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The Impact of Credit on Technical Efficiency Among Vegetable Farmers in Swaziland

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Abstract

Access to credit is regarded as an important intervention for improving the incomes of the rural population, mainly by mobilizing resources to more productive uses. Production of vegetables by smallholder farmers in Swaziland is inconsistent and lower than the national demand, hence the gap is filled by imports from South Africa. The purpose of the study was to assess the influence of credit on technical efficiency of smallholder vegetable farmers in Swaziland. Data were collected in 2013 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). This was followed by a simple 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. The Stochastic Frontier production function was used to analyze the data using the STATA program (version 12). The results revealed that credit had a negative effect on technical efficiency of cabbage and green pepper farmers, while it had a positive effect on the technical efficiency of tomato, and beetroot farmers. The technical efficiency of tomatoes and cabbage farmers was 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 Government of Swaziland should subsidize farming inputs and financial institutions should make credit more available to agribusinesses in order to improve the efficient use of input resources.

Keywords: impact of credit access, technical efficiency, vegetable farmers

1. Introduction

Agriculture is the mainstay of many developing economies, hence the reason for Swazi Bank to fully support commercial agriculture. However, according to Genesis Analytics (2012) commercial banks in Swaziland maintain an unyielding level of profitability by concentrating on more conventional financial products and services. The Government of Swaziland therefore operates a Small Scale Enterprise Loan Guarantee Scheme, administered by the Central Bank of Swaziland. The main objective of the scheme is to establish a loan guarantee fund that would encourage participating financial institutions such as commercial banks, to increase lending to small-scale enterprises. Small-scale Swazi enterprises that are start-ups or already engaged in industry, agriculture, commerce, tourism, construction and services, and comply with the criteria set forward by the fund are eligible for credit under the scheme.

The minimum amount loaned varies with each participating financial institution, but should be as low as possible to allow the scheme to reach the majority of small scale entrepreneurs. The maximum credit should not exceed E500, 000 per loan application. However, the participating financial institution will have to satisfy itself that the project to be financed is technically and financially sound before issuing the loan. In case of default the participating financial institution may invoke the guarantee in respect of any amount in default on account of advance covered under the terms of the scheme. This has really encouraged the Swazi Bank to give out loans (Genesis Analytics, 2012).

Vegetable production in Swaziland is a seasonal activity and farmers, especially on Swazi Nation Land (SNL) produce maize in summer and vegetables in winter with the most commonly produced vegetables in the country being tomato, cabbage, carrot and onion. From mid-winter to early summer these vegetables are abundant at the market place (NAMBoard, 2009). But not much investigation has been carried out on technical efficiency of vegetables growers. The purpose of the study was to assess the influence of credit on technical efficiency of smallholder vegetable farmers in Swaziland using the stochastic frontier function.

2. Literature Review

2.1 Credit Access by Smallholder Farmers

Access to credit as defined by Zuberi (1990) is the ability of the farmers to borrow from a particular source, whereas, participation in the credit market is when the farmers actually borrow from that credit source. Zeller and Sharma (1998) stated that credit facilities may aid smallholder farmers to tap financial resources beyond their own means and take advantage of potentially profitable small business opportunities.

In many developing countries, access to credit by smallholder farmers has been hard for many decades. Mohamed (2003) supports the view by stating that even before the actual financial crises, most of the over one billion smallholder farmers worldwide and many of the rural entrepreneurs from developing countries had little or no access to financial services. For example, in Ethiopia, Yehuala (2008) indicated that the majority of rural households did not have access to credit from the formal credit institutions. Generally, smallholder farmers rely on informal lenders to accomplish their credit needs. However, they are provided very small loans, for a short period and especially for consumption purposes. Furthermore, when credit is requested for purchasing farm equipment and other agricultural inputs, including the introduction of modern irrigation system and other technological development, access becomes a serious concern for farmers since they cannot secure such big loans.

A study by Gonzalez-Vega (1998) reported that only a small portion of farmers in developing countries have received formal loans. Statistics estimate that only 15% of farmers in Asia and Latin America and just 5% in Africa were financed through formal credit sources. For example, formal financial sources in Zanzibar accounted for only 9.9% of the total credit available to the agricultural sector. The remaining 90.1% was from informal financial sources. In Kenya, a study by Nguthi (2007) found that only 16% of the smallholder farmers accessed credit and the majority of them had no access to credit due to lack of collateral to secure their loans from the financial institutions. In Zambia, smallholder farmers also had the lowest access to credit from rural banks, averaging less than 20%.

It has been stated by Patten and Jay (1991) that a vital factor influencing access to formal credit is collateral. In the absence of complete information about borrowers, banks require collateral either as a mechanism to enforce loan payment (Patten & Jay, 1991) or as a screening devise to sort borrowers of varying riskiness (Bester, 1985). Smallholder farmers are poor and the landless have fewer assets acceptable as collateral so they are more likely than the rich not to be considered for credit.

These concerns provide a strong inspiration for the promotion of rural financial deepening. This inspiration also possesses important threats, as many calls for action have been based on incorrect perceptions and expectations about the role of finance in the task of poverty alleviation (Gonzalez-Vega, 1998). Indeed, the supply of formal financial services and poverty are related in complex ways (Gonzalez-Vega, 1998; Zeller et al., 1997). Sometimes formal financial services can release credit constraints and facilitate a fuller exploitation of existing productive opportunities. When this is the case, some households can lift themselves out of poverty (Zeller & Mayer, 2002).

Depending on the circumstances credit can thus increase or decrease poverty. Typically loans cannot create productive opportunities, particularly when other constraints are binding. Credit cannot build the roads needed to bring the crop to market; credit cannot discover the farming technology that does not exist; credit cannot generate key inputs that are not available; credit cannot create or destroy comparative advantage or change consumer preferences.

It is important to recognise that, despite major earlier attempts to expand the supply of agricultural credit and despite the massive use of public funds for this purpose, the majority of rural population of the developing countries has actually never had access to formal financial services (Donald, 1976). Thus, the unquestionably basic question is: why have the rural populations of developing countries never had adequate access and continue not to have access to financial services, despite their justifiable demands for various types of loans,

deposit facilities and other financial products? The answer must lie in the extensive difficulties that explain this widespread outcome.

3. Theoretical Framework

The theoretical framework for this study involved the bank capital channel and the capital constraint model. Also adopted in this study were the lifecycle approach, pecking-order and the agency framework hypothesis that tries to explain the financial structure of small businesses.

3.1 Bank Capital Channel Model

It considers the lending behaviours of banks to small enterprises to be affected by a capital adequacy requirement. According to Obamuyi (2007), the bank capital channel observes an alteration in interest rate as disturbing lending through bank's capital, mostly when the banks' lending is inhibited by a capital adequacy requirement. Thus, an increase in the interest rates will raise the cost of banks' external funding, but reduces banks' profits and capital. The trend is for the banks to reduce their supply of loans if the capital constraint becomes obligatory. However, banks could also become more willing to lend during certain periods because of an improvement in the underlying financial condition. This condition as alleged by this model, is seen clearly in the relationship between banks and smallholder farmers as farmers suffer through a lack of financial assistance as a result of this situation.

3.2 Capital Constraint Model

It describes the behaviour of banks' hold back to give out loans to small enterprises because of the limitation of available financial resources. According to the work of Obamuyi (2007), banks are subjected to both markets and regulator-imposed capital requirement. For prudential purposes, bank regulators normally want banks to maintain capital at not less than a stated fraction of the bank's total assets. For instance, banks are expected to meet the capital adequacy requirement of the Basel Accord of ten percent. This situation is visible especially in Nigeria, as banks are expected to maintain a minimum of forty percent liquidity ratio of total deposits.

The lifecycle approach, as described by Weston and Brigham (1981), was envisioned on the principle of rapid growth and lack of access to capital market. Small firms were seen as starting out by using only the owners' resources. If these firms survived, the danger of undercapitalisation would quickly emerge, as they would then be likely to make use of other sources of funds, such as trade credit and short-term loans from banks. Rapid growth could lead to the dilemma of illiquidity. The dynamic small firm would then have to choose among reducing its growth to keep pace with its internally generated funds, acquire a costly stock market quotation, or seek that most elusive form of finance-venture capital (Weston & Brigham, 1981).

The pecking order theory as revealed by Arrow (1996) stated that firms finance their needs in a hierarchical order, first by using internally available funds, followed by debt and finally, external equity. This practice is more common in small firms and indicates the negative relationship between profitability and external borrowing by small firms. According to Arrow (1996), this hypothesis suggests that there tends to be a negative connection between profitability and external borrowing by small firms. In other words, supposing a zero growth, firms with high profitability would produce higher levels of internal liquidity, reducing the need for borrowing. Older firms, it may be hypothesised, would make less use of external finance and, instead would rely on retained funds.

The agency theory places emphasis on transaction costs and contracting analysis following the work of Stiglitz and Weiss (1981). The work of these writers point to the challenges that surround ownership of contractual agreements, management interrelationships, credit rationing, among others, between SMEs and external providers of finance, thus, subjecting firms to the threat of asset substitution which in practice means a change in firm's asset structure. For very small and micro-enterprises this asset substitution may well take place between the enterprise and the owner's household. As described by Arrow (1996), the presence of these problems in small firms may describe the greater use of collateral lending to small firms and small farmers as a way of dealing with the agency problems. Lenders' policies for dealing with these problems also add considerably to the cost of dealing with this sector. For a large enterprise the appraisal of an application for finance may be limited to the review of an audited set of financial statements and supporting documentation provided by the applicant, while for SMEs the assessment normally has to go far beyond this, implying a substantially higher transaction cost.

Regardless of all the theories explaining the financial needs of SMEs and smallholder farmers, it is clear that the financial needs of these groups in both developing and industrial countries are largely diverse.

4. Methodology

4.1 Sampling Procedure

The target population was 289 active vegetable farmers in the Hhohho region of Swaziland obtained from the Ministry of Agriculture and NAMBoard. The sampling units were the four rural development areas in the Hhohho region namely Madlangemphisi, Mayiwane, Ntfonjeni and Motshane. A stratified random sampling method was used in selecting a sample of 120 farmers. The vegetable crops studied included tomatoes, cabbages, beetroot and green pepper. These crops account for a larger percentage of vegetables produced in the study area. The number of farmers sampled per rural development area is given Table 1.

Table 1. Number of farmers sampled per RDA

Name of RDA	Population per RDA	Sample per RDA
Madlangemphisi	60	25
Mayiwane	76	31
Ntfonjeni	73	30
Ntfonjeni	80	34
Total	289	120

4.2 Data Collection

Primary data were collected from respondents through a structured questionnaire which was administered using personal interviews. The questionnaire was pre-tested to evaluate for validity, reliability, consistency, clarity, and to avoid duplication of questions.

The study used the cognitive laboratory type of personal interviews, which consists of one-on-one interviews where respondents indicated their thoughts, while answering the survey questions. Laboratory interviews provide an important means of finding out directly from respondents what their problems are with the questionnaire (Presser et al., 2004).

4.3 Data Analysis

Descriptive statistics such as frequency, percentage, means and standard deviations were used to analyse variables like the households' socio-economic characteristics, access to extension services, using the program STATA (version 12). The logistic regression model was used to analyse the determinants of smallholder farmers' access to credit. The logistic regression is an approach for prediction like Ordinary Least Squares regression. However, with logistic regression, the researcher is predicting a dichotomous outcome. A Tobit model was employed for the logistic regression while Cob Douglas function was specified in the stochastic production frontier model. The study used a Cob Douglas function and the Tobit model to estimate technical efficiency and establish the factors affecting technical efficiency.

4.4 Analytical Technique

4.4.1 Determinants of Credit

According to Brooks (2008), both the logit and probit are non-linear models and are estimated using maximum likelihood (ML) method. These two models are able to overcome the limitation of linear probability model. They do this by using a function that effectively transforms the regression model so that the fitted values are bounded within the (0, 1) interval. In addition, Sirak and Rice (1994) noted that both logit and probit models guarantee that the estimated probabilities lie between the logical limited of 0 and 1. Due to these advantages, the logit and probit models are the most frequently used models when the dependent variable happens to be dichotomous (Gujarati, 2004). The logit and probit are relatively similar in most applications, the main difference between the two is in the nature of their distribution which is captured by Cumulative Distribution Function (CDF). Probit has a normal distribution, while logit has a logistic (slightly flatter tails) distribution.

The choice of probit versus logit regression depends, therefore, chiefly on the distribution assumption one makes. The logit regression model in practice has been used by many researchers because of its comparative mathematical simplicity. Sirak and Rice (1994) argues that logistic regression is powerful, convenient and flexible and is often chosen if the dependent variables is of categorical nature and/or is not normally distributed.

Some of the predictor variables in the study objectives are categorical and therefore this study applied the logit model to identify the factors that influence access to credit services among smallholder farmers. The basic logistic model is given by:

$$P = \frac{\exp(Z)}{1+\exp(Z)} \quad (1)$$

P = proportion of occurrences

$$Z = \beta o + \beta_1 X_1 .....+ \beta_n X_n + e \quad (2)$$

Z = access to credit

βo = intercept

β_i = regression coefficient

X_1 = age (years)

X_2 = gender (0=male; 1= female)

X_3 = years of formal education (primary, high school, tertiary)

X_4 = access to off farm income (value in Emalangeni)

X_5 = farm size (hectares)

X_6 = household size (number of people available to help in farming operations)

X_7 = membership in farming group (0=member; 1=not a member)

X_8= farmer's experience (years)

e= error term

4.4.2 Explanatory Variables for Access to Credit

Age – According to Dlova, Fraser and Belete (2004) and Bembridge (1984), the younger the farmers the more likely they are to access credit. As the farmers get older, they have poor chances to access credit because they often become more conservative and reluctant to accept risk; they are less capable of carrying out physical activities; and they are risk averse and do not like to enter into debt obligations.

Gender – Since males are physically capable of coping with the manual demands of farming practices, it is expected that they are more likely to access credit (Bembridge, 1984; Dlova et al., 2004).

Education and training – Smallholder farmers must be familiarised with the principles of business economics, record keeping and they should become proficient in managerial skills. Therefore, the more educated the farmers are, the more likely they are to access credit (Bembridge, 1984; Nompozolo, 2000; Dlova et al., 2004)

Access to off-farm income – off-farm income is a substitute for borrowed capital in rural economies where credit markets are either missing or dysfunctional. In addition off-farm income work may serve as collateral to facilitate access to credit by smallholder farmers (Reardon et al., 1994).

Household size – normally, the larger the family size, the more likely the farmer is to become successful as the household has more labour to work on the farm. However, this would only work if all family members are old enough to perform the farm work.

Farm size – relates positively to the chances to access credit because the owner of a large farm would usually have a bigger capital requirement and this would entice the owner to look for external financing opportunities (Nompozolo, 2000).

Table 2. Description of explanatory variables for credit access

Variables	Type of variable	Description	*A priori* expectation
Age	Continuous	Age of farmer.	Younger farmers are more likely to access credit
Gender	Binary	Sex of respondent, 1 if female and 0 otherwise.	Male farmers are more likely to access credit
Education	Continuous	Years of formal schooling.	Access to credit increases with education
Farm size	Continuous	Hectares of land under vegetable production.	Access to credit increases with farm size
Household size	Continuous	Number of people involved in vegetable production.	Access to credit increase with an increase in household size
Farming experience	Continuous	Years of farming experience	Access to credit increase with an increase in farming experience
Membership in farming group	Binary	1 if respondent is not a member and 0 otherwise.	Access to credit increase with membership

4.4.3 Factors Affecting Technical Efficiency

Technical efficiency is the practice of using available resources in the best combination with the aim of maximizing output (Battese & Coelli, 1995). Measuring the technical efficiency of smallholder vegetable farmers included the estimation of the Cobb-Douglas production function in which both the output and inputs were expressed in logarithmic form.

The Cobb-Douglas production function was developed as;

$Y = \beta_0 X_1^{\beta 1} X_2^{\beta 2} X_3^{\beta 3} X_4^{\beta 4} X_5^{\beta 5} e^{(u_i - v_i)}$

Where: Y – vegetable output (kg/ha)

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)

$e^{(u_i - v_i)}$ – error term

β_0 is a constant and β_1, β_2, and β_3, are elasticities to be estimated.

In order to be able to use the Least Squares procedure for estimation, the Cobb-Douglas function was transformed to be linear to get the following linear regression specification:

$\ln Y_i = \beta_0 + \beta_1 \ln X_1 + \beta_2 \ln X_2 + \beta_3 \ln X_3 + V_i - U_i$ called Trans-log

Where: the subscript *i* indicates the *i*th farmer in the sample (i = 1, 2, 3 ...n)

ln – Natural logarithms.

V_i – Random error associated with measurement errors technical efficiency.

U_i are non-negative random variables associated with technical inefficiency of production by vegetable farmers, assumed to be independently distributed, such that the technical inefficiency effects for the i^{th} farmer growing vegetables is normally distributed with mean, μ and variance, σ^2.

A two-limit Tobit regression model was used as a second step analysis to establish the relationship between the socio-economic characteristics, production characteristics and market characteristics of the farmers and the computed indices of technical efficiency. The two-limit Tobit model was adopted because technical efficiency of an individual vegetable farmer is the ratio of the observed input to the corresponding frontier output conditional on the level of input used. Therefore, technical efficiency scores lie within the range of 0 to 1, which are the two

acknowledged restrictions of the model (Wilson, Hadley, Ramsden, & Kalsas, 1998). The Tobit model was developed as follows:

$U^* = \alpha_0 + \alpha_1 + \alpha_2 + \alpha_3 + \alpha_4 + \alpha_5 + \alpha_6 + \alpha_7 + \alpha_8 + \alpha_9 + w$

Where:

α_0- is a constant and

α_1- age

α_2- gender

α_3- farming experience

α_4- credit access

α_5- off farm income

α_6- extension service

α_7- reliable markets

α_8- market driven production

α_9- timely input purchase

w- error term

5. Results and Discussion

5.1 Descriptive Results

As presented in Table 3, 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 suggests that the farmers may be productive since their average age is above the youthful productive stage. 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.

Land size used for vegetable production averaged 2.4 ha per farmer. A marginal portion of the respondents (19.2%) were members of 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 3. Socio-economic 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)
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	0 (25.0)
Age	Years	45
Household size	numbers	8
Land size		2.4 ha
Farming experience		5 years

5.2 Factors Affecting Access to Credit

The results in Table 4 show that education and group membership have a positive relationship with access to credit and are significant ($p < 0.10$). The logit coefficient of education is 0.0202 and its odds ratio is 1.0204 implying that, for every additional year spent in education, other things being equal, the odds of accessing credit increase by 2.0% (1.0204-1). The logit coefficient of group membership is 0.2074 and its odds ratio is 1.2305, implying likewise that chances of accessing credit increase by 23.1% if a farmer is a group member than when a farmer is not a group member.

Table 4. Logit results of Factors affecting household's farmer's access credit

Variable	Coefficient	Std. Error	Z	P (Z)	odd ratio
Constant	0.0496	0.2556	0.194	0.8462	1.0509
Age	0.0043	0.0043	0.998	0.3182	1.0043
Gender	-0.0340	0.0999	-0.034	0.7337	0.9666
Education	0.0202*	0.0106	1.905	0.0567	1.0204
Household size	0.0081	0.0122	-0.658	0.5105	1.0081
Land size	-0.0078	0.0218	-0.360	0.7188	0.9922
Group membership	0.2074*	0.1229	1.686	0.0918	1.2305
Farming experience	0.0291	0.0507	0.574	0.5657	1.0295

* signifies significance at 10% probability level.

5.3 Stochastic Frontier Production Results

From the results presented in Table 5 shows that 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 result in 4.9% increase in tomato yield. This is in agreement with the *a priori* expectation and also agrees with Nyagaka et al. (2010) that farmers who apply the recommended amounts of chemicals 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 in 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.

Table 5. Maximum likelihood estimates of the stochastic frontier production function for the vegetable farmers

Variable	Coefficient	Std. Err.	t-value	p-value
Tomato				
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
Cabbage				
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
Beetroot				
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	0.2568
ln Land 0.0000	-0.1419***	0.0162		8.7593
ln Labour	0.0006***	0.0001	6.0000	0.0000
Green pepper				
Constant	3.3193	0.1121	29.4302	0.0000
ln Seeds	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

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

Furthermore, fertiliser and labour are directly associated with beetroot output and were 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 percent 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 show 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.

5.4 Factors Affecting Technical Efficiency

Table 6 revealed 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 have access to credit are more technically efficient than younger farmers and farmers who have no access to credit respectively.

Education and farming experience are indirectly related to tomato and cabbage farmers' technical efficiency and are 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 have, the more inefficient they are. This is not in line with *a priori* expectation. This may be due to the fact that farmers who are more educated are highly likely to be permanently employed and do farming business on a part time basis, hence are not efficient in their production. Likewise experienced farmers in the study area are usually not keen to adopting new technology and accepting advice because they believe their methods work well for them.

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

For beetroot farmers, age has an indirect relationship their technical efficiency and its significant 5 percent level. On the other hand, off-farm income has a positive and significant ($p < 0.05$), relationship 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 are all negatively related to the farmers' technical efficiency and are significant at 1 percent level.

This inverse relationship of gender means female farmers are more technically efficient in green pepper production. Farmers without credit access, lack of farm income, extension services and market driven production are more technically efficiency than farmers who had credit.

Table 6. Maximum likelihood estimates of the logit model of factors affecting the technical efficiency of the Vegetable farmers

Variable	Coefficient	Std. Err.	t-value	p-value
Tomato				
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	0.3588***	0.1413	9.1654	0.0000

Log likelihood	69.5443			
Cabbage				
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				
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				
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.

6. Conclusions and Recommendations

6.1 Conclusions

Farmers' level of education and being a member of a group enhances their chance of having access to credit while productivity of all the vegetables under consideration have a positive and significant relationship with agricultural inputs except for beetroot and green pepper who are negatively related to land and fertilizer respectively. Age of the farmers have a positive impact on the technical efficiency of vegetable farming in the country except for beetroot production while education and access to credit negatively influenced the farmers technical efficiency except in the case of tomato and green pepper farming respectively. The results imply that older farmers have more experience, hence more efficient than young farmers.

6.2 Recommendations

The study recommends that farmers education and being a members of farmers groups or association should be encouraged to improve their access to credit and that credit given to farmers should be properly monitored for better technical efficiency in vegetable production.

The study further recommends that vegetable farmers should increase the amount of seeds, fertilizer and chemicals used in order to improve yields. Government of Swaziland should subsidize farming inputs and financial institutions should make credit more available to agribusinesses in order to improve the efficient use of input resources

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