Analysis of Profit Efficiency of Grape Production: A Case of Smallholder Grape Farmers in Dodoma, Tanzania

Aristides Nalyoto
(Corresponding author)
E-mail: arisnal741@gmail.com
Deus D. Ngaruko
The Open University of Tanzania
E-mail: ngarukoddp@gmail.com

ABSTRACT
The aim of this study was to assess the contribution of production and profit efficiency of grapes production from farmers in Dodoma region. However, the study was specifically conducted in Dodoma region at Dodoma municipal council, grape farmers were the focal point of the study. The research used two approaches, quantitative approach and qualitative approach. Through purposive and simple random sampling, four (4) respondents from four villages (one officer in each village) who were government extension service officers were interviewed. Moreover, in this study, a sample of 118 respondents from grape farmers were provided with questionnaire. Data were collected through interviews and questionnaires and the results were analyzed using the statistical package for social sciences (SPSS) program version 20. The results show that grape production contributes a lot to the economics of the household since it increases the income of the household up to a profit of Tsh 667,419 per acre. Therefore, we recommend some strategies which should be used to boost grape production in the country. The strategies include the formation of groups or cooperative agriculture; agricultural experts (such as agricultural extension officers) should establish close relationship with farmers to understand farmers' challenges fully and involve them in obtaining solutions. Finally, simple storage facilities should be provided through collaboration with different partners like individuals, private sectors and government.

Keywords: *Grape Production, Dodoma, Tanzania*

INTRODUCTION

Grape is one of the world's largest fruits crops with approximately 67.5 million tons produced each year. The grape grows best in the Mediterranean-type of climate with long relatively dry summers and mild winters. Worldwide, Grape is mainly meant for wine production, however, a certain portion is dried into raisins and a major part is marketed as fresh fruit, making table grapes one of the world's prominent fresh fruit crops (Khoshroo et al., 2013). According to FAO (2010), approximately 71 per cent of the world's grapes production is used for wine, 27 per cent as fresh fruits and 2 per cent as raisins (dried fruit). On the other hand, the peel of grapes is the source of essential oil and pectin. Also serve as a raw material for the production of cattle feed and in the preparation of candies (Kumar, 2010). Consumption of fresh grapes in the US has increased from 2.9 pounds per person in 1970 to 7.9 pounds in 2009 (ESR, 2009). Moreover, the grape is the most important and economical garden fruit crop in the world (Shahraki, Dahmardeh and Karbasi, 2012).

In 2012 US and Canadian markets, the price for fresh grapes jumped to $1,340 per ton compared to prices that last peaked at $986 per ton in 2006 (NASS, 2013). The major grape-producing countries include China which ranks top position with a production per cent share of 12.8, Italy 11.57 per cent and USA 9.24 per cent, Spain 9.07 per cent and France 8.69 per cent together accounting for 51.42 per cent of total world production (FAO, 2012). In Africa, grapes are produced in many countries, South Africa being the leading country while Tanzania is the second largest producer of grapes in the sub-Sahara. During 2018/2019 the country produces 16,139 tonnes of grapes as reported by the Ministry of Agriculture. In Tanzania, grapes are produced in the Dodoma region (Kulwijira *et al.* 2018), but recent research has shown that the crop can grow well in other regions such as Morogoro, Kilimanjaro, Tanga, Tabora, Babati, Bunda and Peramiho. Grapes are among the major fruit crops of economic importance in Tanzania; considered one of the most important cash crops, raw materials and sources of employment. Dodoma is the main region in Tanzania where grapes are grown. According to the Ministry of Agriculture and Cooperatives data, the country produced 16,139 tonnes in the 2018/19 season out of which 11,552 were sold to both domestic and foreign markets. So far there were about 4,810 acres (1,924 ha) under grape production in the region. However, the government production plan is to reach 22,000 tonnes during 2024/25. Grape production is the mainstay for many farmers in Dodoma Municipal and the nearby districts of Chamwino and Kongwa. The regional data show that Dodoma urban produces 70% while Dodoma rural produces 30% of the grapes (SNV Tanzania a report on fresh fruits, 2005).

The trend of grape production in Dodoma has been increasing over time. For example, the annual yield of grapes in Dodoma Municipal Council rose from 3,576 tons in 2010 to 6,831 tons in 2015 (LWR, 2016). The introduction of smaller and more affordable processors such as HOMCO and UWAZAMAM has given incentives to farmers to produce grapes. As more processing options become available to farmers, production will increase as farmers can respond to the demand which is influenced by the price received. Aside from price, farmers consider many other factors to determine the profitability of grape farming, including production, inputs, transport and labour cost. (LWR, 2016). The grape can be marketed in different utilities like form, time, place and possession which create a wide chance to increase farmers' welfare also it has multiple uses, it can be eaten raw or can be used for making jam, juice, jelly, wine, grape seed extracts, raisins, vinegar and grape seed oil. Regardless of the potentiality of grapes, smallholder grape growers in Tanzania are facing production, processing and marketing problems such as inadequate product quality, few processing plants or winery industry, low price, high cost of inputs, low incentives, low output, unreliable rainfall, insufficient agricultural extension services, late payment, low labour productivity, poor infrastructure and poor harvest management and product grades Ilamba S.Y (2016). As a result, farmers end up having unreliable markets and receive low prices for grapes produced as business firms tend to be price makers and farmers are price takers.

It is possible to attain economies of scale in agriculture by expanding the cultivated area and productivity, there is a noticeable increase in the area cultivated and productivity of grapes in the Dodoma region from the year 2010 to 2015 whereby the area cultivated increased from 892 ha to 1 924 ha while production rose from 5 576 tons to 10 813 tons (SNV, 2005). At the same time, there is no clear statistic of how grape farmers are efficient in using factors of production per unit area as well as profit gained after marketing their products. Sustainable production depends much on production efficiency and profits gained, while most researchers on agriculture focus on how to achieve a certain level of yields (e.g. Nakano, 2010 and Zacharia *et al*, 2013) without considering the need to increase agricultural productivity through proper utilization of resources. However, few researchers consider rational resource allocation to improve efficiency. This study will measure the technical efficiency of grape production in Dodoma and identify socio-economic factors that determine technical efficiency. Achievement of technical efficiency will facilitate grape farmers to produce their output at a cheap cost while increasing productivity as well as profit margin.

Lwelamira *et al.* (2015) studied grapevine farming and its contribution to household income and welfare of smallholder farmers in Dodoma which involved a total sample size of 252 respondents. The results showed that grape farming contributes more than 35.6 per cent which is more than one-third of total household income and plays an important role in household welfare, also study identify several challenges facing grape growers which include the low price of grapes, high costs of inputs, limited access to market, the prevalence of pests and diseases, inadequate storage facilities and limited access to quality seedlings. Kalimang`asi *et al* (2014) in his study found that smallholder female farmers were more efficient they produced 2000Kg/1.60 acre than males who produced 1480Kg/1.72Acre, Moreover, results indicated that unmarried smallholders were more efficient (2000kg/1.00acre) compared to married ones who produced 1590 kg/1.75acre. Also, the youngest farmers had the largest grape output (average 2170kg/1.33 acre) compared to elders (1540 kg/1.75 acre). The study revealed that grape production was mostly practised by people with low education levels and each smallholder grape producer sold an average of 1530 kg per year which accounts for 91.4 per cent of market share. The major challenges faced by smallholder grape producers were the decline of the quality of grape due to delayed payment, diseases and unreliable markets.

Njiku *et al.* (2018) researched determinants of technical efficiency and factors contributing to the inefficiency of small-scale sunflower oil processing firms in Tanzania by using a panel design of three years of data with 219 sample size. Results revealed that 75 per cent of the firms operate under capacity with steadily declining technical efficiency, as well as Capital and factors input of production, contributed statistically significantly to the output of the firms under the study. Firm age, location, ownership type, age and education of the owner were found significant determinants of technical efficiency in sunflower oil processing firms in Tanzania. Ibrahim *et al*. (2014) conducted a study in Nigeria on the relationship between input use and inefficiency in maize production, the respondents were surveyed and data on inputs used, cost of production and yields were obtained. The stochastic frontier production function was used to analyze data. The findings revealed that there is technical inefficiency in the use of inputs and certain socio-economic factors contribute to inefficiency.

Asela, (2017) conducted research on technical efficiency by comparing the production efficiency of maize crops among smallholder farmers in Tabora and Ruvuma regions respectively, using maximum likelihood estimation and ordinary least square on the Cobb-Douglas production function and OLS on technical inefficiency model. Findings indicated that Tabora smallholder farmers were more technically efficient with mean technical efficiency of 61 per cent compared to 53 per cent of Ruvuma farmers. Farm size was the most important factor that increased maize output and Tractor assets were the most optimal used factor keeping other factors constant, in both regions. From the technical inefficiency model variable age, household size, primary education and inputs costs increased technical inefficiency while credit access, capital assets, good living condition and crop farming as main activities increased technical efficiency in both regions.

Paudel and Matsuoka (2009) conducted a study to estimate the cost efficiency of 180 maize farmers in Nepal by using the stochastic frontier model. Among other parameters cost of manure, labour, tractor, animal power, fertilizer, pesticides and seeds were used. The maximum likelihood estimates of the parameters reveal positive except for pesticides while the average cost obtained from the cost function showed cost efficiency of 1.634 which indicates that the average maize farms incurred 63% cost above the frontier which is inefficiency. Hidayah *et al.* (2013) studied a production and cost efficiency analysis of the paddy farming system in Indonesia by using a frontier stochastic approach to determine the level of production and cost efficiency with Integrated Plant and Resources Management, maximum likelihood method was used to estimate the parameters. One hundred and twenty was the total number of respondents obtained by using simple random sampling methods. The findings revealed that the variation of the error term in both models was highly influenced by inefficiency factors (production 0.933 and cost 0.948) rather than stochastic factors, while the average technical and cost efficiency was 0.855 and 0.86 respectively. The stochastic Frontier production function was used to measure and compare production frontiers and technical efficiencies of rice production in India and Thailand, the results revealed that all inputs had shown positive relations with output but such factors as seeds and pesticides indicated negative effects for both India and Thailand on rice output. Technical efficiency score increased in India from 0.87 in year 2002 to 0.98 in 2014 while in Thailand TE decreased from 0.96 to 0.94 during the same time (Sirikanchanarak *et al*.2017).

CONCEPTUAL FRAMEWORK

The conceptual framework of the study will be based on production theory. The approach assumes that a set of independent variables are responsible for influencing the situation and behavior of economic agents in a given firm, where policy factors have an important influence on grape productivity since they affect all the other factors. Institutional factors affect production factors whereby some institutional and socio-economic factors tend to reinforce each other. For example, the female gender influences access to credit which influences off-farm income. Factors of production are used directly in the production process but the availability and distribution of these inputs is affected by policy which in turn affects grape productivity. Institutional and socio-economic factors influence grape productivity, like farmer groups, credit access and presence extension services. All these were expected to have a positive effect on productivity. Meanwhile, a factor like age, education and lack of experience is expected to have a negative effect.

.

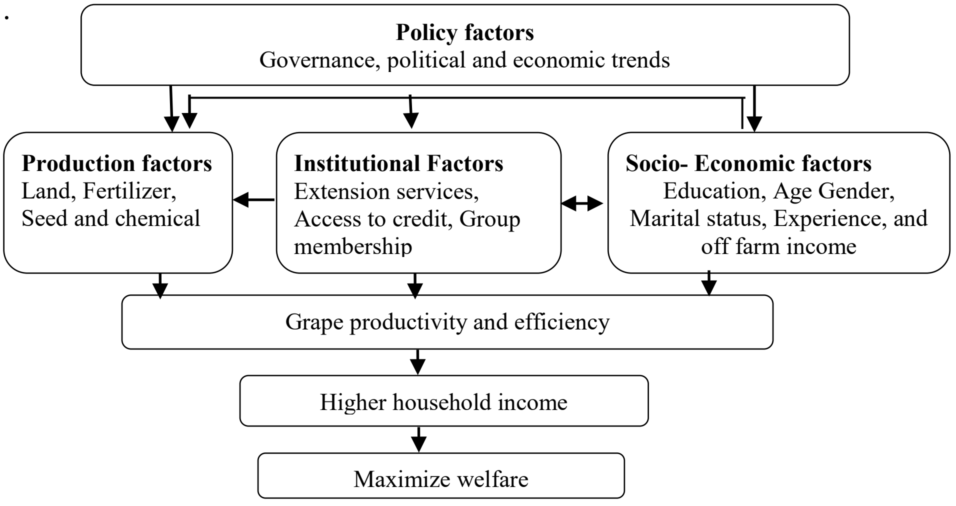

Figure 2.1: Conceptual framework

METHODOLOGY

This study was carried out in the Dodoma Urban district of the Dodoma region. This study used two sampling designs, which are purposive sampling and simple random. Purposive sampling is the act of choosing individuals as a sample from the relevant population to produce targeted information. This study used purposive sampling to select one extension service officer from each village (for four villages) and they are selected because they have skills in grape production. Simple random sampling Kothari (2004) defines simple random sampling as a method of sample selection which gives each possible sample combination an equal probability of being picked up and each item in the entire population has an equal chance of being included in the sample. Kothari explains that once an item is selected for the sample it cannot appear in the sample again. This study used simple random sampling to select four villages (Mpunguzi, Mpunguzi A, Mpunguzi B and Matumbulu) from two wards and three villages provide 30 representatives from each village while one village has only 28 farmers to constitute a sample size of 118. The choices of the study area were based on the grape production potential within the district. Moreover, the study used Microsoft Excel for data analysis on editing, coding, classification and tabulation of facts from filled questionnaires by respondents and from interviewing specific participants of the same population. The major tool of analysis used in this study was based on the stochastic frontier model as proposed by (Battese and Coelli, 1995). Farrell, (1957) was the first scholar to use the frontier production function to measure technical efficiency. The method involves estimating a frontier production function to measure technical efficiency. The frontier production function model is estimated using the maximum likelihood procedure because it considers being asymptotically more efficient than the corrected ordinary least square estimators (Coelli, 1995). The stochastic frontier production function model is specified as presented in the equation (1):

$$Yi = f(Xi, \beta) + (Vi - Ui) \quad \ldots\ldots\ldots\ldots \quad 1$$

Where:

Y_i is the output of the $_i{}^{th}$ farm,

X_i is a 1 x k vector of input quantities of the $_i{}^{th}$ farm,

β - is a vector of unknown parameters to be estimated,

V_i - Are random which are assumed to be normally distributed iiN $(0, \delta_v^2)$ random error and independent of the U_i. It is assumed to account for measurement error and other factors not under the control of the farmer (non-negative random variable).

U_i - Are non-negative random variables, (half normal or truncated to zero) called technical inefficiency effects (Aigner *et al*., 1977).

Analysis tools of this study are based on stochastic frontier model which are explained by estimating the frontier production and cost function to measure technical and cost efficiency separate (Battese and Coelli, 1995). The frontier production function model is estimated by using maximum likelihood procedure (MLE). The stochastic frontier production function on this study is specified for cross sectional data whose error term complies with two components, random effect and technical inefficiency. The model used was expressed as presented in equation (2),

$$Y_i = f(X_i\beta) + (V_i - U_i) \qquad 2$$

Where,
Y_i = quantities of grape output
X_i \= vector of grape input quantity,
β = a vector of parameters,
ε = error term, defines as $=V_i - U_i$
V_i – error due to random effect
U_i – error due to inefficiency

Production and cost inefficiency were expressed by U_i, which cause firm to operate below stochastic frontier, Stochastic frontier cost function error term specified as $(V_i + U_i)$. Expression for stochastic cost frontier function as shown in equation (3)

$$C_i = C\,(Y_i, P_i; \beta) + V_i + U_i \qquad 3$$

Where:
C_i is the total production cost,
P_i is the vector of variable input price
Y_i, is the grape output produced in kg,
β - is a vector of unknown parameters to be estimated,

V_i are random disturbance costs due to the factor's outsides the farmers
U_i - Are non-negative random variables, (half normal or truncated to zero) also define how far did firm operate above the frontier, especially for the frontier cost function

The stochastic production frontier was estimated to find the TE of each respondent. Technical efficiency was expressed as the ratio involving observed production and the production output from the frontier production function (equation 4).

$$TE_i = \frac{Y_i}{\exp(X_i\beta + V_i)} = \frac{\exp(X_i\beta + V_i - U}{\exp(X_i\beta + V_i)} = \exp(-\mu) \quad \ldots\ldots 4$$

Where $0 < TE_i < 1$

Computed TE of each grape farmer was regressed against a set of socio-economic and institutional factors to identify the factors affecting grape production. Farell, (1957) defines TE as the ratio of the observed output to the actual output along the frontier, as estimated from the composed error term and then the production function was used to define the stochastic production. The Cobb-Douglas production function estimation using MLE method is represented as in equation (5):

$$LnY_i = \beta_0 + \beta_1 \ln X_{1i} + \beta_2 \ln X_{2i} + \beta_3 \ln X_{3i} + \beta_4 \ln X_{4i} + \beta_5 \ln X_5 + V_i - U_i \ldots 5$$

Where:
Y = Grape output of the respondents measured in Kg
X_1 = Farm size (acre),
X_2 =family and hired labour (man-day),
X_3 = Grape seeds (kg),
X4 = Fertilizer (kg),
X5= Pesticide (mls)
$\beta_0, \beta_1, \beta_2, \beta_3, \beta_4, \beta_5$ = are Parameters to be estimated

The inefficiency model is represented by U_i which is defined as in equation (6):

$$U_i = d_0 + d_1z_1 + d_2z_2 + d_3z_3 + d_4z_4 + \ldots + dnz_n \ldots\ldots 6$$

U_i = Technical inefficiency,

z_1 = Age (years), z_2 = Access to extension services (Yes = 1, No = 0), z_3 =Level of education (years), z_4 = Access to credit (Yes = 1, No = 0), z_5= Subsidies (Yes=1, No=0), z_6 = off farm income (Tsh), z_7= farm size, d_0, d_1, d_2, ……d_n = Parameters to be estimated.

The stochastic cost frontier was estimated to find the CE of each respondent. Then, the computed CE of each grape farmers were regressed against a set of socio-economic and institutional factors to identify the factors affecting grape production. Farell, (1957). Measurement formula for cost efficiency expressed in equation (7)

$$CE_i = \frac{C(Y_i, P_i; \beta)\exp\{U_i\}}{C_i} \quad \text{.......} 7$$

Where, CE_i is the possible minimum cost ratio with specific inefficiency level toward actual total cost. When $C_i = C\ (P_i\ Y_i;\beta).exp(U_i)$, the CE_i was equal to 1 which implys farming system is in the full efficiency condition in the time *i*. Otherwise, when the actual cost bigger than the minimum estimated cost ($0 \leq CE_i < 1$) the farming system are inefficient.

In order to obtain sources of cost inefficient computed CE for each grape farmer was regressed against a set of socio-economic and institutional factors to identify the factors affecting grape production as presented in equation (8).

$$LnY_i = \beta_0 + \beta_1\ lnX_{1i} + \beta_2\ lnX_{2i} + \beta_3 lnX_{3i} + \beta_4 lnX_{4i} + \beta_5\ lnX_5 + Vi + U_i \text{.......} 8$$

Where:
Y = Grape Output
β_0 = Intercept, β_1 = (i= 1, 2, …5) Parameters to be estimated
X_1 = Cost of hire land/acre,
X_2 =Labour cost/ acre,
X_3 = Grape seeds cost/kg,
X_4 = Fertilizer cost/kg,
X_5= Pesticide (cost/botle)

The inefficiency model is represented by U_i which is defined as expressed in equation (9):

$$U_i = d_0 + d_1 z_1 + d_2 z_2 + d_3 z_3 + d_4 z_4 + \dots + d_n z_n \text{.......} 9$$

Where
U_i = Technical inefficiency,
z_1 = Age (years),
z_2 = Access to extension services,
z_3 = Level of education
z_4 = Access to credit
z_5= Subsidies
z_6 = off farm income (Tsh)
z_7= Farm size
d_0, d_1, d_2, ……d_n are Parameters to be estimated.

To address the determining levels of profit of grape farmers in Dodoma region Gross Margin (GM) Analysis method were used. The GM method is used in this study because it does not consider land value. The GM was expressed as shown in equation (10).

$$GM = \frac{Totalrevenue(TR) - TotalVariable\cos t(TVC)}{Totalrevenue(TR)} \quad \text{.........................} \; 10$$

FINDINGS

Socio-economic description of grape farmers in Dodoma region

Respondent means age for female's lies between 15 to 35 age group and for males, it lies between 36 and 55 age group. This shows the importance of grape production in the area since the majority of participants lie between the low and middle-age groups and most of them are capable farmers and still energetic enough to engage themselves in grape production. Mulashani (2016), declared the importance of age as the factor that can explain the level of production and efficiency, and it is thought that the young population is more productive than the older population. Furthermore, findings indicated that only a few people above 56 years of age were engaged in grape farming activities among the selected sample. Based on gender most females participating in production aged between 15 and 55 (41.5 per cent), while males ranged between 15 and 55 (44.4 per cent). This gives a clear picture that male farmers are more involved in grape production than their female counterparts. Also, the findings show that males at the age of 36 to 55 depend on grape production at 26.3 per cent while females who engage more in 15 to 35 of ages taking 22 per cent (Table 1).

Table 1: Age and sex of respondents (N= 118)

	Female		Male		Total	
Age group	**Number**	**Percentage**	**Number**	**Percentage**	**Number**	**Percentage**
15-35	26	22	19	16.1	45	38.1
36-55	23	19.5	31.	26.3	54	45.8
56-75	9	7.6	6	5.1	15	12.7
76≤	2	1.7	2	1.7	4	3.4
Total	60	50.8	58	49.2	118	100

Source: Field data 2019

The more the farmers are involved in grape production the more their knowledge and efficiency are increased in grape production. The findings in Table 2 show that the number of male-headed households is greater than that of female-headed households. In the study area, 63.6 per cent of male-headed households were engaged in grape production while female-headed households comprised 36.4 per cent; this means that most of the grape farmers are male-headed households implying that most of the resource controllers and decision-makers in the family are men. Conversely, this shows that for male-headed family's grape production is given more priority than female headed families.

Table 2: Status of household head (N= 118)

	Female headed		Male headed		Total	
Village	**Number**	**Percentage**	**Number**	**Percentage**	**Number**	**Percentage**
Mpunguzi A	14	11.9	17	14.4	31	26.3
Mpunguzi B	15	12.7	19	16.1	34	28.8
Mpunguzi	9	7.6	17	14.4	26	22
Matumbulu	5	4.2	22	18.6	27	22.9
Total	43	36.4	75	63.6	118	100

Source: Field data 2019

Based on logic, educated farmers are expected to have more production compared to uneducated farmers. This is because new technology and techniques in production are easily adopted by farmers with education. From the descriptive statistics of the study, 11 per cent of the farmers are uneducated, 60.2 per cent with a primary level of education, 25.4 per cent with a secondary level, and 3.4 per cent with university level. Table 3 shows that farmers with primary education and secondary education are involved in grape production, followed by uneducated farmers while farmers with university education were very few. In the study, only two villages (Mpunguzi B and Matumbulu) were found with grape farmers with university education. Thus, the results show that grape production was practised mostly by lowly educated farmers and farmers with higher education were not effectively engaged in grape production (Table 3). This would entail that the higher the level of education, the lower the involvement in agricultural activities. However, this does not preclude the fact that the number of university graduates living in the study area was generally small compared to the number of people with secondary and primary education.

Table 3: Education of household head (N= 118)

	Level of Education				Total
	None (%)	Primary (%)	Secondary (%)	University (%)	(%)
Mpunguzi A	5.1	14.4	6.8	0.0	26.3
Mpunguzi B	0.8	14.4	11.9	1.7	28.8
Mpunguzi	5.1	15.3	1.7	0.0	22.0
Matumbulu	0.0	16.1	5.1	1.7	22.9
Total	11.0	60.2	25.4	3.4	100

Source: Field data 2019

Potential crops in the study area

The study area is found in the central plateau zone which is famous for the production of fruits. According to the Ministry of Agriculture and Food Security- Horticulture unit, (2005) fruits such as Baobab, Mango, Papaya, Guava and Grapes were found in Dodoma region. According to this study, (Table 4) crops like Ground nuts, Maize, Sunflower, Bambara nuts, Millet, Sesame, and Tomato were found in a different study area. Grape production is the leading crop in the villages under study followed by groundnuts, Tomato and Maize. Sunflowers and other crops are produced on small scale.

Table 4: Potential crop in the area (N=118)

	Village of respondent				Total
Crops	Mpunguzi A	Mpunguzi B	Mpunguzi	Matumbulu	
Ground nuts	22 (6.8%)	14 (4.3%)	16 (4.9%)	10 (3.1%)	62 (19.1%)
Maize	1 (0.3%)	25 (7.7%)	14 (4.3%)	9 (2.8%)	49 (15.1%)
Sunflower		7 (2.2%)	15 (4.6%)	1 (0.3%)	23 (7.1%)
Grape	31 (9.6%)	33 (10.2%)	21 (6.5%)	26 (8.0%)	111 (34.3%)
Potato		12 (3.7%)		3 (0.9%)	15 (4.6%)
Tomato	29 (9.0%)	6 (1.9%)	1 (0.3%)	18 (5.6%)	54 (16.7%)
Sesame	1 (0.3%)				1 (0.3%)
Millet			1 (0.3%)		1 (0.3%)
Bambara Nuts	0 9 (0.0%)	1 (0.3%)	7 (2.2%)		8 (2.5%)
Total	84 (25.9%)	98 (30.2%)	75 (23.1%)	67 (20.7%)	324 (100.0%)

Source: Field data 2019

Technical efficiency and factor influencing grape production

Partial elasticity generated from stochastic production frontier shows that area (0.193), fertilizer (-0.221), pesticide (0.447), Labour (0.169) coefficients are positive which explain that if these inputs increased by ten output will increase by 1.9, 4.4, and 1.7 per cent for input area, pesticide and labour respectively. On the other hand, input fertilizer shows negative sign implying that, once this input is increased by ten percent, output will decrease by 2.2 per cent, this can be due to high fertilizer/ FYM usage during grape production which makes land saturated with this input. These results are consistent with those of Bachewe *et al.,* (2011) who found fertilizer to have a negative effect on yields, advanced by the arguement that the rate of fertilizer application must be accompanied by the right and sufficient use of complimentary inputs such as water and improved seeds to achieve the desired results which are not practiced by many farmers in Dodoma region.

For the variables which determine source of inefficiency, price (-0.765), extension (-0.122) and experience (-0.351) have positive relationship with output or influence technical efficiency. A ten per cent increase of these variables will increase output by 7.66, 1.22 and 3.51 per cent respectively. Price is the most influential variable compared to all variables used in this study; this is due to the fact that most farmers tend to adjust themselves according to their expectations of price change. According to table 5 the coefficient function of MLE estimation is 0.588 which explains that the stochastic production frontier function has the characteristic of decreasing return to scale. It means that the increased use of inputs proportionally will decrease the output production to achieve the maximum profit.

Moreover, the value of γ is 0.99 and significant at the level of 1%. This value shows that 99% of the random errors are mostly influenced by inefficient factor, nor the stochastic variables which is not considered in the model. Therefore, production frontier can possibly be achieved by improving on farming system management. The value of γ which is approaching 1 also remains one side error, where *Ui* dominated the symmetry error distribution from *Vi*. The explanations of one side error also strengthens by the value of likelihood ratio. As shown in table 6, the value of observed LR is 19.94 which is greater than the given LR ($\chi 1^{2}$ = 3.841). Since the observed LR is greater than the given LR, we can conclude that the assumption that all of the grape farming system which is practiced by farmers in Dodoma Region is 100% efficient.

The Grape industry depends on many variables which are used during production, but among all the variables there are five influential variables which all grape sector depends on, for efficiency model variable. These variables are price of pesticide (0.445), and area (0.193) and for the inefficiency model variable grape sector is determined by agricultural extension work price (-0.764), (-0.123) and experience of the farmers (-0.351). The base of grape production observed on price elasticity, if price per kg of grape changes positively grape output will change by more than 76 per cent. In order for grape sector to keep growing these five variables should be well observed, but variables such as fertilizer (FYM), seems to have negative influence on production; this can be caused by much amount of fertilizer applied by other farmers than recommended rate of FYM application.

Table 5: Technical efficiency (N=118)

Variables	Coefficient	Standard error	t-ratio
Efficiency model			
β_0	3.7984918	0.12286504	30.915968
β_1 (Area)	0.19278569	0.12476581	1.5451804**
β_2 (Fertilizer)	-0.22081819	0.30056219	-0.73468388**
β_3 (pesticide)	0.44662340	0.10521648	4.2448047***
β_4 (Labour)	0.16897572	0.14840781	1.1385905*
Inefficiency model			
Z_1 (price)	-0.76452720	0.22038531	-0.34690479**
Z_2(Education)	0.31464961	0.43382102	0.72529821**
Z_3 (Extension)	-0.12180490	0.17884876	-0.68104970*
Z_4 (Age)	0.53681801	0.35412952	1.5158804
Z_5 (Experience)	-0.35106772	0.27713321	-1.2667833***
Z_6 (Irrigation)	0.12970412	0.20183063	0.64263841
sigma-squared	0.20346865	0.62482762	0.32563965
Gamma	0.99999999	0.40046495	0.24970974
log likelihood function	-0.34789606E+02		
LR test of the one-sided error	19.941618E+02		

*= significant at 5%; **= significant at 10% and ***=significant at 1%.

A negative sign of the inefficiency parameter function means the associated variable has a positive effect on technical efficiency and vice versa.

Farmer's efficiency specific score

According to table 6, The Average technical efficiency of stochastic production frontier model is 0.57 with minimum value of 0.21 and maximum value of 0.99, the minimum value shows the most inefficient farmers and maximum value shows the most efficient farmers. Average efficiency of 0.57 signifies that all farmers has the room to increase TE by 0.43 per cent while for inefficiency farmer they have a chance to increase efficiency production by 0.79 per cent and maximum efficiency farmers has a chance to increase by only 1 per cent.

Table 6: Technical efficiency distribution of Grape farming (N=118)

Efficiency range	Frequency	Frequency %	Cum Fre %
0.20-0.39	28	23.73	23.73
0.40-0.59	38	32.20	55.93
0.60-0.79	37	31.36	87.29
0.80-1.00	15	12.71	100
Total	118	100	

Source: Field data 2019

Gross margin of grapes farmers

Most of grape production in Dodoma region is done by smallholder farmers and most of it is produced in their own farm. The majority of grape producer's own land of an average size 1.9 acres with average production of 1280 kg per acre. Table 7 shows household cost incurred during grape production per acre/year. Smallholder farmers incur different cost starting from land preparation up to harvesting in which they use different types labour forces like family, hire or both hired and family labour. In average grape industries use both variables and fixed input like land and FYM among many inputs. The results reveal that the grape industry earns profit of Tzs 667,419.00 per acre which expend the production cost of Tzs 831,000.00.

Table 7: Cost analysis of grape production (N=118)

				Income
Production: 1280.7 kg x1170				**1,498,419.00**
				COST
Variable	**Cost**	**Labour**	**Cost**	
Land preparation		Both (Family & hired)	750000	
Cultivation		Both (Family & hired)	130000	
FYM	145000	Both (Family & hired)	20000	
Planting		Both (Family & hired)	180000	
Pesticide	50,000	Family	25000	
Weeding		Both (Family & hired)	128,000	
Harvesting		Family	78000	
Total cost	**195,000**		**636,000**	**1,498,419.00**
Gross Margin				**667,419.00**

Source: Field data 2019

DISCUSSION

This study assessed the economic analysis of grape production in Tanzania a case of the Dodoma municipal council and the obtained findings shows from Table 1, that respondent means age for female lies in the 15 to 35 age group and for males lies in the 36 to 55 age group. This shows the importance of grape production in the area since the majority of participants lie in the low and middle ages and most of them are capable farmers and still energetic in involving in grape production. Mulashani (2016), declared the importance of age as the factor that can explain the level of production and efficiency, and it is thought that the young population is more productive than the older population.

Furthermore, findings indicated that only a few people above 56 years of age engaged in grape farming activities among the selected sample.

Based on gender most females participating in production aged from 15 to 55 were 41.5 per cent while male ranged 15 to 55 were 44.4 per cent this gives a clear picture that males are more highly involved in grape production than females, these findings relate to a study held by Natalia Kalimang`asi, Robert Majula and Nathaniel Naftali (2014) who found that males produce more than females do. Also, the findings show that males at the age of 36 to 55 depend on grape production 26.3 per cent more than female who engages more in 15 to 35 of ages taking 22 per cent (Table 1).

The obtained findings also indicated that the number of males headed is greater than female-headed Table 2, in the area 63.6 per cent were male-headed engaged in grape production while females were 36.4 per cent; this means most grape farmers are male-headed households implying that most resource controller and decision-makers in the family are men. Also, this shows that for the male-headed family grape production is given priority over female-headed.

According to Table 3, educated farmers are expected to have more production compared to uneducated farmers. This is based on the fact that new technology and techniques in production are easily adopted by farmers with education. From the descriptive statistics of the study, there is a total of 11 per cent of farmers uneducated, 60.2 per cent at the primary level, 25.4 per cent at the secondary level, and 3.4 per cent at the university level. Table 3 shows that farmers with primary education and secondary education were involved in grape production followed by uneducated farmers while farmers with university education were very few. In the study, two villages of Mpunguzi B and Matumbulu were found with grape farmers at the university level. Thus, the result shows that grape production was practised mostly by low-education farmers and farmers with higher education were not effectively engaged in grape production (Table 3). This portrays that the higher education level the lower involvement in agricultural activities.

Furthermore, the study area is found in the central plateau zone which is famous for the production of fruits. According to the Ministry of Agriculture and food security- Horticulture Unit, (2005) fruits such as Baobab, Mango, Papaya, Guava, and Grapes were found in the Dodoma region. According to this study (Table 4) crops like Ground nuts, Maize, Sunflower, Bambara nuts, Millet, Sesame, and Tomato were found in the different study areas. Grape production is the leading crop in the village studied followed by groundnuts, Tomatoes and Maize. Sunflowers and other crops are produced in low level.

So far according to Table 6, The Average technical efficiency of the stochastic production frontier model is 0.57 with a minimum value of 0.21 and maximum value of 0.99, the minimum value shows the most inefficient farmers and the maximum value shows the most efficient farmers. The average efficiency of 0.57 signifies that all farmers have the room to increase TE by 0.43 per cent while inefficiency farmer has a chance to increase efficiency production by 0.79 per cent and maximum efficiency farmers has a chance to increase by only 1 per cent.

Table 7 shows household costs incurred during grape production per acre/year. Stakeholder farmers incur different costs starting from land preparation up to harvesting which they use different labour forces like family, hire or both hired and family labour. On average grape industries use both variable and fixed inputs like land and FYM among many inputs, results reveal that the grape industry earns a profit of 667,419.00 Tzs per acre which expend the production cost of 831,000.00 Tzs.

Major challenges faced by farmers in during 2017/2018 grape production were inadequate capital, insufficient market, crop diseases, lack of storage facilities, transportation problems, high cost of input, low selling price, lack of knowledge, lack of credit, poor government support, lack of extension services in the area and climate change in the area. These challenges contributed to low yield for grape farmers and lead them to earn a low income. From the challenges analyzed (Table 8) in this study, each village had its unique challenges compared to the others. The unreliable market was leading by 41.9 per cent from all villages followed by inadequate capital at 35.9 per cent, crop disease at 35.9 per cent, and low selling price at 23.9 per cent.

Mpunguzi A village was leading in lacking capital, followed by Matumbulu while an unreliable market was highly reported in Mpunguzi village. The challenge of diseases also was highly reported in Mpunguzi A, while a lack of improved variety was highly reported in Matumbulu. Other challenges are shown in Table 8, for the number of respondents interviewed and their percentages contributions in the village. To improve and make grape production sustainable the challenges identified must be considered by the government so that farmers could improve their earning and life standards as well.

CONCLUSION

Proper information should be supplied to young people on the importance and profit obtained from grape farming. It has been shown in this study that most people with 36 to 55 years are engaged in grape production. Also educated people are not much engaged in grape farming as per results 60.2 per cent of all farmers are primarily educated. Grape production faces large competition from other crops in terms of land and other input resources like labour, thirty-four (34) per cent of the one hundred and twenty (120) grape farmers interviewed produce grapes while other crops are produced in small quantities, for example, ground nuts (19.1 per cent), Tomato (16.7 per cent) and maize (15 per cent). Factors which lead to production efficiency several such as contact with an agriculture extension officer to acquire more knowledge concerning production husbandry, and increasing productivity, followed by uses of pesticides like insecticide, and other chemicals to increase profit as well as uses of mixed labour (family and hired labour) which increase efficiency then output which ends up with high profit. Inefficiency factors are those factors which are oriented to the social characteristics of grape farmers which are determined by the knowledge and strength of farmers. These factors can increase or decrease productivity. In this study price extension and experience increase production output, while the area used for grape production decreased production output. This means that grape production depends much on the experience of farmers, extension and price of output. Other factors like age, area/ land and education are not significant for grape production. For the efficient model, the findings revealed that price is the main factor which determines production efficiency. Farmers will be able to reallocate many resources like time, money and labor forces if they predict price increases. Therefore, a study on market integration and market transmission should be considered as a factor to improve production efficiency. The farmers are not technically efficient in grape production. Even if they earn low profits by using indigenous knowledge, they still have room to increase profit. Grape farmers incur a large cost of production which reduces profit from grape farming. If the farmers are efficient, they will have the opportunity to increase production by an average of 47%. Grape farmers use Tzs. 831000 as a production cost to produce 1280 kg per acre. The farmer earns Tzs 667 819 from one acre of grape farm. The farmers have the potential to increase profit up to Tzs 981 693.93 per acre. The increase in profit by grape farmers depends much on the level of increase in efficiency such as the use of fertilizer, pesticide and mechanization in general.

RECOMMENDATIONS

Several strategies should be initiated as key factors to boost grape production. One such strategy is to reduce the cost of input to increase purchasing power of farmers which will rise production efficiency by increasing the use of improved technologies such as fertilizer and pesticide. In addition, agriculture extension officers should be provided to every village because they are the key experts to disseminate improved technologies. The formation of groups or cooperatives is also very important to solve the problem of lack of capital and market problems. Agriculture experts should establish close relationships with farmers to eliminate emerging problems such as disease and inputs. Finally, simple storage facilities should be provided to solve the post-harvest loss of grapes. These strategies should be initiated in collaboration with different partners such as individuals, the private sector and the government.

REFERENCES

Aigner, D. J. Lovell, C. A. K. and Schmidt, P. (1977): *Formulation and Estimation of the Stochastic Frontier Production Function Model. Journal of Econometrics. (6) 21-37.*

Asela M, (2017). *Comparing technical efficiency of maize smallholder farmers in Tabora and Ruvuma regions of Tanzania: a frontier production approach*, Asian Journal of Agriculture and rural Development, Asian Economic and Social Society, 7: 180-197pp.

Bachewe F., Berhane, G., Asrat, S., Gachew, G., Affesse, S.A., and Hoddinot, J. (2011). *Sources of Inefficiency and Growth in Agriculture Output in subsistence Agriculture.* IFPRI, Ethiopia.

Battese, G.E and Coelli, T.J (1995*). "A Model for Technical Inefficiency Effect in Stochastic Frontier Production for Panel Data." Empirical Economics, 20, 325-345.*

Bravo – at el (2007), Technical efficiency in farming: A Meta – Regression Analysis.

Economic Research Service, (2009): *Fruit and Tree Nuts outlook*, USDA.

FAO (2012) *Major Fruits and Vegetables producing Countries in the World (2010 2011*). Rome, Italy.

Green PE and Krieger AM (1992), An application of a product positioning model to pharmaceutical products, marketing science. INFORMS, vol.11(2), pages 117-132

Hidayah I, Hanani N, Anindita R and Setiawan 2013. *Production and Cost Efficiency Analysis Using Frontier Stochastic Approach: A Case on Paddy Farming System with Integrated Plant and Resource Management Approach in Buru District Maluku Province Indonesia*. Journal of Economics and Sustainable Development (online) **4**: No1, 2013.

Ibrahim K, Shamsudin MN, Yacob R and Radam AB (2014). *Technical efficiency in maize production and its determinants:* A survey of farms across agro ecological zones in Northern Nigeria, Trends in Agricultural Economics 7:57-68

Kalimang`asi N, Majula R and Kalimang`asi NN (2014). *The Economic Analysis of the Smallholders Grape Production and Marketing in Dodoma Municipal, International Journal of Scientific and Research Publications 4: 10*, October 2014 www.ijsrp.org

Khoshroo A, Mulwa R, Emrouznejad and Arabi B. (2013): *A non-Parametric Envelopment*

Kothari C.R, (2007*). Research Methodology, Methods and Techniques*, New Delhi:

Kulwijila M, Makindara J and Laswai H (2018). *Grape Value Chain Mapping In Dodoma Region, Tanzania*, *Journal of Economics and Sustainable Development* (Online) **9**: No.2, 2018 www.iiste.org

Kumar, R. T. (2010). Post *harvest profile of grapes Ministry of Agriculture, Department of Agriculture and Cooperation,* Directorate of Marketing and Inspection, MPDC, Nagpur, India.72 pp.

Lutheran World Relief (2016). *Market study of grape juice industry in Dodoma*, Tanzania, Executive summary

Lwelamira J, Safari J, and Wambura P (2015). *Grapevine Farming and its Contribution to Household income and Welfare among smallholder Farmers in Dodoma Urban District, Tanzania.* American Journal of Agriculture and Forestry **3:** 73-79

Ministry of Agriculture, Food and Cooperation (MAFC) report, (2006). *Participatory Agricultural Development and Empowerment Project (PADEP)*, Conducted by Match Maker Associates Limited (MMA)

Ministry of Industry, Trade and Marketing (2008): *Agricultural Marketing policy,* The United Republic of Tanzania, Dar es Salaam.

Mulashani M. (2016). *The Income Effect of Agricultural Intensification on Smallholder Cotton Farmers in Misungwi Distict.*

Nakano, Y. Kajisa, K. (2010). *The Determinant of Technology Adoption. The Case of the Rice Sector in Tanzania. 92 pp.*

National Agricultural Statistic Services, (2013). *Non-Citrus Fruits and Nuts*, USDA

Njiku AR and Nyamsongoro GD (2018). Determinants *of Technical Efficiency of Small-Scale Sunflower Oil Processing Firms in Tanzania,* Asian Journal of Economics and Empirical Research **5:** 79-86

Paudel P and Matsuoka A (2009). *Cost efficiency estimates of maize production in Nepal: A case study of the Chitwan district.* Czech Journal of Agricultural Economics. **55**: 139-14.

Ramanathan, R. (2003). An introduction to data envelopment Analysis: Measurement sage publications, New Delhi.

Shahraki AS, Dahmardeh N and Karbasi A (2012): *Determining Technical Efficiency with Risk for Grape Gardens in Sistan area by using Stochastic Frontier Analysis*, International Journal of Agriculture: Research and Review. **2**: 1037-1044

Sirikanchanarak D, Liu J and Sriboonchitta S (2017). *Measurement and Comparison of Rice Production Efficiency in Thailand and India: An Efficient Frontier Approach*. *Thai Journal of Mathematics*. 215-228 PP

SNV (2005). *Fruits Subsector a Study on fresh fruits: the case study in Morogoro and Dodoma (With Special emphasis on Pineapples); Final Report*

Zacharia, K., Frederick, C. K., Winfred, B. M., Paul, R., Muyenjwa, M., Fikiri, D. M., and Henry, M. (2013). *Optimizing System of Rice Intensification Parameters Using Aquacrop Model for Increasing Water Productivity and Water Use Efficiency on Rice Production in Tanzania.* Journal of Agriculture and sustainability 4: 235-244.