TECHNICAL EFFICIENCY ANALYSIS AMONG SMALL SCALE WATERMELON FARMERS IN UHUNMWODE LOCAL GOVERNMENT AREA EDO STATE, NIGERIA

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C. I. Ada-Okugbowa[1] and J. Egbodion[2]
Department of Agricultural Economics & Extension Services, University of Benin, Edo State, Nigeria
Corresponding author: agboikhena.egbodion@uniben.edu

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Abstract: The study examined technical efficiency (TE) among small-scale watermelon farmers in Uhunmwode Local Government Area Edo state, Nigeria. The specific objectives were to examine the socio-economic characteristics of the farmers, estimate the farmers' productivity, technical efficiency and influence of farmers' socio-economic characteristics on their TE. The data were collected with well-structured questionnaire and assisted with interview schedule. Through a simple random sampling, a sample of 100 respondents was selected in the study area. Data analysis was carried out with the use of descriptive statistics (frequency count, percentages, standard deviation) and the stochastic frontier production function through maximum likelihood estimation procedure. The result of the analysis showed mean age of 41 years, 83% were married, with mean farming experience of 4 years. Majority (97%) of the farmers had training in formal educational system, with a mean household size of 6 persons and farm size of 0.8 hectares. The regression analysis showed that the farmers were operating at an increasing return to scale. All the production factors jointly and positively correlated with farmer's outputs; but only farm size, planting materials and depreciation that were statistically significant at 5%. Technical efficiency ranged from 0.004-0.915 with a mean value of 0.7339, an indication that the farmers were operating at about 26.6% below the frontier, which also indicated an efficiency gap. Farmer's socio-economic characteristics contributed positively to their Technical efficiency. It is concluded that farmers should expand their scale of farming to enjoy economy of scale in production. Policies of governments should be directed at socio economic factors to enhance their TE through assistance in provision of irrigation facilities to farmers in the study area.

Keywords: Small-scale, stochastic frontier production, watermelon

Introduction

Agriculture occupies a predominant place in the economy of Nigeria. The sector accounts for 35% of the Gross Domestic Product (GDP) and employs about two-third (70%) of the active labour force (CBN, 2005) and currently 24.18% (CBN, 2016). In the period preceding the political independence of Nigeria in 1960, agriculture was the major foreign exchange earning sector. However, the important role agriculture has played in Nigeria's economic life has declined tremendously over the years (Mesike*et al.*, 2009). The decline has for a long time been blamed on the neglect of the rural sector, comprising mainly of smallholdings farming families or households by successive administration in the country. Also, the age of farmer, farm size and the farmland tenancy have had their own share of the blame (Abolagba, 2010). Other factors responsible for the decline in agricultural production includes low crop yields, use of unimproved crop varieties, inconsistent macroeconomic policies, pest and disease, wrong choice of enterprise combination and cropping system, poor rural infrastructure, poor fertilizer distribution and high cost of farming inputs. Despite these factors that continuously constrain agricultural activities, the sector still remain important in the economy by accounting for the supply of food for man and livestock consumption, raw materials for industries, employment and revenue generation, significant contribution to both the total export earnings and gross domestic product (GDP) of the country (CBN, 2016).

Watermelon (*Citrulluslenatus*) is a warm season crop that is cultivated worldwide because of its numerous nutritional benefits. It thrives very well in most well drained soils whether clayey or sandy but preferably sandy loams. The global production in 2010 reached 98.9 million mega grams (FAO, 2012). Although China is reported to be the current world largest producers of the commodity followed by Turkey, United States, Iran and Republic of Korea (FAO, 2012, 2013), watermelon is generally believed to have originated from Africa. There are over 1,200 varieties of watermelon worldwide and quite a number of these varieties are also cultivated in Africa (Zohary and Hopf, 2000). The global consumption of the crop is greater than that of any other cucurbit. In Nigeria like many other parts of the world, watermelon is highly cherished as a fresh fruit because of its thirst-quenching attribute in addition to many other identified nutritional values and advantages. Therefore, the consumption of the commodity in recent times has witnessed remarkable increase as it cuts across all socio economic classes. Presently, the largest production of the crop in Nigeria is the northern part. It has however been observed that a good output of the crop could also be achieved in other parts of the country. Specifically, farmers in Uhunmwode local government area have taken the advantages of the possibility of growing the crop twice a year to generate additional income and therefore increased their overall annual farm income.

The potentials of watermelon as a quick cash generating crop is significant for farmers especially those residing near the urban areas. According to Oguntola (2006), watermelon is the most preferred among five other exotic vegetables examined in Benin metropolis. There is nothing as refreshing as having a chilled slice of watermelon on a sunny afternoon. About 92% of this fruit is mostly water and is filled with nutrients, vitamin, organic compound and minerals.

This means every juicy intake of this fruit has high amount of Ca, Vitamin C, protein, fibre, Mg and large amount of K. The seeds contain lycophene antioxidant and amino acids. Lycophene is a phyto-nutrient that is a naturally occurring compound in fruits and vegetables good to the human body.

There are 8 reasons why one should consume watermelon often. The vegetable prevent kidney disorder. It has K which is very helpful in the cleansing and washing off of toxic deposition in the kidney. It helps to reduce the concentration of uric acid in the blood. Constant intake of the fruit lead to frequent urination which is also a way of flushing the kidney, it reduces signs of ageing, regulation of blood pressure, prevention of cancer, a cure for erectile dysfunction. Hydration, supplement for diabetic patient and prevention of heat stroke. Equally, the crop is being cultivated twice in a year in Uhunmwode local government area. The first crop is planted with the first or second rain which mostly occurs around February or early march. The produce at this time will hit the market between May and June when the supply from the northern part of the country must have diminished completely. While the second crop is planted in September to be harvested around December when there will be no supply from the north. Therefore, the farmers cash in on the opportunity to increase their farm income appreciably.

Like the cultivation of many other crops, the basic inputs in watermelon cultivation are land, labour, capital and management. Knowledge of availability of aggregated farm level resources and differences in their production are essential in order to enhance production capacity of the smallholder farmers (Okeke and Chukwujioke, 2012). This indicates the direction of resource use, adjustment and allocation (Ogundari and Ojo, 2006). Efficiency measurement is very important because it leads to resource savings, efficient farms are more likely to generate higher income and then stand a better chance of surviving (Bravo-UretaandRieger, 1991).

Against this background, the study specifically examines the socio-economic characteristics of the farmers, estimates the technical efficiency of resource use among the farmers and ascertains the influence of socioeconomic characteristics of watermelon farmers on production in the study area.

Materials and Methods

Area and scope of study

The study was carried out in Uhunmwode local government area in of Edo state, Nigeria. The area is within the conference of Edo south with the headquarter in the town of Ehor and lies within the rainforest zone of Nigeria of Nigeria with a mean annual rainfall of 3000 mm and maximum average temperature of 33^0C. It has a geographical area of 2,033 $km^2$and a population of 120,813 people at the 2006 census. The local government area is situated within the Edo central and south-south ecological zone. The study area covers a total of seven (7) communities Abumwere, Ehor, Okenien, Ugbiyaya, Ugbiyokho, Ugiamwen and Ukpogo

Agriculture is the predominant occupation of the people in the local government area. The major crop produce are plantain, pineapple yam and watermelon. There is a transit town (Ehor) that favours the marketing of most agricultural produce in the study area.

Data collection and sampling techniques

A two stage sampling technique was employed. The first stage involved a purposive sampling of five communities in the local government area (Abumwere, Ehor, Okenuen, Ugbiyaya and Ugiamwen). The communities were specifically chosen due to the dominance of watermelon farmers in the areas. The second stage involved simple random sampling of 20 respondents from the sampled communities to have a total sample size of 100 respondents used for the study.

Method of data analysis

Descriptive statistics (mean scores, standard deviation, frequency count) and stochastic frontier production function were used to examined farmers socio economic characteristics analyze productivity and technical efficiency respectively. This was used in achieving objective one, which are the socio-economic characteristics of the respondents.

Stochastic frontier production function (SFPF)

This study utilized the cobb-Douglas form of the stochastic frontier production function to analyze the technical efficiency of watermelon farmers in the study area. This function has been employed in other studies to determine technical efficiency of agricultural production (Erhabor and Emokaro, 2007; Egbodion, 2011).

The stochastic frontier production function model is implicitly specified as follows:

$Y = f(X_i\beta_i)e$

Where: Y = Output; X_i = Vector of inputs; β_i = Parameter; e = error term

While the model in its explicit form is given as:

$\ln Y_i = \beta_0 + \beta_1 \ln X_1i + \beta_2 \ln X_2i + \beta_3 \ln X_3i + \beta_4 \ln X_4i + \beta_5 \ln X_5i + \beta_6 \ln X_6i + \beta_7 \ln X_7i + ei$ ……………(3)

Where: ln = natural logarithm; Y = quantity of watermelon produce (kg); X_1 = farm size (Hectares); X_2 = planting material (kg); X_3 = familylabour (man/days); X_4 = hired labour (man/days); X_5 = quantity of fertilizer used (kg); X_6 = quantity of Agro chemical used (liters); X_7 = Depreciation in naira (#); β_0-β_7 = parameters to be estimated (regression coefficients); ei = composite error terms defined as Vi-Ui;

Vi = random variables which are assumed to be independents of ui, identical and normally distributed with zero mean and constant variance N $(0,Sv^2)$; Ui = non–negative random variables which are assumed to account for the technical inefficiency in productions and are often assumed to be independent of vi such that vi is the non-negative truncated Normal distribution.

The inefficiency of production, Ui is modeled in terms of the factors that are assumed to affect the efficiency of production of the farmers some of the factors related to socio-economic characteristics of the farmers and the model will be jointly estimated with equation (3) and is presented below as:

$Ui = \delta_0 + \delta_1 Z_1 + \delta_2 + Z_2 + \delta_3 Z_3 + \delta_4 Z_4 + \delta_5 Z_5 + \delta_6 Z_6 + ei$…………(4)

Where: Ui = technical inefficiency; Z_1 = Age (years); Z_2 = Educational level (years); Z_3 = Farming experience (years); Z_4 = Household size (number); Z_5= Gender (m/f); Z_6= Contact with extension agent (number); ei = Error term; δ_0–δ_6= Parameters to be estimated

The sigma square (σs^2) which indicates the goodness of fit of the model used and the correctness of the distributional assumption and the gamma (γ) which gives the proportion of the deviation of the output from the frontier due to technical inefficiency will also be determined. The parameters of the stochastic frontier production function (SFPF) will be estimated using the computer programmed frontier 4.1 Coelli (1994).

Frequency distribution of socio-economic characteristics of watermelon farmers in the study area

The age distribution of the respondents in the study area is presented in Table 1. The result indicates that majority (40%) of the respondents were in the age bracket of 31-40 years which is the active age. While a few (18.0%) of the respondents belonged to the age bracket of 51 years and above. The mean age was 41 years indicating that all average watermelon farmers were able bodied men and women who are still in their active years? According to the findings of Yusuf, Lategan and Ayinde (2013), age plays a significant role in farming, as it determines the farmer's ability to carry out tedious and rigorous work as defined by some activities in watermelon cultivation for example mounting of knapsack sprayer at the back. The result indicated that majority (85%) of the respondent were male as against female (15%); which implies that more males were engage in watermelon production than females in the study area. A probable reason for this could be as a result of the tedious and rigorous activities involved in the production of watermelon.

Results indicate that 52% of the farmers had a family size of 5-8 persons, 31% had less than 4 persons, 13% had 9-12 persons, while 4% had 13 persons and above with a mean of 6 persons as family size. The implication of these sizes of family is that members of the family will supply readily available labour and this will lead to labour availability in the area for farm family use. In Nigeria, farmers rely on household labour requirement due to increasing cost of hired labour. A famer with a large household size produces more crops with low cost per unit output than a famer with smaller household size. However, the findings negate this *apriori* expectation in the study area. This finding is consistent with the result of Onubuogu (2013), who reported that large house size compliments labour to enhance production and reduce the cost of hired labour. A household comprises all persons who generally live under the same roof and eat from the same pot (FOS, 1985).

Table 1: Frequency distribution of socio-economic characteristics of the respondents

Variables	Freq. (n = 100)	%
Age (range)		
30 and below	19	19.0
31-40	40	40.00
41-50	18	18.0
51-60	15	15.0
61+	8	8.0
Sex		
Male	85	85.0
Female	15	15.0
Family size		
<4	31	31.0
5-8	52	52.0
9-12	13	13.0
13+	4	4.0
Experiences (range)		
<2	19	19.0
3-4	39	39.0
5-6	28	28.0
7-8	12	12.0
9+	2	2.0
Education level		
1	3	3.0
2	15	15.0
3	47	47.0
4	23	23.0
5	10	10.0
6	2	2.0
Farm size (Ha)		
0.5 and below	31	31.0
0.6 - 1.0	54	54.0
1.1 - 1.5	13	13.0
1.5 – 2.0	2	2.0
Total	**100**	**100.0**

Result shows that (39%) of the respondents had farming experience ranging from 3-4 years, (28%) within the range of 5-6 years, (19%) less than 2 years, (12%) within the range of 7-8 years and (2%) with farming experience of 9years and above. The mean farming experience was 4years which implied that the watermelon farmers in the study area were quite new in the business. Experience here, supports the findings of Onubuoge (2013), and Esiobu (2014) that previous experience in agribusiness management enables farmers to set realistic time and cost targets.

Result reveals that majority (47%) of the farmers had secondary education, (15%) had primary education, (2%) had Islamic education, and (33%) had tertiary education while (3%) had no formal education. The result implies that approximately 97% of the farmers had trainings in formal educational institutions which no doubt increases their literacy levels. It is expected that the higher levels of education will contribute significantly to decision making of a farmer. Exposure to high levels of education is also an efficient marketing tool.

This findings support Moyib (2013), Girei (2014) that higher levels of education determines the quality of skills of farmers, their allocative abilities, efficiency and how well informed they are of the innovations and technologies around them. It also supports the result of Onubuogu and Onyeneke (2012) and Onumadu (2014) that individuals with higher education attainment are usually faster in adoption of improved farming technologies.

Result also shows that majority (54%) of the respondents had farm size of between 0.6-1.0 hectares, 13% had 1.1-1.5, 31% had less than 0.5 and 2% had 1.5-2.0 hectares. The mean farm size was 0.8 hectares. This implies that the farmers in the study area are mainly smallholder farmers operating on less than or equal to 2.0 hectares of farm land. A probable reason could be high cost of land or land tenure system that predominant in the area due to the increasing population.

Result reveals that none of the watermelon farmers in the study area received any form of visitation from extension agent. The implication of this result is that none of the watermelon farmers received extension visits so as to ascertain their farming problems, know where they need assistance and pass across to them any new/improved technologies. Also, extension contacts which is a channel through which agricultural innovations and information are passed to farmers for improvement in their standard of living and production are missing This could bring about low productivity and poor resources use efficiency due to lack of innovative information.

Table 2: Ordinary least square (OLS) and maximum likelihood estimate (MLE) stochastic frontier estimates of watermelon production in the study area

Variables	OLS coefficient	Std error	MLE coefficient	Std error
Constant	2.123	1.499	4.007	0.779
Farm size	0.891	0.524	1.900*	0.321
Planting material	0.807	0.275	0.414*	0.159
Family labour	-0.002	0.204	0.099	0.130
Hired labour	0.048	0.164	0.077	0.088
Fertilizer (kg)	0.050	0.204	0.045	0.054
Agro-chemicals (lit)	0.275	0.166	0.250*	0.103
Depreciation	0.468	0.195	0.262*	0.099
Sigma-square	0.436		1.986	0.293
Gamma			0.961	0.015
Log likelihood func.	961.92		-556.30	
Inefficiencymodel				
Constant			10.083	4.140
Age			-0.099	0.076
Education level			-1.263	0.836
Farming experience			-1.263	0.836
Household size			-0.309	0.297
Sex			-0.560	1.018

***Significant at 5%**
Source: Survey data, 2015

Effect of the inputs on total output of farmers

The result of the maximum likelihood of MLE and OLS stochastic frontier estimates of inputs used in watermelon production are presented in Table 2 above. The MLE model presented a better result hence it was adopted for further economic and econometric analysis. All the variables included in the model had positive correlation on the output of farmers but only farm size, planting materials, agro-chemicals and depreciation were statistically significant at 5%. This result indicates that increases in the quantity of these inputs lead to a proportionate increase in the output of farmers in the study area.

The result of the MLE model coefficients were treated as the elastic ties of the inputs used by the farmers in the study areas shown in Table 3. The computed RTS was 3.047 which is positive. This result indicated an increasing return to scale which is not economical; the result showed that production resources are underutilized by farmers in the study area. For these farmers to realize optimum output would require that production resources are expanded to move output to the economic region of production where the farmers will be able to maximize output. These findings agreed with Egbodion, and Emokaro(2013), in which similar return to scale was recorded in the analysis of permanent crop base enterprise in Edo State, Nigeria.

Table 3: Return to scale (RTS) of watermelon production in the study area

Variable inputs	Elasticity
Farm Size	1.900
Planting Martials	0.414
Family labour	0.099
Hired labour	0.077
Fertilizer	0.045
Agrochemicals	0.250
Depreciation	0.256
RTS	3.047

Source: Survey data, 2015

Table 4: Technical efficiency range

Efficiency Level	Frequency	Percent
<0.400	3	3.0
0.401 - 0.500	2	2.0
0.501 - 0.600	13	13.0
0.601 - 0.700	18	18.0
0.701 - 0.800	22	22.0
0.801 - 0.900	39	39.0
0.901 – 1.000	3	3.0
Total	**100**	**100.0**

Mean = 0.7339, **Minimum** = 0.004, **Maximum** = 0.915
Source: Survey data, 2015

Determinants of technical efficiency in the study area

The results of the analysis of the determinant of technical efficiency are shown in Table 2. The entire variable included in the model presented negative signs which indicated that the entire variable jointly contributed to increase the technical efficiency of the farmers in the study area; these findings suggest that to solve the farmer problems policy (such as training of farmers through adaptive extension services and provision of improve technology such as improve seeds that will enhance watermelon production) directed at these farmer socio-economic characteristics will reduce their inefficiency and enhance technical efficiency of watermelon production in the study area.

The coefficient of sigma was high (1.986) and significant, indicating the appropriateness of the model. The coefficient of gamma (0.961) was positive which means that 96.1% variation in the observed technical efficiency from the frontier was mainly due to technical inefficiency whilst at 3.9% is explained by factors beyond the control of the farmer like weather conditions and statistical data collection. The technical efficiency of the farmers in the study area ranged from 0.400 to 1.000 with a mean efficiency value of 0.734, minimum efficiency value of 0.400 and maximum efficiency value of 0.915 respectively. A mean efficiency of 0.734 indicated that an average watermelon farmer was operating 26.6% below the frontier in the study area. The frequency distribution of results of the data analysis of technical efficiency level of inputs used by the farmers is presented in Table 4. The results showed that majority (61.0%) of the watermelon farmers had technical efficiency value between 0.701-0.900 and were above the average technical efficiency value. From the table about 36% of the farmers were operating below the average. This finding agreed with the finding of Egbodion and Ahmadu (2012), who obtained a similar result in the analysis of technical efficiency of arable crop, based farmers in Edo State, Nigeria.

Conclusion and Recommendation

The study revealed that there is technical efficiency gap among small scale watermelon farmers in the study area. It is concluded that farmers should expand their scale of farming to enjoy economy of scale in production and if this is addressed with appropriate agricultural policies, it will increase watermelon production in the study area. Government and donor agencies should direct their agricultural programs to watermelon farmers' socio-economic characteristics that jointly affected their technical efficiency in the study area.

Farmers should expand their production input to advance production to economic region of production where maximum output can be obtained.

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