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Determinants of Technical Efficiency of Head Cabbage Producer Farmers in West Arsi Zone, Oromia Region, Ethiopia

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Abstract: This study investigated technical efficiency head cabbage produce farmers in West Arsi Zone, Oromia Region, Ethiopia. Semi-structured questionnaires were used to collect data from 117 respondents randomly selected from Shashamane and Kofale districts in West Arsi Zone. A stochastic production frontier function was fitted to the sample households. The result revealed that the mean Technical efficiency, head cabbage was 77.10 percent. The sum of the partial elasticity of all inputs head cabbage production was 1.513 that indicates an increase in all inputs at the sample mean by one percent increase head cabbage production by 1.513 percent. This indicates that the production function is characterized by increasing returns to scale. The mean head cabbage yield difference between sample farmers due to technical efficiency variation was 76.56 quintal per hectare. The result of Tobit model estimation indicated that technical efficiency of Head cabbage production was significantly and positively influenced by head cabbage farming experience, education level, extension contact and market information while distance to all-weather road affect it negatively. District office of Agriculture, stockholders and concerned bodies should focus on farmers' experience sharing, providing technical support on production and management as well as farmers should practice different social participation jointly contribute to improve technical efficiency of Head cabbage producer farmers in West Arsi Zone.

Keywords: Efficiency, West Arsi, Frontier Model, Tobit Model

1. Introduction

1.1. Back Ground of the Study

Vegetable growing is one of the priority sectors in agriculture. Vegetables occupy an important place in the food by being an important component of the human diet through source of micronutrients for human nutrition, a source of livelihood to people along the value chain including farmers, traders, processors and transporters, it contributes in food security, employment, foreign exchange and it has been key in alleviation of poverty especially in rural areas where production is intensive [1]. According to [2] to improve income and provide gainful employment, diversification from grain crops to high value crops like vegetables have appeared to be an essential strategy for agricultural growth for any developing country.

Vegetables are integral part of the farming system in Ethiopia. They are grown as sole or intercropped, rainfed or irrigated and plays crucial role in the economy of the country. Its demand is also growing, implying the need for concerted effort to improve productivity through sustainable supply of high yielding vegetable varieties [3].

In Ethiopia, most of the soil types in fruits and vegetables producing regions of the country range from light clay to loam and are well suited for horticultural production. Vegetable production is becoming an increasingly important activity in the agricultural sector of the country mainly due to increased emphasis of the government on the commercialization of smallholder farmers [4]. Integrating vegetable production into a farming system has contributes substantially to the Ethiopia's economy in terms of food and nutrition security as the vegetables complement stable foods for a balanced diet by providing vitamins and minerals [5].

An economically efficient input-output combination would be on both the frontier function and the expansion path. On the other hand, economic efficiency refers to the appropriate alternative of inputs and outputs combination according to their price relation or the ability of the firm to maximize profit by equating marginal revenue product of inputs to their respective marginal costs [6]. Evidence of low productivity in vegetable production was observed because of inefficiency in resource use [2]. Farm efficiency no doubt is an important subject in developing countries agriculture [7]. [8] Provided the impetus for developing the literature on empirical estimation of technical, allocative and economic efficiency. Among the approaches used in measuring efficiency stochastic frontier approach has been used extensively in measuring the level of inefficiency/efficiency.

Vegetables are commonly practiced by the rural private peasant holders even in remote areas. Vegetables took up about 1.68% of the area under all crops at national level. However, of the total estimated area under vegetables, the lion share which is about 66.55% and 20.47% was under red peppers and Ethiopian Cabbage, respectively. Production of vegetables contribute 2.07% of the total crops production, conversely, of the total production of vegetables, the above mentioned crops have the lions share, i.e. about 29.10% and 53.97%, in that order [9].

1.2. Statement of the Problem

The fruit and vegetable sector compares favorably with cereals and other food crop sectors in terms of employment and income generation. The production of vegetables has a comparative advantage particularly under conditions where arable land is scarce and labor is abundant. The traditional small scale fruit and vegetable production and marketing sector is an important sector in terms of employment, income and scale of production [10]. In Ethiopia, cabbage is usually grown in the mid and high altitude areas of the country both for household consumption and as a source of income. Moreover, the portion of cabbage is exported to neighboring countries of Djibouti and Somalia. In 2018, the country exported 1,575 tonnes of cabbage and lettuce to these countries and earned about 300 thousand USD (8.27 million Birr) [11].

Despite the increasing importance of vegetables, the production in Ethiopia, does not meet the need of the country's population for vegetable products and/or the production levels of vegetables are still far below their potential. This was because of, there was inadequate knowledge on improved production systems, marketing, small scale farming systems and poor pre and post-harvest handling techniques and in general, there were inefficiency in production of vegetables [12].

The productivity of head cabbage in Ethiopia, Oromia region and West Arsi Zone was 9.742t/ha, 9.531 t/ha and 10.23 t/ha respectively [9]. Even though productivity of head cabbage in West Arsi zone slightly higher than regional and national average due to favorable climate condition, the productivity is very low as compared to an average yield of 34 t/ ha in China [13]. The productivity has been gripped by several problems. Lack of adapted varieties for the different agro-ecologies of the country, unimproved insect and disease management systems and agronomic practices are among the major constraints that resulted in low productivity and quality in cabbage [14].

There is, however, little knowledge about the level of efficiency of head cabbage farmers who have been producing, and the underlying factors affecting them in West Arsi Zone. Also the knowledge on the source of inefficiency for these commodities is scanty. Therefore, a thorough study on these issues may help to identify the production constraints at farm level and thereby develop policy recommendations to increase head cabbage production and productivity so that it will contribute to food security and poverty reduction efforts. Therefore, a thorough study on these issues may help to identify the production inefficiency constraints at farm level and thereby develop policy recommendations to increase head cabbage production and productivity so that it will contribute to food security and poverty reduction efforts. There are no previous studies conducted in the area of head cabbage efficiency dealing exclusively with technical efficiency of farmers and the factors considered to be important in determining their efficiency farming in west Arsi Zone. Therefore, the analysis of technical efficiency of head cabbage farming is very important to improve head cabbage production.

1.3. Objectives

The objectives of the study were:

1) To estimate technical efficiency among head cabbage producer farmers
2) To identify the factors affecting technical efficiency of head cabbage producer farmers.
3) To identify head cabbage production constraints in the study area

2. Research Methodology

2.1. Description of the Study Area

This study was conducted in Kofale and Shashamane districts of West Arsi zone, Oromia region. It covers an area of 11,776.72 km^2, divided into 12 districts (*weredas*). Based on the 2007 Census conducted by the Central Statistical Agency of Ethiopia (CSA), this Zone has a total population of 1,964,038, of whom 973,743 are men and 990,295 women. 272,084 or 13.85% of population are urban inhabitants [15].

Shashamane district is one of the districts in West Arsi Zone. It shared bordered in South Sidama region, on the East by Kofale district, on the North by Negelle Arsi and on the West Shala district. It has 37 rural kebeles and the annual temperature ranges from 12°C to 27°C, annual rain fall ranges from 800mm to 1100mm with attitude ranges 1600 to 2800 m.a.s.l. Type of crop produced in the district was Teff, wheat, maize, millet, haricot bean, potato, head cabbage, normal cabbage and carrot. The district has 32040 ha of ultivated land 8040ha forest land,2300 ha grazing land,300 land for construction and 23820ha others such as swampy, mountainous or otherwise unusable [16].

Kofele is one of the Districts in the Oromia Region of Ethiopia. It is named after the administrative center of the District, Kofele. Part of the West Arsi Zone, Kofele is bordered on the south by the Kokosa, on the west by the Southern Nations, Nationalities and Peoples' Region, on the northwest by the Shashamene (District), on the north by Kore, on the east by Gedeb Asasa, and on the south east by Dodola. Other towns in Kofele include Wabe Gefersa. The altitude of this woreda ranges from 2000 to 3050 meters above sea level; Mount Duro is the highest point. Rivers include the 35 kilometers of the Anjelo, 30 kilometers of the Totalamo, and 35 kilometers of the Ashoka, all of which are tributaries of the Shebelle River. A survey of the land in this District shows that 30% is arable or cultivable, 29% pasture, 2.9% forest, and the remaining 38.1% is considered swampy, mountainous or otherwise unusable. Vegetables are an important cash crop; hides and skins are the primary export for Kofele [17].

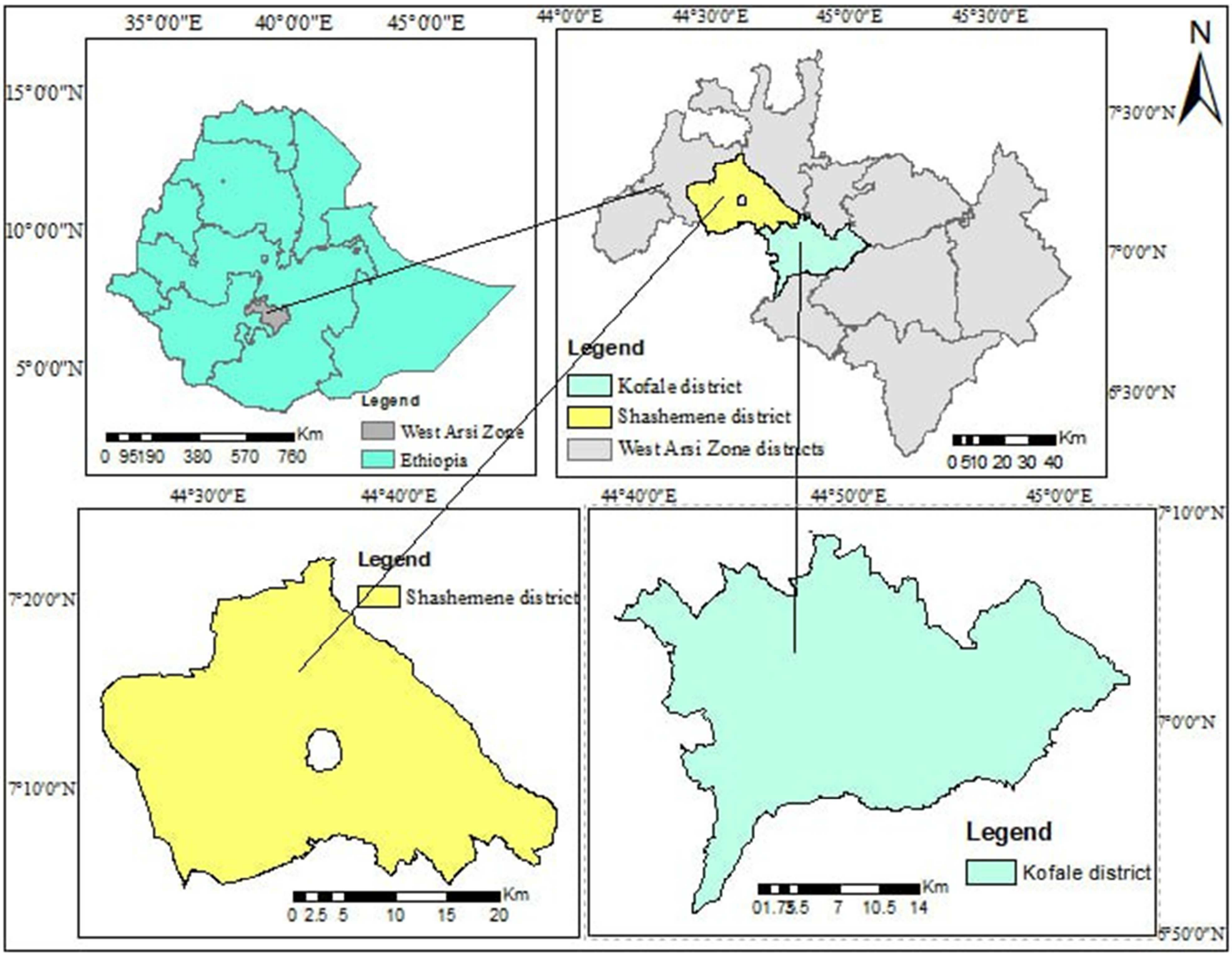

Figure 1. *Map of the study area Source: Own sketch Arc map version 10.1, 2023.*

2.2. Sources and Methods of Data Collection

Both primary and secondary data source was used for this study. The primary data was collected using semi-structured questionnaire, key informant interviews, and focus-group discussions. Prior to the actual data collection, semi-structured questionnaire was pre-tested to ensure clarity, validity, and sequence of the question. The questionnaire was pre-tested in each selected Shashamane and Kofale *Districts* and revised according to the feedback obtained. The major sources of secondary data were from both published materials and online resources such as Central Statistics Agency (CSA), West Arsi zone agriculture office, Shashamane District of Agricultural Office and Kofale District Agricultural Office.

2.3. Sampling Procedure and Sample Size

Multi-stage sampling techniques were applied to determine sample size.

At first stage Shashamane and Kofale *Districts* was purposively selected based on potential of head cabbage volume of production from West Arsi zone with the collaboration experts of West Arsi zone agricultural office.

In the second stage, three head cabbage growing *Kebeles were selected* from each of selected *Districts* using simple random sampling method and proportional size.

In third stage household sample size was determined based on [18] formula:

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

Where: n = is the sample of head cabbage producer households that in West Arsi Zone, N = is the total number of head cabbage producer households in the Zone and e = 0.092 is the level of precision.

The total number of households is 16,650 so sample size is calculated as follows: $n = \frac{16650}{1+16650(0.092)^2} = \frac{16650}{142.31} = 117.$ Therefore, 117 sample households were selected randomly formal interview.

Table 1. *Sampling frame and sample size.*

Name of sampled kebeles	Total head cabbage producers households (number)	Proportion sampled Households (%)	Number of sample household heads (number)
Hursa Simbo	1231	13.68	16
Jengala Wondale	1385	15.38	18
Kerara Filacha	1384	15.38	18
Germama	1230	13.68	16
Gurmicho	1692	18.80	22
Afamo	2077	23.08	27
Total	8999	100	117

Source: ZOA and Own computation, 2021.

2.4. Methods of Data Analysis

In this study, a descriptive and econometric model was used to analyze data.

2.4.1. Descriptive Analysis

Descriptive statistical tools such as average, ratios, percentages, frequencies, etc. were applied to describe household and farm characteristics of the study areas.

2.4.2. Econometrics Model

The analytical models for estimating production function, dual cost function and efficiency decomposition techniques of head cabbage producing smallholder farmers. Stochastic Frontier approach (SFA) will be 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 in farm enterprises, but inefficiency may arise due to a variety of factors, some of which are beyond the control of the 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 [20]. The stochastic frontier model can be expressed in the following form.

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

Where Yi is the production of the i^{th} 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~ $(0, \delta 2)$ 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 parameter.

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

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 technical efficiency of head cabbage producers in the selected districts of West Arsi zone. According to [21], 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. [22] 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 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 [21]

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

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

where;

Â=exp(β_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] firmer derived by applying Shepard's Lemma and substituting the firms input price and adjusted output level into the resulting system of input demand equations.

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

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 i[th] farm are equal to, ωiXi and $\omega i'Xi'$. Those cost measures are used to compute technically and economically efficient indices of the ith farmer as follows:

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

2.4.3. Determinants of Technical Efficiency Scores

Factors affecting technical efficiency of head cabbage producers were computed by two-limit Tobit model. 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 [23]. The following relationship expresses the stochastic model underlying Tobit [24]:

$$\text{Yi} = \beta o + \sum \beta_m Z_{jm} + \text{Ui} \quad (7)$$

Where yi* = latent variable representing the efficiency scores of farm j, β = a vector of unknown parameters, Z_{jm} = 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.

$$Yi = \begin{cases} 1 \text{ if yi} * \geq 1 \\ \text{yi} * \text{ if } 0 < yi * < 1 \\ 0 \text{ if yi} * < 0 \end{cases} \quad (8)$$

To analyzing of yield gap is an important system to estimate to what extent the production could be increased if all factors are controlled.

It is computed as follows:

$TE = \frac{ym}{y*m}$. Then, solving for Ym ∗, the potential yield of each sample farmer was represented as:

∗Ym $= \frac{Ym}{TE}$ Where, TEm, the TE of the m[th] sample farmer in wheat production

∗Ym- the potential output of the m[th] sample farmer in wheat production in qt per ha and

Ym - the actual output of the m[th] sample farmer in wheat production in qt per ha Therefore, yield gap (qt per ha) = ∗Ym – Ym

2.4.4. Explanatory Variables and Description

Table 2. Summary of variables description and hypothesis.

No	Dependent variables			
	Technical efficiency			
	Independent variables	Variable description	Unit	Expected signs
1	Sex	Sex of household head (0= Female, 1=Male)	Dummy	-
2	Experience	Experience of farmer in head cabbage production	Continues	+
3	Dependancy ratio	Age 15-64 years/less 15 and greater 64 years	Continues	-
4	Livestock	Total number of livestock owned (TLU)	Continues	+
5	Education	Number of years of formal education	Continues	+
6	Hcland	Land under headcabbage production in heactares		+/-
7	Social participation	Participation in social group (0= No 1= Yes)	Dummy	+
8	Distance of FTC	Distance of farmer house from FTC	Continues	-
9	Market information	Access to market information (0= No, 1= Yes)	Dummy	+
10	Allweatherroads	Distance to all weatherroads in walking hours	Continues	-
11	Credit	Access to credit services (0= No, 1= Yes)	Dummy	+
12	Extension contact	Frequency of extension contact	Continues	+
13	Non&off-farm	Participation of non&off-farm activities (0= No, 1= Yes)	Dummy	+

3. Results and Discussion

3.1. Descriptive Statistical Results

The average age of the sample respondents were found to be 39 years. This result implied that the sample respondents were work age group and can increase production if they get technology and training. The dependency ratio was about 1.39. The average family size of the sample households was 9.05 persons per household, which is more than the national average of 4.6 persons per household [25]. The farming experience head cabbage production was 8.74 years. This implies that the producers can increase the efficiency as their experience increase since they were adult. The average area covered by head cabbage during the year 2020 cropping season was 0.31 hectares. The average livestock holdings measured in terms of tropical livestock unit (TLU) were found to be 6.03 (Appendix Table 1). This is relatively a large number in the crop-livestock mixed farming system. The average distances to travel from farm to farmers training center (FTC) by sample farmers in the study area was 2.35 kilometers. The average distance all-weather road from the study area was 1.48 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 3).

Table 3. *Summary of descriptive continuous variables.*

Continuous variables	Mean	Std.Dev.
Age in years	39.5	10.95
Depenency ratio in numbers	1.39	0.80
Family size in numbers	9.05	3.83
Farming experience in years	8.74	5.59
Land under head cabbage production in hectares	0.31	0.10
Number of livestock (TLU)	6.03	4.12
Distance to farmers training center (FTC) in kilometres	2.35	2.01
Distance to all weather roads in kilometers	1.48	1.45

Source: Survey result, 2021

Out of the total sample households interviewed only 3.42% participated in non/off-farm activities. The result implies that participation of non/off-farm activity is low. About 59.83% 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 79.49% 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. The accessibility of credit service was low due to high interest rate, shortage of credit service, amount of credit low and inappropriate payback period of received loan. From total sample respondents interviewed, 65.81% of sample respondents had access to market information (Table 4).

Table 4. *Summary of descriptive dummy variable.*

Dummy variables	Yes		No	
	Frequency	Percent	Frequency	Percent
Participation in non-off farm	4	3.42	113	96.58
Access to extension services	70	59.83	47	40.17
Participation in social organizations	93	79.49	24	20.51
Access to credit services	15	12.82	102	87.18
Access to market information	77	65.81	40	34.19

Source: Own survey result, 2021

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 estimated value of gamma is equal to 0.9987 for production of Head cabbage which is statistically significant at 1% level of significance. The estimated value of gamma signifies that 99.87% of the variation in output is due to the variation in technical inefficiency among the farmers while the remaining 0.13% of output variation is due to due to variation in random shocks.

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 -76.24 for head cabbage production. Thus, the log likelihood ratio test is calculated to be 2.93 for production. When this value is compared to the critical value of $\chi 2$ at 4degrees of freedom with 1% level of significance equals to 12.483, the null hypothesis that the Cobb-Douglas production function is characterized by constant return to scale is accepted for head cabbage production function. The null hypothesis of production in efficiency was accepted.

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 agro chemical. The coefficients of the three physical variables, land, labor and seed are significant even at 1% and fertilizer is significant at 10% level of significance. The positive coefficient of land, labor, seed and fertilizer implies that as each of these variables is increased, ceteris paribus, head cabbage output increased. The coefficient of the variable associated, agro chemical although positive is statistically not significant even at 10% level of significance. Therefore these are the less factors explaining head cabbage production in study the area. The finding agrees with the findings of [26].

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	3.703***	0.491	Intercept	2.740***	0.329
LnLand	0.703***	0.170	LnLandcost	0.336***	0.030
LnLabor	0.394***	0.072	LnLaborcost	0.108***	0.027
LnSeed	0.169***	0.056	LnSeedcost	0.227***	0.021
LnFertilizer	0.125*	0.073	LnFertilizercost	0.113***	0.029
LnChemical	0.123	0.085	LnChemicalcost	0.087***	0.028
	$\sum\beta$= 1.513				

Variables	Production frontier		Variables	Cost frontier	
	ML estimate			ML estimate	
	Coefficient	Std.Err		Coefficient	Std.Err
$\sigma^2=\sigma^2_u+\sigma^2_v$	106.63***			16.60	
$\lambda=\sigma_u/\sigma_v$	27.605	38.962		23.425***	6.831
γ (gamma)	0.9987***			0.9982	
Log likelihood	-74.777			19.488	
LR test	2.93			7.49	

*and ***, Significant at 10% and 1% significance level respectively. Source: Own computation, 2021

3.3. Estimation of Technical Efficiency of Head Cabbage Producer Farmers

The study indicated that 77.10% were the mean levels of Technical Efficiency head cabbage. This in turn implies that farmers can increase their head cabbage production on 22.9% at the existing level of inputs and current technology by operating at full technical efficient level. There is a gap among farmers in sample study which range 26.53% to 91.60% head cabbage production. This result indicates that there was a room to improve technical efficiency (Table, 6).

Table 6. *Efficiency estimation by stochastic production frontier model.*

Types of commodity	Efficiency	Mean	St.dev.	Minimum	Maximum
Head cabbage	Technical Efficiency	0.771	0.113	0.265	0.916

Source: Survey data, 2021

3.4. Return to Scale Head Cabbage Production

The return to scale analysis serves as a measure of total resource productivity of head cabbage production. The sum of elasticity of all inputs was 1.513 for head cabbage. It indicates that head cabbage production in study area is stage 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 head cabbage by 1.513% in the study area (Table, 7).

Table 7. *Elasticities and returns to scale of the parameters of stochastic frontier.*

Variables	Production
	Head cabbage
	Elasticities
LnLand	0.703
LnLabor	0.394
LnSeed	0.169
LnFertilizer	0.125
LnChemical	0.123
Returns to scale	1.513

Source: Survey data, 2021

3.5. Determinants of Technical and Economic Efficiencies in Head Cabbage Production

Variance inflation factors (VIF) was computed for all explanatory variables that are used in the Tobit model and the results 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 indicated that the technical efficiency of Head cabbage production was significantly influenced by the variables Head cabbage farming experience, education level, extension contact and market information affect positively while Distance to all-weather road affect it negatively (Table, 8).

Table 8. *Tobit results of determinants of technical and economic efficiencies in head cabbage production.*

Variables	TE			
	Coefficient	Robust Std.Err	p>|t|	Marginal effect
Constant	0.683***	0.083	0.000	
Sex	-0.031	0.055	0.571	-0.031
Head cabbage Farming experience	0.005***	0.0016	0.003	0.005
Dependency Ratio	0.0037	0.0104	0.720	0.0037
Total livestock unit	0.0015	0.0017	0.387	0.0015
Education level	0.006**	0.0027	0.024	0.006
Land for HC production	0.025	0.073	0.731	0.025
Participation of social group	-0.0038	0.021	0.857	-0.0038
Distance to FTC	0.006	0.005	0.281	0.0052
Access to market information	0.06***	0.023	0.009	0.061
Distance to all weather road	-0.023**	0.0087	0.011	-0.023

Variables	TE			
	Coefficient	Robust Std.Err	p>|t|	Marginal effect
Access to credit	-0.014	0.025	0.583	-0.014
Extension contact	0.0042**	0.0022	0.066	0.0042
Non off-farm	-0.002	0.016	0.900	-0.002
Log pseudolikelihood	121.33648			
F(13, 104)	4.94			
Prob > F	0.0000			
Pseudo R2	-0.3559			

Experience of Head cabbage farming: Experience of the household head in head cabbage farming had positive relationship with technical 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 head cabbage production increase by one year, would technical efficiency would increase by 0.5% keeping all other factors constant. This result is in line with the finding of [26].

Education level: The coefficient for the education level had a statistically significant and positive relationship with technical efficiency at 5% and 1% significant level. This is consistent with the prior expectation that those farmers that had got more education. The result implies that an additional unit of education would increase farmers' technical efficiency by 0.61% than others, keeping all other factors constant. Positive coefficient of education means the higher the years of schooling, the higher the incidence of efficiency. Education is not only escalating agricultural productivity by increasing their understanding of modern farming techniques but also opening the mind of farmers. This result is in line with the finding of [27].

Access to market information: Access to market information was found to have a positive and significant influenced on head cabbage technical efficiency at 1% level of significance. Access to market to input and output information by the household head enhance efficiencies of cabbage production by using available input technology. Access to market information increase the probability of head cabbage technical effeciency by 8% than those who had not, keeping all other factors constant This result is in line with the finding of [28].

Frequency of extension contact: Frequency of extension contact was found to have a positive and significant influenced on technical efficiency of sample head cabbage producers at 10% level of significance. This significance indicates that for each additional extension contact head cabbage producer farmers are more likely to produce head cabbage efficiently than others. The result implies that an additional unit of extension contact would increase farmers' technical efficiency by 0.42% than others, keeping all other factors constant suggesting that 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 [26].

Distance to all weather roads: Distance to all weather roads was found to influence farmers head cabbage technical and economic efficiency negatively and significantly at 5% significance level. The result depicts that as distance to all weather roads increase by one kilometer, the probability of farmers' technical efficiency head cabbage would decrease by 2.23% keeping all other factors constant suggesting that more distances to all weather roads increase travel time and travel costs as well as accessibility of available.

3.6. Analysis of Yield Gap of Head Cabbage Production

Productivity can change due to differences in the production technology, efficiency of the production process and environment in which production takes place. The yield gap always occurs due to technical efficiency variation among the farmers.

In the table below, it was observed that the mean head cabbage yield difference between sample farmer due to technical efficiency variation was 76.56 qt per ha.

Table 9. *Yield gap due to technical inefficiency of head cabbage.*

Commodity	Variable	Mean	Std.Dev.	Minimum	Maximum
Head cabbage	Actual qt per hectare	312.410	230.531	28	1200
	Technical efficiency (%)	0.771	0.113	0.265	0.916
	Potential qt per ha	388.970	261.976	97.959	1463.415
	Yield gap (qt per ha)	76.56	31.445	69.959	263.415

Survey Result, 2021

4. Conclusions and Recommendations

4.1. Conclusions

The result revealed that the mean technical efficiency was about 77.10% for head cabbage production. The sum of the partial elasticity of all inputs was 1.513 for head cabbage indicates an increase in all inputs at the sample mean by one percent increase by 1.513% head cabbage respectively. This indicates that the production function is characterized by increasing returns to scale for both productions.

The result of Tobit model revealed that, out of total 13 explanatory variables included in the model for head cabbage production. Total of five variables found significantly determined technical efficiency of head cabbage production.

Those variables were head cabbage farming experience, education level, extension contact and market information affect positively while Distance to all-weather road affect negatively. The mean head cabbage yield difference between sample farmer due to technical efficiency variation was 76.56 qt per ha.

4.2. Recommendations

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

Head cabbage technical and economic efficiency were affected head cabbage farming experience positively. Therefore field day should be organized by district office of Agriculture to conduct farmers experience sharing in order to improve technical efficiency of head cabbage producers.

Head cabbage technical efficiency influenced by frequency of extension contact positively. Therefore agricultural experts and development agent should focus on frequent contact with head cabbage producers by providing technical support and management practices.

Distance to farmers training center negatively affected sample households technical efficiency of head cabbage production. Therefore technology demonstrations should also applied on farmers field for farmers far from farmers training center and include all farmers to visit demonstration practice at farmers training center by arranging field days.

Conflicts of Interest

The authors declare no conflicts of interest.

Appendix

Table A1. *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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