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COMPARATIVE ANALYSIS OF TECHNICAL EFFICIENCIES OF SMALLHOLDER VEGETABLE FARMERS WITH AND WITHOUT CREDIT ACCESS IN SWAZIL AND THE CASE OF THE HHOHHO REGION

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ABSTRACT

The purpose of the study was to determine and compare the technical efficiencies of smallholder vegetable farmers in the Hhohho region of Swaziland. Data were collected from farmers through a structured questionnaire, which was administered using personal interviews. A two-stage sampling procedure was used by stratifying the vegetable farmers in the Hhohho region according to the four Rural Development Areas (RDAs) in the region. This was followed a random sampling technique used to select the number of vegetable farmers from each stratum. A sample size of 120 farmers was selected from a population of 289 vegetable farmers. Descriptive statistics and a Cobb-Douglas production function were used to analyze the data using the STATA program (version 12). The results revealed that tomato yield was positively associated with the amount of chemicals used, while cabbage yield was positively related to seed, and fertilizer. Beetroot has positive relationship with amount of fertilizer and labour, but a negative association with the amount of land used. The yield of green pepper was negatively related to fertilizer and positively related to chemicals and amount of land used. The technical efficiencies of tomato and cabbage farmers were affected by age, education level, farming experience and access to credit ($p < 0.01$), while beetroot and green pepper was affected by farmer's age, and off-farm income ($p < 0.05$). The study recommended that vegetable farmers should increase the amount of seeds, fertilizer and chemicals used in order to improve yields. The Swaziland of Swaziland should subsidize farming inputs and financial institutions should make credit easily available to vegetable farmers in order to improve the efficient use of input resources.

Keywords: Cobb-douglas production function, Comparative analysis, Credit access, Smallholder vegetable farmers, Technical efficiency, Swaziland.

Contribution/ Originality

This study contributes in the existing literature on technical efficiency. It is noted that not many studies have been conducted on technical efficiency in Swaziland, especially on vegetable production. Hence, this is an original contribution in this field.

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1. INTRODUCTION

The agricultural sector in Swaziland is characterised by a dualistic system consisting of modern and traditional sectors. About 80% of the Swazi population lives on Swazi Nation Land (SNL) and they obtain their livelihood from subsistence agricultural production activities (Thompson, 2012). The Ministry of Agriculture encourages the intensification of agricultural production amongst small-scale farmers on SNL. Although the performance of large farms and plantations on Title Deed Land (TDL) remains crucial to export growth and overall economic development in Swaziland, increasing rural employment and income depends mainly on the performance of agriculture on SNL. Accordingly, the Swaziland government focuses her resources on SNL, whilst ensuring that support does not negatively affect agricultural production on TDL. However, the rate of adoption of sugarcane production on SNL is threatening the production of irrigated crops, especially vegetables (Thompson, 2012).

Vegetables by smallholder farmers are mainly produced for consumption and are also sold if there is a surplus (Chadha *et al*., 1999). According to Sekhon and Kaur (2004) 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, such as Swaziland. In most developing countries, including Swaziland, the majority of farmers are poor and have inadequate means of production and resources, and therefore, unable to bear the risks of crop failure. The study sought to determine and compare the technical efficiencies of smallholder vegetable farmers.

2. THEORETICAL FRAMEWORK

2.1. Production and Productive Efficiency

The economic theory of production provides the analytical framework for most empirical research on productivity and efficiency. Productive efficiency means the attainment of a production goal without a waste of resources. Beginning from this basic idea of "no waste", economists have built up a variety of theories of efficiency. The fundamental idea underlying all efficiency measures, however, is that of the quantity of goods and services per unit of input. Consequently, a production unit is said to be technically inefficient if little output is being produced from a given bundle of inputs. There are two basic methods of measuring efficiency and these are the classical approach and the frontier approach. The classical approach is based on the ratio of output to a particular input, and is termed partial productivity measure.

Dissatisfaction with the shortcomings of this approach led economists to develop advanced econometric and linear programming methods for analysing productivity and efficiency. The frontier measure of efficiency implies that efficient firms are those operating on the production frontier. The amount by which a firm lies below its production frontier is regarded as the measure of inefficiency.

2.2. Stochastic Production Frontier (SPF) Analysis and Measurement of Efficiency

The frontier function approach is a method to measure productive inefficiency of individual producers. Inefficiency is measured by the deviation from the frontier, which represent a best-practiced technology among all observed firms. Battese and Coelli (1995) presents two reasons to estimate frontier functions, rather than cost functions, which are conventionally estimated by OLS method. First, the frontier function is consistent with theoretical representation of production activities, which is derived from an optimization process.

For example, the production function consists of a series of outputs attainable, given different combinations of inputs, while cost and profit functions are represented by frontiers derived from optimization. Second, the estimation of frontier function provides a tool for measuring the efficiency level of each firm within a given sample.

The SPF method of analysing efficiency is chosen for this study because, unlike other methods (for example the Data Envelopment Analysis, DEA) the SFP allows for the sensitivity of data to random shocks by including a conventional random error term in the estimation of the production frontier such that only deviation caused by controllable decisions are attributed to inefficiency (Jaforullah and Premachandra, 2003).

Inefficiency is assumed to be part of the error term consisting of two parts. This is the random error term, which is normally distributed N $(0,\sigma^2)$ and represent random shocks and statistical errors, and the inefficiency term which is one-sided (non-negative). The inefficiency error term has a half normal distribution. The SPF is expressed as

$$Yi = f(Xi,\beta)e^{v-u} \quad (1)$$

In logarithm terms the SPF is expressed as

$$lnYi = lnf(Xi,\beta) + Vi - Ui \quad (2)$$

Where Yi is the output vector, Xi is the input vector, β is an unknown parameter vector, Vi is the random error term assumed to be iid N $(0, \sigma^2)$, Ui is the inefficiency term independently distributed from Vi. There is disagreement among econometricians as to the distribution of Ui (Jaforullah and Premachandra, 2003).

Previous studies have used several distributions including single parameter half-normal distribution, exponential and truncated normal distributions and two parameter gamma distribution (Bravo-Ureta *et al.*, 1991; Sharma *et al.*, 1999). In this study the half normal distribution used by Jaforullah and Premachandra (2003) in a cross sectional data similar to this study was adopted.

3. METHODOLOGY

3.1. Research Design

A descriptive research design was employed in the study with an aim of describing and comparing the technical efficiencies for smallholder vegetable farmers.

3.2. Sampling Procedure and Data Collection

The target population was 289 active vegetable farmers in the Hhohho region of Swaziland. An up-todate list of farmers was obtained from the Ministry of Agriculture and also from NAMBoard. A stratified random sampling method was used in selecting a sample of 120 farmers from the four Rural Development Areas (RDAs) in the Hhohho region. The vegetable crops studied included tomatoes, cabbages, beetroot and green pepper. These crops are the mostly grown vegetables in Swaziland.

Data were collected through the use of personal interviews using a structured questionnaire which consisted both open and closed-ended questions. The questionnaire was pre-tested to evaluate for validity, reliability, consistency, and clarity to avoid duplication of questions.

3.3. Data Analysis

Data were analyzed using descriptive statistics involving frequencies. Technical efficiency was conducted by the estimation of the Cobb-Douglas production function in which both the output and inputs were expressed in the logarithmic form, using the program STATA (version 12).

3.4. Analytical Technique

3.4.1. Technical Efficiency

Technical efficiency is the practice of using available resources in the best combination with the aim of maximizing output (Battese and Coelli, 1995). Measuring the technical efficiency of smallholder vegetable farmers involved the estimation of a Stochastic Frontier Production Function. The stochastic frontier production function was independently proposed by Aigner *et al.* (1977) and Meeusen and Van den Broeck (1977). It is defined by:

$$y_i = f(x_i; \beta) \cdot \exp(v_i\text{-}u_i) i = 1,2,3,\ldots,n \qquad (3)$$

Where y_i, is scalar output of the i^{th} farm, x_i is a vector of inputs of the i^{th} farm, and β is a vector of parameters to be estimated. The first error component, v_i, is assumed to be independently and identically distributed and symmetric. This error term represents the random effects, measurement errors, omitted explanatory variables and statistical noise. The second error component, $u_i \geq 0$, is expected to capture the inefficiency of the dairy farm and it is assumed to be independently and identically distributed with mean, μ, and variance, σ_u^2. The technical efficiency for the i^{th} farm, defined by the ratio of observed production to the corresponding frontier production associated with no technical inefficiency, is expressed by:

$$TE_i = Y_i/Y^*_i = f(X_i ; \beta) \exp(v_i - u_i)/f(X_i ; \beta) \exp(v_i) = \exp(-u_i)$$

A technical efficiency score of 1 indicates a perfectly efficient firm, while lower scores indicate lower efficiencies. The prediction of the technical efficiencies is based on the conditional expectation, given the composed random error ($v_i - u_i$), which is to be evaluated at the maximum-likelihood estimates of the parameters of the model (Battese and Coelli, 1995).

3.4.2. Empirical Model Specification

The model of Cobb-Douglas functional form used was specified as;

$$\ln y_i = \beta_0 + \beta_1 \ln x_{1i} + \beta_2 \ln x_{2i} + \beta_3 \ln x_{3i} + \beta_4 \ln x_{4i} + \varepsilon i \quad (4)$$

Where:

ln = Natural logarithm.

y_i= vegetable output (kg/ha)

β_0 = constant term

β_i = regression coefficient of the i^{th} variable

x_1 = amount of vegetable seeds used (kg/ha)

x_2 =amount of fertilizer used (kg/ha)

x_3= amount of chemicals used (kg/ha)

x_4= labour used (man-days/ha)

x_5= farm size used for vegetable production (ha)

ε_i = error term and defined as $(v_i - u_i)$

v_i = random effects (measurement errors, omitted explanatory variables) assumed to be independent of u_i, identically and normally distributed with zero mean and constant variance σ_v^2.

u_i = non-negative random error variables which are assumed to account for technical inefficiency in vegetable farmers.

Uis are the technical inefficiency effects which are assumed to be independent of Vi such that Ui is the non-negative truncation (at zero) of the normal distribution with mean Ui and Variance δ2, where Ui is defined by;

$$\mu_i = \delta_0 + \delta_1 z_{1i} + \delta_2 z_{2i} + \delta_3 z_{3i} + \delta_4 z_{4i} + \delta_5 z_{5i} + \delta_6 z_{6i} + \delta_7 z_{7i} \quad (5)$$

Where:

μ_i = technical inefficiency

δ_i = inefficiency parameter of the i^{th} variable

z_1 = Age (years)

z_2 = Gender (1 for female, 0 for male)

z_3 = Education (years)

z_4 = Farming experience (years)

z_5 = Credit access (1 for yes, 0 for no)

z_6 = Off farm income (1 for yes, 0 for no)

z_7 = Extension service (1 for access, 0 for no access to extension service)

z_8 = Reliable markets (1 for available, 0 for no availability)

z_9 = Market driven production (1, for market driven, 0 for non market driven)

z_{10} = Timely input purchase (1 for yes, 0 for no)

4. RESULTS AND DISCUSSION

4.1. Descriptive Statistics of the Farmers

As presented in Table 1, most households (62.5%) were headed by males. Male dominance can be attributed to loss of jobs, retirement and the high unemployment rate in Swaziland. Most of the interviewed farmers were middle aged, with an average of 45 years, this suggest that the farmers were above the youthful age, which is 35 years. The majority of respondents (61.7%) had a high school certificate at the least (spent a minimum of 12 years in formal education), this means they can easily understand production and marketing information. The household size averaged about 8 persons with the smallest household having only 1 member and the largest household having 20 members.

The average land size was 2.4ha per farmer. A marginal portion of the respondents (19.2%) were members of an association or a farming group, while 72.5% had access to extension service, suggesting that they were assisted technically and they had at least 5 years farming experience. About 68% of the farmers had access to off-farm income. At least 37.5% of the respondents had accessed credit at some point in their lives and only 18.3% used credit in the past 12 months. Seventy five percent of the farmers had reliable markets (pre-determined) and 54% produced vegetables that were demanded by the markets.

Table-1. Socioeconomic Characteristics of the sampled smallholder farmers

Characteristics	Description	Frequency (%)
Gender of household head	Male	75 (62.5)
	Female	45 (37.5)
Level of formal education	Primary school	28 (23.3)
	Secondary school	18 (15.0)
	High school	30 (25.0)
	Tertiary	44 (36.7)
Group membership	Member	23 (19.2)
	Non – member	97 (80.8)
Access to extension service	Access	87 (72.5)
	No access	33 (27.5)
Access to off-farm income	Access	81 (68.0)
	No access	39 (32.0)
Access to credit	Access	45 (37.5)
	No access	75 (62.5)
Access to reliable markets	Access	90 (75.0)
	No access	30 (25.0)
Age		45 years
Household size		8 people
Land size		2.4 ha
Farming experience		5 years

4.2. Production Estimates of Vegetables

From the results presented in Table 2, the amount of chemicals applied has a positive relationship with tomato output and is significant at 10 percent level. This positive relationship means that for a unit increase in the amount of chemicals applied there would be 4.9% increase in tomato yield. This is in agreement with the *a priori* expectation and also agrees with Nyagaka *et* *al.* (2010) statement that farmers who apply the recommended amounts of chemicals usually get higher yields. For cabbage, seeds, fertiliser and labour are directly associated with output and are all significant at 5%, 1% and 10% significance level respectively. The positive coefficients of these variables indicate that a unit increase in the amount of seeds, fertiliser and labour used will increase cabbage output by 15%, 0.23% and 0.05% respectively, which is also line with the *a prior* expectation. According to Dlamini (2012) it is expected that the amount of fertiliser and seeds applied will have a positive relationship with yield, which will in turn have a positive relationship with technical efficiency. Furthermore, fertiliser and labour are directly associated with beetroot output and are both significant ($p < 0.01$). A unit increase in these variables will lead to an increase in beetroot output by 0.3% and 0.06% respectively. Land is indirectly associated with beetroot output and significant at 1% level. For every hectare increase in the land cultivated there will be 14.4% decrease in beetroot output. This observation could be due to farmers cultivating more land than they can manage. Likewise for green pepper, the variable fertiliser has an indirect relationship with green pepper output and significant ($p < 0.01$). The results therefore shows that an increase in the amount of fertiliser used would lead to 0.1% reduction in green pepper output. But chemicals and land are directly associated with green pepper output and are both significant ($p < 0.01$) suggesting a likely output increase of 3.7% and 52.8% for every unit increase of chemicals and land used respectively.

Table-2. Maximum likelihood estimates of the Stochastic Frontier Production and efficiency estimates for the Vegetable farmers

Tomato production factors				
Constant	8.6213***	1.4772	5.8432	0.0000
ln Seeds	0.0115	0.1575	0.0712	0.9421
ln Fertiliser	0.0753	0.2321	0.3210	0.7462
ln Chemicals	0.0491*	0.0253	1.9407	0.0658
ln Land	0.1327	0.1783	0.7433	0.4572
ln Labour	0.0004	0.0003	1.4731	0.7012
Tomato efficiency factors				
Constant	0.7092	1.6979	13.249	0.0000
Age	0.0088***	0.0012	9.1571	0.0000
Gender	-0.0160	0.0281	-0.7243	0.4688
Education	-0.0157***	0.0026	-7.5974	0.0000
Farming experience	-0.0379***	0.0109	-4.4190	0.0000
Credit access	0.0859***	0.0271	4.0342	0.0001
Off farm income	0.0276	0.0241	1.4568	0.1450
Extension service	0.0086	0.0273	0.3987	0.6897
Reliable markets	-0.0198	0.0345	-0.7311	0.4648
Market driven pdn.	0.0002	0.0285	0.000	0.9935
Timely input purchase	-0.0127	0.0278	-0.5814	0.5614
Sigma-squared	0.3588***	0.1413	9.1654	0.0000
Log likelihood	69.5443			
Cabbage production factors				
Constant	0.8146***	0.1019	7.7592	0.0000
ln Seeds	0.1497**	0.0632	2.1258	0.0454
ln Fertiliser	0.0023*	0.0004	5.2984	0.0003
ln Chemicals	0.0160	0.0286	1.1496	0.3301
ln Land	0.0172	0.0583	0.1320	0.1407

ln Labour	0.0005*	0.0003	1.6867	0.0689
Cabbage efficiency factors				
Constant	0.4532	0.8029	9.6075	0.0000
Age	0.0053***	0.0017	4.0074	0.0001
Gender	0.0197	0.0369	0.6632	0.5070
Education	-0.0100***	0.0048	-2.5890	0.0096
Farming experience	-0.1032***	0.0176	-7.2424	0.0000
Credit access	-0.1334***	0.0367	4.5020	0.0000
Off farm income	0.0472	0.0488	1.1687	0.2425
Extension service	-0.0103	0.0363	-0.3514	0.7258
Reliable markets	-0.0208	0.0467	-0.5300	0.5960
Market driven pdn.	-0.0126	0.0402	-0.3891	0.6976
Timely input purchase	-0.0321	0.0369	-1.0764	0.2821
Sigma-squared	0.0795***	0.0083	9.5921	0.0000
Log likelihood	51.1986			
Beetroot production factors				
Constant	2.3561***	0.2357	9.9962	0.0000
ln Seeds	0.0727	0.0511	1.4227	0.5568
ln Fertiliser	0.0029***	0.0002	14.5000	0.0000
ln Chemicals	0.0675	0.0490	1.3776	0.5568
ln Land	0.1419***	0.0162	-8.7593	0.0000
ln Labour	0.0006***	0.0001	6.0000	0.0000
Beetroot efficiency factors				
Constant	1.0518	0.2432	4.3211	0.0000
Age	-0.0072**	0.0049	-2.0101	0.0444
Gender	-0.0615	0.1159	-0.7286	0.4662
Education	-0.0111	0.0115	-1.3242	0.1862
Farming experience	0.0384	0.0584	0.9059	0.3650
Credit access	0.0699	0.1631	0.5894	0.5556
Off farm income	0.2032**	0.1398	1.9973	0.0458
Extension service	-0.1041	0.1359	-1.0534	0.2924
Reliable markets	-0.0825	0.2752	-0.4122	0.6803
Market driven pdn.	0.0211	0.1439	0.2014	0.8407
Timely input purchase	-0.1199	0.1247	-1.3223	0.1863
Sigma-squared	0.2048***	0.2483	8.2458	0.0000
Log likelihood	5.6743			
Green pepper production factors				
Constant	0.4245***	0.0197	21.5482	0.0000
ln Fertiliser	-0.0013***	0.0005	2.6000	0.0137
ln Chemicals	0.0366***	0.0109	3.3578	0.0098
ln Land	0.5276***	0.1047	5.0392	0.0000
ln Labour	-0.0827	0.2748	0.3009	0.6704
Green pepper efficiency factors				
Constant	-0.3276	0.2082	-1.573	0.1157
Age	0.0175***	0.0039	4.447	0.0000
Gender	-0.1806*	0.0997	-1.812	0.0699
Education	0.0198**	0.0082	2.402	0.1158
Farming experience	0.0426	0.0554	0.769	0.4419
Credit access	-0.1578*	0.0852	-1.852	0.0640
Off farm income	-0.3776***	0.0773	-4.887	0.0000
Extension service	-0.2916***	0.0814	-3.581	0.0003
Reliable markets	0.4346***	0.0895	4.854	0.0000
Market driven pdn.	-0.3586***	0.0889	-4.039	0.0001
Timely input purchase	-0.0330	0.0715	-0.461	0.6445
Sigma-squared	0.1303***	0.0174	7.483	0.0000
Log likelihood	17.3419			

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

Table 2 further reveals that age and access to credit were directly related to tomato farmers' technical efficiency and are significant at 1% level of significance. The results suggest that older farmers and farmers who had access to credit were more technically efficient than younger farmers and farmers who had no access to credit respectively.

Education and farming experience were indirectly related to tomato and cabbage farmers' technical efficiency and were significant ($p < 0.01$). The indirect relationship of these variables with technical efficiency means that the more educated the farmers and the more farming experience the farmers had, the more inefficient they were. This is not in line with *a priori* expectation. This may be due to the fact that farmers who were more educated were highly likely to be permanently employed and do farming business on a part time basis, hence were not efficient in their production. Likewise experienced farmers in the study area were usually not keen to adopting new technology and accept advice because they believe their methods work better for them.

Moreover, for cabbage farmers, age had a direct relationship with their technical efficiency and was significant at 1% level meaning that older farmers were more technically efficient than younger farmers in cabbage production. Meanwhile, cabbage farmers who had access to credit were less efficient than their counterparts who did not have access to credit which could be due to farmers allocating funds inappropriately.

For beetroot farmers, age had an indirect relationship with their technical efficiency and is significant at 5% level. On the other hand, off-farm income had a positive and significant ($p < 0.05$), relationship to technical efficiency. In green pepper production, except for age and access to reliable market that have positive relationship with technical efficiency, access to credit, off farm income, extension services and market driven production were all negatively related to the farmers' technical efficiency and were significant at 1% level. This inverse relationship of gender means female farmers were more technically efficient in green pepper production. Farmers without credit access, lack of farm income, extension services and market driven production were more technically efficient than farmers who have.

4.3. Technical Efficiency Levels for Tomato Farmers

The frequency distribution of the estimated technical efficiency levels of the vegetable farmers who planted tomatoes is presented in Table 3. A total of 57% of the sampled tomato farmers had access to credit, while 43% did not have credit access. The study revealed that the technical efficiency of tomato farmers who had access to credit ranges from 57% to 98% with an average of 77.5%. Technical efficiency of tomato farmers who did not have access to credit ranges from 73% to 99% with an average of 86%. A total of 58% of the farmers who had credit access operated above 85% technical efficiency level, while 77.8% of the farmers without credit access operated above 85% technical efficiency level. No farmer operated below the 65% technical efficiency level for those who did not access credit and 20.8% of the famers who had credit access operated below the 65% technical efficiency level. These findings indicate that tomato farmers who did not have credit access were more efficient than their counterparts who had access to credit.

Table-3. Frequency distribution of technical efficiency for tomato farmers

Level of T.E (%)	No. of framers (Credit) N= 24 (57%)	% framers (Credit) N= 18 (43%)	No. framers (no credit)	% framers (no credit)
>85	14	58.3	14	77.8
81 – 85	2	8.3	2	11.1
75 – 80	2	8.3	1	5.6
71 – 75	1	4.2	1	5.6
66 – 70	0	0	0	0
61 – 65	2	8.3	0	0
56 - 60	3	12.5	0	0
Total		100		100
Sample size (N)	24		18	
Average TE (%)	77.5		86	
Min. TE (%)	57		73	
Max. TE (%)	98		99	

4.4. Technical Efficiency Levels for Cabbage Farmers

The frequency distribution of technical efficiency levels for farmers who planted cabbages is presented in Table 4. A total of 56.5% of the sampled cabbage farmers had access to credit, while 43.5% did not have credit access. The study revealed that the technical efficiency of cabbage farmers who had access to credit ranged from 24% to 96% with an average of 60%. The technical efficiency of cabbage farmers who did not have access to credit ranged from 52% to 99.7% with an average of 74.5%. A sum of 46% of the farmers who had access to credit operated above 85% technical efficiency level, while 90% of the farmers without credit access operated above the technical efficiency level of 85%. For farmers who had access to credit, only 3.8% operated below 40% technical efficiency level and no farmer operated below the 55% level of technical efficiency for farmers without credit access. These findings indicate that cabbage farmers who did not have access to credit were more efficient than their counterparts who had credit.

Table-4. Frequency distribution of technical efficiency for cabbage farmers

Level of T.E (%)	No. of framers (Credit) N= 26 (56.5 %)	% framers (Credit)	No. framers (no credit) N= 20 (43.5%)	% framers (no credit)
>85	12	46.2	18	90.0
81 - 85	6	23.1	0	0
76 - 80	1	3.8	1	5.0
71 - 75	1	3.8	0	0
66 - 70	2	7.7	0	0
61 - 65	1	3.8	0	0
56 - 60	0	0	0	0
51 - 55	0	0	1	5.0
46 - 50	0	0	0	0
41 - 45	2	7.7	0	0
<40	1	3.8	0	0

		100		100
Sample size (N)	26		20	
Average TE (%) 60	60		74.5	
Min. TE (%) 24	24		52	
Max. TE (%) 96	96		97	

4.5. Technical Efficiency Levels for Beetroot Farmers

The frequency distribution of the estimated technical efficiency levels of the vegetable farmers who planted beetroot is presented in Table 5. A total of 55.9% of the sampled beetroot farmers had access to credit, while 44.1% of the sampled farmers did not have credit access. The study revealed that the technical efficiency of beetroot farmers who had access to credit ranged from 31% to 99.9% with an average of 65.5%. The technical efficiency of beetroot farmers who did not have access to credit ranged from 13% to 99.9% with an average of 56.5%. A total of 26% of the farmers who had credit access operated above 85% technical efficiency level, while 6.6% of the farmers without credit access operated above the technical efficiency level of 85%. For farmers who had credit access, 21% operated below the 40 % technical efficiency level and 46.7% of the farmers without credit access operated below the 40% level of technical efficiency. These findings indicate that beetroot farmers who did not have access to credit were less efficient than their counterparts who had credit access

Table-5. Frequency distribution of technical efficiency for beetroot farmers

Level of T.E (%)	No. of framers (Credit) N= 19 (55.9 %)	% framers (Credit)	No. framers (no credit) N= 15 (44.1%)	% framers (no credit)
>85	5	26.3	1	6.7
81 - 85	1	5.3	1	6.7
76 - 80	1	5.3	1	6.7
71 - 75	1	5.3	1	6.7
66 - 70	1	5.3	0	0
61 - 65	1	5.3	2	13.0
56 - 60	0	0	1	6.7
51 - 55	1	5.3	0	0
46 - 50	1	5.3	1	6.7
41 - 45	3	15.8	0	0
<40	4	21.0	7	46.7
		100		100
Sample size (N)	19		15	
Average TE (%)	65.5		56.5	
Min. TE (%)	31		13	
Max. TE (%)	99.9		99.9	

4.6. Technical Efficiency Levels of Green Pepper Farmers

The frequency distribution of the estimated technical efficiency levels of the vegetable farmers who planted green pepper is presented in Table 6. Out of the sampled green pepper farmers 42.9% had access to credit, while 57.1% of the sampled farmers did not have access to credit. The study revealed that technical efficiency of green pepper farmers who had access to credit ranges from 18% to 99.9% with an average of 59%. The technical efficiency of green pepper farmers who did not have access to credit ranges from 17% to 99.9% with an average of 58%. A total of 42% of the farmers who had credit access operated above 85% technical efficiency level, while 31.3% of the farmers without credit access operate above a technical efficiency level of 85 %. For farmers who had credit access, 8.3% operate below the 40% technical efficiency level and 18.8% of the farmers without credit access operate below the 40% level of technical efficiency. These findings indicate that green pepper farmers who did not have credit access were less efficient than their counterparts who had credit access.

Table-6. Frequency distribution of technical efficiency for green pepper farmers

Level of T.E (%)	No. of framers (Credit) N= 12 (42.9 %)	% framers (Credit)	No. framers (no credit) N= 16 (57.1%)	% framers (no credit)
>85	5	41.6	5	31.3
81 - 85	1	8.3	3	18.8
76 - 80	0	0	1	6.3
71 - 75	1	8.3	0	0
66 - 70	0	0	0	0
61 - 65	0	0	0	0
56 - 60	0	0	0	0
51 - 55	1	8.3	0	0
46 - 50	2	16.7	1	6.3
41 - 45	1	8.3	3	18.8
<40	1	8.3	3	18.8
		100		100
Sample size (N)	12		16	
Average TE (%)	59		58	
Min. TE (%)	18		17	
Max. TE (%)	99.9		99.9	

5. CONCLUSIONS

Vegetable production in the study area is male dominated and all the respondents were literates but majority of them did not have access to credit. Tomato and cabbage farmers who had access to credit were less technically efficient than their counterparts who did not have access to credit. On the other hand, Beetroot and green pepper farmers who had access to credit were more technically efficient than those who did not have credit access, therefore, access to credit positively affected beetroot and green pepper farmers' technical efficiency.

6. RECOMMENDATIONS

Government should subsidize farming inputs and financial institutions should make credit more available to agribusinesses. This will enhance the farmers' technical efficiencies, as well as encourage female farmers into vegetable production. Also, smallholder vegetable farmers should increase the amount of seeds, fertilizer and chemicals they apply to improve yields and there is need for more extension visits to tomato and cabbage farmers who received credit in particular, for relevant training on effective use of credit to increase production.

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