Determinants of Smallholder Cabbage Farmers' Cost Efficiency under the Vuvulane Irrigated Farm in the Lubombo Region of Eswatini (Swaziland)

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Abstract

Cabbage production in Eswatini can hardly meet the country's demand. To meet this demand, some cabbage is imported from South Africa yet Eswatini has a potential of scaling-up its production. Cabbage is one of the main relishes consumed by rural households across Eswatini. Among challenges faced by small-holder farmers is expensive farm inputs yet are needed for improved productivity of cabbages. To minimize the costs of production while ensuring increased output, farmers need to use the scarce resources more efficiently. Therefore, this study was carried out to ascertain cabbage farmers' cost efficiency and the determinants of cost efficiency. The study used primary data collected from a sample of 60 out of 72 smallholder cabbage farmers cultivating on Vuvulane Irrigation Scheme using structured questionnaires. Stochastic frontier cost function was used to determine farmers' cost efficiencies and an OLS regression was employed to determine factors that influenced farmers' cost efficiency. The results indicated that majority of the farmers were males (66.7), aged between 31 and 40 years (44%), married (53.7%), and unemployed (47%). The majority attained high level of education (43.3%). Small-scale Cabbage farmers were cost efficient at 99.9% and the determinants of farmers' cost efficiency were: age, distance of farm from fertilizer suppliers and incomes generated from cabbage sales. Based on the results, this study recommends that stakeholders including government and the private sector should participate in developing strategies that will attract input dealers to extend their services near farmers and encourage more relatively young Vuvulane population to re-invest in the cabbage production enterprises on the irrigation schemes for increased regional cabbage production at a relatively minimum cost.

Key Words: Cost efficiency, cabbage farmers, Eswatini, cabbage production stochastic frontier

Introduction

Cabbage is a very important vegetable grown worldwide, and it is known for improved human nutrition, containing vitamins and cancer preventing substances. Cabbage is among the most important vegetable in Eswatini grown and consumed especially in rural areas as substitute for meat as sauce (World Food Program (WFP), 2018; Malinga *et al.*, 2015). Gonzales *et al.* (2015)

and Malinga *et al.* (2015) acknowledges that vegetable production enterprise is mostly practiced by smallholder farmers and are mainly grown in homestead gardens to supplement on the household food needs, and the surplus is sold to generate incomes. Most of the small-scale farming is Eswatini is practiced mainly on Swazi National Land (SNL) and this is where most vegetable production occur. The SNL is mainly located in rural areas dominated by 80% of the Swazi population (Xaba and Masuku, 2013a). Among the major vegetables grown on SNL includes cabbage (Xaba and Masuku, 2013b). Eswatini produces an estimated 1,420.72 metric tonnes (MT) of cabbage per year valued at US$331,501.34. Most cabbages is sold in the formal markets (60%), and about 40% of cabbages that is domestically produced is marketed through the informal channels and only 10% of cabbage produced by Eswatini farmers are consumed at the farmers’ households (NamBoard, unpublished).

According to the Department of Agriculture, Forestry and Fisheries –South Africa (DAFF) (2019) report, Eswatini imports cabbages from South Africa to meet the shortage supply. The DAFF (2019) report indicated that Eswatini imported 177tons from South Africa valued at US$56000. In its path to self-food sufficiency, this provides opportunity for farmers in Eswatini to increase the production of cabbages to meet the local demand. However, based on the purchasing power of rural smallholder farmers farm inputs are relatively expensive and need to be used efficiently for increased productivity. This study therefore aimed at exploring the farmers’ cost efficiency and the determinants of farmers’ cost efficiency.

Methodology

The study was both qualitatively and quantitatively designed to explicitly establish cost efficiency of farmers producing cabbages at Vuvulane Irrigation Farm smallholder’s Scheme in the Lubombo region of Eswatini. The irrigation scheme was established in 1962 during the colonial regime. It covers 1,203 ha of Title Deed Land. It was established majorly (70%) to produce sugarcane and supply it to the Mhlume sugar mill (Alan and Ogg, 2017). Although the soils are shallow they can easily allow water penetrating through it and are regarded suitable for irrigated crop production. The extension worker provided a list of 72 small-scale commercial cabbage farmers farming on the Vuvulane Irrigation scheme and at least 60 questionnaires administered to farmers were fully filled. Technically the study employed purposive sampling.

Descriptive statistics involving means and percentages, a stochastic frontier regression analysis to estimate the cost efficiency scores, and an OLS regression was used to identify the determinants of the cost efficiency. The data was analyzed using STATA 12.0 software. To estimate cost efficiency, the stochastic frontier total cost function used total costs as the dependent variable and cost of fertilizer, cost of seed, land under cabbage, and amount of herbicides (all per hectare basis) as independent variables. The stochastic frontier production cost function that was used in the study is simply presented as;

$$C = f\,(X_i;\,\beta_i) + e \qquad (1)$$

Where C is the Cabbage production Costs, X_i is a vector of input costs and β_i is a vector of estimated parameters.

The physical relationship can be derived from the Cobb–Douglas production function and it is given by:

$$C = AX_1^{\alpha_1}X_2^{\alpha_2}\ldots\ldots X_n^{\alpha_n}\gamma \qquad (2)$$

From (2) the linear cost of production function can be re-written as:

$$ln(C_i) = \beta_0 + \Sigma_i\beta_i\, lnX_{ij} + \varepsilon_i \qquad (3)$$

Where ln is natural logarithm, C_i is the Total Cost of production of the i^{th} farmer, β_0 is a Constant, β_i is a Coefficient, X_{ij} is the j input used by farmer i, ε_i = error term.

To normalize and linearize the Cobb-Douglas production function in form of a cost function, all variables were transformed into their nature log and the equation 3 can be rewritten empirically as follows;

$$LnC_i = \beta_{0i} + \beta_1 LnX_{1i} + \beta_2 LnX_{2i} + \beta_3 LnX_{3i} + \beta_4 LnX_{4i} + \beta_5 LnX_{5i} + (V_i - U_i) \qquad (4)$$

Where: i= 1,2,…nth cabbage farmers; Ln= Natural logarithms; C_i = Total Costs of Production (E/ha); X_1 = Cost of seed used (E/ha); X_2 = Cost of fertilizer used (E/ha); X_3 = Cost of land (E/ha); A = Constant; e = Random error term (V-U).

To determine factors that affect the level of cost efficiency, the OLS model was employed. The cost efficiency scores were regressed on farmer's characteristics. Empirically the OLS model was presented as;

$Y = \delta_i Z_i + \varepsilon i$…………………………………………………………………………….………(5)

$Y = \delta_0 + \delta_1 Z_1 + \delta_2 Z_2 + \delta_3 Z_3 + \delta_4 Z_4 + \delta_5 Z_5 + \delta_6 Z_6 + \delta_7 Z_7 + e$……………………..…………(6)

Where Y = Cost efficiency scores; δ –coefficients = are known parameters to be estimated; Z_1 = age of the farmer (years); Z_2 = gender (1=Female, 2=Male,); Z_3 = marital status (2=Married 1=single); Z_4 = level of formal education (1= attained below high school, 2= above high school level); Z_5 = Distance of farmer to the seed supplier (Km); Z_6 = Distance of farmer to the fertilizer supplier (Km), Z_7 = Incomes generated from cabbages sold (emalangeni); e= random error term.

RESULTS AND DISCUSSIONS

Tafesse et al. (2021) indicated that age plays a significant role in farming. On average respondents in this study were aged 44 years. Based on the definition of a youth in Eswatini, the age of 44 years is relatively above the youth age group of 35 years old. This means that most farmers holding plots on the Vuvulane irrigation scheme are old, and are thought to be more experienced in farming with more knowledge of mitigating risks. Table 1 present the age groups of the respondents as follows; 40% of farmers were aged between 31 and 40 years; 25% aged between 51 and 60; 22% of respondents were aged between 41 and 50; 8% of respondents aged above 61; and only 5% of respondents were aged below 30 years. Out of the 60 cabbage farmers interviewed at least 66.7% were males and only 33.3% were females. This may be a reflection of traditional or cultural norms and rules where women are denied ownership of factors of production which includes land and Eswatini is no exceptional (Brown, 2020; Dalo et al., 2017). Chiefs in most cases allocate land to males on behalf of the family denying women ownership yet they contribute 60% - 70% of rural agricultural labour (Kibirige, 2013; Dalo et al., 2017; Brown, 2020).

Results presented in Table 1 indicate that more than half (53%) of the interviewed respondents were married. Married farmers are anticipated to face financial pressures to take care of the day to day family business, feed a huge number of household sizes, and the opportunity availed in terms of free farm labour. This is thought to catalyse increased farm production and productivity. Furthermore, married people are more likely to increase chances of access agricultural information and make meaningful decision making for increased benefits from farming (Opara, 2010; Kibirige, 2013). Formal education attained by farmers is thought to be important most especially during communication and farmer's book keeping for effective operations of the farm. In this study results indicate that at least 97% of farmers had attained some form of formal education at different levels. This improves their chances of easing access to and use of agricultural information from different sources especially when communicated in English language. Categorically, about 43.3 of the farmers attained high school level; 28.3% of the famers attained secondary level; 16.7% of the farmers attained tertiary level; 8.3% of the farmers attended primary and only 3.3% of the famers never attended school.

Table 1: Demographic and Socio-economic characteristics of Cabbage farmers at VIS

Characteristic	Frequency	Percentage
Age		
20-30	3	5
31-40	24	40
41-50	13	21.7
51-60	15	25
61-70	5	8.3
Gender		
Male	40	66.7
Female	20	33.3
Marital Status		
Single	28	46.7
Married	32	53.3
Education Level		
Never attend any formal education	2	3.3
Primary school level	5	8.3
Secondary school level	17	28.3
High school level	26	43.3
Tertiary level	10	16.7
Employment level		
Not employed	47	78.3
Self employed	5	8.3
Formally employed	8	13.3

Based on the findings shown in Table 1, approximately 78% of the farmers were not formally employed, 8.3% of the farmers indicated that they were self-employed and 13.3 % of the farmers reported to be formally employed. Generally the results suggest that more than 50% of the cabbage producers cultivating on the vuvulane irrigation scheme were not employed, and thus assumed that they are more efficient since they have enough time to monitor and respond appropriately where possible to reduce on risks and increase production.

Estimating Cost Efficiency and the Drivers of Cost Efficiency

The stochastic total cost function results presented in Table 2 indicate that all the three input costs were statistically and significantly related to total cost of cabbage farmers at 1 %, respectively. These results were expected by the researcher, meaning that 1% increase seed costs increases total cost by 14%, while a 1% increase in cost fertilizer and land results in 21% and 45% increase in the total cost of cabbage production, respectively.

Table 2: Stochastic frontier Total cost estimates for cabbage enterprise

	Dependent variable = LnTotal Cost			
Independent variables	**Coefficient**	**Std. Err.**	**z**	**P>z**
Cost of seeds (E)	0.265	0.027	9.670	0.000
Cost of fertilizer (E)	0.274	0.029	9.340	0.000
Cost of land preparation (E)	0.418	0.028	14.930	0.000
_cons	1.659	0.340	4.880	0.000
/lnsig2v	-4.751	0.183	-26.00	0.000
/lnsig2u	-14.355	283.984	-0.050	0.960
sigma_v	0.093	0.009		
sigma_u	0.001	0.109		
sigma2	0.009	0.002		
lambda	0.008	0.109		
Number of obs	60			
Wald chi2(3)	485.290			
Prob > chi2	0.000			
Log likelihood	57.387			
Likelihood-ratio test of sigma_u=0: chibar2(01)= 0.00 Prob>=chibar2 = 1.000				

Using the STATA statistical analysis software, after estimating the stochastic frontier total cost function, the cost efficiency scores were predicted. The cost efficiency score results are shown in Table 3. Based on the results, cabbage farmers at Vuvulane Irrigation Scheme were 99.9% cost efficient. This is partly attributed to farms being near each other and this eases farmers' access and sharing of information, and the needed services are shared on their plots at the irrigation scheme. Input service providers would find it easy to supply inputs to a group of farmers cultivating closely to each other rather than scattered farmers to save on transaction costs including transport.

Table 3: Statistics of Cost Efficiency

	Cost efficient scores
Mean	0.999
St deviation	2.29e-06
Variance	5.26e-12
Skewness	0.523
Kurtosis	2.689

The OLS regression was carried out where the generated cost efficiency scores were regresses against the independent variables that included age and gender of respondents, the marital status, education level attained, distance to the supplier of seed from farmer, distance to supplier of fertilizers from the farmer, and incomes generated from cabbages sold. The F-statistics indicate that overall, there was a significant relationship between the dependent and independent variables at 5% level of significance. The findings indicate that the significant drivers of farmers' cost efficiency include age, distance to the supplier of fertilizer from farmer and incomes generated from cabbages sold.

Table 4 Factors affecting Cost efficiency of Cabbage Farmers

	Dependent variable = Cost efficiency score			
Independent variables	Coef.	Std. Err.	t	P>t
Age *(years)*	**6.59e-08**	**3.66e-08**	**1.80**	**0.077**
Gender *(1=Female, 2=Male)*	2.24e-07	6.04e-07	0.37	0.712
Marital status *(1=Married,0=single)*	-2.23e-07	7.60e-07	-0.29	0.771
Education (*1=formal, 0=informal)*	1.09e-06	6.67e-07	1.64	0.107
Distance seed supply *(Km)*	1.05e-09	9.07e-09	0.12	0.909
Distance fertilizer supply (Km)	**-8.39e-08**	**3.86e-08**	**-2.17**	**0.034**
Incomes from Cabbage sold (E)	**-2.41e-10**	**8.07e-11**	**-2.99**	**0.004**
_cons	0.999389	2.85e-06		0.000
Number of obs	=	60		
F(7, 52) = 2.78	=	1.52		
Prob > F	=	0.0155		
R-squared	=	0.2726		
Adj R-squared	=	0.1747		

The age of the farmer is believed to be important in terms of experience the person has generated overtime when producing the product. This helps the farmer to become efficient in his/her operations through lessons learnt in previous years and hence reducing production risks. Although the weight of the coefficient attached to age is minimal results suggest that it has a positive and significant influence on cost efficiency of cabbage farmers in Vuvulane. Thus the older the farmer becomes the more cost efficient would be. Vuvulane area is thought to be a lot far from the urban and semi-urban areas where most input suppliers are including fertilizer suppliers, approximately 14Km on average away from the fertilizer suppliers. The distance may results in increased transaction costs to the farmer in terms of transport and communication needed to deliver the farm inputs on farm. This may explain the negative and significant relationship between distance from the farm to the fertilizer supplier and cost efficiency. Whereas someone would think that increased incomes from cabbage sales increases cost efficiency of the farmer, results of this study indicate otherwise as an increase farmers' income from cabbage results in a slightly significant decrease in cost efficiency of the farmers. This may be interpreted as farmers investing in other enterprises or purchase of assets instead of re-investing in the cabbage production enterprise.

Conclusion and Recommendations

Majority of cabbage farmers at VIF were aged between 31 and 40 year, males (66.7%), completed high school level of education at 43.3%, mostly unemployed (78.7%) and farming is their major occupation (66%). The study indicated that the cabbage producers are cost efficiency at 99.9%. Older farmers, purchasing fertilizers nearby their farms and earn less farm incomes are more likely to be cost efficient compared to young, purchasing fertilizers far away from their farms and earning relatively more farm incomes. Therefore it can be recommended that all stakeholders including government, the private sector, NGOs, CBOs, and farmers among others should participate in developing strategies that will attract especially female youth in acquiring access to irrigation scheme for increased production, establish facilities including infrastructure to attract input dealers to extend their services near farmers and encourage more relatively young Vuvulane population to re-invest in the cabbage production enterprises on the irrigation schemes for increased regional cabbage production at a relatively minimum cost.

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