLU)

Livestock Categories	Conversion factor
Cow/Ox	1
Bull	0.75
Heifer	0.75
Calf	0.2
Horse/Mule	1.1
Camel	1.25
Sheep/Goat	0.13
Donkey	0.7
Poultry	0.013

Source: [33]

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