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

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Abstract: Tomato is one of the major vegetables in Ethiopia experienced massive productivity growth especially central rift valley. Nevertheless, farmers are struggling to find out optimal input combination in their farm that causes inefficient input use as result of Tomato production in the study area was chemical intensive and resource poor farmers out of production. This study investigated Economic Efficiency of Tomato Production in East Shewa Zone, Oromia Region, Ethiopia. A three stage random sampling procedure was used to select 94 sample Tomato producer households from Lume, Dugda and Bora districts. Semi-structured questioners used to collect data from producers. Focal group discussion and key informant interview also used to supplement the data collected from producers. The A stochastic production frontier function was fitted to the sample households. The result revealed that the mean TE, AE and EE was about 54.82%, 92.22% and 50.62% respectively. The result of tobit model on factors affecting technical and economic efficiency revealed that Tomato farming experience and extension contact were found to be positively and significantly affect Tomato technical and Economic efficiency. While Distance to farmers from farmers training center affect it negatively and significantly. District office of Agriculture, stockholders and concerned bodies should focus on farmers experience sharing, providing technical support and farmers practice contribute to the improvement in efficiency of Tomato producer farmers in the study area.

Keywords: Efficiency, East Shewa, Frontier Model, Tobit Model

1. Introduction

1.1. Background of the Study

Agriculture is main economic pillars of the Ethiopian economy and the overall economic growth of the country is highly dependent on the success of the agriculture sector. It contributes about 34.1% to the GDP, accounts 79% of foreign earnings and the major sources of raw material and capital for investment and market [1]. Though agriculture remains the most important sector in the Ethiopian economy, its performance has been disappointing and food production has been lagging behind population growth and also makes the country's economy vulnerable when harvests are destroyed due to drought or exceeding water amounts during the rainy periods.

Varieties of vegetable crops are grown in Ethiopia in different agro ecological zones, as a source of income and food [2]. Exports of vegetable products from Ethiopia have increased from 25,300 tons in 2002/03 and doubled in 2009/10 [3].

Tomato production play an important role in improving household's income, nutrition and food security [2]. From the total annual production of vegetable, tomato shared 3.49% of production and onion shared 7.07% of root crop production [4]. Tomato is one of the commodities with the most potential, especially as tomato concentrate is the most commonly-used [5]. East Shewa zone is known by tomato production in Ethiopia. However, the production and productivity of Tomato 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 [6]. 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 [7]. Production can be increased by expanding the area devoted to crops or raising the yield per unit area of individual crops. Many studies indicated that increasing the level of production using modern technologies (improved varieties, modern irrigation schemes, fertilizers, pesticides, mechanization and other improved practices) on the lands under cultivation [6].

The average tomato yields at national level was 6.52 ton/ha [8]. But, the average yields of tomato on research station was 40 ton/ha. This indicated that the productivity of onion and tomato 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). The tomato productions are also low and insufficient to satisfy the growing demand of population growth. Hence, improving the efficiency of farmers' production is more viable to increase production and productivity and to satisfy the growing demand for tomato caused by population growth. Thus, this study initiated to identify gaps on tomato production 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 tomato production in East Shewa zone of Oromia region, Ethiopia.

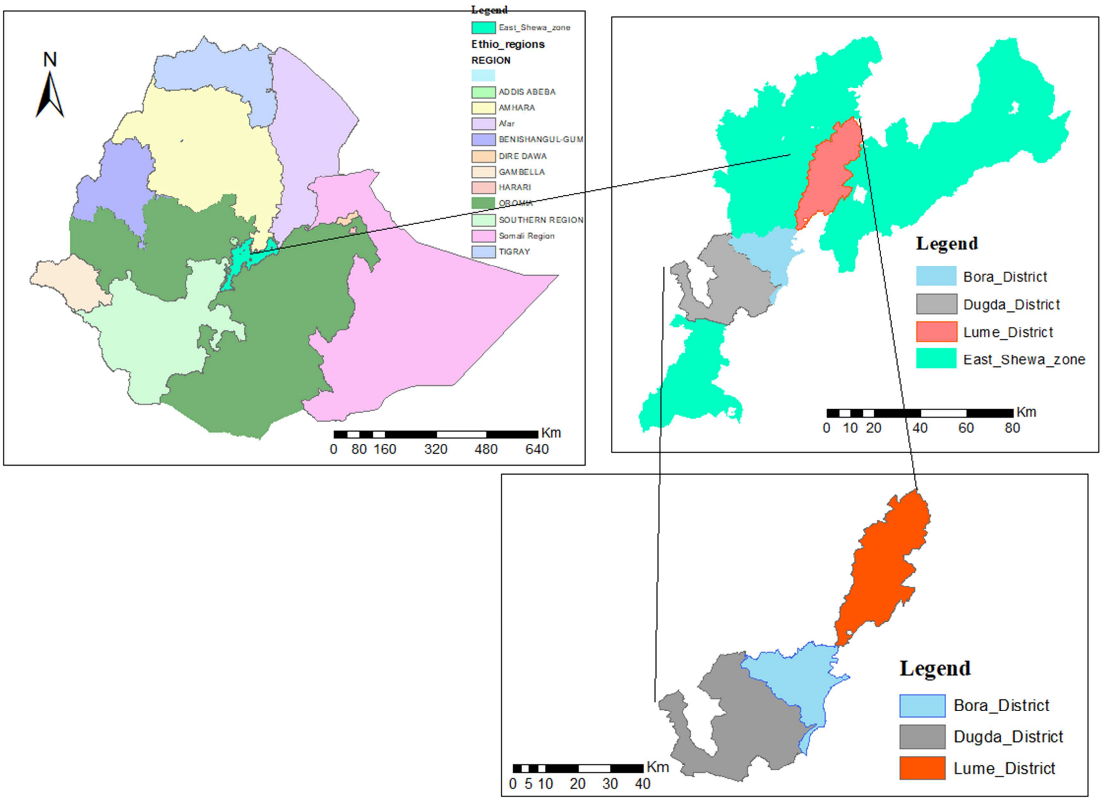
The specific objectives of the study were:

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

2. Research 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 60° 00' N to 70° 35'N and 380° 00'E to 40° 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°C -39°C annual temperature per year [9]. The sample districts were Lume, Dugda and Bora.



Source: Own sketch Arc map version 10.1, 2022.

Figure 1. *Map of the study area.*

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 tomato producers households by preparing semi-structured questionnaire. key informant interview and focus group discussion was also conducted to exhaustively identify production problem pertain to tomato 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 tomato producers in East Shewa Zone. East Shewa zone is known tomato production. Multi-stage sampling procedure was employed in order to select the sample. The first stage sampling encompasses random selection of tomato producer districts from the list of tomato producers' districts. In second stage, Representative Kebeles was selected randomly. In third stage sampling involves the random selection of farming households. Accordingly, a sample of ninety four (94) farming households was collected.

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 [10] to decompose TE, EE and AE. 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 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 [11, 12]. The stochastic frontier model can be expressed in the following form.

$$Yi = \mathrm{F}(\mathrm{Xi};\beta)\exp(\mathrm{Vi}-\mathrm{Ui})\ \ i=1, 2, 3,...n \qquad (1)$$

Where Yi is the production of the i^{th} farmer, Xi is a vector of inputs used by the i^{th} 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.

$$\delta s^2 = \delta v^2 + \delta^2 \text{ and } \gamma = \frac{\delta^2}{\delta s^2} = \frac{\delta^2}{\delta v^2 + \delta^2} \qquad (2)$$

Where,

σ^2 is the variance parameter that denotes deviation from the frontier due to inefficiency.

σv^2 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 and tomato 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 [13] 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. Sharma *[14]*, indicated that the corresponding dual cost frontier of the Cobb Douglas production function could be rewritten as:

$$Ci = C(Wi, Yi*;\ \alpha) \qquad (3)$$

Where i refers to the i^{th} 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 [13].

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

$$\text{Subject to } Y^{i*}_{k} = \hat{A}\prod_{n} X_n^{\beta_n} \qquad (4)$$

where;

$\hat{A}=\exp(\beta_o)$

ω_n =input price

β_n = parameter estimates of the stochastic production function

Y_{ki}*= input oriented adjusted output level from Equation 1.

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.

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

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

$$TE_i = \frac{\omega i' Xit}{\omega i' Xi} \quad (6)$$

$$EE_i = \frac{\omega i' Xit}{\omega i' Xi} \quad (7)$$

Following [15], allocative efficiency index of the ith farmer can be derived from Equations 7 and 8 as follows;

$$AEi = EEi/TEi = \frac{\omega i' Xit}{\omega i' Xi} \quad (8)$$

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 [16]. The following relationship expresses the stochastic model underlying tobit [17].

$$\text{Yi} = \beta o + \sum \beta_m Z_{jm} + \text{Ui} \quad (9)$$

Where yi* = latent variable representing the efficiency scores of farm j, β = 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.

$$Yi = \begin{cases} 1 \text{ if yi} * \geq 1 \\ \text{yi} * \text{ if } 0 < yi * < 1 \\ 0 \text{ if yi} * < 0 \end{cases} \quad (10)$$

2.4.3. Variable Hypotheses and Descriptions

Table 1. *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 and tomato farming	Experience of farmer onion and tomato production	Years	+
Farm size	Total farm size of the household	Hectare	+/-
Extension contact	Frequency of extension contact during cropping period	Number	+
Development center distance	Distance of farmer house from development center	kilometers	-
Social	Membership of social group (1= yes, 0= no)	Dummy	+
Credit	Use of credit for onion and tomato (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 [18].

The farming experience of Tomato 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 Tomato was about 1.17 hectares. The average livestock holdings measured in terms of tropical livestock unit (TLU) were found to be 5.77 (Table 8). 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 (Table 2).

Table 2. *Summary of descriptive Continuous variables.*

Continuous variable	Mean	Std.Dev.
Age of households	30.68	6.50
Tomato production experience (Years)	5.94	3.84
Family size (Numbers)	4.12	2.47
Land allocated for Tomato (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 center (km)	2.24	1.88
Distance to Market center (km)	5.28	3.43

Source: Own survey result, 2020.

Out of the total households interviewed only 11.70% participated in non/off-farm activities. The result implies 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. About 56.38% of the sample farmers participated in social organizations. 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. From total sample respondents interviewed, 75.53% of sample respondents had access to market information (Table 3).

Table 3. *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
Social participation	56.38	43.62
Access to credit	24.47	75.53
Access to market information	75.53	24.47

Source: Own survey result, 2020.

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 1E+00 for production Tomato which is statistically significant at 1% level of significance. The estimated value of gamma signifies that 100% of the variation in output is due to the variation in technical inefficiency among the farmers. 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 model specifications, constant and variable return to scale, show that the value of log-likelihood functions equal to -80.53 and -64.00 for Tomato production. Thus, the log likelihood ratio test is calculated to be 33.056 and when this value is compared to the critical value of χ^2 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. The gamma (γ) of the MLEs of stochastic frontier production is 1. This value is statistically significant implying that 100% of variability of production efficiency were from Tomato production were 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. The positive coefficient of land, labor, seed, agro chemical and fuel implies that as each of these variables is increased, ceteris paribus, Tomato output increased. The negative sign of the fertilizer suggest a situation of excessive (and, hence, inefficient) use of in the production of Tomato in the study area. The coefficients of the all physical variables; land, labor, seed, fertilizer, agro chemical and fuel are significant even at 1% level of significance. Therefore these are the all factors explaining Tomato production in study the area.

The estimated value of gamma is equal to 0.9992 for Tomato cost of production. The estimated value of gamma signifies that 99.92% of the variation in output is due to the variation in allocative inefficiency among the farmers and remaining 0.08% of output variation is due to due to variation output. Hence, the production function estimation using SPF analysis is more appropriate than convectional production function (Table 4).

Table 4. *Estimated Tomato stochastic production and cost frontier function.*

Variables	Production frontier		Variables	Cost frontier	
	ML estimate			ML estimate	
	Coefficient	Std.Err		Coefficient	Std.Err
Intercept	7.738***	0.0002461	Intercept	2.725***	2796985
LnLand	0.772***	0.0000169	LnLandcost	0.048	0.0521777
LnLabor	0.579***	0.0000286	LnLaborcost	0.360***	0.0412801
LnSeed	0.165***	6.26E-06	LnSeedcost	0.098***	0.0118096
LnFertilizer	-0.221***	0.0000164	LnFertilizercost	0.202***	0.0204849
LnChemical	0.040***	5.74E-06	LnChemicalcost	0.153***	0.0155618
LnFuel	0.150***	0.0000183	LnFuelcost	0.012	0.0184297
			LnTractorcost	0.032	0.0394211
	∑β= 1.484				
$\sigma^2=\sigma^2u+\sigma^2v$	1.81E+00***			9.893 ***	
$\lambda=\sigma u / \sigma v$	3.55e+07***	0.427		34.86***	2.686
γ (gamma)	1.00E+00***			0.9992	
Log likelihood	-64.0032			63.0024	
LR test	33.056			12.615	

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

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

The study indicated that 54.8%, 92.2% and 45.2% were the mean levels of technical, allocative and economic Efficiency of Tomato production respectively. This in turn implies that farmers can increase their Tomato on average by 45.2% 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 7% to 100% for Tomato production. This result needs to extension intervention by arrange experience sharing between farmers to reduce the efficiency gap (Table 5).

Table 5. *Efficiency estimation by stochastic production frontier model.*

Types of commodity	Efficiency	Mean	St.dev.	Minimum	Maximum
	Technical Efficiency	0.548	0.266	0.06	1
Tomato	Allocative Efficiency	0.922	0.060	0.52	0.98
	Economic Efficiency	0.506	0.245	0.06	0.97

Source: Survey data, 2020.

3.4. Returns to Scale Tomato and 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 1.484 is obtained from the summation of the coefficients of the estimated inputs (elasticities) of Tomato. It indicates that Tomato 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 Tomato 1.484% respectively in the study area (Table 6).

Table 6. *Elasticities and returns to scale of the parameters of stochastic frontier.*

Variables	Production
	Tomato
	Elasticities
LnLand	0.772
LnLabor	0.579
LnSeed	0.165
LnFertilizer	-0.221
LnChemical	0.040
LnFuel	0.150
Returns to scale	1.484

Source: Survey data, 2020.

3.5. Determinants of Technical and Economic Efficiencies in Tomato 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 Tomato farming experience and Extension contact affect efficiency positively while, distance to FTC affect technical efficiency negatively (Table 7).

Experience of Tomato farming: Experience of the household head in tomato 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. Tomato farming experience increase by one year the Tomato technical and economic efficiency increase by 3.8% and 3.2% respectively keeping all other factors constant. This result is in conformity with the finding of [19].

Distance to FTC: Distance to farmers from Farmers Training Center of farmers had negative relationship with Technical and Economic efficiency as prior expectation significantly at 10% and 5% significance level respectively. This implies the farmers nearby Farmers training Centers (FTC) get more information on know how to use new technologies and better management to improve their technical efficiency and economic efficiency. Farm distance to FTC increase by one kilometer the Tomato technical and economic efficiency would decrease by 9.6% and 11.5% respectively keeping all other factors constant. This is in line with the findings of [20].

Frequency of extension contact: Frequency of extension contact was found to have a positive and significant influenced on Technical and Economic efficiency of sample Tomato producers at 10% and 5% level of significance respectively. This significance indicates that for each additional extension contact Tomato producer farmers are more likely to produce Tomato efficiently than others. The result implies that an additional unit of extension contact would increase farmers' technical efficiency and Economic efficiency by 0.8% and 0.9% 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. This is in line with the findings of [21].

Table 7. *Tobit results of determinants of technical and economic efficiencies in Tomato production.*

Variables	TE				EE			
	Coefficient	Robust Std.Err.	p>|t|	Marginal effect	Coefficient	Robust Std.Err.	p>|t|	Marginal Effect
Constant	0.509***	0.144	0.001		0.458	0.133***	0.001	
Age	-0.002	0.005	0.720	-0.002	-0.001	0.005	0.840	-0.001
Education level	0.001	0.006	0.847	0.001	0.002	0.005	0.754	0.002
Family Size	-0.010	0.014	0.457	-0.010	-0.010	0.013	0.442	-0.010
Tomato Farming Experience	0.038***	0.007	0.000	0.038	0.032	0.006***	0.000	0.032
Total livestock Unit	0.003	0.004	0.445	0.003	0.002	0.003	0.599	0.002
Land for Tomato production	-0.014	0.025	0.571	-0.014	-0.017	0.024	0.497	-0.017
Participation in social group	-0.007	0.038	0.865	-0.007	-0.012	0.036	0.742	-0.012
Distance to FTC	-0.096*	0.053	0.073	-0.096	-0.112	0.047**	0.019	-0.115
Distance to Weather road	0.040	0.044	0.364	0.040	0.038	0.041	0.356	0.038
Extension contact	0.008*	0.004	0.09	0.008	0.009	0.004**	0.028	0.009
Access to market information	-0.048	0.063	0.449	-0.075	-0.053	0.051	0.305	-0.051

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

4. Conclusions and Recommendations

4.1. Conclusions

The overall objective of this study was to examine producers' technical, allocative and economic efficiencies of tomato 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 54.8%, 92.2% and 50.6% of for Tomato 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 Tomato production. To this effect, Tomato farming experience and frequency of extension contact positively influenced households technical and economic efficiency whereas, distance to Farmers Training Center (FTC) negatively affected sample households technical and economic efficiency of Tomato production.

4.2. Recommendations

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

There is huge efficiency gap among tomato producer farmers. Therefore District office of Agriculture should be organize field days to conduct farmers experience sharing.

Tomato 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.

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Appendix

Table 8. *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: Stork *et al*., 1991.

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