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A stochastic frontier approach to technical efficiency analysis of smallholder dairy farmers in Swaziland

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Abstract
The Swazi nation is traditionally an agricultural nation with almost every homestead on Swazi Nation Land (SNL) keeping a variety of livestock for beef and milk. The country has potential to produce more milk but still imports 85% of milk from South Africa. The study evaluated the technical efficiency and constraints of the milk supply chain. A descriptive quantitative research design was used in the study and data were collected in 2014 using structured questionnaires. The data were collected from 93 farmers, 16 retailers and 1 processor. Data were analysed using descriptive statistics, Cobb Douglas function, and Tobit regression model. There were 73.1% males farmers and 50.5% had between 8-14 years of formal education. All the farmers fed their cows with forage and 97.8% used concentrates. The efficiency analysis results indicated that frequency of extension visit and age of the farmer were negatively associated with technical efficiency, while market information positively affected efficiency. The technical efficiency mean was 78.2%. This indicates that overall, there is potential to increase efficiency among dairy farmers by 21.8%. Farmers had problems of scarcity of grazing lands, high feed costs, unavailability of inputs and shortage of water and labour. There is a need for improving extension service, encouraging cooperatives and improving producer’s price of milk in order to enhance productivity and efficiency of farmers.
Keywords: Dairy farmers, Swaziland Dairy Board, supply chain of milk, technical efficiency, stochastic frontier approach.

1. Introduction

The importance of dairy industry in the world is contribution towards the economies of many countries. Among livestock products, milk is the most important commodity which provides relatively quick returns for small-scale livestock farmers. It provides basic nutrients to households and is the key element in food security. Milk is mainly produced by rural households who keep either cattle, goats or sheep (Muhammad et al, 2012).

The Swaziland is traditionally an agricultural country, with almost every homestead on Swazi Nation Land (SNL) keeping a variety of livestock (indigenous and exotic cattle breeds, goats, free range chickens, sheep and indigenous pigs) and growing crops, mainly maize. Cattle is the most dominant type of livestock enterprise in the nation's agriculture sector (traditionally beef cattle only on SNL and very few exotic dairy breeds), although the trend is now changing to small stock and an increasing number of farmers venturing into smallholder dairy projects (Malima, 2005).

Swaziland aspires to have a viable, sustainable and competitive dairy industry to meet the demand of the population with milk and dairy products. However, the production of milk has not increased significantly in recent years due to numerous constraints mostly economic nature faced by the producer and shortage of fodder (Swaziland Dairy Board, 2010). The population has been growing steadily and consumption of dairy products continued to increase. This translated to more milk deficit and as a result the country imports 85% of milk and milk products from South Africa. The most imported products are milk powder and Ultra-High Treated (UHT) milk. The main importers are Parmalat, Cadbury and Family Fun, but there are many other smaller companies that import and distribute milk and dairy products in the country.

The demand for milk in Swaziland is at 51.8 million per year, while the local supply from smallholder and commercial farmers is at 7.5 million litres. Only a third of the locally produced milk is obtained from Swazi Nation Land (SNL) and two thirds from large commercial farmers on TDL (Central Bank of Swaziland, 2010). Since locally produced milk does not satisfy the local demand, there is a need for dairy farmers to increase production. Some ways of increasing milk production include developing and adopting new technologies, decreasing cost of inputs or improving management practices. To increase milk production by adoption of new innovation is a long term process and it needs more funds to be allocated for research and development (Garcia et al., 2003). It is therefore important to estimate the level of technical efficiency of milk producers and identify the socioeconomic characteristics that influence technical efficiency of milk producers in Swaziland.

Technical efficiency measures the ability of a farm to obtain maximum output from a given set of inputs or use the minimum feasible amount of inputs to produce a given level of output (Chimai, 2011). The level of technical efficiency of a particular firm is characterised by the relationship between observed production and some ideal or potential production. Measuring efficiency provides a way of quantifying and comparing the performance of each farmer, and identification of factors explaining any inefficiencies and differences in performance. Identification of factors affecting efficiency would assist stakeholders in the improvement of productivity (Greene, 1993).

The efficient use of scarce resources in fostering agricultural production has long been recognised and has motivated considerable research into the extent and sources of efficiency in different smallholder farmers. Empirical evidence suggests that improving the productivity of smallholder farmers is important for economic development because smallholder farmers provide a source of employment and a more equitable distribution of income (Bravo-Ureta & Evenson 1994). Producers benefit directly from improvements in their technical performance because more efficient farms tend to generate higher incomes and thus have a better chance of surviving and staying in business. Substantial resources can be saved by increasing the technical efficiency of producers (Lawson et al., 2004).

A technical efficient farm operates on the production frontier. A technically inefficient farm operates below the frontier. A farmer could operate on the frontier either by increasing output with the same input bundle or using less input to produce the same output. The closer a farm gets to the frontier, the more technically efficient it becomes. Different farms have got different outputs per unit. The variations in productivity are a function of differences in scale of operation, production technology, operating environment and operating efficiency (Fried et al. 2008). Improving efficiency in production allows farmers to increase their output without additional inputs and changing production technologies resulting in increased productivity (Bravo-Ureta & Pinheiro, 1997). For smallholder farmers, variations in productivity due to differences in efficiency may be affected by socioeconomic factors. In order to identify these factors, there is need to find a way of representing the performance of the farmers.

The study of efficiency is a significant area of research especially in developing economies like Swaziland where resources are meagre and opportunities for developing and adopting better technology are dwindling (Ali et al., 1993 & Udoh, 2000). Improving technical efficiency is an important factor of productivity growth. Technical efficiency is the measure of the farm's success in producing maximum output from a given set of inputs. It is also referred to as the ability to operate on the production frontier or isoquant frontier (Effiong & Onyenweaku, 2006).

The stochastic production frontier model is the commonly used parametric approach to estimate technical efficiency. Most studies including studies by (Dlamini, et al., 2012; Udoh, 2000; Effiong & Onyenweaku, 2006) used stochastic production frontier model to estimate technical efficiency of farmers in their countries. This study used the stochastic production frontier model to determine technical efficiency and also identifies the factors influencing efficiency of smallholder dairy farmers in Swaziland. It is argued by Binam et al. (2004) that as long as interest rest on efficiency measurement and not on the analysis of the general structure of the production technology, the Cobb-Douglas production function provides an adequate estimation of the production technology. The stochastic frontier production function forms include the Cobb-Douglas, constant elasticity of substitution and translog production functions and any deviations from the frontier are attributed to inefficiency (Chirwa, 2003). Stochastic frontiers assume that part of the deviations from the frontier is due to random events (reflecting measurement errors and statistical noise) and part is due to firm specific inefficiency (Battese, 1991).

Empirical evidence provided by various studies by (Muhammad et al, 2012; Dlamini, 2012; Dlamini, Masuku & Rugambisa, 2012) suggest that ttechnical efficiency can be influenced by age. Old farmers are often assumed to have had more time to learn and become more experienced in managing their farms and thus, they are thought to be more efficient. The level of education, positively influence technical efficiency of the farmer. It is assumed that farmers with more years of formal schooling tend to be more efficient in dairy production, presumably due to their enhanced ability to acquire technical knowledge.

2. Objectives

The main objective of the study was to assess the technical efficiency of smallholder milk producing farmers. Specifically the study sought to; i) describe the characteristics of small-holder dairy farmers; ii) determine the level of technical efficiency of the dairy farmers; and iii) identify the factors affecting the technical efficiency of the small-holder dairy farmers.

3. Methodology

3.1 Sampling and data collection

The target population was dairy farmers in Swaziland (N=444) dairy. A two stage sampling procedure involving purposive and stratified random sampling procedures was followed to determine farmers to be included in the study. The Bartlett et al. (2001) table of determining sample size was used, hence 93 farmers were sampled. The sample was stratified and randomly selected according to the four regions of the country (Manzini, Shiselweni, Hhohho and Lubombo) to ensure that all the regions are represented.

The study used primary data, which were collected using structured questionnaires and personal interviews. Information collected include socioeconomic characteristics of farmers, farm characteristics and constraints of dairy farmers in production and marketing of milk. The questionnaires were reviewed by experts in the Department of Agricultural Economics and Management to establish content and face validity.

3.2 Data Analysis

Data were analysed using descriptive statistics, Stochastic Frontier Production function and Tobit model. Means, frequencies, percentages and standard deviations were used to analyse distribution of efficiency levels of farmers, socioeconomic characteristics of the farmers, farm characteristics and problems of farmers on production and marketing of milk. Cobb Douglas was incorporated in the Stochastic frontier production to estimate the elasticity of production and to analyse the factors affecting efficiency, the coefficients of efficiency were be regressed against the factors using Tobit model on STATA 12.

3.3. Analytical framework

The stochastic frontier production method was adopted to estimate the technical efficiency of dairy farmers in Swaziland. A Cobb-Douglas function was fitted to the stochastic frontier production function and estimated the stochastic production frontier for dairy farmers.
The model of Cobb-Douglas functional form used in this research is specified in equation.

$$Y=X_1^{\beta 1}, X_2^{\beta 2}, X_3^{\beta 3} e^{(vi-ui)}$$

$$\ln Y_i = \beta_0 + \beta_1 \ln X_1 + \beta_2 \ln X_2 + \beta_3 \ln X_3 + v_i - u_i$$

Where:
ln = Natural logarithm.
Y_i = average milk production per cow in litres
β_0 = constant
$\beta_{1,2,3}$ = parameters of regression coefficients of the i^{th} variable
X_1 = total amount of feed given as supplement (measured in kg)
X_2 = herd size (number of cows milked)
X_3 = labour used (hours)

Where v_i= Random variable assumed to be independently and identically distributed N (O, δ_i^2) and independent of u_i.
u_i = Random variable that accounts for technical inefficiency

The estimated value of technical efficiency for each observation was calculated as follows.

$$\mu = \delta_0 + \delta_1 X_{1i} + \delta_2 X_{2i} + \delta_3 X_{3i} + \delta_4 X_{4i} + \delta_5 X_{5i} + \delta_6 X_{6i} + \delta_7 X_{7i}$$

Where:
μ = Technical efficiency
δ_i = Efficiency parameters
X_1 = Age (years)
X_2 = Educational level (years)
X_3 = Frequency of extension visits (number of visits)
X_4 = Cooperative (dummy, 1 if a member of cooperative and 0, otherwise)
X_5 = Market information (dummy, 1 if have access to market information and 0, otherwise)
X_6 = Access to credit (dummy; 1 if have access and 0 otherwise)
X_7 = Gender of the farmer (dummy, 1 if male and 0, if female)

Since the technical efficiency scores range between 0 and 1 depicting the upper and lower limits, the factors influencing efficiency were determined using a two-limit Tobit model (Sibiko et al., 2013).

$Y^*_i = X_i\beta_i + \varepsilon_i$

Where,

Y^*_i is a latent variable for the i^{th} dairy farm

X - is a vector of independent variables assumed to influence efficiency.

β - parameter estimates associated with the independent variable to be estimated.

ε- is the error term that is composed of two elements, that is:

$\varepsilon = V_i - U_i$

Where: V_i is the symmetric disturbance assumed to be identically, independently and normally distributed as N $(0, \sigma^2_v)$ given the stochastic structure of the frontier.

U_i is a one-sided error term that is independent of V_i and is normally distributed as $(0, \sigma^2_u)$ allowing the actual production to fall below the frontier but without attributing all short falls in output from the frontier as inefficiency.

Table1 summarizes the variables used in the efficiency model to identify determinants of technical efficiency in dairy farmers. A description of the variables used in the efficiency model was as follows:

X_1 = Age of the farmer (years) is expected to have a negative effect on technical efficiency because older farmers are risk averse making them late adopters of better agricultural technologies.

X_2 = Education level (years of schooling) is expected to have a positive effect; since educated farmers committed in farming may be able to take up improved technologies faster because they understand the benefits associated with the technology, hence increasing their efficiency.

X_3 = Frequency of extension visits (number of visits) is expected to have a positive effect on technical efficiency because more extension visits is expected to increase the farmer's likelihood of adopting improved technologies, which will eventually increase the efficiency level of the dairy farmer.

X_4= Cooperative member (1 = if a member and 0 = if otherwise) is expected to have a positive influence on technical efficiency. This is because it helps farmers to reduce problems associated with market imperfections and reduce transaction costs, hence increasing technical efficiency.

X_5 = Market information (1 = if has access and 0 = if otherwise) is expected to have a positive influence on technical efficiency. The farmers with enough information should be able to access new innovations and technologies and apply them effectively than someone lacking the information.

X_6= Access to credit (1 = if has access and 0 = if otherwise) is expected to have a positive effect on technical efficiency because funds help farmers to overcome the problems that normally hinder them from purchasing inputs in time and when they are available cheaply.

X_7= Gender of the farmer (1= yes and 0= male) is expected to affect technical efficiency positive and negative because it is mainly dependent on the socioeconomic factors and environmental factors.

Table 1. Description of the independent variables used in the Tobit model for determinants of technical efficiency

Variables	Coding system	Category	Expected sign
X_1= Age	Number of years	Continuous	-
X_2 = Educational level	Number of years	Continuous	+
X_3= Frequency of extension visits	Number of visits	Continuous	+
X_4= Cooperative member	1 if a member, 0 otherwise	Dummy	+
X_5=Market information	1 if access, 0 otherwise	Dummy	+
X_6= Access to credit	1 if access, 0 otherwise	Dummy	+
X_7= Gender of the farmer	1 if male , 0 if female	Dummy	+/-

4. Results and discussion

4.1 Socioeconomics characteristics

The results in Table 2 indicate that 73.1 % of the farmers were males, while a small fraction of 26.9% were females. The study revealed that 49.5% of the sampled farmers were in the range of 40 to 54 years old. The youngest farmer had 26 years of age, while the eldest was 87 years old. The results further showed that 62.4% of the farmers had 5 to 9 members in their families. Mellor (1974) indicated that big family sizes are good because the members render cheap family labour to the farmer, enabling production to occur at lower cost. About half (50.5%) of the sampled farmers had 8 to 14 years of formal education and 37% of the farmers had less than O'level education. A majority (63%) of the farmers had gone past the secondary education. Sharma (2009) stated that farmers with high level of education are expected to quickly learn new technologies than non-educated farmers and this will improve their productivity. Education enhances the skills and ability to meet food safety and quality requirements of modern channels and better utilize market information. Most of the sampled farmers raised dairy animals on part-time basis hence 65.6% of them were farming on part-time.

The study results revealed that 88.2 % of the respondents had no access to credit yet finance is important in dairy production for buying feed, medicine and many things for improved production. The findings of the study also revealed that 59.1% of the sampled farmers did not have any contact with extension worker. According to Kumar (2010) agricultural extension is a form of adult education, and can achieve results according to well-planned strategies, but the rate of change is often slow for some communities, even though it may be rapid for specific individuals. Therefore, farmers who have regular contacts with extension workers are likely to get good yields. The results revealed that 72% of the sampled farmers had access to information, while 28% had no contact with extension workers. Market information is vital to market participation behaviour of farmers. It allows farmers to take informed decisions. The average for farming experience was 8 years and the highest monthly income was E350, 000 while the lowest was E490.

Table 2. Socioeconomic characteristics of sampled dairy farmers

Description	Frequency n=93	Percentage
Sex		
Females	25	26.9
Males	68	73.1
Age of the farmer		
25 - 39	7	7.5
40 - 54	46	49.5
55 - 69	35	37.6
70 - 87	5	5.7
Mean=52.7 SD=10.3	Min=26	Max=87
Number of family members		
1 - 4	16	17.2
5 - 9	58	62.4
10 - 14	15	16.1
15 - 17	4	4.3
Mean=7.17 SD=3.119	Min=2	Max=17
Number of years in formal education		
0 - 7	20	21.5
8 - 14	47	50.5
15 - 17	26	28
Mean=11.6 SD=4.599	Min=0	Max=23
Status of dairy farmer		
Part-time	47	50.5
Full-time	46	49.5
Highest level education attained		
Primary	18	19.6
Secondary	16	17.4
High School	28	30.4
Tertiary Education	30	32.6
Farmers' access to credit		

Yes	11		11.8
No	82		88.2
Frequency of extension visits			
None	55		59.1
Once a year	7		7.5
Two times a year	17		18.3
Four times a year	14		15.1
Access to market information by farmers			
No	26		28.0
Yes	67		72.0
Number of years in dairy farming			
1– 8	61		65.6
9– 16	24		25.8
17-25	7		7.5
26– 31	1		1.1
Mean=8.14 SD=5.795	Min=1		Max=31
Monthly income from dairy			
450 – 1000	7		7.5
1001 – 5000	67	.	72.1
5001 – 10000	8		8.6
10001 – 20000	4		4.3
20001 – 50000	3		3.2
50001 – 350000	4		4.3
Mean income =12489.25	SD=44538.23	Min=490	Max=350000
Monthly income from wage employment			
500 – 3000	5		13.9
3500 – 9000	17		47.2
10000 – 16000	11		30.6
17000 – 36000	3		8.3
Mean income=9629.72	SD=6648.22	Min=500	Max=36000

4.2 Farm Characteristics

Most of the farmers used Frisian and jersey breeds and a few used the Nguni breed for milk production (Best et al, 2005). Table 3 shows that 2.2 % of the respondents used Nguni breed and a large proportion (89.2%) of the farmers used the jersey breed. The results also revealed that 73.1% of the farmers raised 1-5 dairy cows. This was an indication that most of the farmers were smallholder farmers. The maximum number of cattle raised was 389 cows, while the minimum was one cow.

The results also revealed that the range of the milk produced was 1994 litres. There were 33.2% farmers who produced 21 -35 litres of milk per day. The mean milk production per day was 85.2 litres, while the standard deviation was 283.9. In some communal areas, cattle have to travel long distance searching for water and food, which reduces the production of milk (Maree & Casey, 1993). From the results it was revealed that 91.4% of the farmers milked their cows 2 times a day. Only 8.6% of the farmers milked their cows once a day. Dorji (2010) stated that cows are usually milked at equal intervals with 12 hours in between the intervals. The results in Table 3 revealed that 47.3% of the farmers did their second milking session after 10 hours.

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Table 3. Farm Characteristics

Description	Frequency		Percentage
Nguni	2		2.2
Friesian	6		6.4
Jersey	83		89.2
Simmental	2		2.2
Number of dairy animals raised by farmers			
1-5	68		73.1
6-10	14		15.1
11-20	4		4.3
21-60	3		3.2
61-390	4		4.3
Mean = 13.28	SD = 45.89	Min = 1	Max= 389
Quantity of milk produced per day (litres)			
5 – 20	28		30.1
21 – 35	30		32.2
36-50	22		23.7
51-100	7		7.5
101-2000	6		6.5
Mean = 85.2	SD = 283.9	Min= 6	Max = 2000
Number of times of milking per day			
1	8		8.6
2	85		91.4
Milking interval (hours)			
6	1		1.1
7	2		2.2
8	10		10.8
9	13		14.0
10	44		47.3
11	3		3.2
12	16		17.2
>12	4		4.2
Mean = 10.3	SD= 2.4	Min= 6	Max=21
Types of feed given to cows			
Forage	93		100
Concentrates	91		97.8
Silage	6		6.5
Licking stone	79		84.9
Maize Bran	25		26.9

Only 17.2% of the farmers milk their cows after 12 hours from the first milking. All farmers sampled fed their cows with forage and 97.8% of the farmers fed their cows with concentrates. Most of the concentrates used is the dairy meal and only 6.5% of the farmers feed the animals with silage and its mostly commercial farmers. FAO (2013) stated that cows are fed with 11kg of hay, 16kg of silage and grain, 2kg of concentrates, supplements like minerals and salt and 80-180 litres of water per day.

4.2. Stochastic production frontier parameters

Table 4 shows the maximum likelihood parameter estimates of the stochastic production function. The results revealed that all the coefficients have positive signs and were statistically significant ($p<0.01$). Concentrates had a coefficient of 0.0195 suggesting that 1% increase in concentrates would increase milk yield by 0.0195 % when other factors are kept constant. This is consistent with other studies that have found that concentrates were statistically significant in improving milk yield (Dlamini, 2012; Tuna & Hilal, 2011). Milking cows and labour were also found to be statistically significant ($p<0.01$) with coefficients 0.0073 and 0.1175 respectively. The coefficient (0.0073) for milking indicates that 1% increase in the number of cows would increase milk yield by 0.0073 % ceteris paribus. Labour had a coefficient of 0.1175 indicating that 1% increase in the hours put in for labour would increase milk yield by 0.1175 % ceteris paribus.

Table 4. Maximum-likelihood estimates of stochastic frontier production function parameters

Variables	Parameters	Coefficient	t-ratio	p-value
Intercept	β_0	0.768	5.2e+04	0.000
Lnconcentrates	β_1	0.0195*	1.1e+04	0.000
Lncows	β_2	0.0073*	1.3e+03	0.000
LnLabour	β_3	0.1175*	2.3e+04	0.000
Number of observations=93		Log likelihood function=30.369		

Notes: * = significant at 1% level.

4.3 Determinants of technical efficiency

Table 5 shows the estimates from the Tobit regression of selected socioeconomic and institutional-support factors on predicted technical efficiency scores. The pseudo R squared was -0.217 and that showed that the explanatory variables chosen for the model were able to explain 21.7% of the variations in technical efficiency levels. The coefficient for age was -0.0037, implying that an increase in the farmer's age by one year reduces the level of technical efficiency index by 0.004. This was consistent with the results of Sibiko et al. (2012). This negative association could be as a result that older farmers strongly believe on their traditional ways of doing things, thus causing them less technical efficient.

The frequency of extension visit was also statistically significant ($p<0.01$), implying that farmers with more extension visits would increase technical efficiency index by 0.02 than those with less frequency of visits. The results were consistent with Yusuf and Adenegan, (2009) and Musaba and Bwacha (2014). This could be as a result that extension in general has not been effective in Swaziland, and that might have led to extension workers lacking modern innovations, which could bring positive change to the farmers. Access to market information had a positive coefficient of 0.0593, which means that farmers with access to market information increase their technical efficiency index by 0.06 compared to those with no market information. The farmers with enough information should be able to access new innovations and technologies and apply them effectively than someone lacking the information. Access to credit, education and cooperatives had a positive sign though not significant, which means they have positive association with technical efficiency.

Table 5. Factors influencing technical efficiency of the dairy farmers.

Variable	Coefficient	t-ratio	p-value
Constant	0.8824	8.94	0.000
Age	-0.0037**	-2.54	0.013
Education	0.0056	1.59	0.116
FreqExtension	-0.0196***	-1.89	0.001
Cooperatives	0.0363	0.91	0.367
MktInfo	0.0593*	1.77	0.080
CreditAccess	0.0452	0.97	0.337
Sex	0.0283	0.85	0.398
log likelihood=47.77	pseudo R squared=-0.217		

Notes:*, **, ****= significant at 10%, 5%, and 1% level respectively.

4.3 Distribution of technical efficiency

Table 6 shows the distribution of technical efficiency estimates for the sampled dairy farms in Swaziland. The results indicated that there were 18 most efficient farms, which recorded a score of 90 – 100%. The most technically efficient participant farm recorded a score of 100%, while the least score was 21.9%. The results give evidence that there is a very huge gap between the two extreme farms in terms of technically efficiency. The results showed that the average technical efficiency was 78.2% and that was an indication that farmers can still improve their efficiency by 21.8%.

Table 6. Distribution of technical efficiency estimates of the sampled dairy farmers

Efficiency (%)	No. of farms	Percentage of farms	Cumulative percentage
< 30	1	1.1	1.1
30 - 39	1	1.1	2.2
40 - 49	4	4.3	6.5
50 - 59	4	4.3	10.8
60 - 70	12	12.9	23.7
70 - 80	23	24.7	48.4
80 - 90	30	32.2	80.6
90 - 100	18	19.4	100
Total	93	100	
Mean (%)	78.2		
Min. (%)	21.9		
Max. (%)	100		

4.4 Production and marketing constraints in the dairy industry.

Table 7 shows the summary of the production and marketing constraints of milk in Swaziland. The results indicated that 67.7% of the farmers had a shortage of feed and 68.8% had problems with high feed costs. The results also revealed that 63.4% of the farmers had problems of shortage of grazing lands. Some of the problems which affect most of the farmers sampled shortage of water 51.6%, unavailability of inputs 48%, shortage of labour 49.9% and prevalence of pest and diseases 43%.

Table 7. Production and marketing constraints of milk in Swaziland

Problem	Frequency	Percentage
Inadequate information about livestock	8	8.6
Lack of transport	11	11.8
Poor market information	4	4.3
Poor road infrastructure	31	33.3
Distance of market site	8	8.6
Unavailability of inputs	45	48.0
Inadequate working capital	16	17.2
Prevalence of pests diseases	40	43.0
Lack of credit	18	19.4
High feed costs	64	68.8
Shortage of labour	46	49.9
Scarcity of grazing land	59	63.4
Seasonal	21	22.6
Shortage of water	48	51.6
Lack of preservation infrastructure	10	10.8
Shortage of feed	63	67.7

5. Conclusions and recommendations

5.1. Conclusions

Based on the findings, the study concludes that there are very few female farmers (26.9%) involved in dairy farming in Swaziland. This could be as a result of the fact that milking is seen as a man job even though most small enterprises in Swaziland are dominated by females. It was noted that the help by extension service was minimal yet their contribution could be important in uplifting the milk supply chain in Swaziland. Farmers in the study were technically efficient since the average efficiency was 78.2%. Farmers in Swaziland were constrained by scarcity of grazing land, high feed costs, unavailability of inputs, shortage of labour and water, pests and diseases.

5.2 Recommendations
There is a need for the improvement of the extension service in the country to ensure that the pay regular visits to dairy farmers so that they can bring latest and improved ways that can make farmers more efficient. The Swaziland government needs to subsidise the price of milk that Parmalat pays to the producers. This can encourage more farmers to join the formal milk market, hence improving local milk production. Farmers should buy inputs as a group rather than individuals to reduce problems of transport and gaining cash discounts. They can do this through collective action whereby they pool their money together and share transport costs and lowering the cost of transactions.

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