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Economic Efficiency of Table Grape Production in Waterberg and Sekhukhune Districts, Limpopo Province, South Africa

Abstract. Table grape production plays an important role in the economy of many countries in Africa. It serves as a source of income for the people who are engaged in its production and being one of the enterprises that is labour-intensive, thereby providing employment for more people. The main purpose of this study was to analyse the economic efficiency of table grape production in Waterberg and Sekhukhune Districts of Limpopo province, South Africa. The study used primary data collected through administration of structured questionnaires on a sample of 12 farmers by employing a snowball sampling method. Analytical tools employed include descriptive statistics (such as tables and frequencies), Stochastic Frontier Model and Technical Inefficiency Model.
Results from data analysis revealed that in terms of efficiency, farming experience ($p<0.01$), educational level ($p<0.05$), household size ($p<0.10$) and age of farmer ($p<0.10$) were associated with increased efficiency indicating that these factors play important roles in ensuring that resources used in the production of table grapes enhanced productivity and were not wasted. Also, technical efficiency among farmers was found to range from 0.8 to 1, with a mean of 0.89, thus implying a major possibility for improvement in production. However, the allocative efficiency was found to range from 0.47 to 1, with a mean of 0.68. This indicates that some farmers were finding it difficult to allocate their resources efficiently. Again, economic efficiency ranges from 0.56 to 1, with a mean of 0.73, an indication that most of the farmers were economically efficient.
Meanwhile, some of the constraints faced by these farmers include high electricity bills and labour costs, water shortages as well as instability around land policy. The study therefore recommends capacity building of farmers through education and other skill enhancement programmes. Also, provision of incentives to encourage youth participation in farming through internship programmes is very important to increase farm productivity.

Key words: efficiency, farmers, table grapes, South Africa, stochastic frontier model

JEL Classification: D13, D61, O13, Q12, Q15

Introduction

In agriculture, resources needed for agricultural production are scarce and therefore one needs to know how to deal with this issue and be able to increase the level of output regardless of the circumstances. The scarcity of resources leads to the concept of economic efficiency to deal with the problem. For a farmer to be economically efficient, he or she needs to produce maximum output at the lowest possible costs and ensure that resources used are not wasted (Quattara 2012).

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Economic efficiency comprises of technical efficiency and allocative efficiency. According to Aung (2012), technical efficiency refers to the ability of a farm to increase output for a given set of inputs and also produce at the lowest cost. On the other hand, allocative efficiency is the extent to which farmers can make efficient decisions by using inputs up to the level to which their marginal contribution to production value is equal to the cost. It is a good analysis of production as it outlines whether a farmer is operating at a good level of output or not.

In the same vein, Mburu, Ackello-Ogutu, Mulwa (2014) indicate that technical efficiency increases with farm size. This clearly indicates that farm size is vital for a farmer to be economically efficient. In contrast Aung (2012), states that farms may be technically and allocatively efficient without being economically efficient, even if these two concepts are the properties or requirements of economic efficiency.

The measures required for the evaluation of efficiency analysis are classified into two groups, namely; non-parametric models which are exemplified by Data Envelopment Analysis (DEA) and parametric models such as Deterministic Frontier Analysis and Stochastic Frontier Analysis (Jarzebowski 2013). On the other hand, methods used to measure the inefficiency level of production can be derived by the inefficiency model (Conradie, Cockson, Thirtle 2006).

A degree of inefficiency is obtained by most farmers or producers during their production processes (Makombe et al. 2011). This shows that this concept of inefficiency is a part and parcel of production whether producers like it or not. Crudely defined, according to Rajamanickamnic (2001), inefficiency refers to a situation whereby the same level of output is produced, however, with less of one input. This is similarly supported by a study that was done by Kumar and Managi (2009), as it stated that inefficiency is due to the state of operating in the range of constant returns to scale, therefore, inefficiency level should be higher than zero.

Measurements of technical inefficiency are quite helpful as they provide information on the minimum quantity of inputs required for a farmer to produce maximum output (Neupane, Moss, 2015). Furthermore, technical and allocative inefficiency measures the size of consequent loss in production (Mendes, Soares da Silva, Santos, 2013). Hence, the inefficiency aspect is vital in ensuring that all the inefficiency variables are outlined and minimised effectively to enable producers to improve on their level of production. Moreover, farm performance can be potentially influenced by production assortment and quality interventions (Tasevska 2012).

From the foregoing, the study therefore examined allocative and technical efficiency of table grape production in Waterberg and Sekhukhune districts of Limpopo province, South Africa to get a clear understanding of the production level and what needs to be done to improve it.

Limited studies have been done on table grape farming in Limpopo province as a majority of the studies done in the province only focused on vegetables, maize and livestock production, etc. This study therefore aimed at providing answers to the following questions;

- What are the socioeconomic characteristics of farmers producing table grapes?
- Are the table grape farmers economically efficient in their production?
- What are the constraints to efficient production of table grapes?

Research Methodology

Study Area

The study was conducted in Waterberg and Sekhukhune Districts of Limpopo province, South Africa. In Waterberg District, Modimolle Local Municipality was selected while in Sekhukhune District, Marble-hall and Groblersdal Local Municipality were selected. The area cultivated between 2007 and 2017 showed a decrease in the production of table grapes per hectare and in area planted (Steyn 2008).

Overview of Waterberg District Municipality

Waterberg district municipality (Table 1) is located in the western part of Limpopo province, sharing a provincial border with Botswana. Also, Waterberg shares its borders with Capricorn and Sekhukhune District Municipalities with a total area of approximately 4,951,882 sq.km (Du Toit 2002).

According to Census 2011, population growth rate was 1.2% over a ten-year period. The district area in nature is both semi-arid and hot. Furthermore, average rainfall is 600-650 mm and the rainfall period occurs from November to February. Major economic activities in the area include agriculture, mining and tourism.

However, Modimolle Local Municipality is located under Waterberg District with a total area of 13,521.75 sq.km and has a population size of approximately 106,621 people (Census, 2011). Agricultural activities in the area include both commercial and subsistence farming. Commercial farming mainly focused on grapes, watermelons, citrus, maize, strawberries and vegetable production (Integreted…, 2009).

Table 1. Distribution of residents by gender in Waterberg District

Local Municipalities	Male	Female	Total
Thabazimbi	42773	29072	71845
Lephalale	56704	48259	104964
Mookgophong	15748	14760	30509
Modimolle	30614	29760	60373
Bela - Bela	28799	27603	56401
Mogalakwena	137512	158285	295796
Waterberg	312150	307739	619889

Source: Census 2011.

Overview of Sekhukhune District Municipality

Sekhukhune District Municipality is one of the 5 districts of Limpopo province. It is located in the northern part of South Africa and covers an area of approximately 13,527.72 sq.km. It has a population size of approximately 1,076,840 people and the population growth rate, on an annual basis is 1.88%. About 53.79% of the population are females while males constitute about 46.21%. Major economic activities include mining, agriculture and tourism (Census, 2011).

On the other hand, Groblersdal Local Municipality is located under the Sekhukhune District with a total area of 10.88 sq. km, and has a population size of approximately 8440

people. Marble-hall Local Municipality is located in the same area with a total area of 3708.3 sq.km and a population size of approximately 34904 individuals. According to (Belete et al. 2016), Marble-hall is a major producer of citrus and table grapes, amongst others they are also engaged in vegetable production. Groblersdal Municipality is characterized by production of grapes, wheat, tobacco, maize, soya beans, citrus fruits, vegetables and cotton (Integrated…, 2017).

Data sources and sampling method

Data for this study was collected using a structured questionnaire consisting of a set of 47 questions. A pilot survey was conducted with the help of extension officers in the district areas to test the reliability of the questionnaire. Face-to-face interview was conducted as a method of data collection using the questionnaire, from 27 February 2020 to 26 March 2020. A sample of 12 farmers were interviewed for the study. Since the table grape farmers were few, a sampling technique called 'snowball' was employed to locate the table grape farmers that were avaialble in the two districts namely; Sekhukhune and Waterberg Districts. This technique reveals all the relevant participants that ordinarily wouldn't have been accessible.

Snowball technique is a sampling method that is applied when samples with the target characteristics are not easily accessible (Naderifar, Goli, Ghaljoe, 2017). In addition, this is a way of obtaining information among individuals who have informal social relations (Rajamanickamnic 2001). This sampling method was adopted because table grape farmers are few in the study area and also not easily accessible.

Analytical methods

Descriptive statistics, Stochastic Frontier Model (SFM) and Technical Inefficiency Model were used to analyse the objectives of the study. Descriptive statistics methods such as tables and frequencies were used to analyse and describe the socioeconomic characteristics of table grape farmers and the constraints faced in producing table grapes.

On the other hand, Stochastic Frontier Model (SFM) and Technical Inefficiency Model were employed to address the second question. The SFM is an econometric model which presents a method assuming two error elements. In this approach, inefficiency is assumed to have asymmetrical distribution, usually half normal distribution, and random error is expected to have symmetrical distribution (Vincova 2005). According to Belete et al. (2016), its main advantage is that it captures random variables which are beyond the producer's control, in order to ensure that there is more consistency with the potential output under "normal" working conditions. It is a good measure of economic efficiency, as it analyzes both the technical and allocative efficiency simultaneously. Hence, the rationale for using Stochastic Frontier and Technical inefficiency

The model in this study is to examine the economic efficiency and unravel the determinants of table grape production and also ascertain the sources of inefficiency.Thus, this is in line with the study done by Mburu, Ackello-Ogutu, Mulwa (2014).

According to Bushara and Abuagala (2016), this model measures technical inefficiency by using the Technical Inefficiency Effect Model, which is captured by the normal distribution means U_i. It is assumed to be independently distributed such that U_i will be obtained by truncating (at zero) the normal distribution with mean U_i and variance $\delta 2$.

On the other hand, technical inefficiency refers to when a higher level of output is technically obtained by a given set of inputs or the level that can be obtained by using few inputs in the production process (Kumbhakar, Wang, Horncastle, 2015). In addition, it is likely caused by inadequate information, insufficient technical skills and lastly untimely input supply (Wassie 2012).

Model specification and estimation of parameters

Stochastic Production Frontier Function Model Specifications:

$Qi = \alpha U_i + (Z_i - X_i)$, cu i=1, n

Where: Q_i = table grape production of farmer i

α = vector of unknown parameters

U_i = number of inputs for table grape farmers from X_i

Z_i = stochastic variables considered N (0, δ2z) and independent

X_i = non-negative stochastic variables relating to production technical inefficiency and considered |N (0, δ2z)|

Estimation of economic efficiency

EE = Price (Quantity of table grapes)/ Price (Quantity of inputs)

Model for technical inefficiency

$U_i = \sigma_0 + \sigma_i Z_i + \varepsilon_i$

Where:

U_i = table grape production of farmer i

σ_i = Vector of coefficients to be estimated

Z_i = Vector of independent variables such as access to support services and social-demographic variables

The Maximum Likelihood Method will be used to estimate the stochastic frontier and the inefficiency model (Bettese, Malik, Gill, 1996).

Limitations of the Study

There are few table grape farms that are available in the study area because most of the farms have been taken over by commercial farmers and these farms do not produce table grape. The table grape farms that were provided through the land restitution pillar are not that functional and they have collapsed due to lack of capacity, conflicts amongst members of the project, political instabilities in the area, just to mention a few. Hence, the number of table grape farms in Waterberg and Sekhukhune Districts has decreased gradually and most have shifted to the production of strawberries amongst other things, as this is in high demand by the export market, especially in the Waterberg District.

Although Limpopo province is recognized as being among the table grape producers in South Africa, the production of table grapes happens in only two districts (Waterberg and Sekhukhune Districts) out of the five districts in the province. This shows that Limpopo province has only a few farmers growing table grapes. According to Limpopo Economic Development (Local…, 2010), the province had approximately 90 farms

supplying grapes to the international market. However, the number of farms has gradually and drastically decreased due to some of the above-mentioned constraints.

The measures undertaken to overcome the limitations of the study were to engage with the extension officers to assist in locating table grape farmers, since they have a working relationship with them. In cases where the farms given through the land redistribution had failed, the beneficiaries were also interviewed.

Results and Discussion

Socioeconomic Characteristics of Table Grape Farmers in Waterberg and Sekhukhune Districts

Age of the farmers

From Table 2, the average age of the respondents (table grape farmers) is 47 years while the minimum age is 31 years and the maximum is 61 years. Hence, the production of table grapes is engaged by people who are middle aged, indicating that youths are not major players in the production of table grapes. This is validated by a study conducted by Kakade, Pawar and Bamkar (2011) and Lwelamira, Wambura and Safari (2015), where it was found that the majority of grape farmers were mostly middle aged and educated.

Household size of table grape farmers

Table 2 also indicates that on average, each household of the farmers consists of 5 members. The minimum household has 3 members while the maximum has 11. Contrarily, a study that was done by Lwelamira, Wambura and Safari (2015) and Mburu, Ackello-Ogutu and Mulwa (2014), found that table grape farmers on average had large household size.

Household income

From Table 2, it was revealed that on average, household income amounts to R47 600 ($2800 USD). This clearly shows that table grape farming enterprises are well-established as they can feed their loved ones and also manage to pay off their expenses. In contrast, on average table grape farmers may earn between 5million Tsh. ($1886 USD) and 10 million Tsh. ($3772 USD).

Farming experience of table grape farmers

The average number of years in the production of grapes is 16 years. The minimum number of years is 8 while the maximum is 30 (Table 2). This simply implies that these farmers are more experienced in the production of grapes and well educated. Contrarily, in a study conducted by Lwelamira, Safari and Wambura (2015), it was found that table grape farmers had a minimum of five years' experience and with an average of 10 years.

Farm size

As depicted in Table 2, the minimum farm size is 10 hectares while the maximum farm size is 116 hectares. On average, the farm size is 44.25 hectares. This clearly indicates that these grape farmers can meet the supply and demand of grapes in the market. However, in a

study that was done by Deng et al. (2016), farm size was less than 1 hectare which does not enable them to meet the target demand of buyers.

Table 2. Summary statistics of farmers' socioeconomic characteristics

Description	Minimum	Maximum	Mean
Age of the farmer	31	61	46.67
Household size	3	11	4.92
Household income	$ 1476.45	$ 5122.36	$ 2668.52
Farming experience (years)	8	30	15.83
Farm size (ha)	10	116	44.25
Costs of establishment	$ 3615.79	$ 49476.01	$ 10963.37
Maintenance of the farm	$ 482.10	$ 24105.24	$ 30279.68

Source: Authors' computation from data.

Table 3 clearly shows that the majority of respondents were males (75%), while 25% were females. This clearly indicates that production of table grapes is a male-dominated type of enterprise. This is validated by a study conducted by Kebede and Redae fa (2017) and Conradie (2005), which indicated that males dominated the table grape production sphere.

Table 3. Gender of table grape farmers

Gender	Frequency	Percentage
Male	9	75
Female	3	25
Total	12	100

Source: Authors' computation from data.

Table 4 reveals that about 33% of the farmers are single, while 67% are married. This is like a study that was done by Lwelamira, Safari and Wambura (2015), where it was found that the majority of grape farmers were married. Hence, table grape production is a family-oriented business wherein farmers take pride in what they do regardless of the challenges they may come across.

Table 4. Marital status of table grape farmers

Marital status	Frequency	Percentage
Single	4	33
Married	8	67
Divorced	0	0
Widowed	0	0
Total	12	100

Source: Authors' computation from data.

Table 5 indicates that the majority (67%) of the farmers have tertiary education while only 33% have secondary education. This indicates that most of the farmers are educated and as such capable of improving their businesses. On the other hand, the average years of schooling is 15 years. This is validated by a study that was done by Odoemenen and Obinne (2010) and Tasevska (2012), which stated that the majority of the grape farmers are

more educated, and as such this enables them to be more informative on this type of farming.

Table 5. Educational level of table grape farmers

Specification	Frequency	Percentages	Average years of schooling
No formal education	0	0	0
Primary education	0	0	0
Secondary education	4	33	15
Tertiary education	8	67	
Total	12	100	-

Source: Authors' computation from data.

From Table 6, it was indicated that only 58% of the farmers have access to an agricultural extensionist, while 42% do not have an extension officer and rely on their own knowledge to improve production of grapes. This clearly indicates that table grape farmers take the services provided for by the extension officers into careful consideration and they also play an important role in the production of table grapes. This finding concurs with a study that was done by Gulati et al. (2018) and Haq (2013), which stated that extension services have a positive significant role as farmers are able to achieve higher farm income and also be empowered. Thus, these services do improve farmers' level of production.

Table 6. Extension services provided to table grape farmers

Extension service contact	Frequency	Percentage
No	5	42
Yes	7	58
Total	12	100

Source: Authors' computation from data.

Table 7 indicates that about 50% of the farmers have access to credit facilities, while 50% do not have access to credit as some are financially stable and others do not have collateral to take up loans from the bank. The issue of having no collateral poses a serious threat in terms of their potential to grow as outlined in a study conducted by Amadhila and Ikhide (2016).

Table 7. Credit details of table grape farmers

Access to credit facilities	Names or types of credit facilities	Frequency	Percentage
No	Not applicable	6	50
Yes	Bank	6	50
Total	-	12	100

Source: Authors' computation from data.

From Table 8, average costs of establishing a vineyard amount to $109554.11. On the other hand, it was stated in a study done by Lwelamira, Safari and Wambura (2015), that the cost of establishing a vineyard was $15054.85. This clearly shows that there is great variance in terms of the costs involved in establishing a vineyard. The minimum maintenance costs of the farm are $10839.49, while the maximum amount is $24087.75. In

addition, the production quantity on average amounts to 70045 kg/ha, while the minimum amount is 14000 kg/ha and the maximum amount is 180 000 kg/ha.

Table 8. Production costs for table grape production

Specification	Min.	Max.	Mean
Cost of establishment	$ 3613,16	$ 4944011	$ 109554,11
Maintenance costs of the farm	$ 4817,55	$ 24087,75	$ 30257,73
Production quantity per season (kg/ha)	14 000	180 000	70045
Price per box or crate	$ 4,22	$ 9.03	$ 6,07
Cost of pesticides	$ 361,32	$ 16379,67	$ 47780,26
Litres of water used to produce table grapes	10950	1 000000	1625697.50
Earnings for labourers	$ 72,26	$ 210,77	$ 187,67
Total number of labourers employed per season	96	600	291

Source: Authors' computation from data.

Table 8 shows that price per box for the grapes, on average is $6.07 as indicated by local sales. The minimum price is $4.22, whereas the maximum amount is $9.03. The average cost for pesticides is $47836.18. The minimum earnings for a labourer is $72.26, depending on the size of the farm and the maximum amount that a labourer can earn per month is $210.77. On average, the amount that a labourer can get is $187.67. Therefore, this is in contrast with a study that was done by Conradie (2005), which stated that on average the labour wage was $67.63 in 2004. On the other hand, the average number of labourers that are engaged in the production of table grapes in this sample is only 291 individuals.

Stochastic Frontier Model Analysis Results

The technical, allocative and economic efficiency scores of table grape farmers were determined by using the Stochastic Frontier Model. An overall summary of the results obtained from the use of inputs (seedlings, farm size, equipment, pesticide, fertilizer) is presented in Tables 9 -12.

Inputs, Output and Input Prices used in SFM

Quantity of inputs

Table 9 illustrates that on average table grape seedlings amount to R7135 ($440 USD), thus, this is the amount used in the production of table grapes. The minimum hectare that is utilized by the grape farmers was found to be 10 hectares, while on maximum it amounts to 116 ha. This indicates that these farmers are operating on a large scale, as on average their production amounts to 70045 kg of grapes.

Table 9 also shows that on average, the man-hours taken by the labourers is approximately 6 hours per day and per season. On the other hand, farmers in this study applied pesticides and fertilizers to their farms to make it productive, and on average they applied 55.78 ml of pesticides and 442.5 kg of fertilizer.

Inputs costs

Table 9 indicates that table grapes require a lot of investment capital, thus, on average seedlings costs $2929.81. On the other hand labour costs are straining these farmers as they keep them during off season of the production of grapes, so that the labourers can maintain the farm. Farmers on average pay labourers $187.67 during the production season.

The minimum cost of pesticides is $361.32, while for the fertilizer is $150.55. Water plays a vital role in the production of table grapes and on average farmers pay $31370.20.

Table 9. Summary statistics of inputs, output and input prices used in SFM

Variable	Mean	Std. Dev	Min.	Max.
Grapes production (kg)	70045	51896.09	14000	180000
Inputs				
Quantity of seedlings (amount)	7135	75631	1500	232000
Farm size (ha)	44.25	35.012	10	116
Man-hours (per season)	5.5	4.58	5	8
Pesticides (ml)	55.78	35.67	49	568.4
Fertilizer (kg)	442.5	354.7	100	1160
Input Prices				
Cost of seedlings	$ 2929.81	$ 1969.53	$ 391.43	$ 59047.03
Cost of labour	$ 187.67	$ 40.09	$ 72.26	$ 210.77
Cost of pesticide	$ 47780.26	$ 5536.32	$ 361.32	$ 16379.67
Cost of fertilizer	$ 182.31	$ 26.12	$ 150.55	$ 216.79
Equipment costs	$ 41357.56	$ 672228.67	$ 2739.98	$ 204745.89
Cost of water	$ 31370.20	$ 85965.63	$ 21076.78	$ 303023.92

Source: Authors' computation from data.

The table below also shows that the equipment costs are quite expensive as on average it amounts to $41357.56, while costs of pesticides equals $47780.26 on average. In addition, according to a study conducted by Kebede and Redae fa (2017), the equipment costs for the production of grapes amount to 120 000 ETB ($3553.49). This is far from the findings of this study, which showed that on average equipment costs amount to $41357.56, and clearly indicates that they are quite expensive in South Africa. In contrast, to a study that was done by Kakade, Pawar and Bamkar (2011), it was found that grape equipment costs amount to $1520.21 for a 4 ha grape vineyard. This clearly indicates that farmers need a good investment plan to cover cost of production.

Technical and Allocative Efficiency on Table Grape Production

Farm size used for production of table grapes

Table 10 indicates that the total number of hectares was found to be significant at 1% level and is positively related to the yield of table grapes. The expected sign for farm size is a positive relationship with output, which has been validated with findings from this study. This implies that as more land is cultivated, there will be an increase in production output. This concurs with a study that was done by Belete et al. (2016). This is further validated by

a study done by Koçtürk and Engindeniz (2016), which stated that efficiency is dependent on farm size.

Cost of establishment

On the cost of establishment (Table 10), it was found to have a negative relationship to the production of grapes. However, it is significant at 10% level. Findings from this study showed that there is a negative relationship between cost of establishment and output, which is in contrast with the expected sign. This suggests that as there is a decrease in the cost of establishment, there will be an increase in production. This concurs with a study that was done by Local Economic Development (2010), which stated that small farm areas tend to produce more output as their cost of establishments are small.

Equipment costs

From Table 10, the expected sign for equipment costs was negative and this is validated by the findings from this study. Costs for the equipment used in the production of table grapes is positively related to the production of table grapes. However, it is not significant; this implies that for every additional piece of equipment, there will be an increase in the equipment costs of 0.028%. This concurs with a study that was done by Kopeva and Noev (2001), which found that table grape equipment has a negative significant impact for producers; however, for cereal and vegetable producers, it had a positive significant impact on farm efficiency.

Pesticide used

For every output increase, the use of pesticides increases by an additional 0.65%. Pesticides are significant at 5% confidence level. The expected sign of pesticide costs was positive; likewise, this is validated by the findings from this study (i.e. Table 10). This implies that when productivity of table grapes increases, cost of pesticides also increases being expensive for the farmers to purchase. According to a study that was done by Koçtürk and Engindeniz (2016), it was concluded that a decrease in the cost of pesticides resulted in an increase in table grape production and this enables an increase in exportation of table grapes.

Cost of water

The cost of water is negatively related to the production of table grapes and it is significant at 1% level. The expected sign for the cost of water was negative and as such this concurs with the findings of this study (i.e. Table 10). This implies that when yield increases, cost of water decreases by 0.80%. Similarly, in a study that was done by Deng et al. (2016), it was found that water and electricity were the lowest input cost for farmers at 7%, while labour costs were found to be the second most important input cost (38%).

Grape Prices

Table 10 indicates that the prices for table grapes are statistically significant at 5% level. Grape prices are negatively related to the production of table grapes. This simply implies that the cost of producing additional units of table grapes increases as more are produced. Thus, a study that was conducted by Conradie, Cockson and Thirtle (2006)

showed that table grape farmers produced more and showed more variance on their farm productions due to higher prices of table grapes.

Quantity of labourers

From Table 10, it indicates that the work force is negatively related to the production of table grapes and is significant at 1% level. The expected sign of the quantity of labourers at the grape farms is negative and concurs with the findings from this study. This implies that increased labour results in a decrease in production of table grapes. This concurs with a study that was done by Steyn (2008) and Tasevska (2016), which found that grape production in South Africa has a negative influence on labour use with regards to efficiency and as variable cost of labour increases it decreases efficiency of the farm.

Household income

Table 10 shows that farmers' household income is positively related to the production of table grapes; however, it is not statistically significant. The expected sign of the household income was to be positively related to efficiency and thus, the findings from the study validated the expectations. Consequently, this is validated by a study that was done by Makombe et al. (2011), which found that if productivity of table grapes were to be improved this could potentially reduce poverty as household income would be increased. Furthermore, it was stated that grape production highly contributes to household income despite its low productivity and low grape pricing.

Table 10. Efficiency factors (determinants of efficiency)

Production quantity	Coefficient	Std. Err.	Z	P > Z
Farm size	8719.79	1314.80	6.62	0.000***
Cost of establishment	-.0433	.006759	-5.38	0.1***
Equipment costs	.028002	.0259063	1.18	0.241
Pesticides used	.65801	.1122	4.98	0.05**
Cost of water	-.8005408	.1393405	-5.75	0.000***
Grape prices	-6742.50	186.111	4.58	-0.15**
Quantity of labourers	2328.493	-371.5989	-6.28	0.000***
Household income	18.14016	27.90677	0.67	0.521
_cons	-382992	165973.6	-2.31	0.021

Source: Authors' computation from data.

coefficient significant @ 1%, 5% and 10% (***, ** and *).

From Table 11, it shows that the age of farmer (1%), household size (1%), fertilizers (5%) and extension services (10%) are positively related to the economic efficiency of table grape production and are significant at 1%, 5% and 10% respectively. This concurs with a study that was done by Lwelamira, Wambura and Safari (2015), which stated that fertilizers were significant at a 5% level. The educational level of farmers is significant at 1%; this is similar to a study conducted by Oluwatayo and Adedeji (2019), which found that years of education played an important positive significant impact on the efficiency of production.

Table 11. Inefficiency factors

Specification	Coefficient	Std. Err.	Z	P > Z
Gender	-0.568	0.143	2.173	2.45
Age	0.223	1.506	1.593	0.000***
Educational level	0.5208	-0.258	-1.241	0.000***
Credit	-4532.50	4351.56	3.78	5.69
Marital status	-3458,54	8956.400	-3.25	-0.45
Extension services	719.601	317.4	-2.265	0.33*
Fertilizers	0.1956	-3.800	-0.418	1.66**
Household size	0.5208	-0.258	-1.241	0.000***
_cons	-0.8888	286.50	2.501	0.02

Source: Authors' computation from data, coefficient significant @ 1%, 5% and 10% (***, ** and *).

Summary of Efficiency Scores for Waterberg and Sekhukhune Districts' Table Grape Farmers

Table 12 indicates that the Allocative Efficiency scores of table grape farmers had a mean of 0.6841, with a minimum of 0.473 and a maximum of 1.000. This shows that farmers are not utilizing inputs efficiently given the input price and average costs. Technical efficiency scores range from 0.80 to 1.000 with a mean of 0.8925, implying that 89% of the farmers were technically efficient and could produce over 80% of the maximum feasible output. This is similar to a study conducted by Steyn (2008), which found technical scores ranging between 0.80 and 1.000.

Furthermore, Table 12 shows that the economic efficiency score on average was found to be 0.7256, with a minimum of 0.563 and a maximum of 1. This implies that table grape farmers are economically efficient, and the cost of table grape production could be increased on average by approximately 56%.

Table 12. Efficiency scores for table grape farmers

Variable	Mean	Standard deviation	Minimum	Maximum
AE	0.6841	0.1432	0.473	1
TE	0.8925	0.078545	0.80	1
EE	0.7256	0. 16532	0.563	1

Source: Authors' computation from data.

Constraints Faced by Table Grape Farmers in the Study Area

Table 13 indicates that constraints such as labour costs, high electricity bills, and instabilities surrounding land policies have topped the rankings, as this poses a serious threat to the growth of their businesses, especially for the export market. Diseases, lack of rainfall (water shortage), financial instabilities and theft ranked second when it comes to the constraints that they face. On the other hand, marginalization of groups, maladministration and corruption are ranked third, thus, this can be seen from farms that were provided through the land restitution programme. The land is owned in groups and profits are shared amongst farmers. However, proper monitoring and evaluation of the farm is not adhered to.

Lastly, the quality of water which affects table grapes sales ranked fourth. This clearly shows that constraints that farmers are faced with are the ones that hinder their progress in terms of growth in their grape production.

Table 13. Constraints ranking by table grape farmers

Constraints	Rankings
Instabilities surrounding land policies, labour costs, electrical costs	1
Diseases, rainfall, financial instability and theft	2
Marginalization of groups, maladministration and corruption	3
Quality of water which affects sales	4

Source: Authors' computation from data.

Summary, Conclusion and Recommendations

Summary of Findings and Conclusion

The study found that table grape production is a male-dominated enterprise and that the majority of farmers are married. Table grape production is labor-intensive and requires a lot of investment in terms of equipment and maintaining the farm. A majority of the grape farmers are well educated as they have acquired a tertiary degree, while only a minority have acquired a secondary education.

The study also revealed that most of the farmers do have access to extension services, which enables them to make improvements on their grape production. On the other hand, farmers that do not use the extension services make use of their own knowledge acquired from the tertiary education, informal schooling, workshops, etc.

The average cost of maintaining a farm was found to be $30257.73. Pesticides amount to $47836.18 on average. The minimum production quantity per season was 14 000 kg/ha, while the maximum quantity produced was 180 000 kg/ha. It was found that the price of table grapes per crate ranges between $4.2 and $9.03, while the average is $6.07. The number of persons employed on the grape farms on average amounts to 291 people and this is determined by the size of farm.

Despite capital-investments such as labour and electrical costs that farmers deal with in the production of table grapes, they are also constrained by the instabilities of land policies in the country as they are faced with the repossession of land through the policy that stated that land should be given to its rightful owners without compensation. The factors that were found to be positively related to the technical efficiency of table grape production were age of the farmer, educational level, hectares, labour, extension services, fertilizers, household size and are also significant.

Recommendations

Based on the study findings, the following recommendations are made:

- Capacity building of farmers through education is very key to enhancing productivity. Labour was found to be significant and positively influenced by the quantity of grapes produced. This means that labourers are an important aspect of the farm as table grape farming is labour-intensive, and thus, this requires that

more people need to be trained on how to run and maintain a grape farm as there is a high level of unemployment in the country.

- Provision of incentives to encourage youth participation in farming is also very important. The study revealed that an increased age of farmers was associated with increased efficiency and is statistically significant. This means that productivity increases before gradually decreasing as the farmers get older. Thus, there is a need to encourage youth participation by ensuring that grape farming trainings through learnerships and internships are provided to enhance or improve participation.

Declarations:

Ethical Approval and Consent to participate: All ethical issues relating to this study were adhered to and participants' consent was sought in the course of data collection.

Consent for publication: Authors consented that the manuscript be published.

Availability of supporting data: Data collected (in Excel format) is available on request.

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