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Effects of Watermelon Production on the Livelihoods of Smallholder Farmers in Ekiti State, Nigeria

[1]Adedapo, A. O. and [2]Kehinde-Fadare, A. F.

[1]Department of Agricultural Economics and Extension Services, Faculty of Agricultural Sciences, Ekiti State University, Ado Ekiti, Ekiti State, Nigeria
[2]Department of Crop, Horticulture and Landscape, Faculty of Agricultural Sciences, Ekiti State University, Ado Ekiti, Ekiti State, Nigeria
Email of the Corresponding author: ayodeji.adedapo@eksu.edu.ng

Abstract: The study examined the effects of watermelon production on the livelihoods of smallholder farmers in Ekiti State, Nigeria. Specifically, the study described the demographic characteristics of the respondents, estimate the cost and returns analysis of watermelon production, determine the resource use efficiency of watermelon production and describe the constraints to watermelon production in the study area. A well-structured interview schedule was used to elicit information from 120 watermelon farmers through a multi-stage sampling procedure. The data collected were analyzed using descriptive statistics, cost and returns analysis, frontier stochastic statistical tools and Chi-Square analysis. The study revealed that the average age of the respondents was 41.34 years, mostly male, married, with relatively large household size of 8 persons and had one or more forms of education. Their average year of farming experience was 12 years, while their common mode of land acquisition was inheritance and rentage. Also, family labour was their common source of labour. The sources of finance available were banks, personal savings and friends and relations. Also, 46.67 percent have access to credit facilities and non-availability of bank in the locality, lack of collateral and lack of proper information were the reasons for not being able to access credit facilities. Farm gate and local market were the common points of sales used by the farmers to market their harvested watermelon. The farm size (0.046), labour per day (0.032) and qualities of seeds (0.491) were found to be significant variables in technical efficiency of watermelon farmers. The inefficiency sources model shows that age, household size and farming experience were the significant factors affecting watermelon production in the study area. The estimate of cost and return analysis of watermelon farming showed the profitability with ₦253,268.52 total cost incurred, total revenue was ₦487,436.05, net profit was ₦234,167.53, gross return was 0.52, while the rate of returns was 0.92 and the benefit cost ratio was 1.92. The result of the distribution of technical efficiency scores showed that increase output level of the efficiency of inputs usage was increased by 0.15. The constraints to watermelon production were transportation, high cost of inputs, pest and diseases infestation, limited extension agents contact, lack of improved seeds, limited access to land, lack of credit facilities and storage or preservation challenges. Hence, watermelon farming is a profitable enterprise with little capital investment. There should be availability of good feeder roads, subsidized and adequate farm inputs, adequate extension service delivery, availability of farmland, credit facilities and storage facilities to enhance the production of watermelon in the area.
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1. Introduction

Watermelon (*Citrullus lanatus*) is a plant that belongs to the Cucurbitaceae family, which is made up of about 118 genera and over 825 species. It originates from both Kalahari and Sahara deserts in Africa, where it was found growing wild and it was known as points of distribution to other parts of the world (Otunaiya and Adedeji, 2014). It was grown by a Native American in the 16th century and early French explorers found the fruit, being cultivated in the Mississippi valley. Many sources stated that watermelon was introduced in Massachusetts in early 1629. Recently, more than 44 states in the US grow watermelon commercially (Majid, 2011). The result made available in 1954 shown that gray melon from Charleston is rhombus in shape and hard rind made it easy to stack and ship (Amao, Ajiboye, Adeagbo and Akinyemi, 2014). Hence, it is a warm season crop that is cultivated globally due to its nutritional benefits and it blossoms very well in most well drained soils whether clayey or sandy soil but preferably sandy loams (Ajewole, 2015). China produces about 70.2

million metric tons of watermelon annually and was ranked the highest producer. Followed by Greece and Cyprus producing about 62 tons, Iran, Turkey and Brazil jointly produced about 2 million metric tons (FAO, 2013). Nigeria produced about 139,223 tons while Kenya produced about 66,196 tons and South Africa produced about 77,993 tons (This Day Live, 2014). There are over 1,200 varieties of watermelon worldwide and quite a number of these varieties are also cultivated in Africa and its consumption is greater than that of any other cucurbit (Zohary and Hopf, 2000).

Watermelon is a pleasant thirst-quenching fresh fruit with highly refreshing sources of much needed water, protein, vitamin and electrolytes especially in the scorching tropical-summer temperatures. It contains about 93 – 95 percent of water, phosphorus (9 mg), ascorbic acid (8 mg), vitamins C and A (0.64 g), calcium (8 mg) and carbohydrate (5 mg) per 100 g (Achiri, Konje, Nkuh and Nsobinenyui, 2019). It is also rich in citrulline, potassium, carotenoids and amino acids which are associated with improved heart and liver functions, controls blood pressure, prevention of stroke, reduced risk of developing muscular degeneration and protect body cells against damage by free radicals (De Lannoy, 2001; Kim, 2008). It also helps to reduce the risk of certain cancers such as prostate, pancreases and stomach.

However, the largest production of the crop was produced in the northern part of Nigeria where suitable agro-ecology was found (Oyediran *et al*., 2018). The recent increase in the cultivation of watermelon in southwest Nigeria especially Ekiti State could be attributed to the state government sponsored of Youth Commercial Agricultural development Programme (YCAD) which emphases watermelon production as one of the commercial crop under the programme to reduce employment rate, improve agricultural production and income to farmers as well as enhancement of the livelihoods of the dwellers. Coupled with remarkable increase in the consumption of watermelon due to its nutritional potentials and it could be cultivated twice a year with high productivity and income that encourages many farmers to go into its production. It is therefore expedient to examine the effects of watermelon production on the livelihoods of farmers in the study area. Consequently, the study identified the demographic characteristics of the farmers, examined the costs and returns of watermelon production, resource use efficiency and constraints to watermelon production in Ekiti State.

2. Material and Methods

Study Area: This study was carried out in Ekiti State. The State lies within the tropics between longitude $4°45^{1}$ and $6°45^{1}$ East of Greenwich meridian and latitude $6°15^{1}$ and $8°5^{1}$ North of equator. The State experiences a typical tropical climate with two different seasons, raining season between April-October while dry season is between November-March. The State shares boundary in the South with Kwara and Kogi States, in the east with Ondo State and in the west with Osun State. The State has a population of about 2,384,212 which represent about 1.7% of the nation's total population with covered land area of 6,353 km^2 and about 90% of the land is used for farming and agricultural related enterprise (NBS, 2008; NPC, 2006). Also, about 70% of her population engaged in farming activities (NAERLS and NPAFS 2010). The state is endowed with favorable agro-climatic conditions suitable for agricultural productions of tree crops such as oil palm, citrus, mango, kola nut and guava and arable crops such as maize, rice, plantain, tomato, okro, melon and water melon. The average annual rainfall in the state ranges between 2000 mm - 2400 mm, the average annual temperature ranges from 20^0C - 27^0C and 60% relative humidity. There are sixteen (16) Local Government Areas in the State. Ekiti State was purposively chosen for the study due to increase in population and demand for fruits and vegetable.

Sampling Procedure and Sample Size: A total of 120 watermelon farmers from four (4) Local Government Areas were selected using a multi-stage sampling procedure and a well-structured interview schedule was used to elicit information for this study. Data were collected on socio-economic characteristics of respondents, cost and returns of watermelon and constraints to watermelon production in the study area.

Methods of data analysis: Data were analyzed with the use of descriptive statistics such as frequency counts, percentages and mean to describe the socio-economic characteristic and constraints to watermelon farming in the study area. Cost and return analysis was used to estimate the profitability of watermelon farming in the study area. Frontier stochastic statistical tools analysis was used to analyse the economic efficiency of watermelon production in the study area. Chi-Square analysis was used to analysis the effects of watermelon production on the livelihoods of the farmers in the study area.

Chi-Square Analysis

$$X^2 = \frac{(O-E)^2}{E}$$

Where;

O = the observed effects of watermelon production on the livelihoods of the farmers.

E = the expected effects of watermelon production on the livelihoods of the farmers.

Cost and Returns Analysis

TC = Total Fixed Cost (TFC) + Total Variable Cost (TVC)

Net Profit = TR – TC

ROR = Net Profit/TC

GR = TC/RC

BCR = TR/TC

TC = Total Cost

TR = Total Revenue

ROR = Rate of Returns

BCR = Benefit Cost Ratio

Stochastic frontier production function

Estimating the stochastic production frontier function and predicting individual farm's technical efficiency determine production efficiency. In a stochastic frontier production model, output is assumed to be bounded from above by a stochastic production. The essential idea behind the stochastic frontier model is that error term is composed of two parts, a systematic and a one-sided component. Stochastic frontier is an econometric analytical technique, which allows for variation of output of individual producers from the frontier of maximum achievable level to be accounted for by the firm (Battese, *et al*., 1997).

The model in its implicit form is as follows:

$Y = f(X_i;\beta_i) + e_i$

$e_i = V_i - U_i$

Where:

Y = quantity of output (kg)

Xi = vector of the inputs used by the i^{th} farm

β_i = a vector of the parameter to be estimated

ei = composed error term

Vi = random error beyond the control of producers

Ui = technical inefficiency effects

$f(Xi;\beta)$=appropriate functional form of the vector.

A general Stochastic Frontier Production model following Aigner, *et al.,* (1977) is expressed implicitly as:-

$ln\ Y_i = \beta_0 + \sum \beta_j\ ln\ X_{ji} + V_i - U_i$

The stochastic frontier model for estimating the technical efficiency of watermelon farmers is specified by the Cobb- Douglas frontier production function, which is defined by:

$$InY_i = \beta_0 + \beta_1 Inx_1 + \beta_2 Inx_2 + \beta_3 Inx_3 + \beta_4 Inx_4 + \beta_5 Inx_5 + v_i - u_i$$

Where:

In = natural logarithm to base e

Y_i = Output of watermelon (kg)

β_0 = constant or intercept

β_1 - β_5 = unknown scalar parameters to be estimated

X_1= farm size (ha)

X_2= labour used (man per day)

X_3= quantity of seeds (kg)

X_4= quantity of fertilizers used (kg)

X_5= quantity of agrochemicals (litres)

V_i = random errors

U_i = Technical inefficiency effects predicted by the model

Subscript i indicate the i^{th} farmer in the sample.

The technical inefficiency effects U_i is affected by demographic characteristics of the farmers and is defined by:

$$U_i = \alpha_o + \alpha_1 Z_1 + \alpha_2 Z_2 + \alpha_3 Z_3 + \alpha_4 Z_4 + \alpha_5 Z_5 + \alpha_6 Z_6$$

Where:

U_i = technical inefficiency effects

Z_1 = Age of the ith farmer in years

Z_2 = Household Size

Z_3 = Education Level

Z_4 = Farming Experience

Z_5 = Credit Accessibility in dummy of one if ith farmer accessed credit and zero otherwise α_1 - α_7 are unknown scalar parameters to be estimated α_o = constant or intercept.

These were included in the model to indicate their possible influence on the technical efficiency of the farmers.

Battese and Coelli (1995) stated that the TE of a farmer is between 0 and 1 and is inversely related to the level of the technical inefficiency. Technical efficiency is defined as the ratio of observed output to maximum feasible output. $TE_i = 1$ shows that the ith firm obtains the maximum feasible output, while TEi < 1 provides a measure of the shortfall of the observed output from maximum feasible output. It is estimated as;

TE_i = Observed Output / Frontier Output

Technical inefficiency = $1 - \overline{TE}$

3. Results and Discussion

Demographic Characteristics of the Respondents

The result in Table 1 shows distribution of the respondents based on their demographic characteristics. The average age of the respondents was 41.34 years and this implies that watermelon farmers in the area were mostly youths and within the active age range. They were mostly male (75.83%), married (63.33%) with average household size of 8 persons, they had one or more forms of education and their main source of livelihood was predominantly farming. Their average years of farming experience was 12 years, more than half (55.83%) of them

belongs to one or more cooperative societies and the sources of their labour were family and hired labour.

Land inheritance was the common mode of farmland acquisition as indicated by 91.67 percent of the farmers. Farm gate and local market were the common points of sales by which the farmers trade their harvested watermelon as indicated by 30.83 and 36.67 percentages, respectively. Less than half (46.67%) of the farmers indicated that banks was their source of finance, while 31.67 percent indicated that their source of income was personal savings and 21.66 percent indicated that friends and relations was their sources of finance. This implies that all the watermelon farmers in the study area have one or more sources of finance.

Table 1. Demographic Characteristics

Variables	Freq.	%
Age (Years)		
Less than 31	15	12.50
31 – 40	56	46.67
41 – 50	21	17.50
Above 50	28	23.33
Mean Age	**41.34**	
Sex		
Male	91	75.83
Female	29	24.17
Marital Status		
Single	15	12.50
Married	76	63.33
Divorced	5	4.17
Widow	24	20.00
Household Size		
1 – 5	15	12.50
6 – 10	75	62.50
More than 10	10	8.33
Average Household size	**8**	
Household Head		
Male	91	75.83
Female	29	24.17
Educational Status		
Never Attended School	30	25.00
Primary School Education	5	4.17
Secondary School Education	75	62.50
Tertiary School Education	10	8.33
Farming as Primary Occupation		
Yes	101	84.17
No	19	15.83
Years of Farming Experience		
1 – 10	61	50.83
11 – 20	36	30.00
More than 20	23	19.17
Average years of Experience	**12.15**	
Membership of Coop.		
Yes	67	55.83
No	53	44.17
Sources of Labour		
Family Labour	71	59.17
Hired labour	49	40.83
Mode of land ownership		
Inheritance	110	91.67
Rent	10	8.33
Point of Sales of harvested watermelon		

Farm gate	37	30.83
Local market	44	36.67
Urban market	10	8.33
Both farm gate and local M	29	24.17
Source of Finance		
Personal Savings	38	31.67
Friends and Relations	26	21.66
Banks	56	46.67

Source: Field survey, 2019.

Cost and Returns Analysis of Watermelon Production

The results in Table 2 shows the estimate of cost and return analysis made from watermelon farming in Ekiti State using the total cost and the income generated by each of the respondents per month. The total cost incurred on watermelon production in the study area was ₦253,268.52 and the total revenue was ₦487,436.05. The Net profit for watermelon farming was ₦234,167.53, which depicts the difference between the total revenue and total cost. The Gross return for watermelon farming was 0.52, while the rate of returns was 0.92 which indicate that for every ₦1.00 invested in watermelon farming, 92 kobo is been gained. The benefit cost ratio for watermelon farming was 1.92 and this implies that watermelon farming is a profitable enterprise. This corroborate the rule of thumb, any benefit cost ratio greater than one, equal to one or less than one indicate profit, break-even or loss, respectively. Since, the benefit cost ratio of this is greater than 1.0 and it shows that it is profitable even with little capital investment. This affirmed the findings of Ajewole (2015) that watermelon production in Ekiti State is profitable.

Table 2. Cost and Returns Analysis of Watermelon Farming

Variables	**₦**
Variable Cost	
Planting materials (Seeds)	2,347.50
Fertilizer (kg)	2,305.00
Farm Clearing (Ha.)	14,921.57
Agro-Chemicals	4,185.89
Harvesting Operation (labour per day)	6,984.09
Handling and Transportation	10,836.73
Weeding Operation (labour per day)	6,020.41
Land Preparation (labour per day)	8,837.73
Planting Operation (labour per day)	5,163.27
Transportation	19,866.33
Workmanship	25,000.00
Total Variable Cost	**106,468.52**
Fixed Cost	
Cutlass (5)	4,200.00
Hoe (5)	5,600.00
Sprayer (2)	34,000.00
Pumping machine (1)	35,000.00
Pipe	68,000.00
Total Fixed Cost	**146,800.00**
Revenue	
Average amount per kg	101.17
Average quantity sold per/kg/ha	4,817.99
Total Revenue	**487,436.05**
Total Cost	**253,268.52**
Net Profit (TR - TC)	**234,167.53**
Gross Return (TC/TR)	**0.52**
Benefit Cost Ratio (TR/TC)	**1.92**
Rate of Returns (Net profit/TC)	**0.92**

Source: Field survey, 2019.

Technical Efficiency Results

The results of the stochastic frontier model estimated in Table 3 shows that there was significant technical efficiency among watermelon farmers in study area. The estimated parameter of sigma-squared was 0.324 significantly different from zero at 1% level of probability, indicating a good fit and the correctness of the specified distributional assumption of the composite error term. The value of the gamma statistics 0.621, though statistically significant at 5% was attributable to watermelon farmers' inefficiency factors. The generalized likelihood ratio statistics was 151.7, exceeds the critical chi-square values at 1% level of significance which represents the value that maximizes the joint densities in the estimated model. Thus, the Cobb-Douglas used in this estimation is an adequate representation of the data.

The results also revealed that the farm size (X_1), labour per day (X_2) and Quantities of seeds (X_3) were found to be significant variables in technical efficiency of watermelon farmers. The estimated coefficient of farm size (0.046) was in line with *a* priori expectation and significant at 5% which implies that output would increase if watermelon farmers increase the farm size devote for watermelon farming. Similarly, the parameter estimates for labour (0.032) was significant at 10% while quantity of seeds (0.491) was significant at 10% and were all in line with *a* priori expectations. The positive signs of these variables are expected as the quantities of inputs owned by the farmer and labour used per day, being a subsistence venture, increases output of watermelon. The results also implies that a unit increase in the farm size devoted to watermelon farming, labour and quantities of seeds would increase watermelon output by 0.046, 0.032 and 0.491 units, respectively.

However, though not significant, the negative value of quantity of agro-chemicals (X_5) implies that a unit increase in this variable will decrease output by 0.190 units. The regression coefficients of Cobb-Douglas production function are the production elasticities and their sum indicates the return to scale. The sum of the elasticities of production of the inputs was 2.258, indicating increasing returns to scale. This means that with a percentage increase, all the inputs that showed positive relationship results in a greater percentage increase in output. Also, the sum of the elasticities of production obtained in this study implies that watermelon farmers were in stage one of production which is irrational stage, this is because at this stage farmers cannot maximize their profit. Resources at this stage were under-utilized; hence, there is need for the farmers to increase the use of inputs. The inefficiency sources modelled showed that all variables were in line with a priori expectations but, only age, household size and farming experience were the significant factor affecting watermelon production in the study area.

Table 3: MLE of the Cobb−douglas Stochastic Frontier Model for watermelon farming

Variables	Parameters	Coefficient (□)	SE	t-ration
Frontier Production Function				
Intercept	*B*o	0.852	0.117	7.29
Farm size (X_1)	β_1	0.046	0.021	2.24
Labour per day (X_2)	β_2	0.032	0.019	1.71
Quantities of Seeds (X_3)	β_3	0.491	0.311	1.58
Quantities of fertilizer (X_4)	β_4	0.152	0.158	0.96
Quantities of Agro-chemical (X_5)	β_5	-0.190	0.186	-1.02
Technical Efficiency				
Constant	W_0	-1.052	-0.523	-2.01
Age (Z_1)	W_1	-0.540	-0.180	-3.00
Household Size (Z_2)	W_2	-0.184	0.062	-2.95
Educational Status (Z_3)	W_3	-0.099	0.095	-1.04
Farming Experience (Z_4)	W_4	-0.342	0.197	-1.74
Access to credit facilities (Z_5)	W_5	0.042	0.029	1.43
Diagnostic Statistics				
Sigma Square ($\sigma v^2 + \sigma u^2$)	σ^2	0.324	0.105	3.08
Gamma ($\sigma u^2 / \sigma u$)	γ	0.621	0.297	2.09
LR test		151.7		
Log likelihood		49.5		
No of Observation		120		
Average Technical efficiency		84.9		

Source: Computed Result, 2019.

Distribution of Technical Efficiency

The distribution of technical efficiency scores, relative to the best practice frontier score and relative efficiency indices are reported in Table 4. The result reveals the mean technical efficiencies to be approximately 0.85. This implies that watermelon farmers could increase output level if the efficiency of inputs usage is increased by 0.15. Thus, opportunity still exists for increasing watermelon productivity and income through increased efficiency with the use of existing resources. Suffice to note that the bulk of farmers (about 70%) were above sixth quartile distribution efficiency.

Table 4: Deciles distribution of Technical Inefficiencies of Watermelon Farmers

Efficiency Index	No of Farmers (F)	Percentage (%)
0.01 – 0.10	2	1.67
0.11 – 0.20	4	3.33
0.21 – 0.30	0	0.00
0.31 – 0.40	6	5.00
0.41 – 0.50	12	10.00
0.51 – 0.60	12	10.00
0.61 – 0.70	14	11.67
0.71 – 0.80	34	28.33
0.81 – 0.90	30	25.00
0.91 – 1.0	6	5.00
Total	**120**	**100.00**
Mean	**84.9**	
Minimum	**0.19**	
Maximum	**92.50**	

Source: Field survey, 2019.

Constraints to Watermelon Production in the Area

The result in Table 5 shows the constraints to watermelon production in the study area. All (100.00%) the respondents indicated that transportation challenge was one of the constraints to watermelon farming. It was followed by, high cost of inputs (100.00%), pest and diseases (92.50%), limited extension agents contact (88.33%), lack of improved seeds (62.50%), limited access to land (42.50%), lack of credit facilities (28.33%) and storage or preservation challenges (16.67%). This implies that watermelon farmers in the study area encountered one or more constraints in the cultivation of watermelon.

Table 5: Constraints to watermelon production

Constraints	Frequency	Percentage
Lack of credit facilities	34	28.33
Pest and Disease infestation	111	92.50
Lack of improved seeds	75	62.50
Limited access to land	51	42.50
Limited extension agent contact	106	88.33
Transportation challenge	120	100.00
High cost of input (s)	120	100.00
Storage/preservation challenges	20	16.67

Source: Field survey, 2019. *multiple responses

Chi-Square Analysis of the Effects of Watermelon Production on Farmers' Livelihoods

The result in Table 6 shows the effects of watermelon production on the livelihoods of watermelon farmers in the study area. The result revealed that watermelon production in the study area has significant effects on the livelihoods assets of the farmers. Hence, the livelihood assets of the farmers were significant at 1% level of probability.

Table 6: Chi-Square Analysis of the Effects of Watermelon Production on Farmers' Livelihoods

Livelihood Assets	Chi-Square	df	Sig.
Physical	41.360***	3	0.001
Economic	1.2782***	5	0.001
Social	33.520***	8	0.001

Source: Computed result, 2019.

Conclusion and Recommendation

The study concluded that; watermelon farming in the study area is a profitable enterprise with little capital investments. Sources of finance available were banks, personal savings and friends and relations, while more than half of the farmers did not have access to credit facilities from the banks due to non-availability of bank in the locality, lack of collateral and lack of proper information. Farm gate and local market were the common points of sales used by the farmers for trading of watermelon. Farm size, labour per day and quantities of seeds were found to be significant variables in technical efficiency of watermelon farmers. The constraints to watermelon production were transportation, high cost of inputs, pest and diseases infestation, limited extension service delivery, lack of improved seeds, limited access to land, lack of credit facilities and storage facilities. Hence, watermelon production has significant effects on farmers' livelihoods in the study area. There should be availability of good feeder roads, subsidized and adequate farm inputs, adequate extension service delivery, availability of farmland, credit facilities and storage facilities to enhance the production of watermelon in the study area. Also, government, cooperatives and donors should provide funds with favourable repayment method.

Corresponding Author:
Dr. ADEDAPO, Ayodeji Oluwamuyiwa
Dept. of Agric. Economics and Extension Services,
Faculty of Agricultural Sciences,
Ekiti State University, Ado Ekiti
E-mail: Ayodeji.adedapo@eksu.edu.ng.

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